

MASTER

Enhancing empathy comparing implicit and explicit physiological synchronization feedback

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Eindhoven, March 2012

Enhancing Empathy:

Comparing implicit and explicit physiological
synchronization feedback

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ABSTRACT

Enhancing Empathy: Comparing implicit and explicit physiological synchronization feedback

Empathy is seen as a communicative process of understanding and responding to the (inferred) feelings and emotions of others and is essential for personal interaction. Training empathy might help improve interpersonal skills. A recent study shows that it is possible to use explicit synchronization feedback (i.e., a colored band) to improve empathy (JANSSEN, IJSSELSTEIJN, & WESTERINK, 2012). In this study, I investigated if empathy is higher when giving explicit feedback or when giving implicit feedback? One hundred and twenty one participants were randomly assigned to a 2 (implicit / explicit instruction) X 2 (real / random feedback) between-subjects design. Were participants in the Explicit conditions received clear instructions about the feedback, participants in the Implicit conditions did not and empathy was reinforced by giving positive triggers, unconsciously influencing the users' empathy. Participants in the Real Feedback conditions had to be excluded from analysis due to a technical error. The results show that people who received explicit random feedback had less physiological synchronization than people who received implicit random feedback. Attention drift and/or over-arousal may suggest a main effect of instruction. However it is also possible that people in the Explicit Random condition reacted stronger to the random feedback and therefore were pointed in the wrong direction. Although the results did not answer the main research question, differences between explicit and implicit physiological synchronization feedback are still expected. Opportunities for future research and practical implications are discussed.

PREFACE

As part of my master's degree Human – Technology Interaction I conducted my graduation project at Philips Research. This report presents the experiment that I conducted during my stay of seven months in the group Brain Body and Behavior at Philips Research. I continued the work on physiological synchronization feedback but was left free to fill it in with my own ideas. The topic of empathy intrigued me right from the start because I see empathy (and with me many others) as one of the fundamental factors of a successful social interaction between humans. As humans we can see and feel what other humans are feeling and also possess the ability to react on others emotions with social support. During the project I again experienced that social support is a really nice virtue to give and receive.

This report not only shows the results of the experiment but also the errors that were made during the project. Unfortunately some of the errors were crucial for this project and affected the results significantly. Chapter 1 Introduction and Chapter 2 Methodology of this report are focused on the original goals of the experiment and show how the experiment was set up. Then Chapter 3 Errors describes what errors were made, and the analyses that followed to uncover the origin of the errors, and their impact on the dataset. Chapter 4 Results shows the final results of the experiment and these results are argued in Chapter 5 Discussion.

I want to thank Philips Research for the opportunity to discover the company and let me free to define my own experiment. I especially liked the weekly meetings of the Brain Body and Behavior group where people showed their projects. It helped me to discover a lot of interesting work where the Brain body and Behavior group is working on.

I want to thank Joyce Westerink, who was one of my supervisors at Philips Research, for her support during the project. I appreciated your support and our conversations about the project. Furthermore, I would like to thank Wijnand IJsselsteijn, who supervised me during this period, for sharing his expertise. Special thanks for the willingness to meet me on weekly basis. The critical remarks and ideas during these meetings helped me to successfully complete this project. Special thanks to Joris Janssen who provided me with the opportunity to continue his prior work on physiological synchronization feedback. I also want to thank him for his practical knowledge about methods, programming and writing a good report. I really appreciated our meetings that even took place when you worked at Stanford University in the United States of America and our conversations about future jobs. I want to thank Martin Boschman for his help discovering the errors in the software. Also thanks to my fellow interns at Philips Research for the nice conversations and tips and tricks during my first month. Last but not least I want to thank my friends and family for their commitment, support and all the welcome distractions they provided me with.

Again I want to thank you all for this unique experience that helped me improving my technical and social skills. The one thing that I always will remember is that failure is success if we learn from it.

Rick Arts

March 2012, Eindhoven

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1. INTRODUCTION

If your emotional abilities are not in hand, if you do not have self-awareness, if you are not able to manage your distressing emotions, if you cannot have empathy and have effective relationships, then no matter how smart you are, you are not going to get very far.
(GOLEMAN, 1995a)

Although our society is based on competition and individualism, we are all biologically wired to be empathic (DE WAAL, 2009). De Waal (2009) argues that a society with more emphasis on empathy can help to prevent future social and economic crises. In the same vein, Ekman (2011) calls the desire for less individualism the need for global compassion. Daniel Goleman (1995b) describes empathy as one of the basic components of emotional intelligence (EQ). According to Goleman, empathy is a critical part of social awareness, and, as such, a key to success in life. Empathy is what facilitates our interactions and our connections to the other people around us and is therefore a fundamental people skill. Without the sense of connection, without the ability to consider other people's views or feelings or to place ourselves in other people's situations, we would be very anti-social.

Research shows a decline in empathy that needs a response (NEUMANN, EDELHAUSER, TAUSCHEL, FISCHER, WIRTZ, WOOPEN, *et al.*, 2011). Neumann and colleagues (2011) show in a meta-analysis of 18 studies that empathy is declining among medical students and residents. Nunes, Williams, Bidyadhar, and Stevenson (2011) show a decline in self-reported empathy scores of students from five different health disciplines during their first year of training. If we want to answer the call for a society with more emphasis on empathy we may have to look for interventions that can help to improve empathy in human interaction. These intervention may also be helpful for people that do not have the ability to be empathic, like people with autism, or people that have to be empathic to successfully perform their jobs like physicians (WEST, HUSCHKA., NOVOTNY, SLOAN, KOLARS, HABERMANN, *et al.*, 2006; LARSON & YAO, 2005), teachers (MORGAN, 1984; McALLISTER & IRVINE, 2002), salesmen (MAYER & GREENBERG, 1964; TOBOLSKI & KERR, 1952) and all other people who want to be successful (Goleman, 1995b).

The focus of this research is on taking the next step in looking for interventions that help to improve empathy in human interaction. Research already shows that explicit feedback can help to enhance empathy (JANSSEN, WESTERINK, & IJSELSTEIJN, 2012) and implicit feedback can help to enhance interaction synchrony (BALAAM, FITZPATRICK, GOOD, & HARRIS, 2011). The next step would be to find out which feedback method, implicit or explicit, has the most positive influence on empathy. Before going into more detail it is important to understand what empathy really is. In the next section a theoretical framework around empathy will be discussed followed by relevant work and the current research.

THEORETICAL FRAMEWORK

Edward Titchener (1867-1927) translated the German word for “feeling into” (einfühlung) into empathy. The word empathy has been used for a process with many different definitions, see Table 1 for an overview of the different components and processes related to empathy. In this research empathy is seen as a communicative process of understanding and responding to the (inferred) feelings and emotions of others (JANSSEN *et al.*, 2012; SINGER & LAMM, 2009). Levenson (2010) proposes three major components of empathy, see Figure 1 for a graphical representation. First, see me, the ability to know what emotions someone is experiencing, also known as empathic accuracy or cognitive empathy. Second, feel me, the ability to experience the same emotions as someone is experiencing, called emotional empathy in the literature (see Table 1). Third, touch me / heal me, the ability to be sympathetic or the ability to show pro social behavior, often called empathic responding in the literature (see Table 1). Although many researchers agree with Levenson on the existence of these three components of empathy (DECETY & JACKSON, 2004; EKMAN, 2011; GOLEMAN, 2007; JANSSEN, 2012), there is still some unclarity about the functions and interactions of the components.

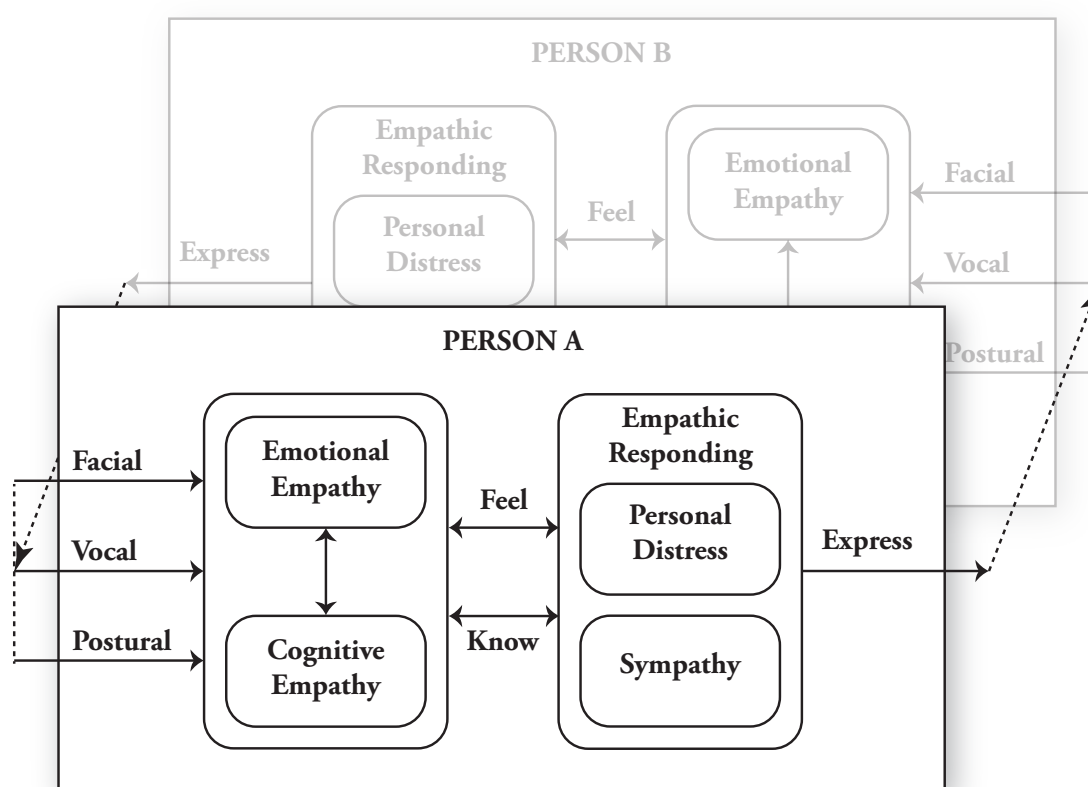


Figure 1: a graphical representation of the empathy process in human interaction. The three components of empathy are emotional empathy, cognitive empathy and empathic responding.

See me	Feel me	Touch me / heal me
Cognitive empathy (ICKES, 1997);	Emotional empathy (LEVENSON, 2010);	Empathic responding (EISENBERG & EGGUM, 2009);
Empathic accuracy (ICKES, 1993);	Emotional convergence (JANSSEN, 2012; SINGER & LAMM, 2009);	Compassionate empathy (EKMAN in GOLEMAN, 2007);
Theory of mind (SHAMAY-TSOORY, 2009);	Affective sharing (DECETY & JACKSON, 2004);	Empathic concern (GOLEMAN, 2007).
Internal state empathy (PRESTON & DEWAAL, 2001);	Emotional contagion (HATFIELD, RAPSON, & LE, 2009);	
Mentalizing (STONE & GERRANS, 2006).	Motor mimicry (DIMBERG, THUNBERG, & GRUNEDAL, 2002; DIMBERG, THUNBERG, & ELMEHED, 2000; HOFFMAN, 2000);	
	Facial empathy (GORDON, 1995);	
	Imitation (MELTZOFF & MOORE, 1997; TITCHENER, 1909);	
	Motor empathy (BLAIR & PERSCHARDT, 2001; BLAIR, 2005);	
	Emotion catching (HATFIELD <i>et al.</i> , 1994).	

