The influence of inner-state displays on human-human interaction

Master thesis Human Media Interaction

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Abstract

Motivation: In today's society people are sharing more and more of their daily life and emotions on social media. These social media posts contain more and more private information. Extamicy is the concept used to describe this public privateness. People are not only more aware of their social context, by using smart watches and fit bands they also become more aware of their body state and are focussed on being healthier and happier people. Measuring their exercise levels and choosing to share them with the world is common, but there are systems that go one step further and share more private information, such as live heart rate visualisation. These kind of systems are defined in this research as inner-state displays, since they display the inner-state of the user.
Problem statement: The problem with new techniques like inner-state displays, such as the Neurotiq Social which visualizes the EEG of the user, is that there has been almost no research into usefulness of such an inner-state display in a social context. The attitude towards an inner-state display has not been researched a lot. In this research the social context will be focussed around the concept of empathy. The first research question is: "What is the influence of an inner-state display on empathy in a human-human interaction?" and the second: "What is the attitude towards an inner-state display, focussing on the acceptance and usability?".
Approach: To measure the usefulness and the attitudes towards the Neurotiq Social this research is divided into three steps. The first step is a validation of the colours of the Neurotiq Social. The second step is a dictator game experiment using the Neurotiq Social as stimulus to evoke empathy which is measured by the amount given away in the experiment. The last step is focus groups interviews to learn more about the opinions and attitudes towards the Neurotiq Social and inner-state displays in general.
Results: 98 participants were part of the pre-experiment on colour association. These results showed that overall participants associate brain activity states with green-blue. Due to the fact that not all the frequency bands can have the same colour, the colours were chosen partially based on the results and partially due to the fact that the colours needed to differ. In the dictator game 40 students participated in 20 pairs. The results showed that there was no difference in the amount of lottery tickets given away between the condition with or without the Neurotiq Social. Ten students participated in the focus group interviews, resulting into two focus groups who came to similar results. In general, the students were sceptical about wearing the Neurotiq Social in any social context, mainly because it is something they would not normally wear and it was something that was too much in their face and distracting. They saw possibilities in changing the wearable to something like a bracelet and show information that is easier to interpret.
Conclusions: This research showed that there is no significant measurable usefulness of the Neurotiq Social, however it gained insight in some attitudes towards inner-state displays. Overall there is potential for inner-state displays, if they are subtle and easy to interpret.

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Chapter 1

Introduction

Social Networking Sites (SNSs) such as Twitter and Facebook enable us to share our actions and thoughts with others, friends but also with everyone who wants to read them. Not only actions and thought, but also our emotions considering these actions and thoughts. In 2013 Facebook added the option to add an emoticon to your message. There are over a hundred different emotional states you can add to your message, such as "Drinking coffee, feeling happy". The concept on Facebook used to be that you could *like* someone's message if the message was funny, but also to show your support when a message was sad. However, this was complicated sometimes, because liking the fact that somebody's grandmother died felt wrong and liking that somebody got married felt a bit of an understatement. The Facebook Data Team (2010) shows with their data analysis a negative correlation between the amount of likes and the use of negative emotions. To increase the emotional response readers could give, Facebook introduced, on the 24th of February 2016, six different animated emoji "Reactions": Like, Love, Haha, Wow, Sad and Angry. Facebook Newsroom (2016) says the following about the introduction of *reactions*: "We've been listening to people and know that there should be more ways to easily and quickly express how something you see in News Feed makes you feel. That's why today we are launching Reactions, an extension of the Like button, to give you more ways to share your reaction to a post in a quick and easy way.". Multiple sources show the increase of users of SNSs, in the Netherlands the CBS (2015) shows an increase of users of 16% between 2012 and 2014. This example suggests a transition in the western culture towards the SNSs and from internal emotions towards shared external emotions.

A crucial part of what is described above holds close connection with a crucial mechanism in human to human interaction, which is empathy. Being able to feel what a person is feeling and to communicate those feelings towards them. Knowing what somebody is feeling is always difficult, but body language is a way to interpret what somebody feels. If somebody blushes it means often they feel uncomfortable or embarrassed. Seeing these emotions and feelings, understanding them and communicating a proper response are all part of empathy, but it is not always easy to read somebody's emotional state. Facebook allows users to communicate their emotional state. Just like SNSs tech-companies also focus more on the emotional state of the user.

Tech companies are launching more and more gadgets that allow the user to see their inner-state and to monitor that state. With fitness bands, they encourage you to live healthier, but there are also emotional versions where your excitement or

stress level is monitored. Products like the leaf (Bellabeat, 2016), the moodmetric ring (Moodmetric, 2015) and the feel (Sentio Solutions Inc., 2015) all promote a healthier and happier life style wearing some kind of jewellery able to measure certain physiological body measurements, such as heart rate and galvanic skin response. These previous technologies are relatively small but there are also larger products such as the hexoskin (Carre Technologies inc., 2016), a smart t-shirt that monitors heart rate, heart rate variability to measure stress, breathing volume, activity (steps, cadence & calories) and sleep. The motto of this shirt is: "Listen to your body and live a longer, healthier, and happier life.". Where all the previous products focus on heart rate and other physiological body measurements that can be interpreted relatively straight forward, there are wearables that monitor a person's inner-state by measuring EEG such as the Emotiv Insight (EMOTIV Inc., 2016) or the Muse headband (Interaxon, 2016). Those products are also focussed on making the wearer more aware of their inner-state.

The previous examples all fit somewhere in the wearable spectrum. This spectrum starts with something like a smart watch, a typical commercial product which is more and more present in our daily lives and ends with futuristic products such as the NEUROTiQ by Sensoree which uses the Muse headband. All these products are user-centred technologies, without somebody to wear them, they are useless.

Sensoree is a company which makes wearables that have a place on the more futuristic part of the spectrum. Some of their products are not only wearables that serve the users themselves but also serve the social environment of the user by communicating the inner-state outwards. These products display what the user's body provides the system, such as heart rate or EEG. These systems are defined as **inner state displays (ISDs)**. An ISD is a piece of technology showing the physiological state of the user, such as the Neurotiq Social. Showing this state is not only in a visual modality but could also extend to other modalities such as audio.

One of the challenges with new technologies such as the ISDs created by Sensoree is that there is not much research on the acceptance of the technology and the influence of the technology. One of the ISDs created by Sensoree is the Neurotiq Social, this ISD is used in this thesis. A way to test these technologies is in the controlled environment of an experiment. This serves as a proof of concept of the benefits of a wearable inner-state display, specifically the Neurotiq Social. The Neurotiq Social is a brain-computer interface. This is a wearable cap that uses LEDs to display the brain activity. The intention of the Neurotiq Social is to serve a social purpose.

The aim of this thesis is to present a proof of concept of the social benefits of the Neurotiq Social. Besides this proof of concept this thesis also shows the opinion of Dutch students on the concept of the Neurotiq Social and wearable technology.

This thesis aims to prove the usefulness of inner-state-displays to society and the attitude of society towards inner-state-displays. The usefulness is measured as a function of altruism, closely related to empathy, and the attitude is measured with a focus group. To achieve this, this thesis answers the following questions.

First research question What is the influence of an inner-state display on empathy in a human-human interaction?

Second research question: What is the attitude towards an inner-state display, focussing on the acceptance and usability?

The first question is used to show the usefulness of the Neurotiq Social in a social, yet individualistic setting, such as the dictator game. Chapter 6 shows the methods

and results that answer this question. The second question is used to answer the attitudes towards inner-state displays in general, but also the functionality and usability of the Neurotiq Social in particular. Chapter 7 shows the methods and results us to answer the question considering the attitude. But first the concepts of social behaviour in the context of wearables, the ISDs and the related concept of extimacy, the acceptance of such an ISD are discussed in chapter 2. Following the related work is a detailed introduction of the Neurotiq Social in chapter 3. After the theory and experiments chapter 8 presents the conclusion of this research.

Chapter 2

Related Work

This chapter provides a literature framework to place the research questions into context. The concepts that play an important role in the research questions are: human-human interaction, empathy and inner-state displays. Section 2.1 focusses upon the social nature of humans and concept of empathy in that context. Section 2.2 explores the concept of social and affective intelligence since this is crucial to the concept of empathy. The last section, section 2.3, elaborates on the concept of inner-state displays and extimacy.

2.1 Social beings and empathy

For most of us humans, the core of our being is interacting with other humans and to develop relationships. Batson (1990) questions how social we really are. According to him we live in a social world where the actions of a human are almost all the time directed towards others or in response to others. But does living in a social world make human beings social beings? According to Batson it does, since humans value others not only for their own gain but also for the benefit of others. To determine how social humans are Batson (1990) tests the empathy-helping relationship which describes the obvious fact that humans help each other. Most research shows that empathy is a crucial part of this helping relationship. Humans are more likely to help someone when they feel for the other. But why do they help the other: to relief their own feeling of guilt (egocentric motivation) or to benefit the other (altruistic motivation)? Altruism is defined as the disinterested and selfless concern for the well-being of others (Stevenson, 2010). The human capacity for altruistic caring is, however, limited to those to whom they feel empathy (Batson, 1990, p.344).

There are many different definitions of empathy but there is consensus among researchers on what is a part of empathy. Baron-cohen & Wheelwright (2004, p.163) define empathy as something that allows us to understand the intention of others, predict their behaviour, and experience an emotion trigger by their emotion. Figure 2.1 shows this empathy model in more detail. This model has combined the two camps: affective and cognitive. This model incorporates most of the varieties of affective empathy, such as: matching feelings between observer and observed, the emotional response of the observer is appropriate but not matching with the feeling of the observed, and the feeling is one of concern or compassion for the observed (Baron-cohen & Wheelwright, 2004). In their model, sympathy is described as a special part

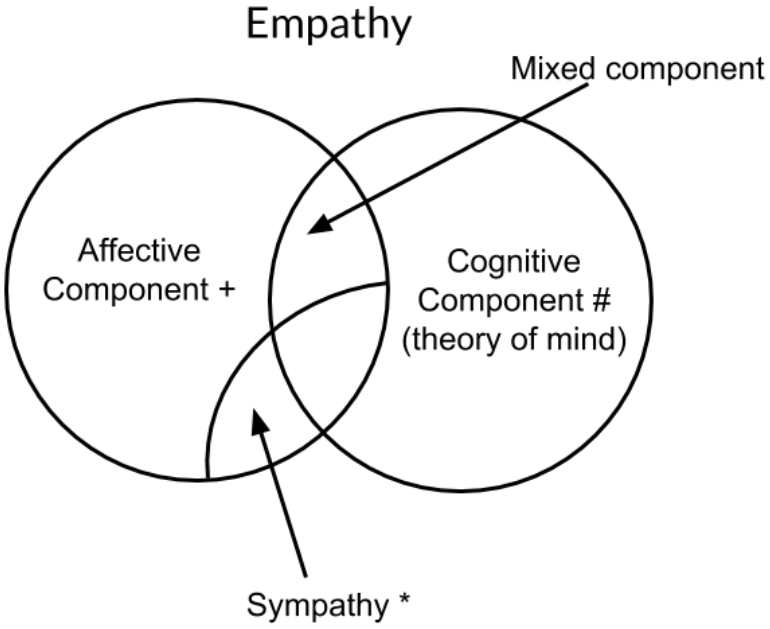


Figure 2.1: Baron-cohen & Wheelwright's empathy model showing the two overlapping components and sympathy as special case of affective component of empathy.
+*Feeling an appropriate emotion triggered by seeing learning of another's emotion.*
*Understanding and or predicting what someone else might think, feel, or do.*
******* *Feeling an emotion triggered by seeing learning of someone else's distress which moves you to want to alleviate their suffering*

of the affective component with a part of the cognitive component. The cognitive component emphasizes the need for understanding the feelings of the other person, putting aside one's own perspective and taking on the perspective of the other.

Decety & Jackson (2004, p.75) describes the functional architecture of empathy, consisting of three major components:

- affective sharing between the self and the other, based on perception-action coupling that lead to shared representations;
- self-other awareness. Even when there is some temporary identification, there is no confusion between self and other;
- mental flexibility to adopt the subjective perspective of the other and also regulatory processes.

These components also fit in the model of Baron-cohen & Wheelwright (2004), the first component fits in the affective component and the last in the cognitive component. The second component is one of the key components of the model of Baron-cohen & Wheelwright (2004) and is also part of the description of Batson (1990).

A common way evaluate altruistic behaviour is during the dictator game, Andreoni & Rao (2011) made some adaptations to the traditional game. In the dictator game

resources have to be divided among two participants. There is one person who has all the resources and is allowed to divide those the way he (the dictator) seems fit. Andreoni & Rao (2011) shows that the situation where the receiver is allowed to ask for a share elicits a more altruistic approach, which can be explained with the second component of Decety & Jackson (2004). The dictator becomes aware of the other and is able to start affective sharing. According to Andreoni & Rao (2011, p.514), the empathy-altruism hypothesis posits that feelings of empathy are the primary explanation for altruistic acts for which the agent does not expect to receive compensating material benefits through reciprocity or the absence of sanctions. Other possible games or experiments to test altruism are described in appendix A.

2.2 Social and affective intelligence

To understand emotions, to express empathy and to have social interactions with others is important. A key concept in having such interactions is social intelligence. The traditional division of intelligence into abstract, mechanical and social intelligence also includes social intelligence (Thorndike & Stein, 1937). Social intelligence is the ability to understand and manage people (Thorndike & Stein, 1937, p.275). These social skills could also include the ability to understand oneself (Salovey & Mayer, 1990). To understand oneself and another are both crucial to empathy (Baron-cohen & Wheelwright, 2004). As mentioned before social interaction also involves the expression of emotions. Salovey & Mayer (1990, p.189) defines emotional intelligence as a subset of social intelligence, involving the ability to monitor one's own and others' feelings and emotions, to discriminate among them and to use this information to guide one's thinking and actions. Figure 2.2 shows the conceptualization of emotional intelligence by Salovey & Mayer, which shows the three building blocks of emotional intelligence: appraisal and expression of emotion, regulation of emotion and utilization of emotion. Empathy is the appraisal and expression of emotions towards others. Its counterpart is non-verbal perception, with empathy being more than just perception and a central characteristic to emotionally intelligent behaviour (Salovey & Mayer, 1990).