Table 1: the different names and concepts that are strongly related to the three components of empathy.

SEE ME

To understand the first component of empathy, imagine the following situation: you arrive at work and you greet your colleagues, who are already there, like you do every morning. But one of your colleague's does not react to your salute. To you, this is strange because normally she is in a good mood and instantly greets you back. You walk over to her desk and when you see her face you instantly know she is sad. You recognized your colleague's emotional state by analyzing the context and her facial expressions. This is exactly what cognitive empathy is; you correctly identify the emotions of another person by analyzing what you see and hear. Cognitive empathy is seen as a cold route that uses cues and algorithms to define emotional states of others (LEVENSON, 2010). Neuroscientific research shows that cognitive empathy consists of mainly higher order cognitive processes (SHAMAY-TSOORY, 2009). Shamay-Tsoory (2009) gives a complete overview of neuroscience studies that show that different regions of the neocortex are involved in cognitive empathy. Cognitive empathy has been given many names in literature; see Table 1 for an overview.

Cognitive empathy abilities are often tested using pictures that show people that are experiencing different emotions. The task is to identify the emotion that the person in the picture is feeling. However, recent research shows that verbal information is the most important information channel for cognitive empathy in humans (GESN & ICKES, 1999; HALL & SCHMID MAST, 2007). This result is confirmed by Zaki, Bolger and Ochsner (2009); they compared verbal and facial signals in their research. These results suggest that the picture stimulus is not the best stimulus to use, for testing cognitive empathy.

FEEL ME

Emotional empathy is the second component of empathy. Emotional empathy is seen as a hot route; people get to know other people's emotions by reading their own emotional reaction. Emotional empathy consists of both bottom-up and top-down processes. Neuroscience research shows that there can be made a distinction between an automatic bottom-up and a top-down influence on emotional empathy (for a review, see SINGER & LAMM, 2009). Fan and Han (2008) show that there is an early automatic response and a later cognitive response.

A good example of emotional empathy is what people experience when they are crying during a movie. What happens is that they feel the same sad emotion as the person in the movie. What happens in real life interactions is that the emotions of the persons interacting are moving towards each other (emotional convergence, JANSSEN, 2012). The process behind this convergence of emotions is seen as a low level automatic process (JANSSEN, 2012) called emotional contagion (HATFIELD, RAPSON, & LE, 2009). Processes that are strongly related to emotional contagion or emotional empathy are also shown in Table 1.

Emotional contagion consists of two steps (HATFIELD *et al.*, 2009); see Figure 2 for a graphical representation. The first step is the automatic mimicry of facial, vocal, and / or postural expressions of another person. Research suggests that mirror neurons are the basis of this mimicry process (SINGER, 2006). Research showed that the same neurons in the pre-motor cortex fired when a monkey performed a hand action and when the monkey watched another monkey perform that same hand action (RIZZOLATTI, FADIGA, GALLESE, & FOGASSI, 1996). Since the discovery of these mirror neurons similar research has been done on humans (for a review, see BLAKEMORE & DECETY, 2001; GREZES & DECETY, 2001). The second step is the feedback that the central nervous system gets from the bodily changes induced by the mimicking behavior. This feedback changes emotional experiences (DARWIN, 1872), and is related to the James-Lange view on emotions. This theory states that emotions are perceptions of bodily states (JAMES, 1884; PRINZ, 2004).

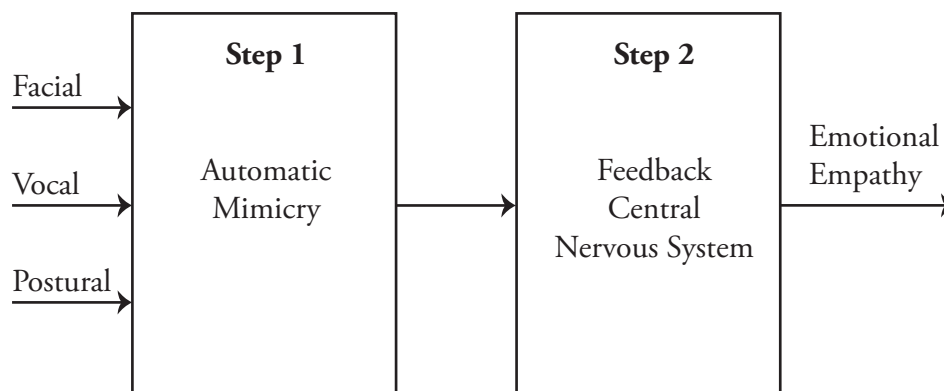


Figure 2: steps of emotional Contagion. Step 1 automatic mimicry: facial mimicry (SMITH, 1759; HURLEY & CHATER, 2005; HESS & BLAIRY, 2001), vocal mimicry (CAPPELLA & PLANALP, 1981), and postural mimicry (BERNIERI, 1988; BERNIERI, REZNICK, & ROSENTHAL, 1988). Step 2 feedback to the central nervous system and emotional experience: facial influence (LAIRD & BRESLER, 1992; EKMAN, LEVENSON, & FRIESEN, 1983), vocal influence (DUCLOS, LAIRD, SCHNEIDER, SEXTER, STERN, & VAN LIGHTEN, 1989; ZAJONC, MURPHY, & INGLEHART, 1989), and postural influence (ADELMANN & ZAJONC, 1989; HATFIELD, CACIOPPO, & RAPSON, 1994) on emotions.

TOUCH ME / HEAL ME

The third component of empathy is mainly focused on the response of someone on the emotions of someone else (EISENBERG, SHEA, CARLO, & KNIGHT, 1991). This component of empathy is called empathic responding (JANSSEN, 2012) or empathic concern (GOLEMAN, 2007). Empathic responding can be roughly categorized in two groups of responses. The first type of response consists of sympathy (the feeling of sorrow or concern for someone else; HOFFMAN, 2000) and is focused on relieving the other's distress (BATSON, 1991). Ekman (2011) describes sympathy as knowing or feeling the emotions of another person but at the same time appropriate this emotion. So it is important that you have the same judgment about the situation and react on behalf of this judgment. The second response is one of personal distress. This response is focused on reducing one's own distress (BATSON, 1991) and therefore is focused on the self (EISENBERG & EGGUM, 2009). So a clear distinction between the self and other is needed (EISENBERG & FABES, 1990), which makes it also different from emotional empathy. According to Eisenberg and Fabes (1990), sympathy and personal distress may arise from both emotional and cognitive empathy.

The direction of the response (towards the self or towards the other) depends on one's ability to self-regulate emotions (EISENBERG, FABES, MURPHY, KARBON, MASZK, SMITH, *et al.*, 1994; EISENBERG, FABES, MURPHY, KARBON, SMITH, & MASZK, 1996). For example, in a situation where a lot of negative emotions are shown, over-arousal is likely to occur when one has low self-regulation. In turn, this over-arousal leads to a self-focused response (EISENBERG, VALIENTE, & CHAMPION, 2004). Contrary to people that have low self-regulation skills, people that can self-regulate are more likely to react with a response towards the other when confronted with increases in emotional arousal.

To conclude, many researchers agree on the presented theoretical framework of empathy (DECETY & JACKSON, 2004; EKMAN, 2011; GOLEMAN, 2007; JANSSEN, 2012) but there are still some issues in the interaction between the components that have to be explored. In this research the showed framework is used.

RELATED WORK

In the previous section the theoretical framework of empathy is explained. Towards the ambition of enhancing empathy in human interaction several steps are already considered. In this section, research that taps into the process of empathy is discussed.

FEEDBACK

A possible way to support empathy is by giving feedback on empathy (MARANGONI, GARCIA, ICKES, & TENG, 1995; BARONE, HUTCHINGS, KIMMEL, TRAUB, COOPER, & MARSHALL, 2005). Marangoni and colleagues (1995) showed that during a one hour session people improved their empathy levels more when getting feedback compared to people who did not receive feedback. Barone and colleagues (2005) did a longer study of several months and also showed that empathy increased more for people who received feedback. So feedback on empathy can enhance empathy.

The feedback used in the described studies was based on information of observers. To give more objective feedback it would be better to look at technology that can automatically infer affective states (CALVO & D'MELLO, 2010; ZENG, PANTIC, ROISMAN, & HUANG, 2009). Studies show that technology is already better in recognizing others' emotional states than humans are (for a complete overview see JANSSEN, 2012). This technology could be used to tell people what emotions others' are experiencing and thereby assist people with the cognitive part of empathy. This could be useful for autistic people who are known to have limited cognitive empathy abilities.

TOWARDS AUTOMATED MEASUREMENTS OF EMPATHY

It is also possible to focus less on the cognitive part of empathy and more on the emotional part of empathy. This part, which is based on more low level automatic processes, could be used to give feedback on a more associative level (JANSSEN, 2012), but also needs an automated measure of empathy. Levenson and Ruef (1992) measured the physiological signals of participants and calculated the correlation of the participant's physiological signals and the person's physiological

signals in the videos that the participants were watching. The calculated correlations based on skin conductance and heart rate correlated with self-reported empathy. In the same vein, other studies show heart rate synchronization between therapists' heart rate and their clients (STANEK, HAHN, & MAYER, 1973; COLEMAN, GREENBLATT, & SOLOMON, 1956). Marci, Ham, Moran, and Orr (2007) show that synchronization of the skin conductance signals of a therapist and client correlates with perceived empathy by the client. The score that describes the synchronization between the skin conductance signals is called skin conductance concordance. Altogether, these results show that physiological similarity between people can be used as a measure of empathy.

The theory relating physiological changes to emotions (EKMAN, LEVENSON, & FRIESEN, 1983) provides a basis for using physiological synchronisation as a measure of empathy. The James-Lange theory of emotion is even more direct and states that emotions are based on our mind's perception of the body. Hence, when two persons experience the same bodily changes (the physiological signals move in synchrony) they are likely to experience the same emotion. This experience of the same emotion is also closely related to the definition of the emotional part of empathy, feel what the other person is feeling.

ENHANCE EMPATHY BY GIVING PHYSIOLOGICAL SYNCHRONIZATION FEEDBACK

Janssen and colleagues (2012) show that physiological synchronization feedback can be used to enhance empathy. They show with an experiment that there is higher-reported empathy and physiological synchronization when using synchronization feedback compared to random feedback and no feedback. Despite the promising results of Janssen and colleagues (2012) the question remains if this explicit way of giving feedback works well for the more low level automatic processes of emotional empathy. It is questionable if the explicit form of feedback does not take too much attention of the user. One could argue that the feedback takes the attention away from the facial and postural expression of the other person, which are important for the cognitive part of empathy. Instead of giving explicit feedback, one could also consider implicit feedback. The difference between implicit and explicit feedback is defined in the instructions that come with the feedback. The feedback Janssen and colleagues (2012) used was explicit because they gave their participants clear instructions about the feedback and how they could use it to perform better on their task. Implicit feedback would be feedback that does not has instruction about the feedback, like Balaam and colleagues (2012) used in their research. Hence, the participants were not instructed about the meaning of the feedback and the presence of the feedback. Balaam and colleagues (2011) used an ambient display to give implicit feedback about rapport and showed that implicit feedback on rapport increases the amount of interactional synchrony.

CURRENT WORK

Thus far it is known that feedback can enhance empathy (JANSSEN *et al.*, 2012) and rapport (BALAAM *et al.*, 2011). Nonetheless, it is still unclear which of these feedback methods works best when trying to enhance empathy. In the section theoretical framework the process of empathy was described in more detail. However there are still some issues in the interaction between the components. This makes it difficult to give predictions about which feedback method would work best. The goal of this research is to further look into the different effects of explicit and implicit feedback on empathy. More specifically, the current research tries to find the answer on the question: when looking for interventions that help to enhance empathy, is it better to use synchronization feedback in an implicit or explicit way?