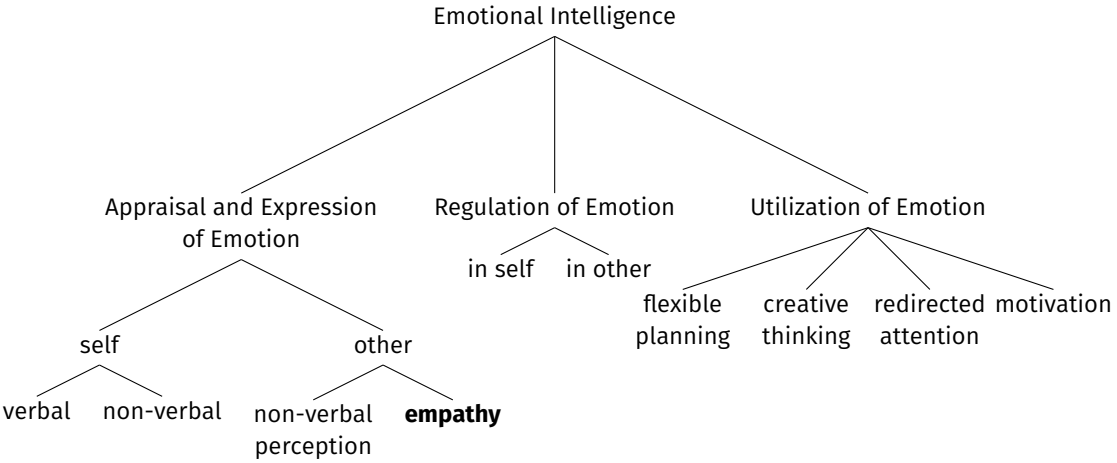


Figure 2.2: Conceptualization of Emotional Intelligence (Salovey & Mayer, 1990)

Where Salovey & Mayer and others before them focussed on human to human

interaction, Picard & Cosier (1997) focusses on the interaction between human and computer, especially the communication of emotion called “affective intelligence”. The problem with today’s technology is that it often mediates in human to human interaction and blocks the affective information. There is a great need for tools that enable affective communication. Not only with disabled people who rely on systems to convey their message, but also in business settings where people rely on teleconferences (Picard & Cosier, 1997).

2.3 Inner state displays (ISDs)

As shown before, affective computing is becoming more important due to the technological nature of our environment. To show affective states of the user, it is crucial to measure a user’s affective/emotional state, such as heartbeat, galvanic skin response or EEG. An inner state displays is able to show a person’s inner functions, such as heart rate or brain activity. Brain activity can be recorded by electroencephalography (EEG). Showing an inner state is not only visual but could also be in another modality such as audio. Inner state displays can be as simple as a monitoring system in a hospital showing the vital signs of a patient, but could also be more futuristic like the Heart Sync or Neurotiq Social by Sensoree. This section focusses on wearable ISDs like those of Sensoree.

According to Uğur (2013) emotion is always related to motion, wearable interface can easily measure body motion, but also inner body motion, such as ECG because they are placed on the body. The Neurotiq Social is an example of an “organic user interface”, a concept introduced by Holman & Vertegaal (2008). The idea behind an organic user interface is that is adapts to its user and is flexible, due to nature of the technology used. In the case of the Neurotiq Social, the LED strip, the material of the cap and partially the Muse can adapt to the user and are not static. Also the movement of the LEDs makes the interface itself more organic than static. By turning the body into a dynamic display, these interfaces can change the way in which emotions are normally expressed (Uğur, 2013, p.51).

The expression of emotion is something, even though in normal human interaction is something we cannot always control, we try to control as much as possible. Showing emotion in a public setting is something that differs from culture to culture and from person to person. Duval & Hashizume (2005) shows the difference between Japanese and French and also the difference between gender on the show of emotion and the acceptance of wearables. Schaar & Ziefle (1999) shows the same difference in gender and the fact that technical experience is also crucial in the acceptance of wearables. Duval & Hashizume (2005) presents universal guidelines for the acceptance of wearables.

- Wearables should improve the comfort and safety of their wearer, and possibly of surrounding or distant people.
- Wearables should be able to communicate with other devices, and to suggest them a behaviour based on knowledge about their wearer.
- Support for communication should focus on disrupted settings (e.g. on trips, or with disabled persons) rather than on standard situations
- Design should be gender-oriented, taking into accounts the specific concerns of males and females.

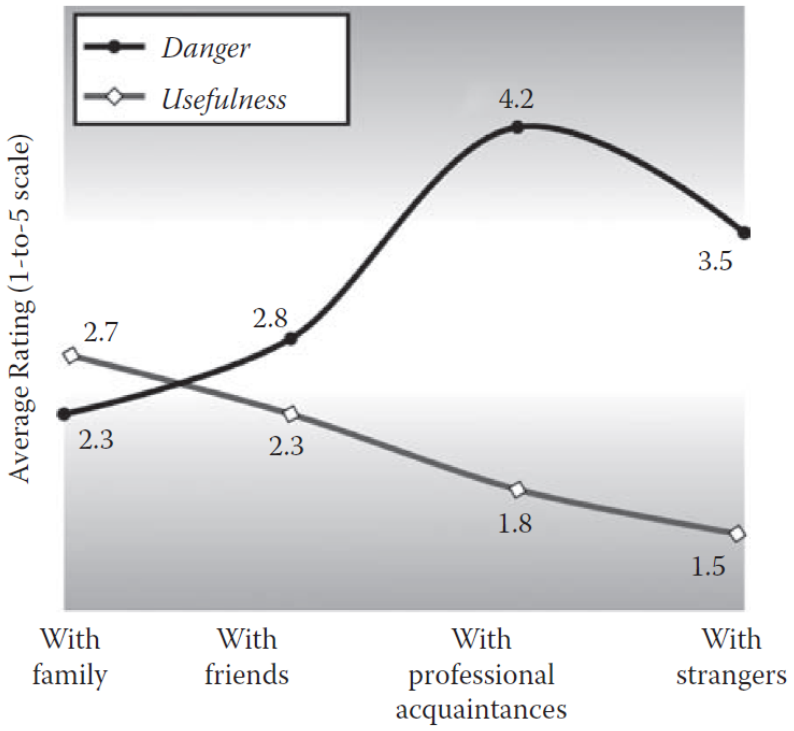


Figure 2.3: The perceived usefulness and danger when sharing emotions with wearables (Duval & Hashizume, 2006)

- Full control of the system by an artificial agent should be avoided, and the autonomy and intelligence of the system should be selected based on cultural preferences.

Schaar & Ziefle (1999, p.607) adds to this that a persons' acceptance is primarily formed by the assumed fears and the perceived disadvantages rather than driven by a positively connoted usage motivation. People are more afraid of losing control of their shared emotion than willing to see the beneficial functions, such as an increase in empathy. Duval et al. (2009) shows with figure 2.3 that people see more fear in disclosing their emotions than they see the usefulness. Buenaflor (2013) shows that there are six factors that are crucial for the acceptance of technology and one of those is the fundamental needs as introduced by Maslov. This shows that people accept technology earlier when it contributes to a lower need such as the need for health and safety than for a need for intimacy. This also explains the finding of Duval et al. (2009), since the need for safety triumphs the need for intimacy. To increase the acceptance of ISDs as affective wearables, it is important to keep the guidelines of Duval & Hashizume in mind, but also to show the positive connotation and benefits to counter the assumed fears and disadvantages.

The Neurotiq Social focusses mainly on the need of love and belonging and only in certain cases, such as people with disability like Locked-in syndrome it could help with the need focussed on family and social stability. Since this is a relatively high

need in the hierarchy people tend to reject this technology faster than, for example, a smart watch that focusses on the physiological needs and does not share emotions without consent.

The sections above show the paradox of inner state displays. On one hand the user might benefit on many levels of sharing his emotions as shown by Uğur (2013) and it would help many people to behave more social intelligent, but it also breaks some control and social barriers. It increases the lack of privacy by showing emotion without control from the user. One advantage of the Neurotiq Social is that is does not directly and clearly shows or communicate emotions, but shows the mental activity of a person, even though this might be interpreted by others as showing the emotional state.

Taking everything above into consideration there is one more concept that needs introduction here and that is “extimacy”. The concept of “extimacy” was originally defined by the Parisian psychoanalyst Jacques Lacan (April 13, 1901 to September 9, 1981). "Jacques Lacan coined the neologism ‘extimacy’ (extimité) in order to theorize two interrelated modes of psychical apprehension: first, how our most intimate feelings can be extremely strange and Other to us. Second, how our feelings can be radically externalized on to objects without losing their sincerity and intensity." (Kingsbury, 2007, p.235). Mateus (2010) introduced extimacy as public intimacy. Of course privacy and intimacy are important, but as Mateus describes, the focus of what you share and what is private has shifted over the last three centuries. Making contemporary intimacy a public display of intimate things, such as posting relationship statuses on Facebook. This is an example of making the interior and exterior concurrent and the intimate and public appear simultaneous (Mateus, 2010). “Only what is essential to enrich the individual’s personality is publicly displayed” (Mateus, 2010, p.69). This last quote is something that supports the usefulness of the Neurotiq Social, since the Neurotiq Social is something that enriches somebody’s personality and is publicly displayed. According to Kristin Neidlinger Sensoree has adapted the term extimacy to be defined as externalized intimacy, showing how one feels on the inside to the outside world. SENSOREEs Therapeutic Biomedia is a wearable sensitive technology that monitors the bodies’ systems, then visualizes emotional states with audio, visual, or tactile feedback. This interface offers biofeedback to the wearer by provoking insight and awareness as well as aids to develop empathy for others as we communicate our inner most feelings.

Chapter 3

NEUROTiQ by Sensoree

This master thesis is constructed around the Neurotiq Social by Sensoree. The Neurotiq Social is a version of the NEUROTiQ. Section 3.1 describes the concept of the Neurotiq and the different versions, section 3.2 describes the role of EEG in the Neurotiq and section 3.3 goes into more detail about the Neurotiq Social.

3.1 History of the NEUROTiQ

Sensoree (2016) describes the first NEUROTiQ as follows: "NEUROTiQ is brain animating fashion – a knitted EEG brain sensor – that maps thoughts and exhibits brain states with colour.". There are different versions of the NEUROTiQ: the first is the real NEUROTiQ, the second was the Neurotiq Spa (see figure 3.1b) and the last version is the Neurotiq Social (see figure 3.1c). These different versions all had different goals and have been used in different settings. The NEUROTiQ (figure 3.1a) was designed to be a museum piece or artefact.

Sensoree was commissioned to create a new concept piece for a 3d Print exhibition. The Sensoree Therapeutic Biomedia – embedded in the design – is the technology that converts the BCI data to colour frequencies. This visualizes brain states with colour and maps brain activity on the head for others to see. This design also premièred in NYFW 2014 and since has travelled globally. In 2015, they created the NeurotiQ Spa version as an experiential exhibit for 3 people to try the design and be lead through a brain exercise class (such as meditation). A data log / print out of their experience wearing the design was also added.

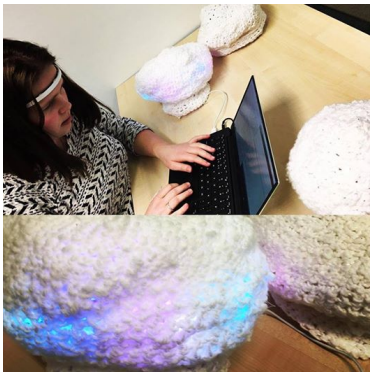
The Neurotiq converts EEG signals into light. To capture these EEG signals the first version used the Emotiv EPOC, the latter versions used the MUSE headset (see figure 3.2). The Neurotiq Spa was part of the Sensoree Spa and was mainly used by the leader of the meditation to monitor the participants. The Neurotiq Social is the most wearable version of the Neurotiq so far, it is wireless and the participants can walk around and move around.

3.2 Neurotiqs and EEG

As mentioned before EEG is a way to monitor and record brain activity. Hans Berger recorded the first EEG in 1924 (Haas, 1992). Berger characterized the alpha, beta, delta

(a) The NEUROTiQ

(b) The Neurotiq Spa



(c) The Neurotiq Social

Figure 3.1: The different Neurotiqs

and theta waves (Collura, 1997). These waves are part of the whole frequency spectrum of brain activity measured with an EEG. The studied frequency bands are between the 4 and 60 Hz (Ray & Oathes, 2003). This does not include the delta-band since that ranges from 0.1 — 4 Hz. Figure 3.3 shows the different frequency bands that can be deduced from a raw EEG. The Neurotiq translates those five frequency bands into different colours. Since the different frequency bands are associated with different amounts of brain activity the Neurotiqs convey the amount of brain activity.

3.3 Neurotiq Social

The Neurotiq Social is designed by Kristin Neidlinger and is, in comparison to the other two versions, more robust. The cap is knitted with optical fibres and acrylic wool. The optical fibres are mostly there to provide some stability in the cap. The knitted structure and white acrylic wool already allows the light to shine through, the optical fibres are not really used to transmit light. The cap contains an LED strip where each LED is diffused using a little plastic cylinder. The LEDs are placed at the base of the cap and are controlled using an Arduino Pro Mini.

A crucial part of the Neurotiq Social is the Muse headset. This EEG headband measures brain signals. The MUSE SDK enables a fast and easy conversion from raw data into frequency bands. These results are the input for the Processing code. This code is used determine what colours the cap should have and runs on a laptop. The results are send to the LEDs via a Bluetooth connection with a BlueSmirf that is connected to the Arduino board.

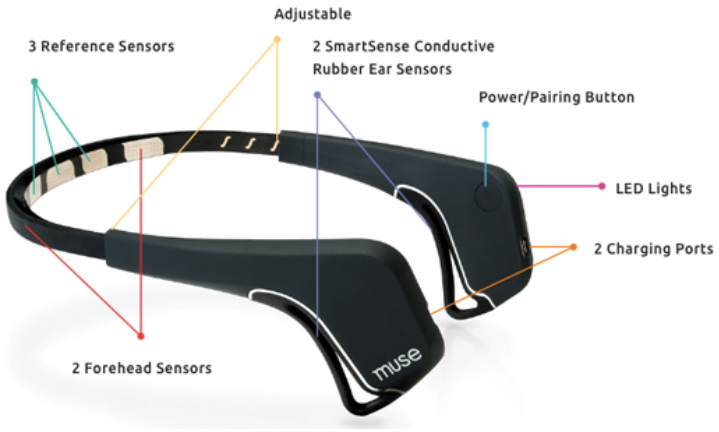


Figure 3.2: The MUSE EEG headset

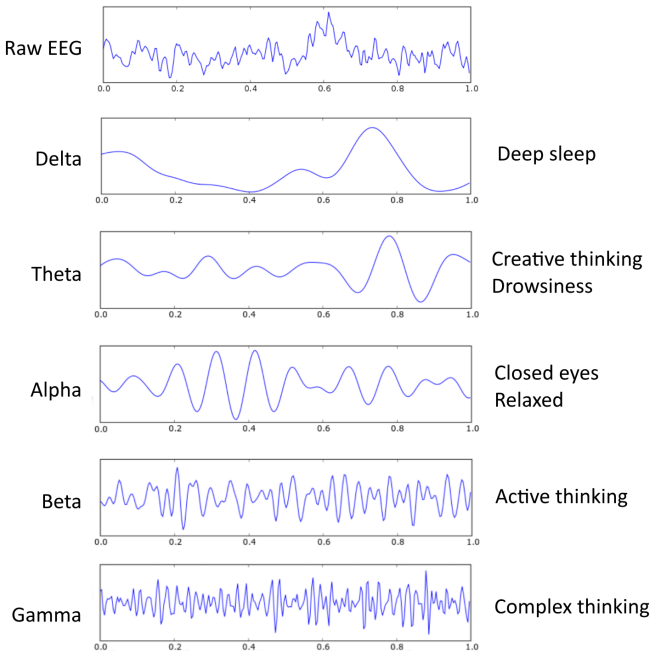


Figure 3.3: A raw EEG and the different frequency bands

Chapter 4

Methodology

To answer the research questions proposed in section 1 different steps need to be taken. This is due to the different nature of the two questions. The first question has a quantitative nature and the second one a more qualitative nature. This chapter will discuss the major methodology decisions, where chapters 5, 6 and 7 will describe the methodology in more detail.

The goal of this research is to show the added value of the inner-state display: the Neurotiq Social. To show this added value, the Neurotiq Social needs to be placed into a scientific setting. As mentioned in section 3, the colours that were initially chosen, were chosen based upon their relation towards the visual spectrum, however the association of those colours by the observer were not taken into account. The first step towards the goal is to gain more insight into the colour association subject. There are different ways to gain insight into such a subject, with literature research, experiments or questionnaires. In this research the subject was tested using a questionnaire, this due to the specific nature and population used in this research. There is not enough colour association research using a Dutch sample, which makes the cultural bias heavier. This is why this thesis creates its own baseline with a Dutch sample. The second problem is the fact that the colours are represented by the Neurotiq Social, which is nowhere comparable to the calibrated colours used in most colour research.

With the colours chosen based upon a Dutch sample and the actual colours on the Neurotiq Social, the next step is to choose a method to gain more insight into the influence of the Neurotiq Social on empathy. To conceptualize the concept of empathy different experiments mentioned in literature were reviewed (shown in appendix A). Literature shows that there are different ways to test empathy, and often the concept of altruism is used as a measurement of empathy. A commonly used experiment to test altruism is the dictator game (see section 6.1.1 for detailed information about the chosen dictator game version). To validate that the different conditions did not differ too much, personality questionnaires were used to compare the conditions.

Even though this experiment would answer the first research question there is a part of the complexity of the use of an ISD that has not gotten the complete attention and that is the qualitative side of the experiment. The attitude of the users towards the ISD. There are different ways to gain insight in the attitudes of the user. One way is doing interviews with the participants of the main experiment after the dictator game. Due to the competitive nature of that experiment and fact that the participants did not know each other a group interview might not have resulted in honest answers. These conditions often result in social desired answers. Another method could be

a questionnaire with open questions, this method would allow people to give their opinions in their own time in their own place, but because the concept of an ISD is not commonly known and the Neurotiq Social is a unique and unknown product this would not have worked in this case. One of the, more well known, methods for gaining insight into attitudes and opinions is focus group interviews. As the name implies the interviews are conducted with a group, specifically a group of people who are known to have a strong opinion in general or a strong opinion on the matter. By leaving the discussion open to the participants and letting the participants discuss among each other instead of with the interviewer this method allows for a relatively neutral way of gathering data. This research uses the focus group interview method to gather data.

Chapter 5

Pre-experiment: Colour interpretation test

This section shows the pre-experiment used to determine the colours of the Neurotiq Social. This pre-experiment used a questionnaire to test colour association. Section 5.2 explains more about the experiment and 5.3 shows the results of this experiment.

5.1 Motivation

The goal of this experiment is to determine suitable colours for the Neurotiq Social to represent brain activity. The original colours used in the first two versions of the NEUROTiQ were chosen based on the wavelength of colours, the lowest frequency got the reddest colour and the highest the bluest. The colours are shown in figure 5.1. The problem noticed during the use of the first two versions was that not all the colours were distinct enough, especially the difference between the alpha and beta colours were hard to observe. Since both colours are blue tones and due to the changing intensity of the LEDs it was hard to differentiate between those two. This experiment leads to five colours to represent the five frequency bands (alpha, beta, gamma, theta and delta).

Colour interpretation has been the topic of many papers (such as Naz & Epps (2004), Silver et al. (1988), Silver & Ferrante (1995)). Since colour interpretation differs between race (Silver et al., 1988), genders (Silver et al., 1988; Silver & Ferrante, 1995), ages (Silver et al., 1988) and the way the colours are represented in this experiment, it is hard to derive the colours that fit these five bands exactly. Especially since most of the colour interpretation experiments ask for an emotional interpretation. This focus on emotional interpretation of colours is logical since it is an interpretation that is an integrated part of society. The colour red is associated with hate and with love, depending on the context. The film Inside Out (Docter & del Carmen, 2015) explicitly shows the colours associated with different emotions. However, as mentioned before the Neurotiq Social shows no emotions but frequency bands which do not correspond one on one with emotion. To make a reliable decision on the colours the *activity*-words describe the mental states related to the frequency bands. However, aware of the association with emotions those emotions are also validated to have a baseline for comments on function of the Neurotiq Social in further experiments. This results

Figure 5.1: Original colour scale and interpretation of the Neurotiq Social

in a questionnaire of two dimensions.

In this case the representation of the colours are the LEDs on the Neurotiq Social, as shown in figure 5.2. This leads to a LED light diffused by wool. The colours used in colour experiments are most of the time defined and reproducible, but since the Neurotiq Social cannot represent the colours in the exact same way, colours could be interpreted different. Another problem is that the colour experiments are most of the time done in another language than Dutch, which might lead to discrepancies, since the Dutch word *leuk* is not one on one translatable to English and vice versa.

The research questions below show the emphasis for this experiment. It is crucial to find five colours to represent the frequency bands and for further experiments it is important to establish a baseline for the emotions associated with the colours that are displayed on the Neurotiq Social.

- Which colour do Dutch students associate with certain words?
  - Which colours represent the five frequency bands?
  - Which colours are associated with *emotion*-words?

5.2 Method

5.2.1 Participants

Ninety-eight students from the University of Twente participated in this study. The questionnaire has been distributed among students of the University of Twente. The main demographic groups that filled in this questionnaire due to the distribution were computer science, technical medicine and civil engineering students. Table 5.1 describes the population based on gender. Table 5.2 describes the population based on age. The last table, table 5.3 shows the statistics on colour-blindness.

Gender	Count	Percentage
Male	62	63.27 %
Female	36	36.73 %

Table 5.1: Descriptive statistics Gender (n = 98)

Min	Max	Mean	Std. Dev.
18	26	21.02	1.626

Table 5.2: Descriptive statistics age (n=98)

No	Yes	Synaesthesia	Don't know
95	1	1	1

Table 5.3: Descriptive statistics colours blindness (n = 98)

5.2.2 Materials

The materials used in this pre-experiment are questionnaires especially made for this experiment. The questionnaire starts with three demographic questions: age, gender and colour-blindness. This last demographic might be useful if certain participants cause outliers. After those three questions the participant completes two parts of the questionnaire with a similar lay-out, both contain the same twelve colours and a different set of words (see appendix B). To prevent the influence of biases, ten different versions of the questionnaire were distributed. The word order differed amongst these versions. The questionnaires were handed out randomly.

As mentioned in section 5.1 this questionnaire has two dimensions, the frequency dimension and the emotion dimension. The first half of the questionnaire contains *activity*-words associated with the frequency bands. In the second half the participants rated a set of *emotion*-words. Appendix B.2 shows the Dutch version. In this thesis the English translation is used.

The words used to describe the different frequency bands are shown below. The words are chosen based on the work of Collura (1997) and Wikipedia for the Dutch translation (Wikipedia, 2016).

Delta: Deep sleep

Theta: Drowsiness, daydreaming & creativity

Alpha: Relaxed and alert

Beta: Concentration & active thinking

Gamma: Problem solving

The words used to describe emotions are chosen based on the work of Ekman & Cordaro. Ekman & Cordaro were the first to start working on the subject of basic emotions and have done extensive research on the matter since 1960. In this research the six basic emotions as mentioned by Ekman & Cordaro (2011) are used. These emotions are: anger, disgust, fear, happiness, sadness and surprise. The other words included in the questionnaire are feelings that could be associated with the dictator game: admiration, envy, love, pride, regret and shame.

The colours shown in figure 5.2 are the actual colours on the Neurotiq Social, representing the twelve colours of a colour wheel. As shown in figure 5.2 colours differ from the colour wheel even though RGB values are the same.

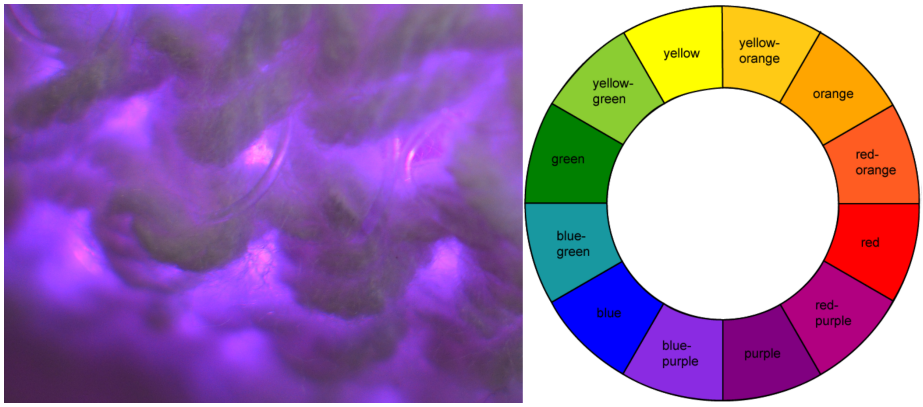


Figure 5.2: The colour wheel and the LED representation of purple

The goal is to determine a baseline for the colour interpretations. The results of the first part are used as colour representation of the five different frequency bands. The second part is used to account for any biases in the main experiment. Since this is used in the main experiment the participants are not completely briefed on the meaning of the colours and experiment, especially since the colours are determined after the experiment.

5.2.3 Procedure

The participants were given a consent form which they filled in before they were given a questionnaire (see Appendix B.1). They were not given more information than in the consent form. After they completed the consent forms they were given a version of the questionnaire and once they completed the questionnaire they were finished.

5.2.4 Statistical analysis

The nature of the questionnaire is categorical; the data does not have a rank or a continuous scale. This kind of data is best analysed using a chi-squared test. Multiple chi-squared tests are used. The first test is used to verify that the responses to the different questionnaires do not differ significantly. This shows that the randomisation had no influence on the answers. The second test tests the results of all participants against a null hypothesis that says that the results are randomly distributed. To test which colour should belong to which frequency band a chi-squared test checked if a specific colour was mentioned significantly more than another, combining the responses to multiple words.

5.3 Results

This section discusses the results of the pre-experiment. Firstly, the influence of the different versions is validated. Secondly the results are checked on randomness, and

finally, the frequency bands are checked.

5.3.1 Chi-squared test: questionnaire version

Table 5.4 shows that there exists no statistical dependence between the questionnaire versions and the tested words. This shows that the order of the words did not statistically influence the chosen colour. The degrees of freedom differ due to the fact that certain colours were not mentioned with some words. The maximum number of degrees of freedom is 99: $(groups - 1) * (colours - 1) = (10 - 1) * (12 - 1)$. But in some cases such as love only nine colours were chosen, which results in a degree of freedom of 72.

Dutch word	Translation	χ^2	df	p-value
Diepe slaap	Deep sleep	104.46	99	0.3343
Dagdromen	Daydreaming	74.79	90	0.8758
Alert	Alert	64.428	72	0.7253
Nadenken	Active thinking	114.63	99	0.1348
Creativiteit	Creativity	108.83	99	0.2347
Slaperig	Drowsiness	102.61	99	0.3817
Oplossend van problemen	Problem solving	91.372	99	0.6946
Concentratie	Concentration	108.94	99	0.2323
Ontspannen	Relaxed	110.97	90	0.06621
Vreugde	Joy	93.74	90	0.3728
Verdriet	Sadness	104.61	99	0.8193
Angst	Fear	86.092	99	0.1122
Woede	Anger	91.221	72	0.06271
Verbazing	Amazement	87.436	90	0.5569
Afschuw	Disgust	114.38	99	0.1384
Bewondering	Admiration	115.48	99	0.1233
Afgunst	Envy	121.98	99	0.05846
Liefde	Love	70.285	72	0.5352
Trots	Pride	99.77	99	0.4594
Spijt	Regret	93.605	99	0.6342
Schaamte	Shame	112.52	99	0.1667

Table 5.4: Chi-squared test to validate that there was no difference between the questionnaire versions

5.3.2 Chi-squared test: goodness of fit

This section describes the results of the test to verify if the responses were divided better than random over the colours. The number of chosen colours is represented in table 5.5 in the column *df*, describing the degrees of freedom of the chi-squared test. The dashed line indicates the difference between the words associated with frequency bands and the words associated with emotion.

As table 5.5 shows for most of the colours the responses are divided better then random with a p-value smaller then 0.05. This is true for all the concepts except fear, the p-value of fear is 0.1122. Figure 5.3 shows that many different colours are associated with fear. A concept with a clear significant difference compared to an

evenly distribution is deep sleep. Figure 5.4 shows that almost half of all participants (n = 45) associate deep sleep with blue. The graphs of the other concepts can be found in Appendix C.

Dutch word	Translation	χ^2	df	p-value
Diepe slaap	Deep sleep	225.14	12	<2.2e-16
Dagdromen	Daydreaming	38.939	10	2.602e-05
Alert	Alert	177.33	8	<2.2e-16
Nadenken	Active thinking	55.878	12	1.259e-07
Creativiteit	Creativity	63.041	12	6.263e-09
Slaperig	Drowsiness	46.735	11	2.397e-06
Oplossend van problemen	Problem solving	69.939	12	3.289e-10
Concentratie	Concentration	51.367	12	8.023e-07
Ontspannen	Relaxed	75.755	10	3.391e-12
Vreugde	Joy	51.061	10	1.702e-07
Verdriet	Sadness	69.143	12	4.632e-10
Angst	**Fear**	16.857	11	**0.1122**
Woede	Anger	466.24	8	<2.2e-16
Verbazing	Amazement	33.51	11	0.0004348
Afschuw	Disgust	39.878	11	3.754e-05
Bewondering	Admiration	51.367	12	8.023e-07
Afgunst	Envy	36.51	12	0.0002681
Liefde	Love	170.16	8	<2.2e-16
Trots	Pride	42.571	11	1.289e-05
Spijt	Regret	52.612	11	2.111e-07
Schaamte	Shame	95.714	11	1.255e-15

Table 5.5: goodness of fit chi-squared test

5.3.3 Chi-squared test: frequency bands

The goal of the last test is to show that there is a statistical dependence between the words belonging to one frequency band. This is the case with the theta, alpha and beta waves. Table 5.6 shows that there are no significant results, which means that the words that belong to a certain frequency band do not have a common colour that significantly differs from the other colours.