The first hypothesis is based on Janssen and colleagues (2012), and Balaam and colleagues (2011) who show that participants who receive feedback show more empathy and rapport. Based on these results the first hypothesis is that self-reported empathy and physiological synchronization is higher when people receive implicit or explicit synchronization feedback compared to random feedback (*H1*).

While in theory there is a distinction between emotional and cognitive empathy, in practice it is very difficult to disassemble the emotional and cognitive components of empathy. There will always be a part of both components of empathy in measured empathy (MARINETTI, MOORE, LUCAS, & PARKINSON, 2011). Therefore it is difficult to make a second hypothesis about the research question regarding the difference between implicit and explicit synchronization feedback. Although it is interesting to look into the components of empathy to extend the existing theoretical framework, the goal of this research is to explore which feedback method works best to enhance general empathy (all three levels of empathy added together). To make a hypothesis about the outcome it is important to look at the theoretical framework again and particularly to the emotional and cognitive empathy components.

Janssen and colleagues (2012) argue that by repeatedly giving enhancement feedback about the emotional component of empathy it is possible to improve the more low level automatic processes of empathy. This theory is based on the principle of learning by conditioning which shows that people do not have to know what they are changing in their behavior (SPENCE, 1956) and behavior is changed in the direction of the reinforcement (MACKINTOSH, 1983). So what we know is that the emotional component of empathy partly relies on the automatic bottom-up process of mimicry (HATFIELD *et al.*, 2009). Physiological synchronization is induced by bodily changes that in turn are linked to emotional component of empathy. Because the physiological synchronization score is linked to this fairly automatic bottom-up process one could argue that physiological synchronization feedback would tap into the bottom-up process and therefore enhance emotional empathy. To summarize, it is possible that physiological synchronization feedback enhances the

emotional part of empathy.

Enhancement of empathy through improvement of the emotional component of empathy is possible in both the Implicit and Explicit Physiological Synchronization Feedback conditions. This is because the feedback that causes the enhancement is present in both conditions and behavior will change in the direction of the reinforcement (MACKINTOSH, 1983). The instructions presumably will not have an effect on this enhancement, although this is an assumption that has yet to be substantiated.

The cognitive empathy component consists of mainly higher order top down processes (SHAMAY-TSOORY, 2009). When keeping this in mind one could argue that in the Explicit condition the feedback can be used to enhance the cognitive component of empathy. This because the feedback shows how well the person does in empathizing with the feelings of the other person (this is also what is told to the person) and the person can cognitively react on this by using the feedback as an extra cue. For example, the feedback shows me I am not empathizing enough so what I am thinking about the other persons' emotions might not be correct. Thus, in the Explicit Feedback condition the feedback can also be used as an extra cue for cognitive empathy. In the Implicit condition the feedback is unlikely to function as an extra cue for the cognitive component of empathy, because the person does not know about the feedback. Consequently the stimulus will be less salient.

A possible drawback of the feedback is attention drift and comes in two forms visual attention drift and cognitive attention drift. First, visual attention drift is what happens when people are too focused on the feedback stimulus. Due to the focus on the feedback stimulus it is possible that facial and postural cues are missed. Facial and postural cues are important for the mimicry part of emotional empathy (HATFIELD *et al.*, 2009). Hence, visual attention drift will influence the emotional component of empathy. Visual attention drift will most likely appear in the Explicit conditions because the participants in those conditions are told to use the feedback to perform better. Second, cognitive attention drift is what happens when people are wondering what the feedback resemblances. For example, people in the Explicit conditions could try to find out which behavior the feedback is relevant to. So it is possible that the attention drifts away from the original task and more cognitive load goes to their new task. Both kinds of attention drifts are less likely to happen in the Implicit conditions because the feedback is expected to be less salient in these conditions (one of the reasons why the feedback is chosen in the first place).

All in all, feedback can have both positive and negative effects on empathy when giving explicit or implicit feedback. First, the emotional component of empathy can be enhanced by both implicit and explicit feedback. Second, the cognitive component of empathy can most likely only be enhanced by explicit feedback. Third, attention drift is most likely to occur when giving explicit feedback. As you can see the second and third are contradictory in terms of empathy enhancement. So it is difficult to hypothesis which feedback method will enhance empathy the most. Therefore

the question remains if self-reported empathy and physiological synchronization is higher when giving explicit synchronization feedback or when giving implicit synchronization feedback (*RQ1*)?

EXPERIMENT

The physiological synchronization feedback that is used in the current research is based on the skin conductance concordance score that also is used in Janssen and colleagues (2012). The skin conductance concordance score highly correlates with self-reported empathy and is a measure of physiological synchronization (MARCHI *et al.*, 2007). Janssen and colleagues (2012) used a colored band around a video window, 4 cm in width. Every 20 seconds a physiological synchronization score of the most recent 15 second window was calculated. When the score was positive the band faded in and out into a green color. When the score was negative a red color was used. Fading in and out took 9 seconds. In the Random condition Janssen and colleagues (2012) generated a pseudo-random value every 20 seconds. The physiological synchronization score was set to this pseudo-random generated value and the feedback given was based on this value just like in the Real condition. A similar method is used in the current research with the exception of the visualization of the feedback.

The feedback visualization in this current research is based on the ripples used in Balaam and colleagues (2011) and is in general more implicit than the feedback visualization used in Janssen and colleagues (2012). Balaam and colleagues used implicit positive reinforcement feedback to stimulate the behavior of rapport and based their design of their display on a set of self-generated criteria. These criteria are (as in BALAAM *et al.*, p869, 2011): *the display should not be distracting; the display should appear neutral; the display should show potential to make available*



Figure 3: The ambient display used by Balaam and colleagues (2011).

the patterning of cues for subconscious processing; the display should not jar with the study environment. The display is shown in Figure 3 and was adapted from “Water” by Rui Gil. The display is subtly animated, giving the appearance of small water ripples on the surface (see Figure 3), in response to the sensing of the nonverbal manifestations of rapport. Hence, ripples were triggered in response to several behaviors (for a more detailed description of these behaviors see BALAAM & COLLEAGUES, 2011) and participants were not aware of the meaning of the ripples (implicit feedback). In more

detail, they triggered a median of six ripples to appear on the display whenever nonverbal behaviors associated with rapport were observed. Each ripple dissipated over nine seconds, growing from a diameter of 25mm to 100mm. The placement of each ripple on the display was determined at random.

The ripple feedback, which was used by Balaam and colleagues (2011), is less salient than the colored band feedback used by Janssen and colleagues (2012). This because the colors used by Janssen and colleagues (2012) had a clear symbolic meaning. Because of this clear symbolic meaning it is not possible to use the colored band as implicit feedback in this research. The ripples can be used to give implicit feedback as showed by Balaam and colleagues (2011). However the ripples can also be used to give explicit feedback. It is possible to vary the number of ripples on the screen and tell the user that more ripples means better performance. Therefore in this research ripples will be used to give implicit and explicit feedback about empathy.

The difference between implicit and explicit feedback is defined in the instructions that come with the feedback. In the Explicit condition, participants will be explicitly instructed that they will receive feedback in the form of ripples and the instruction will also include the definition that more ripples connote more empathy. In the Implicit condition participants will not receive these instructions. A more detailed description of the method used in this experiment will be discussed in the next chapter.

2. METHODOLOGY

PARTICIPANTS AND DESIGN

One hundred and twenty one native Dutch speaking persons participated in an experiment, 41 of them were women and 80 of them were men with an average age of 26 ranging from 18 to 64. Men and women were equally distributed across the different conditions. The experiment had a 2 (instruction) X 2 (feedback) between-subjects design and participants were randomly assigned to one of the four conditions. In the Feedback Instruction conditions (Explicit conditions) the participants received information about the feedback in their instructions; in the No Feedback Instruction conditions (Implicit conditions) the participants did not receive this information (see appendix for the complete instructions). The feedback the participant got could either be real feedback (Physiological Feedback conditions) or random feedback (Control Feedback conditions).

APPARATUS

The research was conducted in a lab setting at Eindhoven University of Technology. The entire experiment was conducted on a desktop computer that was standing in an experimentation booth. A 17 inch Dell AX510 screen at a viewing distance of 50 centimeters and a Seinnheiser HD256 linear headset were used. Physiological responses were measured using the Mobi-8 from TMS International (Enschede Netherlands) and wirelessly send to the same desktop computer.

ECG was measured at a sample frequency of 1024 Hz. Three electrodes were attached to the participant's body using removable Ag/AgCl electrodes. The electrodes were placed using the lead-3 placement: the ground electrode was placed on the left shoulder, the negative electrode on the right shoulder and the plus electrode on the left side of the belly. Skin conductance was measured at a sample frequency of 128 Hz. Two Velcro strips with dry electrodes were strapped around the distal phalanx of the index and ring finger of the non-dominant hand. Skin temperature was measured at sample frequency of 128 Hz. A thermistor was strapped to the distal phalanx of the little finger of the non-dominant hand with medical adhesive tape. Respiration rate was measured at a sample frequency of 128 Hz, with a gauge band positioned over the clothes around the chest.

VIDEO STIMULUS

A video of a man disclosing sad emotional events from his past was used to generate empathy. These kind of autobiographical recollections are known to elicit strong emotional reactions (Zaki, Bolger, & Ochsner, 2008). The video has been used before by Janssen and colleagues (2012) for a similar kind of experiment. The video was recorded by an experimenter who interviewed the man in the video. The man in the video did not know the interviewer before the experiment.

The process of recording the video consisted of four steps. First, the man was asked to write two short paragraphs about sad emotional events from his life. In the second step, physiological sensors

(the same sensors as described above) were attached to the man. After attaching the sensors, the man watched a baseline video about underwater life of eight minutes. The man could relax during this video and his physiological signals could return back to base levels. In step three, the man was instructed to talk about the two paragraphs that were written in step one. The interviewer sometimes asked clarification questions to keep the discloser going. The conversation was recorded with a JVC HD camera, filming the face and upper torso of the man from the front. In the fourth step the man was asked to watch the video of his disclosure and continuously rate how positive or negative his emotional reactions were when the video was recorded. This was done using a continuous rating dial which is a validated instrument for continuous recordings of emotional state after autobiographical recollection (GOTTMAN & LEVENSON, 1988; LEVENSON & RUEF, 1992). The resulting video is 11:29 seconds long and consisted of both positive and negative emotional expressions.

SYNCHRONIZATION FEEDBACK

The physiological synchronization feedback which was used to give feedback in the Real Feedback conditions was based on the feedback Janssen and colleagues (2012) gave to their participants. In this experiment a derivative of the skin conductance concordance (SCC) score, which correlates with self-reported empathy and is a validated way of measuring physiological synchronization (MARCI AND ORR, 2006; MARCI *et al.*, 2007), was used. The SCC score contains both positive and negative correlations between the skin conductance signals of the participant and the man in the video. The SCC score is calculated by dividing the total sum of positive correlations through the absolute total score of negative correlations (JANSSEN *et al.*, 2012). After the experiment, the total SCC score was used as an objective measure of empathy. To give feedback during the video, one single correlation score per feedback moment was used.