Band	χ^2	df	p-value
Theta - Drowsiness & creativity	71	63	0.2286
Theta - Drowsiness & daydreaming	81	72	0.2189
Theta - Daydreaming & creativity	69	59	0.1138
Alpha	66	63	0.3736
Beta	52.333	48	0.3095

Table 5.6: Chi-squared test: frequency bands

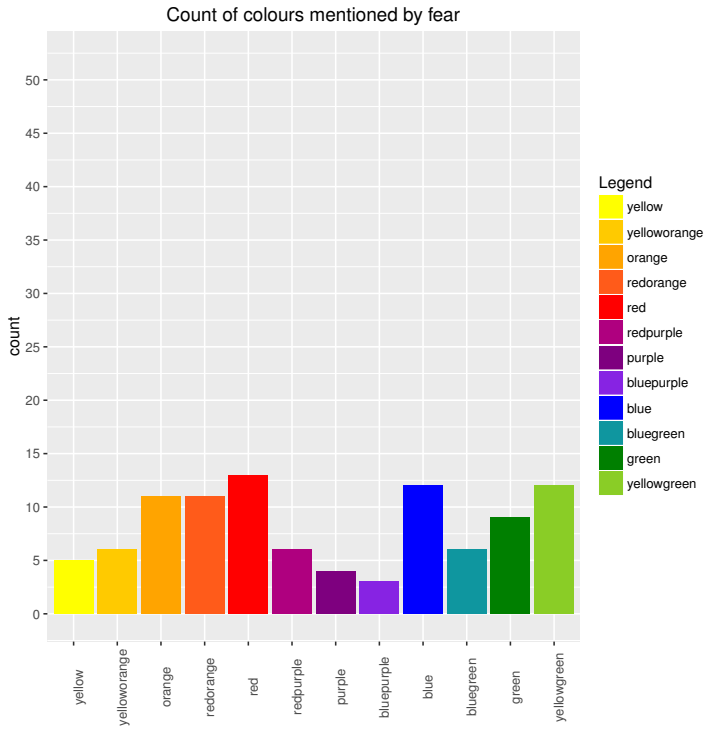


Figure 5.3: Graph of distribution responses to the concept of fear

5.4 Final colour selection

The goal of this experiment was to choose the colours that represent the different frequency bands: delta, theta, alpha, beta and gamma. Since the χ^2-test did not show a significant relationship for the frequency bands with multiple constructs (see table 5.6), the colours are first determined based on the most votes per colour. For the waves with multiple concepts, the votes are added to result in one majority vote (see table 5.7). Since this does not result in different colours for the bands, and the fact that the colour red is only a majority due to the fact that 51 people associated alert with red and not with relaxed, another approach needs to be taken to determine the colours for the Neurotiq Social. The colours are partially picked based on the votes: delta has the colour blue and beta the colour blue green, however delta is not visualized on the Neurotiq Social. For the other three frequency bands the colours were chosen as follows: yellow orange for theta since this was associated with creativity, green for alpha and purple for gamma, mostly since these colours were distinctive enough from the other colours. The final colours are shown in figure 5.5.

5.5 Discussion

To summarize the above, it was hard to deduce a distinct colour per frequency band. So a few remarks must be made that may explain these results and give the results some context. There were two comments often made by participants: one about the

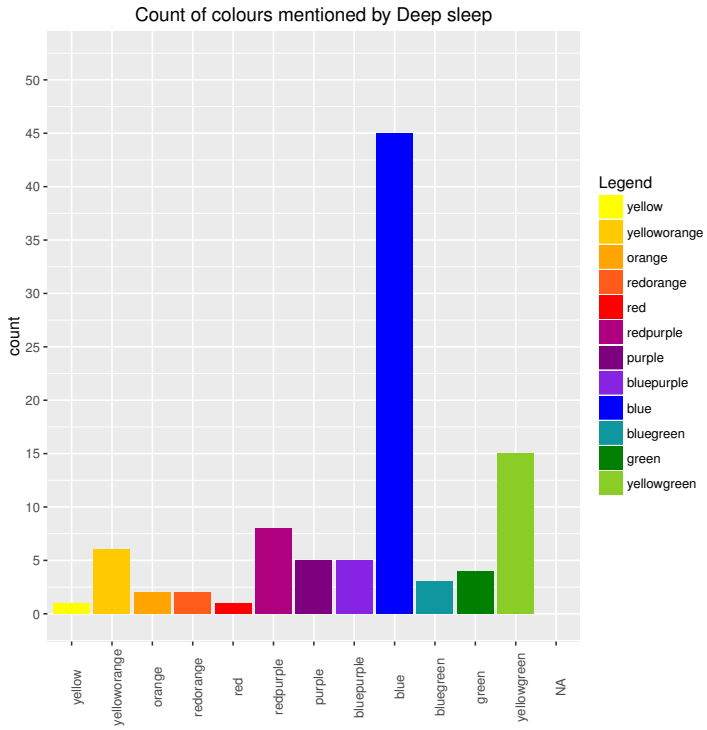


Figure 5.4: Graph of distribution responses to the concept of deep sleep

Band	Colour	Number of votes
Delta	Blue	45
Theta	Blue green	55
Alpha	Red	51
Beta	Blue green	44
Gamma	Blue green	23

Table 5.7: Colours for the Neurotiq Social based on majority vote

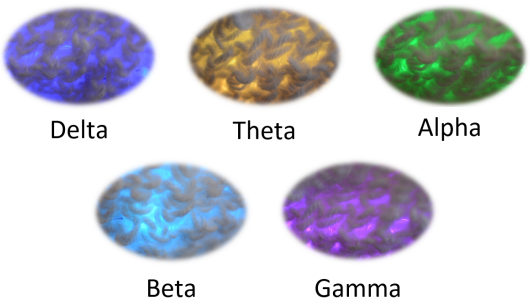


Figure 5.5: Final colours per frequency band represented on the Neurotiq Social

colours and one about the words. The first one about the colours were often participants who pointed out that in their opinion there were a lot of purple shades com-

pared to the other colours. This has two reasons, one reason is the fact that the printer printed the blue-purple and the red-purple more purple than they are on the Neurotiq Social. Another reason is the fact that the colours are more purple-like on the Neurotiq Social due to the material and the LEDs. Even though this remark was made often, it does not show in the results that people were forced to pick a purple colour often.

The second comment regarded the *activity*-words, the words related to the frequency bands. Participants had a hard time matching colours to these kind of words, probably since these words have less colour association compared to words as love and anger which are associated with red in western cultures. Due to this difficulty and the wide variety of colours participants could choose the number of votes per colour is still relatively low, resulting in a low reliability of the chi-squared tests.

Chapter 6

Neurotiq Social experiment

6.1 Introduction

The goal of the main experiment is to measure the influence of the inner-state display (Neurotiq Social) on social interaction. As shown in sections 1 & 2 the key-concept is empathy. The concept of empathy is conceptualized towards altruism because altruism is a more measurable concept. This results in the following research question: Does an inner-state display increase the level of altruism in a human-human interaction?

6.1.1 Dictator game

To measure the level of altruism the dictator game (DG) is used. In the original dictator game there is no contact at all between the allocator and the recipient, but Andreoni & Rao (2011) argues that this does not represent the real world since most of the time altruism does not take place in an isolated setting. Their baseline experiment (the traditional DG without interaction) showed that 15% of the funds were given away.

Andreoni & Rao (2011) used three different conditions to prove that social interaction influences altruism and empathy. The conditions differed in the amount of interaction: which participant was allowed to talked differed per condition. In the condition in which only the dictator could talk (E, explaining condition) to explain why he divided the funds the way he did, the allocated funds dropped to 6%. In the other conditions, where the receiver could ask the dictator(A, asking condition) the allocated funds rose to 24% and when the conditions were merged: the receiver asking and then the dictator explaining(AE, asking and explaining condition), the allocated funds rose to 30% of the total. To see the largest effect of the Neurotiq Social the condition with the lowest amount of allocated funds is chosen for this research. This condition is the only explaining condition. In this situation the most effect could be achieved since the other two conditions already showed an increase in allocated funds and this condition was the only one that decreased the allocated funds in comparison to the baseline of 15%. The results of the experiment by Andreoni & Rao (2011) serves as a baseline for this experiment, using the 6% as null hypothesis.

6.1.2 Hypothesis

Based on the previous and the notion of the need for a control group this experiment has two conditions as well. The experiment condition with the Neurotiq Social and the control condition with just the muse (more on this subject in section 6.2.2). The E-condition of Andreoni & Rao provides the numbers presented in the hypothesis below. There are two hypothesis that are tested in this experiment:

- In the condition with the muse the allocated funds will be higher than 6%
- In the condition with the Neurotiq Social the allocated funds will be higher than 6% and higher than in the condition with just the muse

6.2 Method

6.2.1 Participants

Forty students from the University of Twente (24 men and 16 women) participated in this study, ranging in age from 19 to 30 years old (M = 22.55 years, SD = 2.3637 years). These forty participants participated in couples, the participants were volunteers from the social network of the experiment leader. The couples were made based on the knowledge of the experiment leader to match as many participants with other participants they did not know. Another restriction was that all the participants were able to speak in their native tongue with each other, in this case Dutch. The couples were randomly divided over the two conditions and also the role of the participants was random, but chosen by the participants themselves without knowledge. Informed consent was obtained from all participants (consent form can be found in appendix D.1). There was no compensation offered except a chocolate at the end. The participants are representative of the population of students at the University of Twente.

6.2.2 Conditions

The experiment has two conditions. The first condition is the condition where the participants wear the muse headsets but not the Neurotiq Social. This condition is to see if the presence of technology itself influences the outcome. The second condition is the Neurotiq Social condition. In this condition the participants wear the muse and the Neurotiq Social is fully operational. Since the Neurotiq Social is heavy, not really comfortable over a longer period of time and are not one size fits all the Neurotiq Social lies in front of the participants on the table during the DC. The set-up is such that the participants do not see their own Neurotiq Social. Separated by a panel, it is ensured that a participant can only see the Neurotiq Social of the other participant.

6.2.3 Apparatus and materials

6.2.3.1 Equipment

This section describes the experimental set-up (see figure 6.1) and the equipment used. Figure 6.1 shows the set-up for this experiment. The researcher is in the room but is hidden from the participants by a wall of black fabric. This allows the researcher to write down observations and to monitor the Neurotiq Social without disturbing the participants. Two cameras record the session, these are placed on tripods and placed

in such a way that the view of the cameras was mirrored but identical. The participants used an iPad to fill in the questionnaires in an individual setting, separated by the same fabric used to separate the researcher from the participants. On the table where the participants played the dictator game a 30 centimetre high cardboard screen was placed to obscure their own Neurotiq Social from them during the experiment. The same Neurotiq Social's were used for all the participants, and the same Muse-headsets. The Neurotiq Social and Muse assigned to the participant depended on their role. Each participant was given a pen to sign their consent form and the dictator ballot.

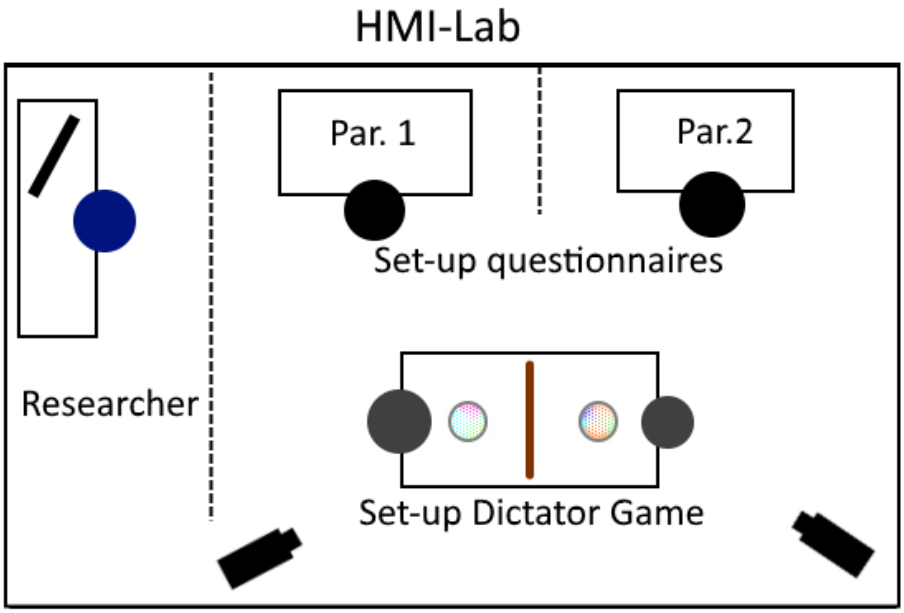


Figure 6.1: Set-up Experiment in HMI lab

6.2.3.2 Materials

This section describes all the materials used in this experiment, the questionnaires and other materials that are not mechanical devices. The consent form can be found in appendix D.1. The following three questionnaires were filled in on the iPad, the complete questionnaire can be found here: `http://tinyurl.com/jxxkxpt`

Inclusion of Other in Self scale The Inclusion of Other in Self scale (IOSS) is used to measure the structure of closeness between the participants. Before the dictator game this scale is used to validate the requirement of limited personal connection between the participants. After the dictator game the questionnaire is used to see if the closeness between the participants has improved or decreased.

Personality scale The personality scale chosen for this research is the Eysenck personality scale (SANDERMAN et al., 1991), (Sanderman et al., 2012). This personality scale is based upon the 3-factor model. This model states that there are three major

factors: neuroticism, extraversion and psychoticism. Neuroticism can be described as emotional instability, people who score high on this scale are often easily scared and worried. They often worry about what could go wrong and they tend to respond emotionally to all sorts of situations (Sanderman et al., 2012). Extraversion is a continuous scale from introvert to extravert. People with a low score on this scale are relatively calm and are more focussed on themselves, they like to plan ahead and will not respond impulsive. People who score high on the extraversion scale are the opposite of the introverts. They value social contact, have a lot of friends, try a lot of new things and take risks and are impulsive in comparison to introvert people (Sanderman et al., 2012). The psychoticism scale measure how individualistic people are, scoring high people tend to care less about others and are often cruel, inhumane and insensitive. Guilt and empathy are not part of their vocabulary (Sanderman et al., 2012). This questionnaire is chosen because the factors are relevant to this research. There is a short version of the questionnaire and it has been validated in the Netherlands with different populations. Although there are three factors in the personality model of Eysenck, four scales are part of the personality test. The scale that is tested, yet not part of the personality model, is the Lie scale. This scale is used to measure how likely a person is to answer the questions in the other scales as he expects is socially desired (Sanderman et al., 2012). In this experiment the EPQ-RSS, the short version with 48 items was used. This results in a maximum score per scale of 12 points.