To calculate the correlation between the man in the video and the participant, the skin conductance signals of both were first filtered with a Bartlett window (OPPENHEIM & SCHAFER, 1989). Then the signals were down sampled to 2 Hz, and differenced at order one to remove any linear trends that might inflate the correlation (CHATFIELD, 2004). Correlations between the skin conductance signal of the man in the video and the participant were calculated over 15 second windows. The correlations were based on the slopes of both signals calculated over 5-second moving windows with 1-second increments. The correlation score in the 15 second window was used to give feedback every 20 seconds.

To keep the amount of feedback that participants received in the Random conditions the same as in the Real conditions I matched every participant's feedback in the Random conditions with participant's feedback in the Real condition. The order of the feedback moments was randomized with a permute function. So the sum of positive feedback moments stayed the same and the load of feedback per positive feedback moment stayed the same, only the order of feedback moments

was randomized. The visualization and timing also stayed the same.

VISUALIZATION OF SYNCHRONIZATION FEEDBACK

A similar feedback visualization as used in Balaam and colleagues (2011) was used. In the centre of the screen the video of the discloser was shown. Every 20 seconds an SCC score was calculated as described in the previous section. Based on this score (varying from -1 to 1) a set of ripples was shown within a 15cm band around the video (see Figure 4). Five intervals were defined, to determine the number of ripples, ranging from interval 0 (correlation score range 0 to 0.2) to interval 4 (correlation score range 0.8 to 1). The number of ripples was calculated by function 1, where NR is the Number of ripples and x is the interval (range 0 to 4). The coordinates of each ripple centre were randomly generated. Each ripple dissipated over nine seconds, growing from a diameter of 5 mm to 50 mm.

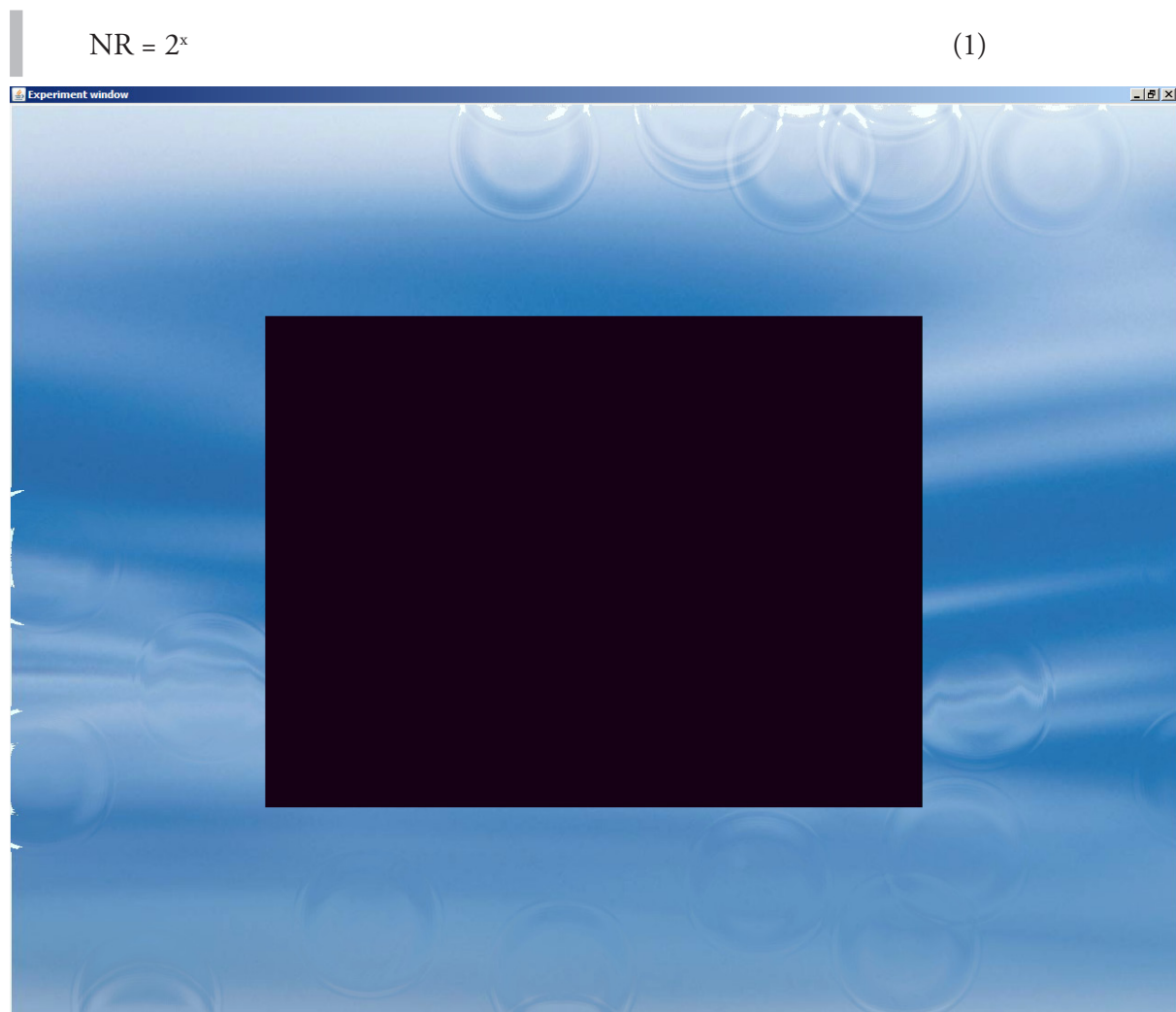


Figure 4: the visualization of the feedback. In the centre of the screen the video of the discloser was shown with around it the 15 cm band. In the band the ripple feedback was shown. Each ripple dissipated over nine seconds, growing from a diameter of 5 mm to 50 mm.

SUBJECTIVE MEASUREMENTS

INTERPERSONAL REACTIVITY INDEX

The Interpersonal Reactivity Index (IRI) is a multidimensional scale composed of 28 self-report items designed to measure both cognitive and emotional components of empathy (DAVIS, 1984). The subscale scores range from 0 to 28. The IRI has four subscales of seven items each. First, the perspective taking scale measures the tendency to take the psychological point of view of others. Second, the fantasy scale measures the tendency to get caught up in fictional stories and imagine oneself in the same situations as fictional characters. Third, the empathic concern scale measures sympathy and concern for others. Fourth, the personal distress scale measures the kind of feelings (anxiety, etc.) that get in the way of helping others. The IRI was used in this experiment as a measure of individual differences.

BATSON'S SYMPATHY AND DISTRESS SCALE

As a subjective measure of empathy (during the video watching) the Batson's sympathy and Distress Scale (BATSON, BOLEN, CROSS, & NEURINGER-BENEFIEL, 1986) was used. This scale consists of two components. The first component consists of eight adjectives associated with sympathy (sympathetic, moved, kind, compassionate, softhearted, tender, empathic, and warm) and the second component consists of twelve adjectives associated with personal distress (worried, upset, grieved, distressed, uneasy, concerned, touched, anxious, alarmed, bothered, troubled, and disturbed). Participants had to respond on a 7-point Likert scale, responses range from 1 (not at all experienced this adjective during the movie) to 7 (extremely experienced this adjective during the movie).

UWIST MOOD ADJECTIVE CHECKLIST

As a measure of mood, I used the UWIST Mood Adjective Checklist (UMACL; MATTHEWS *et al.*, 1990). The UMACL contains three bipolar subscales of mood. First, the energy scale (EA) which consists of six adjectives (energetic, passive, unenterprising, alert, tired and active). Second, the tension scale (TA) which consists of six adjectives (relaxed, restful, anxious, calm, nervous and tense). Third, the hedonic tone scale (HT) which also consists of six adjectives (dissatisfied, satisfied, depressed, happy, sad, and cheerful). Participants had to respond on a 4-point scale; responses range from 1 to 4 (1. definitely not; 2. slightly not; 3. slightly; 4. definitely). High EA and HT reflect positive emotions, and high TA reflects negative emotion (THAYER, 1989).

INTIMACY

Research argues that familiarity can have effects on empathy (STINSON & ICKES, 1992). Intimacy and familiarity are related but are not the same. Although intimacy usually implies familiarity, familiarity does not imply intimacy. To test for a possible correlation between empathy and intimacy I used two scales that measure intimacy. First the Inclusion of Other in Self-Scale (IOS; ARON, ARON, TUDOR, & NELSON, 1991) that asks for the relationship between the participant and the discloser. The IOS is a scale that uses pictures with two circles on it. One circle representing the participant and the other circle representing the man in the video. How close the circles are differs per picture.

As a second measure of closeness I used a scale that measures closeness (CAMARENA, SARIGIANI AND PETERSEN, 1990) with four questions (“I feel close towards the other”, “I feel the other is similar to me”, “I like the other”, “I could be friends with the other”). Responses are on a 9-point Likert scale; responses range from 1 (not at all) to 9 (very much).

COGNITIVE EMPATHY

As a measure of cognitive empathy I used a similar method to Zaki, Bolger, and Ochsner (2009) in testing empathic accuracy. Zaki and colleagues used the same method as used in this experiment for recording a stimulus video and also asked for continuous recordings of emotional state of the person in the video. These continuous recordings after autobiographical recollection are known to be a valid measure of emotional state (GOTTMAN & LEVENSON, 1988; LEVENSON & RUEF, 1992). Participants in the experiment by Zaki and colleagues (2009) had to watch the recorded video and had to do the continuous ratings of emotional state. Participants’ ratings of emotional state were then correlated with the discloser’s ratings and used as a score for empathic accuracy. In this experiment the continuous recordings of emotional state of the person in the video were also used. However the task for the participants in this experiment was different. Recordings could influence the objective measures of empathy and the subjective measure of sympathy and personal distress. Therefore 10 fragments of the video were shown after the questionnaires about sympathy and personal distress.

The ten fragments of ten seconds each were carefully chosen based on the ratings done by the man in the video (two positive (4, 7), three neutral (0, 0, 0), and 5 negative fragments(-1, -3, -6, -4, -7)). The fragments were shown in a chronological order. After each fragment the participants were asked to rate how positive or negative the discloser felt in that fragment, with a slider showing on the left side negative feeling (range -7 to 0) and on the right side positive feeling (range 0 to 7). The difference between the discloser’s score and the participants’ score was calculated. Scores of each of the 10 fragments were summed and used as a total score for cognitive empathy

CHARITY

To test if the actual helping behavior changed due to the conditions the participants were in; the possibility to donate a part of their reward to charity was given. Levenson (2011) did a similar test in which he gave participants 10 dollars and asked if they wanted to donate a part of the money after seeing an emotional movie about people suffering from hunger.

Before the charity question the participants were told they finished the experiment and were asked to look at one last thing. When they pressed continue the question to donate money was shown on the screen with several banners around it. After the experiment the experiment leader told the participants the charity question was part of the experiment and paid them the full amount of participant money.

FEEDBACK EXPERIENCE

To test the participants' experience of the ripples I asked 12 questions on a 7- point Likert scale; ranging from "Completely disagree" to "Completely agree". Questions were about understanding (i.e. "I understood the ripples" and "It was difficult to understand the ripples") and liking (i.e., "I liked the empathy ripples" and "I did not like the ripples") of the ripples.

MANIPULATION CHECKS

Nearly at the end of the experiment some manipulation checks were done, including the questions "What do you think this experiment was about?", "Do you have any other comments about this experiment?", "Did you notice the ripples and how often did they appear?"

PROCEDURE

When the participants entered the lab, they were first asked to sign an informed consent form. Subsequently, the physiological sensors were attached and the headphones were put on. The experiment leader told the participants to follow the instructions on the screen and left the room.

The participants started with one demographical question (gender) followed by the IRI questionnaire about empathy in daily life. After filling in the questionnaire the participants watched an eight minute baseline video about underwater life. The baseline movie made sure that everyone started in the same physiological state before the main part of the experiment started.