Dispositional Empathy To measure the dispositional empathy of the participants, the Baron-Cohen Empathy Quotient is used Baron-cohen & Wheelwright (2004). The Dutch 40-item version is used by De Corte & Uzieblo (2006). This measurement is used to rule out an eventual effect based on characteristics of the dictator.

Dictator game instructions and ballot The instructions for the dictator game were given in writing to the participants. The receiver and the dictator received different instructions in Dutch and the dictator also received a ballot to fill out with his choice and explanation which he/she had to read out loud. The instructions, ballot and translations can be found in appendix D.2.

6.2.4 Procedure

This section describes the procedure of the experiment. Appendix D.3 shows the procedure in more detail. The first step of the preparation was finding participants and making couples and decide their condition based on a coin toss, head is Neurotiq Social and tail is Muse. The design of this experiment is a between subject design since there are two conditions with different participants doing the same experiment. The participants sat down at the centre table and filled out the consent forms. After that they were given the Muse or Neurotiq Social and were sent off to their individual tables to fill out the first half of the questionnaires. They told the researcher when they finished. Then they sat down at the centre table again to follow the instructions of the dictator game. These instructions are shown in English in figures 6.2 and 6.4. The ballot which is used by the dictator to write down the decision and explanation is shown in figure 6.3. In the game the dictator, called distributor for the sake of the game, was able to distribute 100 lottery tickets. When they finished they were sent back to their individual tables to finish the last part of the questionnaire. This was

the end of the experiment. After this the participants were debriefed at the centre table.

You are the distributor and your part is: You have 100 lottery tickets. With these tickets you participate in a lottery to win a 20 euro Bol.com-cheque. You can divide these tickets between you both. The receiver is not allowed to say anything. You may divide the tickets the way you want to. You write down the distribution on the ballot and the explanation why you distribute them that way. When you filled out the ballot you read the ballot out loud. The receiver is not allowed to respond on that. After that you can take your place at your iPad and continue the questionnaire.

Figure 6.2: English translation of instructions for the dictator

Ik, de verdeler geef ..... van de 100 lootjes aan de ontvanger. Ik verdeel dit zo omdat:

Figure 6.3: Dutch ballot for distributing the lottery tickets

You are the receiver and your part is: During this part 100 lottery tickets will be distributed. With these tickets you participate in a lottery to win a 20 euro Bol.com-cheque. During this part of experiment you remain silent. You are not allowed to say to or ask something from the other participant. You are allowed to ask the researcher something or stop the experiment. Once the distributor explained how many lottery tickets he gave you and why you can take your place at your iPad and continue the questionnaire.

Figure 6.4: English translation of instructions for the receiver

6.3 Results

This section describes the results of the Neurotiq Social experiment. Firstly, the results regarding altruism are given. After that the results of the IOSS, also regarding the benefits to society, are discussed. Lastly the results of the questionnaires used to measure the dispositional empathy and the personality are discussed. Since the sample size is relatively small and a normal distribution cannot be assumed, the analysis is done with a non-parametrical test: the Mann-Whitney-Wilcoxon Test.

6.3.1 Lottery tickets and IOSS

This section describes the results that answer the question whether the Neurotiq Social could benefit society. The lottery tickets were distributed twenty times, ten times in each condition. The dictators in the muse condition gave 44 lottery tickets away

and the dictators in the Neurotiq Social condition gave 44.5 lottery tickets away. This difference is not statistically significant: W=53.5, p=0.7655.

Besides the quantitative data of the lottery tickets, the ballot also resulted in qualitative data. Table D.4 shows the Dutch responses on the ballots and the number of lottery tickets given away. The major theme mentioned in these explanations were fairness (in Dutch indicated by the word *eerlijk*). The concept of fairness was both expressed by honesty and also by equal chances. Another theme mentioned was effort, the dictator thought in several experiments that due to the fact that both participants put time and effort into the experiment they should have an equal share (see table 6.1). Only one participant indicated that he did not want to look selfish and gave the receiver more lottery tickets. In the three cases where the dictator gave all or a majority of its tickets away the dictators indicated that they did not see a great value in the bol.com-cheque because they would not benefit from it.

Honesty	Equal chances	Effort
11	10	2

Table 6.1: Times concepts were mentioned on ballot

Another measurement of a benefit to society is the IOSS, to see if the Neurotiq Social promotes the feeling of inclusion of the other in the self. In general, the experiment shows a significant effect, W = 439.5, p <0.001, meaning that people include others more in the self after the experiment (see figure 6.5). However, no significant result can be found when taking in account the conditions or roles. These are tested by calculating the difference between the pre and post experiment value. The conditions are not significant, W = 185, p = 0.6741, nor are the roles, W = 253, p = 0.1278.

6.3.2 Questionnaires

This section describes the results of the questionnaires used to validate that there is no real difference between the condition groups nor between the different roles.

Table 6.2 shows the average scores and standard deviation on the Eysenck personality questionnaire of the participants of this experiment on the left and the results of a similar group on the right. This shows that the group students is relatively similar to the validation group used by Sanderman et al., and that makes the premise that this group is representative for the population stronger. Table 6.3 shows that there is no significant difference on any category in none of the conditions or roles. This shows that the conditions are similar enough to compare. A similar result is shown in table 6.4 for the empathy questionnaire.

scale (max. score = 12)	mean	SD	mean	SD
psychotism	2.58	1.97	3.0	1.9
neuroticism	5.05	3.15	3.8	2.9
extravertism	8.00	3.70	8.4	2.9
social desirability	5.20	2.07	3.8	3.5

Table 6.2: Scores on the Eysenck personality scale (n=40) || Mean and standard deviation (SD) from the manual Sanderman et al. (2012), research 4, age group: 18 - 24

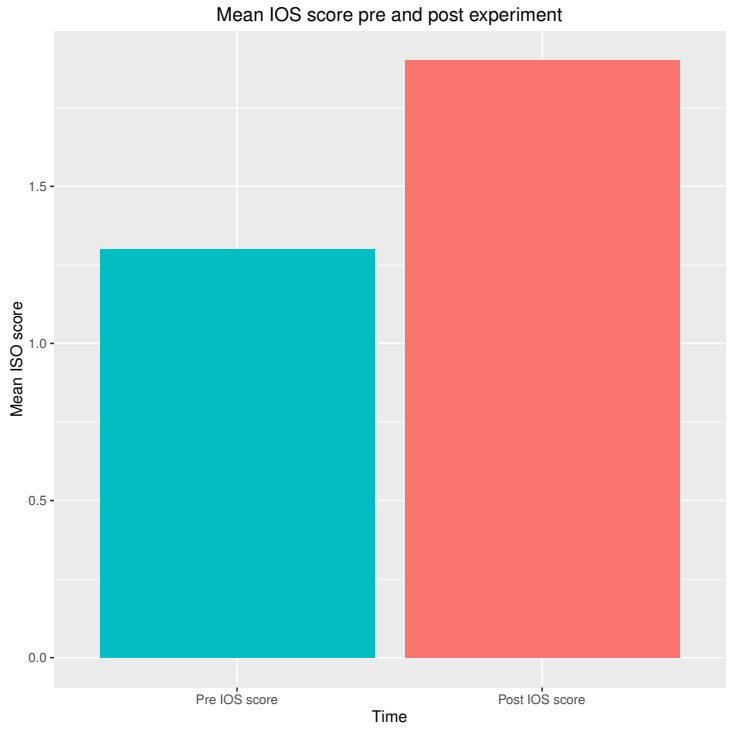


Figure 6.5: Graph showing significant difference in IOS score pre and post the dictator game

Tested category	W	p-value
Psychotism by condition	189.5	0.784
Psychotism by role	165.5	0.3513
Neuroticism by condition	171.5	0.4462
Neuroticism by role	192	0.8383
Extravertism by condition	221	0.5757
Extravertism by role	161	0.2932
Social desirability by condition	184	0.671
Social desirability by role	260	0.103

Table 6.3: Mann-Whitney-Wilcoxon test: Eysenck personality questionnaire

Tested category	W	p-value
EQ by condition	193	0.8603
EQ by role	185.5	0.7047

Table 6.4: Mann-Whitney-Wilcoxon test: empathy questionnaire

6.4 Discussion

On the contrary of what was expected there was no difference between the two conditions, however there was a difference to what was expected. It was expected that there would be similar results to the research of Andreoni & Rao, however in both con-

ditions the participants gave away almost 50 %. There are a few differences between their research and this, first of all, the participants were allowed to introduce themselves, even though they were not obliged to do so. This could already create a sense of belonging and empathy. Second of all, there are fewer participants in this research, in the research of Andreoni & Rao there were 40 participants in one condition, in this research there were half that number. It could be that by increasing the number of participants a pattern might become clear. Third of all, and the most obvious of all, the participant population differs. In this research Dutch students from the University of Twente were used as participants, in the original research Americans were used. The cultural difference between the two populations and the different atmosphere with this research using only students from the social environment of the researcher.

6.5 Future work

The discussion above already shows some points of improvement. To gain more insight in the benefit of the Neurotiq Social the experiment might benefit from more regulations and anonymity. In this experiment all the participants knew the researcher, which lead to an informal setting which might have influenced the behaviour of the allocator. This was also confirmed by Andreoni & Rao (personal communication, 21th of June 2016) who said: "We did a study recently where we got big differences based on which of my students was running the study. I'm not sure why, but when we put in a control variable for the experimenter it got a huge coefficient and all the other coefficients all shaped up. It was rather frightening to see just how important this was. So, on the one hand I'm not surprised that people will get different results in these settings, as I also believe that social cues or influences that we as experimenters are not aware of are at play.". So a more regulated experiment, with an experimenter that is not acquainted with the participants and keeps to a script that is formal might create a setting in which the participants would behave more like the experiment of Andreoni & Rao (2011). This research also used only students from the University of Twente as participants, who are relatively wealthy and might have considered the chance to win twenty Euro was not enough incentive to keep the tickets to themselves.. So doing this experiment again with a bigger monetary reward could also show a difference between the two conditions. It might also be beneficial to set up a baseline experiment with the Dutch student population with a traditional DG. This baseline could then place the results of the following experiments in a better context.

In general, this research shows an honest view of the participants and their thinking, but to dismiss the effect of the Neurotiq Social is too harsh. Based upon the suggestions above another research might yield more insight into the usefulness of the Neurotiq Social in a social context.

Chapter 7

Focus Groups

7.1 Introduction

Besides the lack of quantitative data proving the use of inner-state displays there is also still a lack of qualitative data showing the attitude of people in general, and especially of Dutch students, towards IDS. There are multiple ways to gather data on attitudes, but one of the more elaborate ways is the focus group. A focus group is a technique involving the use of in-depth group interviews focused on a given topic, with participants who have something to say, rather than being representative of the population (Rabiee, 2004). The group dynamic results in deeper and richer obtained data than from normal interviews. Section 7.2 elaborates more on the used method in a focus group.

As mentioned in chapter 1 the research question for this section is: What is the attitude towards an inner-state display, focussing on the acceptance and usability? This question allows for a broad review of the concept of an inner-state display, however not losing focus of the most important points, usability and acceptance of such a new technique. The first goal is to learn more about the opinion on technology that promotes extimacy and to learn more about acceptance of such technology. Since this product has not been worn a lot and has never been subject to such extensive testing the designer wants to know what the users think about the product. The second goal is to see if the designers intention for this product also corresponds with the user's ideas.

7.2 Method

7.2.1 Participants

A total of ten participants were part of the focus group interviews, these ten participants were divided equally into groups of five, the gender distribution was also equal, three males and two females. Nine of the participants were students at the University of Twente and one studies at the Christelijke Hogeschool in Ede. Seven of the participants study in the field of Computer Science and IT.

7.2.2 Apparatus

The focus group interviews took place in different rooms, but with a similar setting. There were two tables placed aside from the other tables with six chairs where the participants and the leader sat down. The microphone array used to record the session was placed in the middle of the table and a video recorder was placed in the corner to have a back up for sound or for situations that required a review of the video material to deduce the meaning of a quote. Furthermore, a laptop was placed at the location of the leader to monitor the audio recordings and to start the Neurotiq Social and to show the visualisations. There were two Neurotiq Socials used in the focus groups.

7.2.3 Procedure

7.2.3.1 Focus group interview

The participants were asked to prepare before the focus group interviews by reading up on the topic. The mail sent can be found in appendix E.1. The procedure can be found in appendix E.2 and the consent form can be found in appendix E.3. In general, there were three phases, the experimental phase, the discussion of the experiment and the general discussion. The experimental phase was the phase in which two of the participants volunteered to wear the Neurotiq Social and did a six-minute exercise in which they did the following:

1. Continue talking and doing what they were doing before wearing the Neurotiq Social.
2. Close their eyes and relax
3. Serially subtract 7 from 1000 (Fitzgibbon et al., 2004)

These three tasks were chosen for the following reasons: the first because it would allow the wearers and observers to get used to the Neurotiq Social and set up a baseline. The second task because it should trigger a lot of alpha activity and the last task because if should trigger a lot of gamma activity according to Fitzgibbon et al. Since the activity would change the observers should be able to distinct between the different tasks and get a sense of the use of the Neurotiq Social. After these six minutes the wearers and observers were asked to discuss the observations (phase two) and experiences and were shown a figure in which the brain activity was shown over the whole two minute tasks rather than the livestream of the Neurotiq Social. Figure 7.1 shows an example of such a visualisation, showing a clear increase in alpha (green) in the second task and gamma (purple) in the third task.

Figure 7.1: The Neurotiq Social EEG representation of the focus group tasks from left to right

After this discussion the participants were asked to discuss the idea of such a wearable in general. Since the input of the groups differed, the questions also differed

but the main lines were: What do you think of the Neurotiq Social and what would you change? In what situations would you use the Neurotiq Social? What do you think of ISDs?

7.2.3.2 Analysis focus group interviews

The method to analyse this focus group data is based on the work of Rabiee and Krueger & Casey. Since Rabiee based his framework upon Krueger & Casey's the focus will lie upon the framework of Rabiee.

There are some important characteristics a focus group should have before it functions optimally. The first is the participants, those should feel comfortable around each other, have similar characteristics and should have something to say. The optimum size of a focus group differs, but around six people should be manageable. Rabiee (2004, p.656) describes this as large enough to gain a variety of perspectives and small enough not to become disorderly or fragmented. Also the environment, physical as well as social, should make the participants feel at home and relaxed so they feel free to talk about the subject in a personal matter (Rabiee, 2004).

Appendix E.1 shows the mail sent to the participants to inform them about the procedure and give them more information about wearables and the Neurotiq Social and the procedure that follows once the participants arrive. This procedure is based on the guidelines of Krueger & Casey (2001).

The data from the focus group is all spoken words on a recording, to analyse these recordings they needed to be transcribed. Rabiee (2004, p.657) describes the analysis process as follows: "The process of qualitative analysis aims to bring meaning to a situation rather than the search for truth focused on by quantitative research.". There are five key stages to the analytical process: familiarization; identifying a thematic framework; indexing; charting; mapping and interpretation (Rabiee, 2004).

familiarization By reading the transcripts multiple times, watching and listening to the tapes and reading the notes from the focus group the researcher gets familiar with the data. This way the researcher gets a sense of the whole discussion before breaking the interview into parts (Rabiee, 2004).

identifying a thematic framework After reading the text multiple times ideas and concepts arise from the text, in this phase these ideas are written in the side line still following the chronological order of the questions.

indexing In this phase quotes are highlighted and sorted, based on the concept of Krueger & Casey (2001). This research used open coding to create and analyse the concepts

charting The quotes from the previous stage are lifted from their original context and placed on the formed concepts and categories. Together with the previous steps, these steps are used to reduce the data (Rabiee, 2004).

mapping and interpretation Once the data is reduced and sorted the task is to make a whole of the separate quotes. To do this there are certain concepts to keep in mind: words; context; internal consistency; frequency and extensiveness of comments; specificity of comments; intensity of comments; big ideas (Rabiee, 2004).

After transcribing the script, reading the whole script and applying open coding, the concepts are placed into a network showing the relations between the several concepts. In the following section these codes and their relations are placed into a complete text.

7.3 Result

This section describes the results of the focus group and is divided into two parts, being *inner state display& Neurotiq Social* and *social context.* These results correspond with the three main questions asked: What do you think of the Neurotiq Social and what would you change? In what situations would you use the Neurotiq Social? What do you think of ISDs? The concept that also played a major role in this focus group was the notion of acceptance, since this concept was crucial in all the three questions, it is discussed in all the sections.

7.3.1 Inner state display & Neurotiq Social

The general conclusion about inner state displays across both groups is that sharing your inner state like that is not yet accepted, although the participants see the opportunities in the future. The major remark made in this discussion is that the Neurotiq Social would not be something the participants would wear. The Neurotiq Social is considered distracting and not fitting with the participants' wardrobe. The participants were positive regarding the visualisation of the measured EEG and were able to make some sense of the visualisation. They also thought that analysing the data afterwards would have a benefit for themselves, but not with a display. This understanding was one of the major remarks considering the Neurotiq Social and the usage of EEG. The interpretation of the EEG and the corresponding colours was difficult and ambiguous due to the nature of the frequency bands and the fast changing colours.

The participants found the Neurotiq Social too different from what they were used to and too distracting but came with suggestions and improvements to create an inner state display they all regarded more positive and useful. An improvement to the Neurotiq Social could be to change the animation on the cap, the changing of the light was considered distracting and also hard to interpret. To make this easier the participants suggested to only display one colour on the head, or at least one colour per quadrant and make the animation between colours slower. Another suggestion was to show the colour that was most present over the last period of time, just like with the EEG visualisation. These changes would improve the Neurotiq Social, but another suggestion from both groups was to change from a cap towards something more subtle like a bracelet. This change would allow the wearer to wear it subtler and would lessen the distraction during conversations because there is less going on around the speakers face.

In general, the participants were not really in favour of inner state displays but the reasons differed. Some participants wanted an ISD that would be easier to interpret, such as a wearable showing the heart rate or another measurement of emotion, since it is easier to understand and respond to emotion than it is to respond to a visualisation of the cognitive activity. Others disagreed with this statement since showing something that would be easier to interpret also meant a bigger infringement on the privacy of the wearer. This concern was raised in both groups, that showing your inner state is a privacy violation, however they also considered it as the choice of the wearer

and realised that this might be weird now but could be more normal and accepted in the future.

7.3.2 Social context

As shown above the participants all have some reservation towards wearing an inner state display, this was most of all because it is not yet accepted, however the participants came up with some situations in which the Neurotiq Social and also ISDs in general could benefit society.

In general, none of the participants wanted to wear the Neurotiq Social, but in specific social contexts like education the Neurotiq Social might be useful. Both groups came with the same use case, using the Neurotiq Social to monitor the *attention span* of the class with students. This way the teacher could easily monitor the class. However due to the nature of the EEG bands the teacher would not be able to distinguish between someone who is concentrated and thinking about the lecture and someone who is focussed on a computer game. Another situation mentioned by both groups was in a therapy setting, where a psychologist or psychiatrist could use the Neurotiq Social as a tool to monitor the client and as a tool for the client to become more aware of his/her state of mind. The social context of meeting friends was also discussed by both groups and resulted in different opinions, part of the participants thought that the Neurotiq Social or a ISD could benefit social interaction by providing an extra source of information about the people they would be interacting with, other participants thought that the ISD would distract them from the conversation or make them judge a person based on the ISD instead of what the person was saying. Overall the participants doubt the usefulness of the Neurotiq Social in its current state in a social context. However with the changes suggested in the previous section and social contexts where there is a specific use ISDs could benefit society and could be accepted more and more until there is a society in which everybody wears a ISD and the ISD is an integrated part of social interaction.

7.4 Discussion and future work

The section above shows some general conclusion based on two focus groups. However, the conclusions were only based on the opinion of 10 participants and the participants did not agree with everything. To validate these results and to learn more about the acceptance of ISDs it is necessary to conduct more focus groups. These focus group should also include people with a less technical background. Almost all of the participants of this research study at the University of Twente and most of them study Technical Computer Science or a related subject such as Business & IT. Another improvement would be the use a microphone per participant, which would ensure that every comment is audible on the recording. Also the addition of someone who would take notes during the focus group and would provide the leader with follow up questions could increase the depth and detail of the answers. In general, this focus group yields valid and reliable results, however to reach a better understanding of the concepts that play a role more focus groups need to be conducted, and to validate those concepts more focus group interviews until the concepts stop changing. These focus groups are invaluable to the field of ISDs to gain insight in the road ahead for societal acceptance.

Chapter 8

Conclusion

The main research question of this thesis is as follows: “What is the influence of an inner-state display on empathy in a human-human interaction?”. The short and realistic answer to this question is that there is no influence of the tested ISD, the Neurotiq Social, on empathy in human-human interaction. This question was answered in the main experiment, which showed no significant differences between the control and experimental condition regarding the displayed altruism.

To provide an answer to the second research question: “What is the attitude towards an inner-state display, focussing on the acceptance and usability?”, conclusions are mainly deducted from the focus group. First of all, the Neurotiq Social is especially interesting because of the monitoring feature of the MUSE more than because of the showing and sharing feature, which means that the attitude is positive towards EEG headsets and not towards ISDs. Second of all, the users want to know what the ISD is visualising and what that visualisation means. Especially the latter is important because this increases the usefulness. This is probably the reason why the participants did not pay much attention to the Neurotiq Social in the main experiment, because they did not know enough about the visualisation to interpret the live visualisation. Third of all, an ISD should be subtle and fit into a user’s wardrobe and have the option to regulate what the user shares. Last, but not least, the benefits to society matter less to the individual if he or she is not comfortable sharing, which is the status quo in society at the moment. Even though people endorse the concept of extimacy more and more on social media platforms they are not ready to show their inner state with the Neurotiq Social and see the usefulness of inner state displays more as a monitoring device than a sharing social device. However, most remarks showed that there is a future imaginable in which everybody would wear some kind of ISD and that these ISDs would be an integral part of social interaction.

This research began to fill the void on the subject of wearables, inner-state displays and empathy. It showed a way to measure empathy and use an ISD. It started with gathering information on the attitudes of Dutch students towards ISDs. There is still a lot of research that needs to be done and the focus should lie upon the development of a framework about the attitudes towards ISDs. Developing such a framework is important because it allows designers and developers to create ISDs that are accepted and usable. The acceptance of ISDs will lead to an increase in usage of those ISDs and will enable research into the benefits of them in human-human interaction in the long term.

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Appendix A

Social Experiments to measure empathy

Game & Author	Description	Remarks
Dictator game Andreoni & Rao (2011)	The dictator game is a game in which one player has all the resources and is asked by the researcher to allocate these resources between him and another participant. In the original version the allocator is not allowed to talk to the receiver. In the version of Andreoni & Rao (2011) the talking schedule differs	Empathy can be measured as a function of the allocated resources. Andreoni & Rao (2011) showed that when the receiver could communicate with the allocator more funds were given to the receiver. In this research the heads could serve as a way of interaction, and could increase the funds given to the receiver.
Prisoners dilemm Twenge et al. (2007)	The prisoners dilemma by Rapoport & Chammah is a game in which the choice the one person makes influences the outcome for the other person. This game is used to measure cooperative responses.	Since this game is mostly used to measure cooperative responses it might be harder to link this to empathy.
Ultimatum game Page (2002)	The ultimatum game is a different take on the dictator game. This game allows to receiver to refuse the offer made by the allocator. If the receiver refuses the offer, both go home with nothing.	This game can measure the empathy the same way the dictator game can, but by introducing the refusing clause into the equation selfishness also plays a role since the allocator also want to take money home. So the reason to give is not purely altruistic.
Light game Swingle (1966)	Contrary to the previous games Swingle (1966) introduces a game that is not used in experimental economics. This game has two players who both have buttons in colours and leds that light up in a certain order. This order is the order that the other player should push. If the other player correctly pushes the order this playes scores a point. The goal is to obtain the most points.	This game has a similar remark as the previous one, there is personal interest in helping the other player, because that other players has to help you and provide you with the correct information This game might be interesting since it is not a game that has been used very often but might have some interesting mechanics.
Pencils Twenge et al. (2007)	A measurement used by Twenge et al. (2007) to measure pro social behaviour is helping after a mishap. The idea is that the researchers throws pencils on the ground and the count of pencils picked up by the participant is a measurement of pro social behaviour.	In this thesis one participant could be briefed to do this at the end of the experiment and the other participants empathy could be measured as a function of pro social behaviour.
Seating BURGOON & JONES (1976)	Seating is not really a game, but similar to pencils a measurement to measure personal space. People choose their seating place based on a lot of different factors, and one of these factors in how well people know each other.	Measuring the seating pre and post experiment could indicate whether the participants felt closer to each other after the experiment.

Table A.1: Measurements for empathy/altruism suggested by literature

Appendix B

Materials colour experiment

B.1 Consent form

CONSENT FORM

Participant no.

Doel : Masterthesis Human Media Interaction
Onderzoeker: Anne-Greeth van Herwijnen

Uitleg: In dit onderzoek word je gevraagd om bij ieder woord een kleur te zoeken die jij daar het beste bij vind passen. Je mag een kleur aan meerdere woorden toewijzen. Je mag **niet** meerdere kleuren aan één woord toewijzen. Je wordt gevraagd om dit twee keer te doen. Ga beide niet met elkaar vergelijken. Dit onderzoek is bedoeld om kleurinterpretatie vast te stellen bij Nederlandse studenten.

Kruis de vakjes aan (x)	
1. Ik heb de uitleg gelezen en begrijp dat ik tijdens het experiment vragen mag stellen.	
2. Ik begrijp dat ik op ieder moment kan stoppen zonder daar uitleg voor hoef te geven. Mijn data zal dan geen onderdeel uitmaken van het onderzoek.	
3. Ik geef toestemming dat mijn data gebruikt mag worden voor het doel van dit onderzoek.	
4. Mijn data mag ook voor verder onderzoek in het onderzoeksgebied van Human Media Interaction worden gebruikt.	

_____
Naam van de participant

_____ _____
Handtekening participant Datum

_____ _____
Handtekening onderzoeker Datum

Demografische vragenlijst: Kruis aan wat van toepassing is

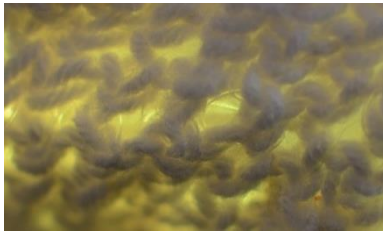
Geslacht: ☐ man ☐ vrouw ☐ anders, namelijk …….

Leeftijd: ……

Kleurenblind: ☐ ja ☐ nee ☐ weet ik niet

B.2 Questionnaire colour experiment

The questionnaire below shows one of the versions of the questionnaire used in the colour experiment.



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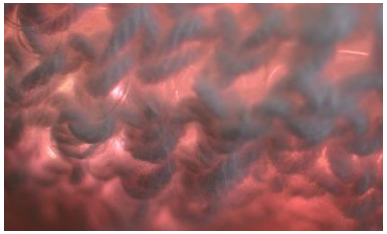

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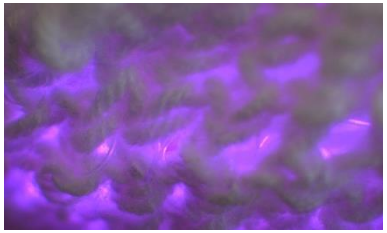

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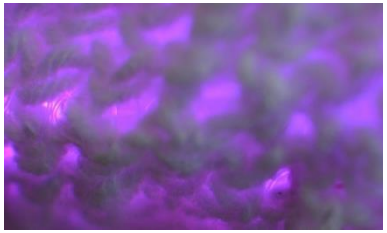

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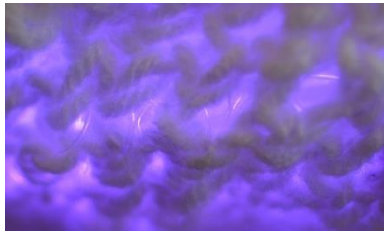

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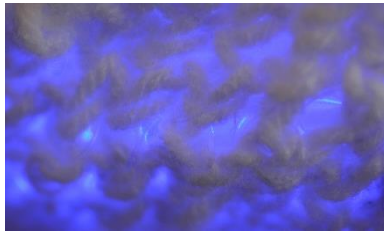

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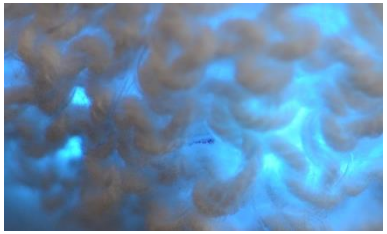

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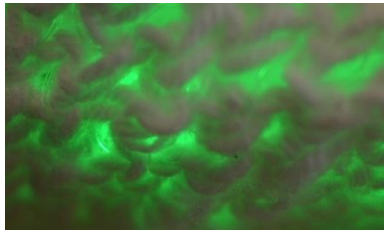


11

12

Schrijf achter ieder onderstaand woord het nummertje van de bijpassende kleur. Je mag een kleur vaker dan een keer gebruiken.