After the baseline video, participants received condition dependent instructions. In the Implicit conditions the participants were told to watch the following video and try to be as empathic as possible. In the Explicit conditions participants also received these instructions, but now these were extended with an explanation of the feedback (see attachments for complete instructions). The video of the discloser was shown. During the video, condition dependent feedback was given: SCC feedback in the Real Feedback conditions and random feedback in the Random conditions.

After the video the participants were asked to complete the Batson's empathy questionnaire, the UWIST Mood Adjective Checklist, the IOS question, the closeness questionnaire, and the cognitive empathy questions. These questionnaires were followed by the manipulation checks.

The participants were then told that this was the end of the experiment and were asked (on screen) to donate a part of their remuneration. After filling out this question, the participants were again informed about their task during the video of the man. This instruction was followed by the questions about the ripples. Finally, the participants were asked for any further comments. A debriefing followed on the screen and the participants were instructed to go to the experiment leader. The participants got paid (independent of what they donated) and debriefed about the charity question. The experiment took about one hour of the participant's time. Each participant received 10 euro for participation.

3. ERRORS

Not everything worked out as it was planned to be. Half of the data was not usable due to some errors in the technical details of the experiment. In this chapter I try to unravel the origin of the mistakes and show the effect of the mistakes on the data. The mistakes are reported in chronological order of discovery. The first mistake had the least impact on the data and the last one the most.

SAMPLE FREQUENCY AND MISSING SAMPLES

The first error had influence on the data storage process (see Figure 5 for a graphical representation of the process). Physiological signals were measured with a sample frequency of 1024Hz by a device and sent to a personal computer for storage. On the personal computer the data was temporarily saved in dll registers until it was retrieved for storage. Data was saved by the program MobiHTI. Every sample was coupled to a sample number and a timestamp. The physiological synchronization feedback was based on the data in the data file. Hence, the storage process had to be real time to give real time feedback.

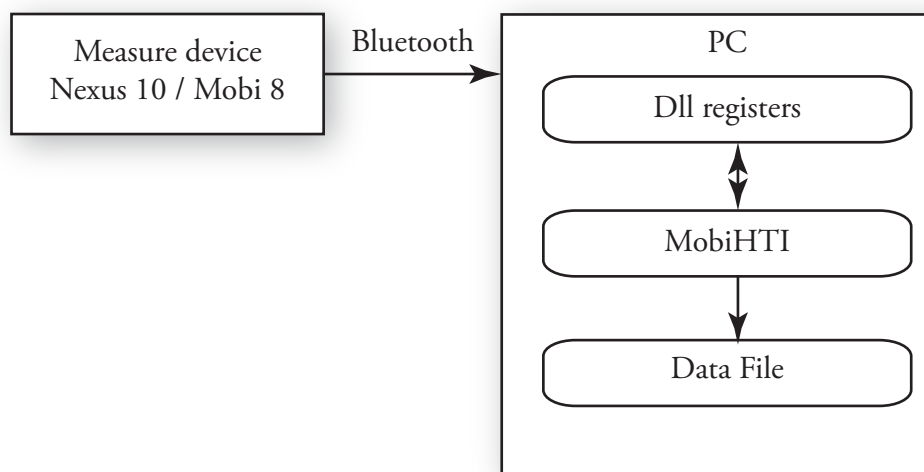


Figure 5: data storage process. The data is measured by the measure device and sent to the Pc by a one way Bluetooth connection. On the computer the data is temporary saved in dll registers. The MobiHTI application collects the data from the dll registers and saves the data in the data file. With every data sample a sample number and timestamp is saved. The feedback is based on the retrieved data from the data file.

The origin of the first discovered problem lays in the Bluetooth connection between the measure device and the personal computer. The Bluetooth connection is a one way connection (so the data is sent without any handshake protocol) that is designed by the manufacturer of the device. Consequently it is possible that now and then samples are missed. This is a well known problem of the device but should not influence the feedback because one sample is only $1 / 1024$ of a second of the data and the skin conductance signal is known to be relatively slow changing signal (JANSSEN *et al.*, 2012; BOUCSEIN, 1992).

To test how many samples per hour were missed a test run (sample frequency: 2048; Bluetooth dongle: CN-523 BT dongle) was conducted. The results showed that on a time span of three hours, 5.6 seconds of data per hour was missed. I discovered that the error was not in the Bluetooth connection itself but in the dll register of the manufacturer. An update of the dll register helped to overcome this problem but unfortunately this problem was not discovered until after running the experiment. So during the experimental video about one second of data was lost. The lost data had no serious effect on the data but has been addressed to avoid future problems.

Although the lost data did not have a serious effect on the data I would like to highlight the fact that before running the experiment, the assumption was made that correction for missing samples was possible. I assumed that it was possible to find missing samples by analyzing the timestamps (that were stored with the samples). However, I discovered that the connotation of the timestamps was different from what I expected. The timestamps that were stored by the program MobiHTI are based on the time of storage of the data and not, as I expected, on the time the data was measured. In addition, the saving process was not as constant as the measurement process, as can be seen in Figure 6a. Hence the timestamps are not acquired with enough precision to check for missing samples.

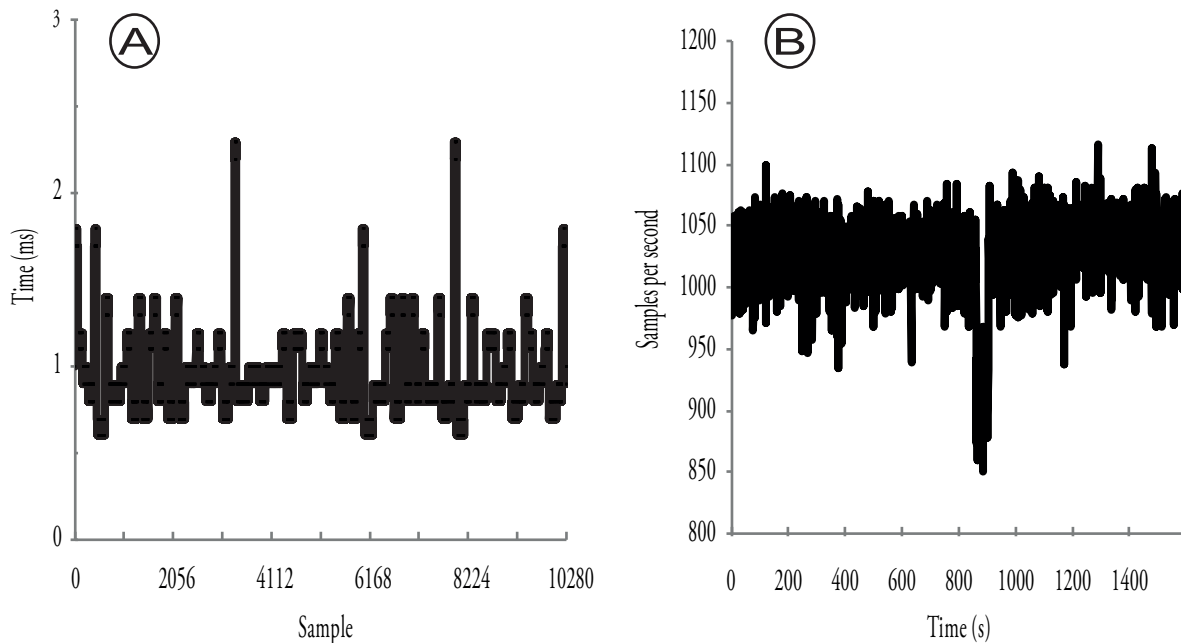


Figure 6: timing of the data saving process. The left graph (a) shows the time between each sample for participant 2. The first 10280 samples are shown. The sample frequency is 1028 Hz, this would mean a time of 0.9 ms between the samples. However this is not the case as can be seen. The right graph (b) shows the saving frequency over time. What we see is a dip in the saving frequency just in between the videos. This dip causes a delay in the stored signal.

WATERRIPLER CLASS

During the process of apprehending the problem of missing samples another problem was discovered. To find out how many samples were saved per second, graphs like the one in Figure 6b were created. For every participant such a graph was created and a recurring deviation in the save frequency was detected. Figure 6b shows a drop in the save frequency. The save frequency dropped with about 100 samples per second for all the participants at a given time. Further investigation of the data revealed that this drop in the save frequency occurred in between the baseline video and the experimental video. After studying the java code I discovered that the drop can be explained by a technical problem in the Waterripler class. This class was used to make the ripple animations on the screen.

The question is what happened with the samples that were not saved in time because the drop in saving frequency left data in the buffer. Our first intuition was that the data was saved on a moment later in time. This intuition would infer that after some time of storing data with a lower frequency the signal would have a delay that could influence the real time feedback. The amount of delay would differ per participant because it depended on the time between the two videos. To determine the maximum amount of delay on the signal, the size of the buffer was important because after

some time the buffer would be full and samples would be missed. The dll register could only store 1.55 seconds of data. So after a while of saving data with a lower frequency the register would be full and the oldest samples were dropped. As a result this shows that the maximum amount of delay on the signal is 1.55 seconds. A longer delay in the saving process would mean losing samples. All in all the delay per participant was max 1.55 seconds.

Knowing that data from all participants had a delay in the storage process it is possible to account for this delay during analyses. However the delay had also influenced the real time feedback. Nonetheless, the influence of this error was short lasting because the program catches up with saving in the first seconds of the experimental video (in these few seconds all the delayed samples were stored).

MATCHING DATA

The third error was that the video started too late in contrast with the physiological data file. As a result of the error, the Skin conductance (SCL) signal of the discloser and the SCL signal of participants were not correctly synchronized. The difference was six seconds in favor of the SCL signal of the discloser. Because of these six seconds, the physiological feedback, that half of the participants got, was incorrect and so had to be excluded from analysis.

To further analyze the effects of the incorrect synchronization, I use the bogus SCL signals shown in Figure 7. Figure 7 shows a sinus wave that represents the SCL signal of the discloser. In an ideal situation the participants' responses would be exactly the same as the responses of the discloser. So both SCL signals would be like the normal one (in Figure 7) and the Skin Conductance Concordance (SCC) score would be optimal (669 in this example). However a delay in one of the two signals can have an effect on the SCC score and such on the feedback (the feedback is based on the SCC score). To show this effect I introduced three bogus delays and calculated the corresponding SCC scores between the normal signal and the delayed signals. The results (delay 1/8: 2.8144; delay 1/4: 0.9973; delay 1/2: 0.0015) show a drastic drop in the SCC score and would mean that the feedback was wrong. Scores lower than one even present that there were more negative than positive correlations and a negative correlation meant no feedback at all. Although this is a bogus signal and the real signal is completely different it helps to understand the effect of a delay on the correlation between signals.

A signal with the same periodicity as the real signals is needed to show the effect of the delay on the SCC score. To show this effect the SCL signal of the discloser was used (see Figure 8a). Again in an ideal situation the responses of the participants and the discloser would be the same. So to show the effect of a delay on the SCC score, the SCL signal of the discloser was used to correlate it with itself. The delay was introduced by taking steps of one sample. Figure 9a shows the SCC scores for all the delays. Again a drastic drop in SCC score is noticeable. After a delay of three

seconds the SCC score moves to a score of one and not zero as the graph maybe suggests. The SCC score reaches the score of one for the first time with a delay of about 3 seconds after this the score fluctuates around a score of 1 (that would suggest no physiological synchronization; JANSSEN *et al.*, 2012). To conclude, a delay of more than 3 seconds has a crucial effect on the SCC score and therefore the feedback in the Physiological Feedback conditions was not correct.