Diepe slaap:

Dagdromen:

Alert:

Nadenken:

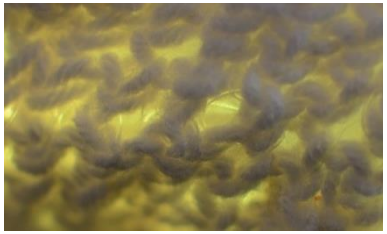
Creativiteit:

Slaperig:

Oplossen van problemen:

Concentratie:

Ontspannen:



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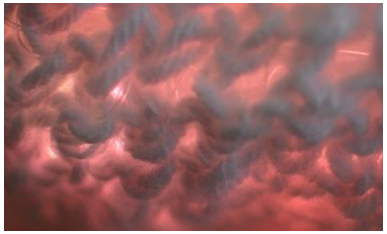

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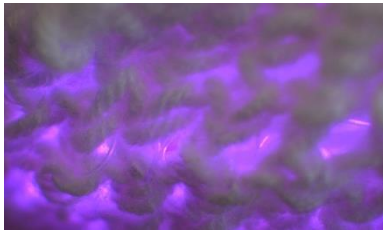

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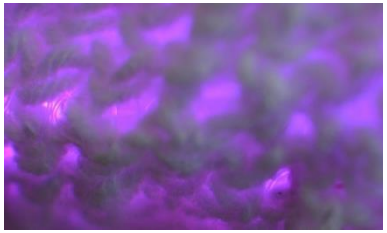

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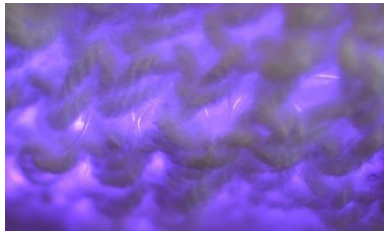

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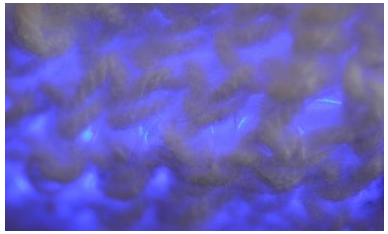

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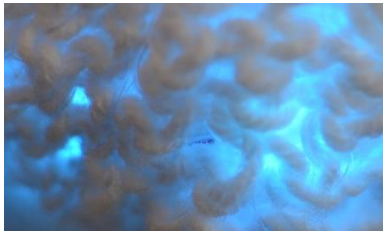

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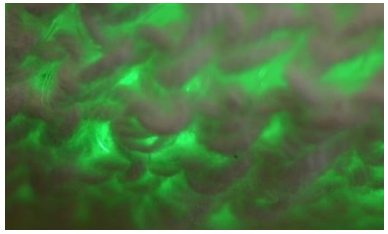


11

12

Schrijf achter ieder onderstaand woord het nummertje van de bijpassende kleur. Je mag een kleur vaker dan een keer gebruiken.

Vreugde:

Verdriet:

Angst:

Woede:

Verbazing:

Afschuw:

Bewondering:

Afgunst:

Liefde:

Trots:

Spijt:

Schaamte:

Appendix C

Graphs colour experiment

C.1 BCI words

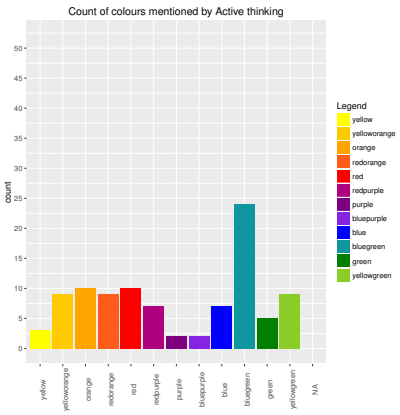


Figure C.1: Graph of distribution responses to the concept of active thinking

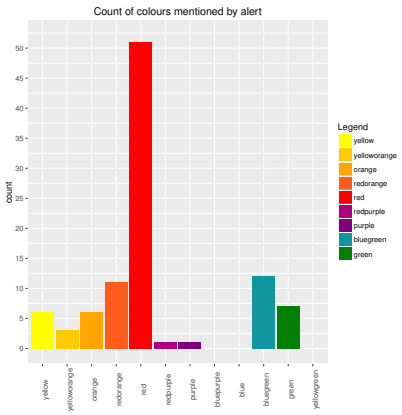


Figure C.2: Graph of distribution responses to the concept of alert

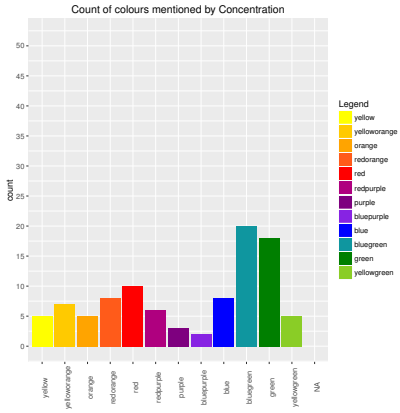


Figure C.3: Graph of distribution responses to the concept of concentration

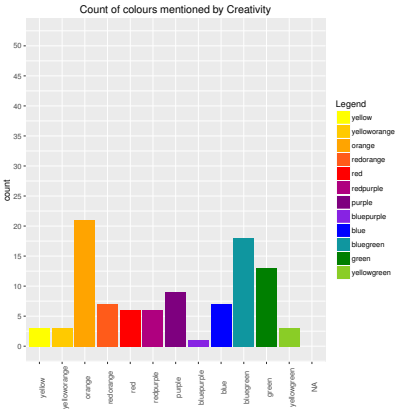


Figure C.4: Graph of distribution responses to the concept of creativity

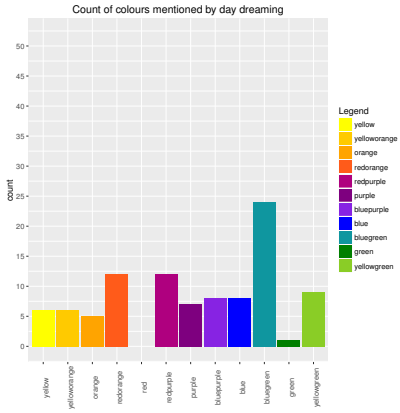


Figure C.5: Graph of distribution responses to the concept of daydreaming

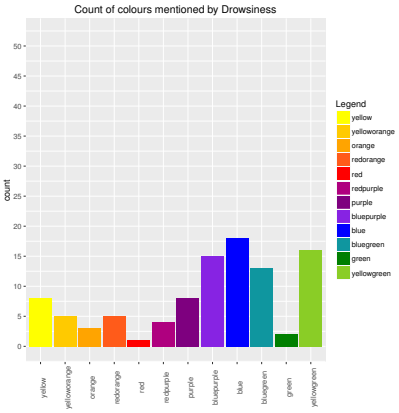


Figure C.6: Graph of distribution responses to the concept of drowsiness

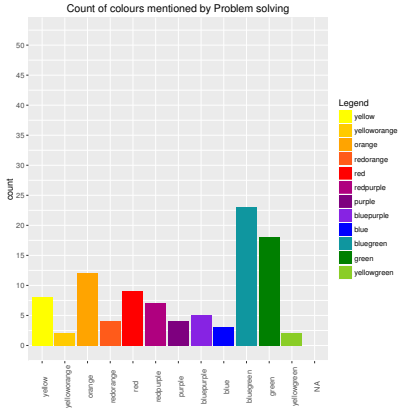


Figure C.7: Graph of distribution responses to the concept of problem solving

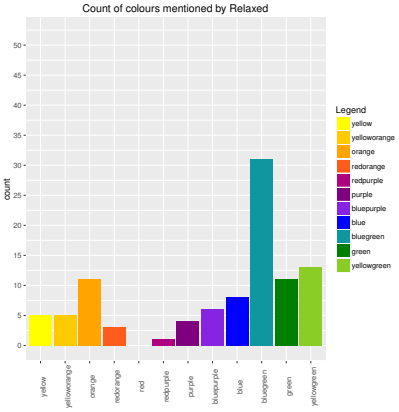


Figure C.8: Graph of distribution responses to the concept of relaxed

C.2 Emotion

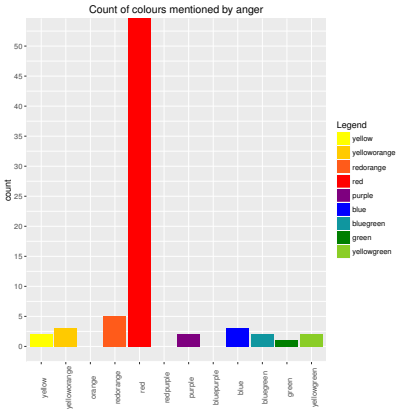


Figure C.9: Graph of distribution responses to the concept of anger

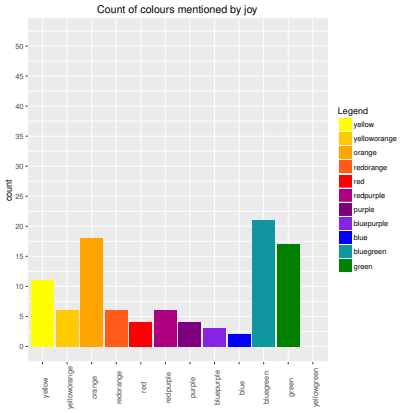


Figure C.10: Graph of distribution responses to the concept of joy

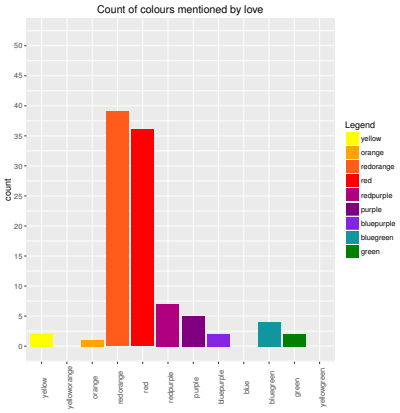


Figure C.11: Graph of distribution responses to the concept of love

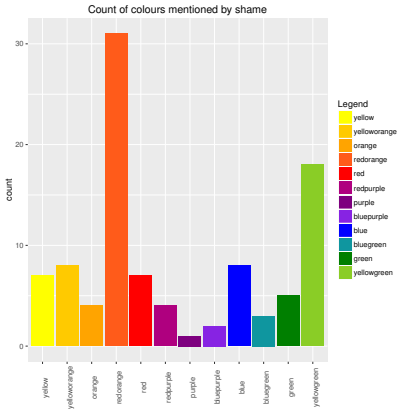


Figure C.12: Graph of distribution responses to the concept of shame

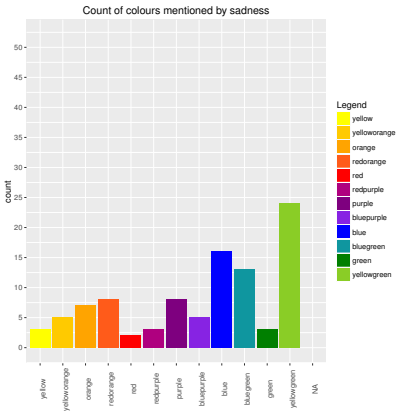


Figure C.13: Graph of distribution responses to the concept of sadness

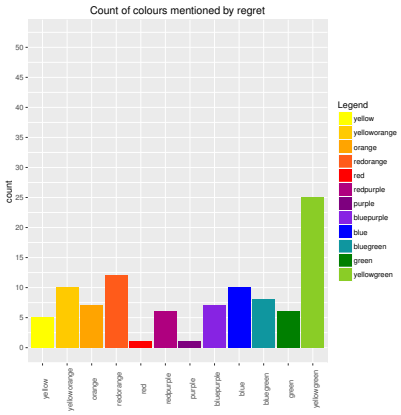


Figure C.14: Graph of distribution responses to the concept of regret

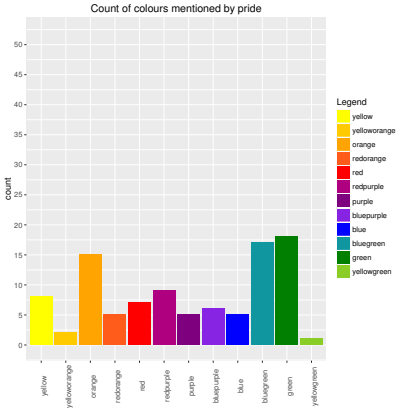


Figure C.15: Graph of distribution responses to the concept of pride

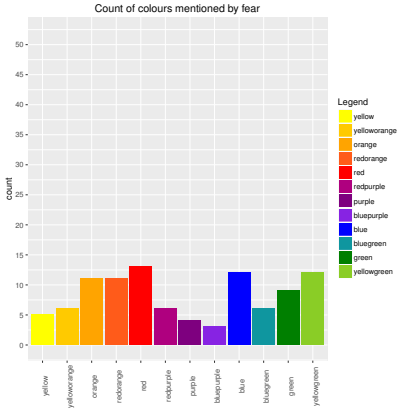


Figure C.16: Graph of distribution responses to the concept of fear

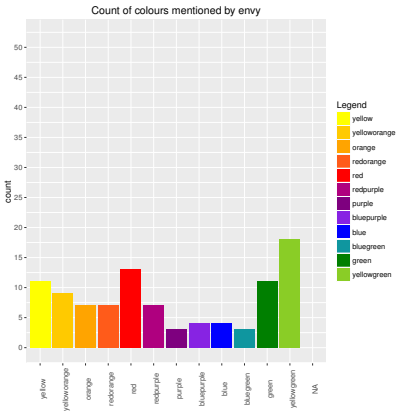


Figure C.17: Graph of distribution responses to the concept of envy

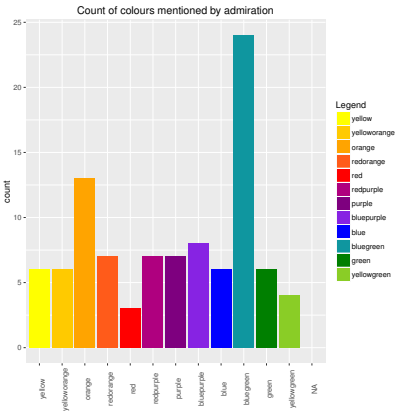


Figure C.18: Graph of distribution responses to the concept of admiration

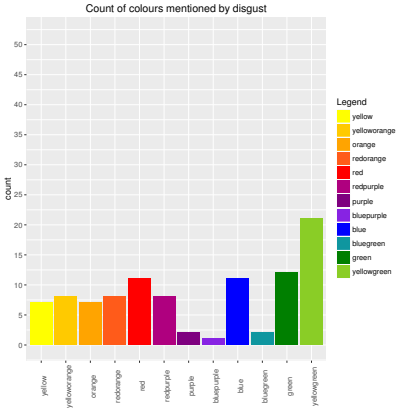


Figure C.19: Graph of distribution responses to the concept of disgust

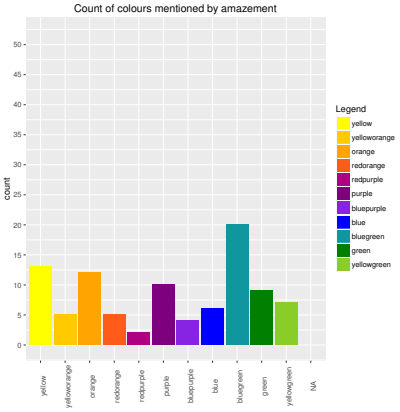


Figure C.20: Graph of distribution responses to the concept of amazement

Appendix D

Materials main experiment

D.1 Consent form

CONSENT FORM

Participant no.