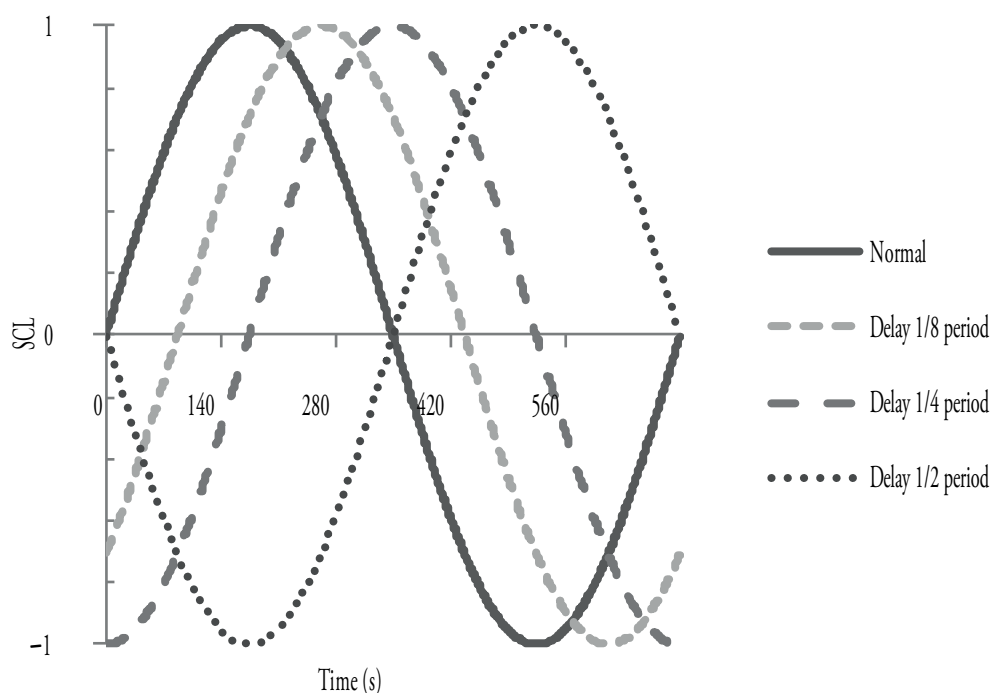


Figure 7: the bogus skin conductance signals. A delay in one of the two signals causes a drastic drop in the skin conductance concordance score (SCC score). SCC scores: delay 1/8: 2.8144; delay 1/4: 0.9973; delay 1/2: 0.0015.

Another point of concern is the noise on the SCL signal (see Figure 8). It is possible to clean the signal by using a low pass filter. Figure 8b shows the SCL signal after a low pass filter of 2Hz; all the high frequent changes that can be seen as noise are filtered out. It is advisable to always use this low pass filter because the noise can have an ascendant effect on the SCC signal as well, as can be seen in Figure 9a. Small delays in the signal show already big changes in SCC score. This is completely caused by the noise because after filtering the fast changes in the SCC score are gone (see Figure 9b). Hence the use of a low pass filter is desirable to make the SCC score more homogenous even after small delays.

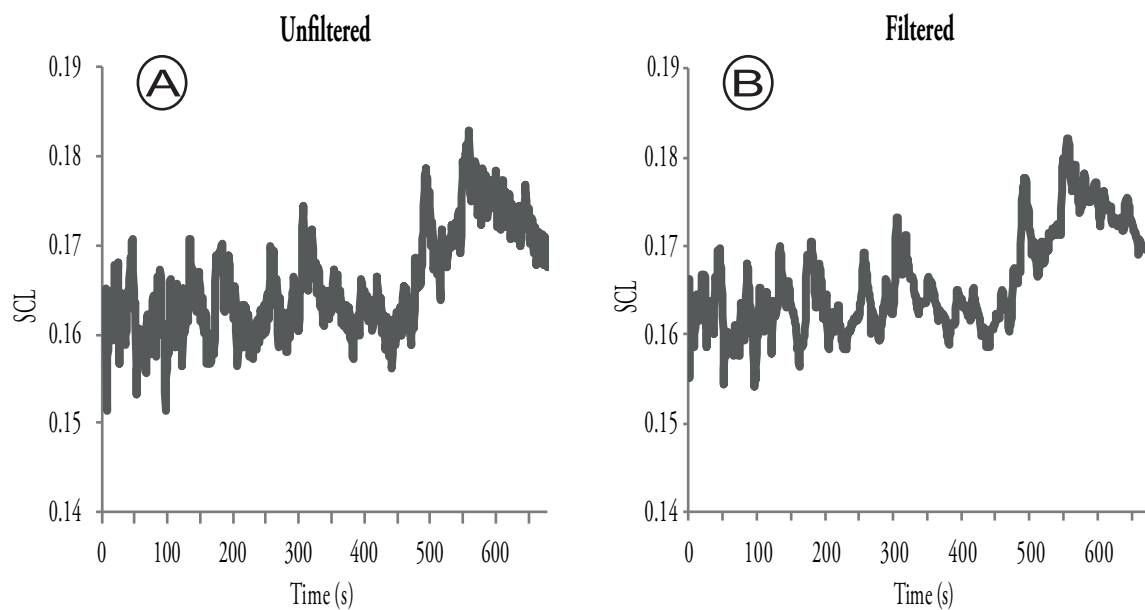


Figure 8: the skin conductance signal (SCL) of the discloser. The left graph (a) shows the SCL signal of the discloser, with a sample frequency of 128 Hz. The right graph (b) shows the signal after filtering it with a 2 Hz low pass filter. This filter suppresses the noise on the signal.

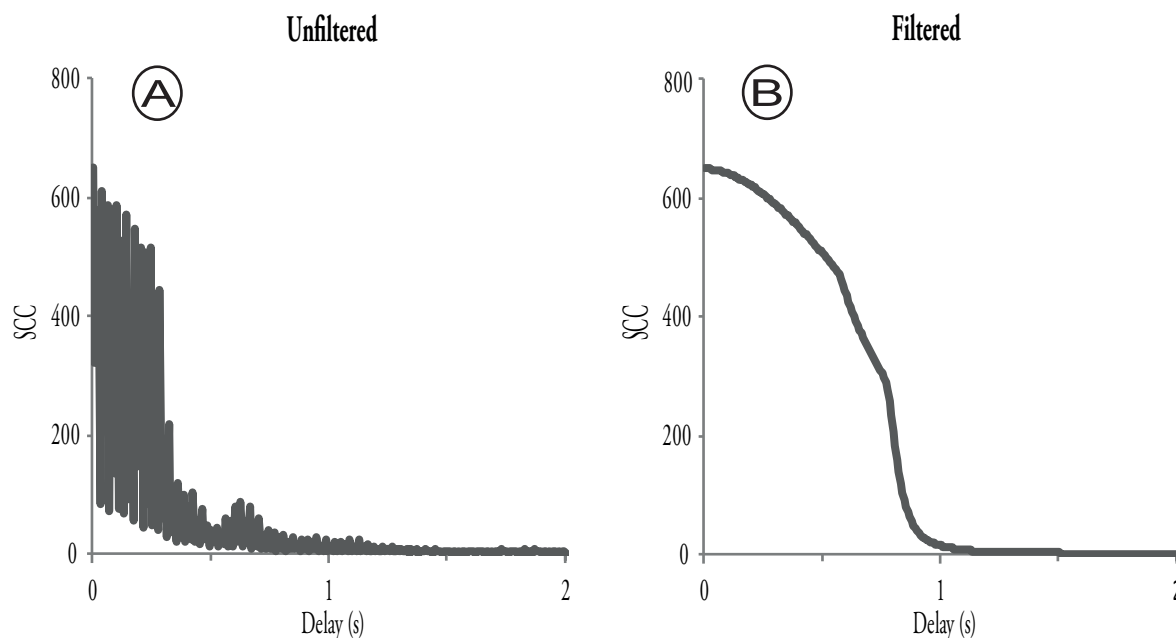


Figure 9: the skin conductance concordance (SCC) scores for the different delays. The left graph (a) shows the SCC scores for the delays with steps of one sample ($1/1028$ s). The right graph (b) shows also SCC scores however for this graph the signal, which was used to determine the SCC score, was first filtered with a low pass filter of 2Hz. This filter cleans the signal by removing the 50 Hz noise and other unexpected rapid changes.

To conclude, the first error (missing samples) had almost no influence on the real feedback given during the experiment. The second error (drop in save frequency) also had almost no influence on the real feedback given during the experiment. However the third error (matching data) had a crucial effect on the real feedback given during the experiment. Therefore all participants in the real feedback condition were excluded from analyses. So the remaining analyses were done on the Random conditions only.

4. RESULTS

Seventy-three participants were excluded from this analysis, 68 because of the errors explained in Chapter 3 Errors and five because of misinterpretation of the experiment based on the answers of the open questions and the debriefing. From the 49 participants that were used for this analysis 20 were women and 31 were men with an average age of 25 ranging from 19 to 59. In this chapter the results are shown of the analyses that were done on the Random Feedback conditions only.

SELF-REPORTED EMPATHY

Two-tailed *t*-tests were conducted to test the effect of the Story variable on self-reported empathy. Before testing empathy and personal distress were calculated by averaging over the individual items (Cronbach's α 's were .88 and .77 respectively). For sympathy no significant difference was found between the Explicit Story condition ($M = 4.23$, $SE = .14$) and the Implicit Story condition ($M = 4.28$, $SE = .21$) ($t(47) = 0.18$, $p = .86$, $r = .001$, one-tailed test). For personal distress also no significant difference was found between the Explicit Story condition ($M = 3.29$, $SE = .16$) and the Implicit Story condition ($M = 3.00$, $SE = .13$) ($t(47) = 1.47$, $p = .15$, $r = .044$, one-tailed test).

SKIN CONDUCTANCE CONCORDANCE

A two-tailed *t*-test was conducted to test the effect of the Story variable on skin conductance concordance. Homogeneity of variance had been violated (Levene's test, $p = 0.01$) so equal variance was not assumed. A significant difference was found between the Random conditions ($t(36) = -2.34$, $p < 0.05$, $r = .36$, two-tailed test). Means and SE's are depicted in Figure 10.

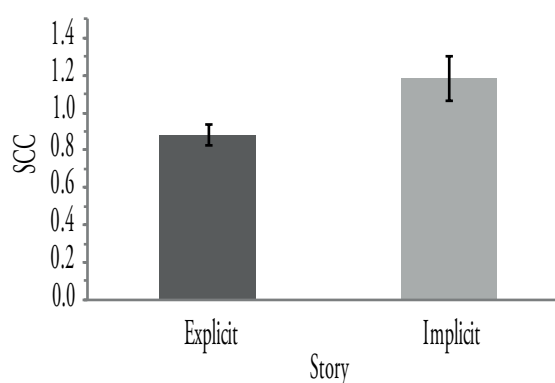


Figure 10: skin conductance concordance for the two random conditions. Error bars depict ± 1 SE.

MOOD

Three subscales of mood were used to test the effect of the Story variable on mood. First, the energy scale (EA) which consists of six adjectives (energetic, passive, unenterprising, alert, tired and active). Second, the tension scale (TA) which consists of six adjectives (relaxed, restful, anxious, calm, nervous and tense). Third, the hedonic tone scale (HT) which also consists of six adjectives (dissatisfied, satisfied, depressed, happy, sad, and cheerful). The three subscales were calculated by averaging the adjectives scores (Cronbach's α 's were .738, .736 and .717 respectively). No significant effect was found between the Explicit Story condition ($M = 2.43$, $SE = 0.10$) and the Implicit Story condition ($M = 2.35$, $SE = 0.11$) on the EA scale ($t(47) = .55$, $p = .59$, $r = .01$, two-tailed test). For TA no significant difference was

found between the Explicit Story condition ($M = 1.97$, $SE = .10$) and the Implicit Story condition ($M = 1.78$, $SE = .08$) ($t(47) = 1.54$, $p = .13$, $r = .05$, two-tailed test). Also for HT no significant difference was found between the Explicit Story condition ($M = 2.50$, $SE = .10$) and the Implicit Story condition ($M = 2.56$, $SE = .10$) ($t(47) = -.33$, $p = .74$, $r = .002$, two-tailed test).

COGNITIVE EMPATHY

To determine the effect of the Story variable on the cognitive empathy ratings a two-tailed t-test was conducted. The difference between the disclosers score and the participants score was calculated for the ten fragments separately and then averaged. The score was used as an indication of cognitive empathy. No significant difference was found between the Explicit condition ($M = -.57$, $SE = .23$) and the Implicit condition ($M = -.39$, $SE = .16$) ($t(47) = -.67$, $p = .51$, $r = .01$, two-tailed test). Further analyses show that the grand mean ($M = -.47$, $SE = .14$) is significant different from zero ($t(48) = -3.48$, $p < 0.05$, $r = .06$, two-tailed test).

INTIMACY

To determine the effect of the Story on relationship (IOS) a two-tailed t-test was performed. For the relationship score no significant difference was found between the Explicit Story condition ($M = 3.5$, $SE = .24$) and the Implicit Story condition ($M = 3.22$, $SE = 2.3$) ($t(47) = .78$, $p = .44$, $r = .01$, two-tailed test). To determine the effect of the Story on closeness a two-tailed t-test was performed. The closeness scale was calculated by averaging over the four individual items (close, similar, like, friends) (Cronbach's $\alpha = .87$). For the closeness score no significant difference was found between the Explicit Story condition ($M = 4.38$, $SE = 1.35$) and the Implicit Story condition ($M = 4.20$, $SE = 1.04$) ($t(47) = .42$, $p = .68$, $r = .004$, two-tailed test).

EXPERIENCE OF FEEDBACK

Two-tailed t-tests were conducted to investigate the effect of the Story variable on the experience of the feedback. Two items that measured liking (Cronbach's $\alpha = .87$) and two items that measured understanding (Cronbach's $\alpha = .79$) of the feedback were averaged to create liking and understanding scores. For both the liking and understanding scores a significant difference was found between the Explicit Story condition and the Implicit Story condition (respectively: $t(47) = 2.14$, $p < .05$, $r = .09$, two-tailed test; $t(47) = 3.41$, $p < .05$, $r = .20$, two-tailed test), see Figure 11.

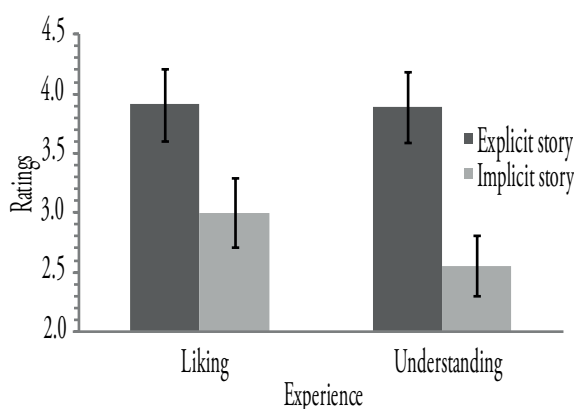


Figure 11: experience for the two random conditions. Error bars depict +/- 1 SE

CHARITY

A Mann-Whitney test was conducted to test the effect of the Story variable on the donation question. The Implicit Story condition (Mean Rank = 24.8) and Explicit Story condition (Mean Rank = 25.3) did not significantly differ in extend of donation behavior ($U = 290.5$, $p = .86$, $Z = -.18$).

EMPATHY AND INTIMACY

To test if increases in empathy are indeed related to increases in intimacy I assessed correlations for the sympathy and personal distress scale with the IOS scale and the closeness scale. Significant correlations were found between sympathy and IOS ($r(49) = .44$, $p < .005$), between sympathy and closeness ($r(49) = .50$, $p < .005$), and between personal distress and closeness ($r(49) = .37$, $p < .005$). No significant result was found between personal distress and closeness ($r(49) = .26$, $p = .07$).

5. DISCUSSION

The focus of this research was on taking the next step in looking for interventions that help to improve empathy in human interaction. Empathy, i.e., the ability to recognize and share emotions with another social being, is of central importance in human relationships. The basic capacity to empathize is probably innate in humans and can be regulated unconsciously. However, it is possible to train empathic skills, and to achieve empathy with various degrees of intensity or accuracy. Empathy can be roughly categorized in three components (JANSSEN *et al.*, 2012). First, cognitive empathy, the ability to recognize someone's emotions by analyzing what you see and hear, which is seen as a cold route that uses cues and algorithms to define emotional states of others (LEVENSON, 2011). Second, emotional empathy, the ability to experience the same emotions as someone is experiencing, which consists of mainly bottom up processes. Third, empathic responding the ability to respond to someone's emotions, this response can be focused on helping the self or on helping the other (BATSON, 1991). A recent study by Janssen and colleagues (2012) showed that self-reported empathy and physiological synchronization is higher when giving explicit physiological synchronization feedback compared to random and no feedback. In the current study I aimed to investigate if self-reported empathy and physiological synchronization is higher when giving implicit physiological synchronization feedback compared to explicit physiological synchronization feedback.

To test for this possible effect an experiment was conducted with a 2 X 2 design. In two conditions participants received physiological synchronization feedback and in the other two conditions the participants received random feedback (Control conditions). The second variable was the Story variable. In two conditions participants received explicit instructions about the feedback and in the other conditions participants received implicit instructions. Chapter 3 Errors showed that the experiment did not go as intended due to technical errors. All participants in the physiological synchronization conditions were excluded from analysis. Therefore, it was not possible to confirm the first hypothesis (H1: empathy is higher in both the Implicit and Explicit Synchronization Feedback conditions compared to the Random conditions). It was also not possible to answer research question 1 (RQ1: is self-reported empathy and physiological synchronization higher when giving explicit synchronization feedback or when giving implicit synchronization feedback?). In this chapter, I discuss the effects that were found between the two Random Feedback conditions.

The main result of this study was that people who received explicit random feedback synchronized less with the discloser than people who received implicit random feedback. No effects were found on the subjective measures of empathy (sympathy and personal distress) between the Explicit Random condition and Implicit Random condition. Also no effects were found on closeness, mood and donation behavior. No effect was found between the conditions on the cognitive empathy ratings. However in both conditions the cognitive empathy ratings differed significantly from zero. In

both conditions the people rated the emotions of the discloser more negatively than they were experienced by the discloser. Finally, an effect of feedback on experience was found. People in the Explicit Feedback condition gave higher ratings on both the liking and the understanding scale.

RELATION OF FINDINGS TO PREVIOUS RESEARCH

EMPATHY

The present study showed no effect on sympathy and personal distress but showed an effect on the objective measure of empathy. At least three potential explanations could account for this effect. The first explanation is based on the assumption that people in the Explicit Real Feedback condition would have higher empathy levels than people in the Implicit Real Feedback condition. I hypothesized that explicit real feedback enhances both the cognitive and emotional components of empathy while implicit real feedback enhances only the emotional component of empathy. So the assumption would suggest that feedback has more influence on people when giving explicit feedback. So people who receive random feedback will also react stronger to this feedback when it is explicit. However, as the random feedback points them in the wrong direction, they will perform worse, as the results show.

A second potential explanation may be that people may always perform better in the Implicit conditions because their attention is not drawn away from the facial, postural and vocal cues of the other person. Facial and postural cues are important cues for emotional empathy (HATFIELD *et al.*, 2009). Thus, an attention drift away from the discloser's face as a consequence of the peripheral feedback could lead to missing cues and therefore to worse performance on empathy. A third explanation could be that the explicit feedback causes over-arousal. In turn, this over-arousal leads to a self-focused response (EISENBERG *et al.*, 2004). So due to the explicit feedback the participants are more focused on themselves and less on the discloser.

Although these explanations are different they are not mutually exclusive because all explanations suggest better performance in the Implicit Random condition. The difference between the explanations is mainly in the two Real conditions that were not tested in this experiment. While the first explanation would suggest better performance in the Explicit Physiological Feedback condition and so an interaction effect, the second and third suggest better performance in the Implicit Physiological Feedback condition and so a main effect of the Story variable. To conclude, research question 1 cannot be answered by this research.

Another interesting observation is that in this research the mean physiological synchronization scores are lower than in the research done by Janssen and colleagues (2012). This could be caused by the fact that in this research only positive reinforcement feedback was used and in the research by Janssen and colleagues (2012) both positive and negative feedback was used. So in the current research people could have experienced less feedback and the more feedback you get the faster

you may improve your skills (SPENCE, 1956). It is also possible that the limitation of the current research lays in the temporal dynamics of the feedback. The feedback is probably most effective when given as close to the actual event as possible, as this creates the strongest association with the event (SPENCE, 1956; MACKINTOSH, 1983). Janssen and colleagues (2012) used discrete moments to give feedback, as not to distract users that much. The limitation of the current research may lay in the discreteness of the feedback moments. In the current research not every 20 seconds feedback appeared on the screen as only positive feedback was used. This may distract the users and so lead to worse performance.

It is also possible that negative feedback is especially important in the process of enhancing empathy and so a lack of it could also lead to worse performance. Whether or not negative feedback is indeed more important for enhancing empathy is an interesting question for future research.

COGNITIVE EMPATHY AND MOOD

According to the second hypothesis explicit feedback influences both the emotional and cognitive component of empathy and implicit feedback influences only the emotional component. Cognitive empathy ratings and a mood questionnaire were conducted to test for this reasoning. No difference was found between the implicit and Explicit Random Feedback conditions in mood. This neither confirms nor denies the hypothesis but shows that there is no difference in mood between the Random conditions what may suggest no differences in emotional empathy. Also no difference was found in the cognitive empathy ratings between the two Random Feedback conditions. Again this result does not confirm nor deny the hypothesis as the feedback was random and so should influence the ratings negatively in the Explicit Feedback condition. However there was a negative bias effect in the data. People rated the emotions of the discloser significantly more negatively than they actually were. This bias effect should be kept in mind in future research.

EXPERIENCE

Understanding and liking was higher for people who received explicit random feedback compared to implicit random feedback. So the instructions about the feedback had influence on experience. Compared to the study of Janssen and colleagues (2012), who also gave explicit feedback about empathy, the ratings on the understanding scale are lower for both explicit and implicit feedback. This is probably caused by the visualization of the feedback. The feedback that Janssen and colleagues (2012) used in their experiment was even more explicit than the feedback used in the current research. Janssen and colleagues (2012) used the colors red (negative) and green (positive) to give feedback about performance. These colors have a clear symbolic meaning compared to the ripples that were used in the current research. So it looks like understanding about the feedback drops when the feedback is getting more implicit. When comparing the scores on the liking scale of both studies we saw a different effect. The score on the liking scale was higher for the current research explicit random feedback compared to the explicit random feedback of Janssen and colleagues

(2012). This could be an effect of aesthetic appreciation. However, because these comparisons were done on the Random Feedback conditions only; it would be interesting for future research to further investigate these effects on understanding and liking for explicit and implicit real feedback.

EMPATHY AND INTIMACY

Empathy is important for bonding and close relationships (JANSSEN *et al.*, 2012). This research confirms that there is a medium positive correlation between sympathy and intimacy and between personal distress and intimacy, as also was shown by Janssen and colleagues (2012). It could be that increases in empathy led to increases in intimacy, it could also be that increases in intimacy led to increases in empathy (CWIR, CARR, WALTON, & SPENCER, 2011; JANSSEN *et al.*, 2012). So these results do not prove any causality. Nevertheless, it is interesting to see that this research confirms that both constructs are related, as shown by the correlations.

LIMITATIONS AND FUTURE RESEARCH

There were a few limitations to the results of the current study. First of all, people that participated in the study did not know the discloser. This was done to allow control over the history between the persons. However, familiarity with a person influences empathy (STINSON & ICKES, 1992). The effect is positive so when people become more familiar, empathy increases. Future research could look into this effect by comparing people with different levels of familiarity.

A second possible limitation of the current research is that participants were mainly students. Other groups may react differently on the feedback and this should be taken in account by future research. These differences may be age-related. Empathic responding relies on structures of the neo-cortex which are the latest to mature and are not fully matured up to an age of 25 (SINGER, 2006). Nonetheless, there are also individual differences on empathy (MEHRABIAN, YOUNG, & SATO, 1988). For example, males were found consistently to be less empathic than females (ICKES, GESN, & GRAHAM, 2000). It might be important to take these individual differences into account when measuring empathy or when giving feedback about empathy. One could imagine how frustrating it is to constantly receive negative feedback while for personal standards the performance is quite high. Future empathy-supporting technology could take into account these individual differences by learning the individual standards (JANSSEN *et al.*, 2012).

A third limitation of the current study lies in the feedback algorithm. Chapter 3 Errors showed that not using a low pass filter influences the skin conductance concordance (SCC) score a lot. Because of the noise on the skin conductance signal, small delays can already lead to big differences in the SCC score. A low pass filter will not influence the real reaction because the skin conductance signal is known to be relatively slow changing signal (JANSSEN *et al.*, 2012; BOUCSEIN, 1992). Therefore it is recommended adding a low pass filter to the algorithm to filter out all the noise.

A fourth limitation of the current study is that an effect was found on physiological synchronization but not on self-reported empathy. Self-reported empathy is often used to validate physiological synchronization algorithms and it is known that they highly correlate (BATSON, 1991; MARCI & ORR, 2006; LEVENSON & RUEF, 1992; JANSSEN *et al.*, 2012). However it is unclear if people are always accurate at self-reporting. Therefore, it might be interesting for future research to use other measures that can be used to measure empathy and makes triangulation of the variables possible. One possible option is to look at synchronization of facial, vocal and / or postural expressions. Research shows that mimicry of these expressions is part of the emotional component of empathy (HATFIELD *et al.*, 2009) and synchronization of these signals could just as well be related to empathy (NIJHOLT, WELBERGEN, AKKER, & RUTKAY, 2008; RAMSEYER & TSCHACHER, 2008). Another option is to use the cognitive empathy ratings that are also used in the current study. These ratings measure how accurately people can rate the intensity and direction (positive or negative) of others' emotional states (ZAKI *et al.*, 2009; ICKES, 1997).

Finally, Janssen and colleagues (2012) showed that the effect sizes in their research were medium. They showed that the effectiveness of the feedback could benefit from improvements to the feedback system. They also suggested making the feedback system more implicit as an improvement to make the feedback more effective. The original goal of the current research was to find if this improvement would work. However due to technical failure it was not possible to test differences between random and real feedback and only tests between implicit and explicit random feedback could be done. Between implicit and explicit random feedback an effect was found in physiological synchronization but with a medium effect size. On subjective empathy no differences were found. These results could imply that there is no strong effect of implicit versus explicit feedback. But again in this study only the Random conditions were tested so it is not possible to conclude that a more implicit form of real feedback also does not contribute to bigger effect sizes. Therefore, a more implicit feedback method is still interesting for future research.

IMPLICATIONS AND APPLICATIONS

Although the results of the current study did not confirm the hypotheses, differences between explicit and implicit physiological synchronization feedback are still expected. I am still convinced the method that was used in the current research can be used to answer the research question (When looking for interventions that help to enhance empathy, is it better to use synchronization feedback in an implicit or explicit way?). The results do not speculate that the hypothesis is false (H1: self-reported empathy and physiological synchronization is higher when people receive implicit or explicit synchronization feedback compared to random feedback) and also not answer the research question (RQ1: is self-reported empathy and physiological synchronization higher when giving explicit synchronization feedback or when giving implicit synchronization feedback?) The different explanations that were shown to explain the results could either suggest a main effect of the Story

variable or an interaction effect between the four conditions when running the experiment again. Although I think the next step for future research is still to compare explicit feedback with implicit feedback, the embodiment of an actual feedback system can still take many different forms. To deal with possible distractions or interference of the feedback with the interaction I chose to implement a more implicit form of feedback. Balaam and colleagues (2012) already showed that using an implicit form of feedback could enhance nonverbal synchronization during a holiday planning task. So implicit feedback might be a method that does not distract the user much from the interaction with the other. However it is also possible to choose a different modality to give feedback about empathy. I already showed that the visual feedback can distract the user from the facial and postural cues that are known to be important for emotional empathy (HATFIELD *et al.*, 2009). Possible other modalities would be sound or haptics. Sound may interfere with the vocal cues that are also important for emotional empathy (HATFIELD *et al.*, 2009). The haptic modality would be a better modality because it does not interfere with the facial, postural and vocal cues. The modality is also more private because it can only be perceived by the wearer of the feedback module (JANSSEN *et al.*, 2012).

The haptic modality has also some disadvantages. First, it is hard to make a symbolic connection between the feedback and empathy (JANSSEN *et al.*, 2012). Second, the haptic modality may cause bodily changes itself. The haptic modality will be on the body of the user and may cause arousal as it is a stimulus the user does not know. This could mean that the feedback is not based on the empathic reactions but more on the feedback itself. Third, haptic feedback does also require attention and might therefore distract a user. All in all, haptic feedback has also some disadvantages but it is still worthy for future research to look at it as a modality.

Admitting that we still have to answer some questions about empathy feedback, implementing empathy feedback into applications can be a successful product. One on one interaction is an important aspect that narrows down the possible applications. However I think there is still a large target group that can benefit from technology that enhances empathy. For instance, it can improve parents' understanding the needs of their children (CROSBY, 2002), and create closer relationships between romantic partners (LAURENCEAU, RIVERA, SCHAFFER, & PIETROMONACO, 2004). But it can also help physicians, doctors, teachers, and salesmen to perform better on their jobs (MORGAN, 1984; MAYER & GREENBERG, 1964; WEST *et al.*, 2006).

LESSONS LEARNED

During this master thesis project not every went as smoothly as it should be, but this does not mean that I did not learn anything from it. Contrary, I think I learned a lot from it. Therefore, in this section I reflect on the process of the project and especially on the important learning moments. In this way not only I but also future students may benefit from the mistakes that were

made during this project.

The main focus of this research was on designing, conducting and reporting an experiment. A part of the design process was implementing the testing application that was used for conducting the experiment. The final testing application consisted of other applications that were already used for other studies. Unfortunately I discovered after running the experiment that there were some small errors in the final application that did not turn up in the pilot. These errors are described in the chapter on errors. For me these errors were a harsh reminder that showed me that extensive testing is always needed even if the building blocks of your application have been used before. However, I also think that it would be very difficult to have discovered these mistakes beforehand without the knowledge I now have. On the bright side, I learned a lot from the errors. First, I got a complete overview of the application that gives me technical knowledge I can use in future research. Second, I learned about the limitations of the physiological measure device and software and triggered some improvements. Third, and last, I got complete understanding of the feedback algorithm and found an improvement for it.

Meetings with my supervisors helped me a lot with keeping track of the project planning. The meetings were a nice opportunity to show status reports and to discuss unclear subjects. During the project one of my supervisors was abroad. I experienced the online meetings we had (on skype) as pleasant. Due to the time difference planning was necessary but I perceived this more as an advantage because it forced me to ask good questions. However there is one thing I would do different in future projects. During the project I mainly had meetings with my supervisors separately. Although I think the meetings always went well, it would be better to have more meetings with all of the supervisors together. In this project it was no problem because everyone was on the same wavelength however I can imagine situations where it would be better to meet together.

All in all, I attained a lot of knowledge from this project and beside the technical errors and the limitations I think the described method can still be used for future research.

GENERAL CONCLUSION

The focus of this research was on taking the next step in looking for interventions that help to improve empathy in human interaction. Research already showed that explicit feedback can help to enhance empathy (JANSSEN *et al.*, 2012) and implicit feedback can help to enhance interaction synchrony (BALAAM *et al.*, 2011). The research question, when looking for interventions that help to enhance empathy, is it better to use synchronization feedback in an implicit or explicit way could not be answered by this study. The results could not confirm neither disprove the hypothesis and research question (H1: self-reported empathy and physiological synchronization is higher when people receive implicit or explicit synchronization feedback compared to random feedback; RQ1: is self-reported empathy and physiological synchronization higher when giving explicit synchronization feedback or when giving implicit synchronization feedback?). However the results made my intuition about the outcome stronger. I still think that it is a good step to compare implicit feedback with explicit feedback but the errors and limitations of this research have to be kept in mind. Although this study did not show any important results, I see opportunities to eventually integrate the proposed technology in computer-mediated interactions and so to improve social interaction.

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APPENDIX

The difference between the Explicit and Implicit conditions was in the briefing that the participants got before the video of the man disclosing sad emotional events from his past. The participants in condition 1 and 3 (Explicit conditions) received instructions about the feedback they would experience during the video. The participants in condition 2 and 4 (Implicit conditions) did not receive these instructions (see Table 2 for the complete instructions as the participants received it). The actual feedback during the video stayed the same.

Conditions	Instructions
1, 2, 3, 4	<p>Lees deze instructie zorgvuldig door voordat je verder gaat.</p> <p>Je krijgt zometeen een video te zien van ongeveer 10 minuten.</p> <p>In deze video zie je een persoon vertellen over gebeurtenissen die hij heeft meegemaakt.</p> <p>Het is jou taak om de video te bekijken en met zoveel mogelijk empathie te reageren op de video.</p> <p>Probeer je dus zo goed mogelijk in te leven in die persoon en met hem mee te voelen.</p> <p>Met de sensoren die zijn aangesloten meten we tijdens het kijken naar de video continu hoe empatisch je reageert.</p>
1, 3	<p>Hierover krijg je feedback.</p> <p>Als er in de rand om de video heen rimpelingen verschijnen, betekent dit dat je het goed doet.</p> <p>Elke 20 seconde zullen er nieuwe rimpelingen verschijnen als je het goed doet</p> <p>Hoe meer rimpelingen er verschijnen hoe beter je het doet.</p> <p>Als er geen rimpelingen verschijnen om de 20 seconde betekent dit dat je het niet zo goed doet.</p> <p>Dan moet je dus proberen om empatischer te reageren.</p> <p>Het is dus de bedoeling om zoveel mogelijk rimpelingen in de rand om de video te laten verschijnen. Dit doe je door zo empatisch mogelijk te reageren.</p>
1, 2, 3, 4	<p>Het is erg belangrijk dat je deze taak zo goed mogelijk uitvoert.</p> <p>Druk op continue om te beginnen met de film als je daar klaar voor bent.</p>

Table 2: condition dependent instructions.