Doel : Masterthesis Human Media Interaction
Onderzoeker: Anne-Greeth van Herwijnen
Begeleider: Khiet Truong

Uitleg: Dit onderzoek bestaat uit vier delen. Het eerste deel is een vragenlijst, het tweede deel is een spel, het derde deel is een vragenlijst en het vierde deel is een user-experience test.

Kruis de vakjes aan (x)	
1. Ik heb de uitleg gelezen en begrijp dat ik tijdens het experiment vragen mag stellen.	
2a. Ik geef toestemming voor het maken van audio en video opnames tijdens dit experiment	
2b. Ik wil onherkenbaar gemaakt worden als mijn video opnames worden gebruikt tijdens een presentatie of in een paper.	
3. Ik begrijp dat ik op ieder moment kan stoppen zonder daar uitleg voor hoef te geven. Mijn data zal dan geen onderdeel uitmaken van het onderzoek.	
4. Ik geef toestemming dat mijn data gebruikt mag worden voor het doel van dit onderzoek.	
5. Mijn data mag ook voor verder onderzoek in het onderzoeksgebied van Human Media Interaction worden gebruikt.	

_____
Naam van de participant

_____ _____
Handtekening participant Datum

_____ _____
Handtekening onderzoeker Datum

D.2 Dictator game instructions and ballot

D.2.1 Dictator instructions

Jij bent de verdeler en jouw rol is: Jij hebt 100 lootjes. Met deze lootjes maak je aan kans op een bol.com bon van 20 euro. Deze lootjes mag je verdelen over jullie beide. De ontvanger mag niets zeggen. Je mag de lootjes zo verdelen als jij wilt. Je schrijft de verdeling op het papiertje en de uitleg waarom je het zo verdeeld. Als je het papiertje hebt ingevuld lees je hardop voor wat er op het papiertje staat. De ontvanger mag hier niet op reageren. Daarna mag je weer plek nemen achter je iPad en verder gaan met de vragenlijst

D.2.2 Receiver instructions

Jij bent de ontvanger en jouw rol is: In dit onderdeel worden 100 lootjes verdeeld. Met deze lootjes maak je kans op een bol.com bon van 20 euro. Voor dit deel van het experiment moet je zwijgen. Je mag niets zeggen of vragen aan de andere participant. Je mag wel dingen vragen aan de onderzoeker of het experiment stoppen. Als de verdeler heeft uitgelegd hoeveel lootjes hij jou heeft gegeven en waarom mag je weer plaats nemen achter je iPad en de vragenlijst afmaken

D.2.3 Ballot

Ik, de verdeler geef ..... van de 100 lootjes aan de ontvanger. Ik verdeel dit zo omdat:

D.3 Procedure

Draaiboek NeurotiQ experiment

Gebruikte materialen:

- 2 Cameras
- 2 iPads
- Doeken
- Schot
- Verwelkom beide participanten: “Welkom, leuk dat jullie meedoen aan dit experiment. Jullie mogen nu plaats nemen en het consentform doornemen.”
  - De plek waar de participant gaat zitten bepaald of hij/zij dictator of ontvanger is.
    * Consentforms zijn van tevoren genummerd met 1V & 1O en dan 2V & 2O
  - De conditie Neurotiq of Muse word van tevoren door middel van kop of munt bepaald. Kop = Neurotiq, Munt = Muse

- Participanten lezen de concentforms door en vullen deze in.
  - Als er toestemming gegeven word voor opnames worden op dit punt de camera's gestart en gesynchroniseerd door middel van een hard klap, te zien op alle camera's.
- De onderzoeker legt het experiment uit: "Dit experiment bestaat ook drie delen, maar eerst zetten we de Muse (of Neurotiq) op en controleren of deze goed zit.
  - De Muse is een headset die EEG signalen meet. De Neurotiq visualiseert deze EEG signalen met licht. Hier is ook de legenda bij de Neurotiq, deze legenda geeft aan welke kleuren de neurotiq kan vertonen en bij welke frequentieband de kleur wordt vertoond.
    * Muse opzetten en controleren of deze goed zit en Neurotiq aansluiten
      · Als de verbinding nog niet goed is, aanwijzingen geven over waar deze nog niet goed is, of met een doekje de Muse afnemen.
- Uitleg: "Het volgende wat je nu gaat doen is de vragenlijst die klaarstaat op de computer. Deze mogen jullie invullen tot het scherm waarop staat: "Je bent klaar met het eerste deel van de vragenlijst, wacht op instructies van de onderzoeker." Tussendoor mogen jullie altijd vragen stellen."
  - Geef aan als je bij de pagina bent waarop staat: Je bent klaar.
- De participanten vullen de vragenlijsten in met de Neuro/Muse op.
  - Vragenlijst deel 1:
    * Demografische variabelen: Leeftijd, geslacht, kleurenblindheid
    * Inclusion of Other in the Self Scale (IOSS)
    * Persoonlijkheidstest: EPQ (Eysenck Personality Questionnaire)
- De participanten bereiken de pagina: "Je begint nu aan deel 2" . De participants geven dit aan en de onderzoeker zegt: "Jullie mogen nu plaats nemen en de Neurotiq neerleggen bij de ander z'n plek. Verder liggen er papiertjes die vertellen wat jullie moeten doen.
  - Verdeler krijgt papiertje met daarop de volgende tekst:
    * Jij hebt 100 lootjes. Met deze lootjes maak je aan kans op een bol.com bon van 20 euro. Deze lootjes mag je verdelen over jullie beide. De ontvanger mag niets zeggen. Je mag de lootjes zo verdelen als jij wilt. Je schrijft de verdeling op het papiertje en de uitleg waarom je het zo verdeeld. Als je het papiertje hebt ingevuld lees je hardop voor wat er op het papiertje staat. De ontvanger mag hier niet op reageren. Daarna mag je weer plek nemen achter je iPad en verder gaan met de vragenlijst
  - Ontvanger krijgt een papiertje met daarop de volgende tekst:
    * In dit onderdeel worden 100 lootjes verdeeld. Met deze lootjes maak je kans op een bol.com bon van 20 euro. Voor dit deel van het experiment moet je zwijgen. Je mag niets zeggen of vragen aan de andere participant. Je mag wel dingen vragen aan de onderzoeker of het experiment stoppen. Als de verdeler heeft uitgelegd hoeveel lootjes hij jou heeft gegeven en waarom mag je weer plaats nemen achter je iPad en de vragenlijst afmaken.

- De participanten maken het tweede deel van de vragenlijst:
  - Deel 2
    * IOSS
    * Het empathiequotiënt (EQ)
    * Open vragen over de ervaring (alleen in de Neurotiq conditie)
      · Beïnvloedde de Neurotiq het beeld wat jij van de ander had en hoe?
      · In wat voor situaties zou jij de Neurotiq Social gebruiken?
      · Wat is de betekenis van de kleuren van de Neurotiq Social?
      · Opmerkingen
    * Open vragen aan de dictator
      · Beïnvloedde de wetenschap dat de ontvanger je inner-state kon zien je beslissing over het verdelen van het geld?
      · Beïnvloedde het feit dat jij de inner-state van de ontvanger kon zien beslissing over het verdelen van het geld?
  - De participanten geven aan klaar te zijn met de vragenlijst.
  - De onderzoeker debrieft de participanten: “Dit onderzoek is gebaseerd op de dictator game. Deze game is gebruikt om een mate van altruïsme te meten in de vorm van de hoeveelheid geld die is weggegeven. De onderzoeksvraag is of het zien van iemands inner-state, wat gebeurd door de Neurotiq altruïsme kan beïnvloeden. De groep zonder de Neurotiq is gebruikt om te kijken of alleen de aanwezigheid van een stukje technologie ook al een samenbindend effect heeft. Zijn er nog vragen?”

D.4 Results ballot

This section shows the results of the ballots filled in by the participants. Since the participants filled those ballots in in Dutch this section shows the non-translated ballot text.

Table D.1: Text written on the ballots by the dictators

Couple number	Lottery tickets given away	Explanation
1	50	“Ik dat het meest eerlijk vind. Zo hebben we allebei dezelfde kans op die bon ene heeft niemand recht om te zeuren.”
2	50	“Ik iedereen een eerlijke kans wil geven”
3	50	“Lijkt me wel zo eelijk, we doen allebei hier aan mee.”
4	50	“Beide evenveel tijd er in gestoken.”

Couple number	Lottery tickets given away	Explanation
5	50	“Ik vind dat ik niet meer of minder kans zou moeten maken dan de ander.”
6	50	“Beide evenveel kans”
7	50	“Hij er evenveel tijd en moeite in heeft gestoken als ik en dat me eerlijk lijkt.”
8	50	“Dat eerlijk is. Het is niet zo dat een van ons beiden meer zou verdienen, nu maken we evenveel kans.”
9	50	“We dan allebei een eerlijke kans maken op de bol.com bon. En persoonlijk vind ik het leuk als ik de ban win, maar zoveel boeit het mij ook weer niet. Als de ontvanger de bon windt vind ik het ook leuk, want dan heb ik de ontvanger blij gemaakt.”
10	30	“Er op deze manier toch nog een grote kans voor de ontvanger is om de prijs te winnen maar mijn kansen net wat hoger liggen.”
11	50	“Dit eerlijk is.”
12	100	“De bon voor mij weinig meerwaarde heeft ook al waardeer ik de intentie. Ook geeft dit mij het gevoeld dit “project”[1] af te hebben gesloten omdat ik dan geen aandeel heb in de loting.”
13	50	“De kansen dan het eerlijkst verdeeld zijn”
14	80	“Ik het vermoeden heb niet zoveel aan een bol.com bon te hebben en daarom liever iemand anders de kans geef bij bol.com iets te bestellen. Een 80/20 verdeling is denk ik prima, er is een kans ongeveer even groot als mijn verlangen om hem toch te winnen.”
15	50	“Het het eerlijkst is, dan hebben we beiden evenveel kans.”

[1]These quotes were placed by the dictator themselves

Couple number	Lottery tickets given away	Explanation
16	50	“Dit eerlijk is en we dan even grote kans hebben op de bon.”
17	50	“Ik ken je niet, dus wel zo eerlijk. Zo hebben we beide evenveel kans.”
18	100	“Ik niet van plan ben iets op bol.com te kopen, en verwacht dat de ontvanger er meer plezier van zal hebben.”
19	55	“Ik niet aan de ene kant niet alles weg wil geven, maar aan de andere kant geen egoïstische indruk wil achterlaten.”
20	50	“Ik vind het belangrijk dat we gelijke kansen hebben in deze ’loterij’[1]. Ook al ken ik de ontvanger niet, dan nog vind ik dat ik niet recht heb op meer lootjes dan hij. We doen tenslotte beide mee aan dit onderzoek waarbij de een niet belangrijker is dan de ander, dus verdienen we gelijke kansen.

D.5 Figures of the questionnaires of the main experiment

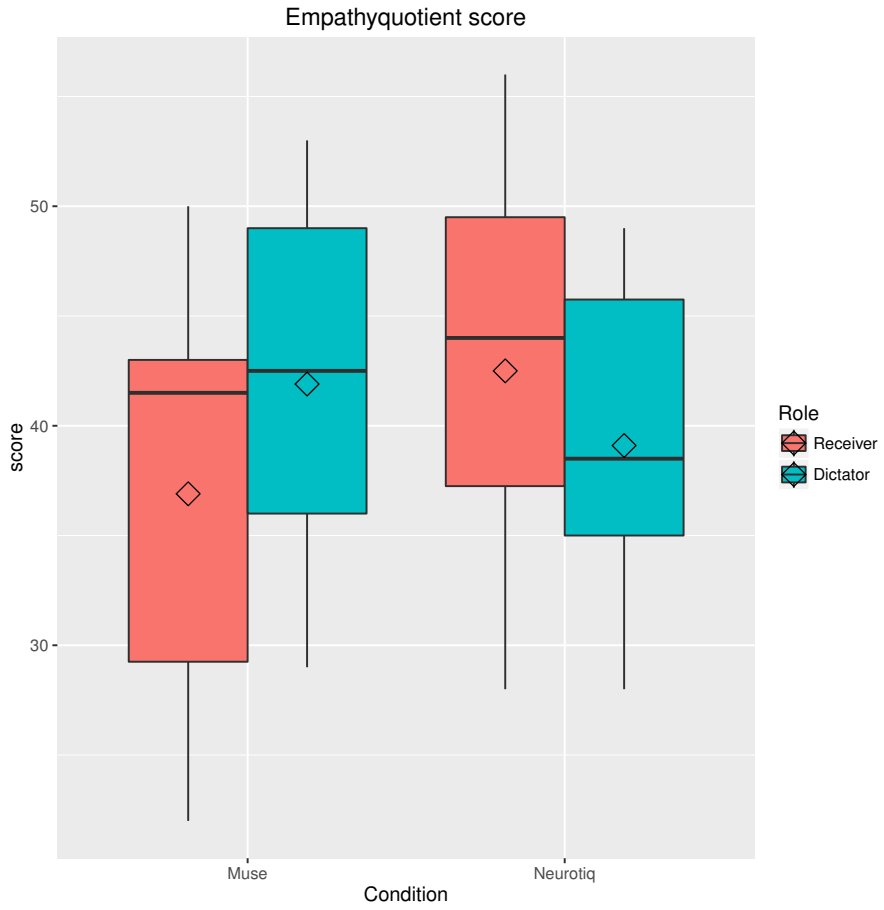


Figure D.1: Empathy quotient score by condition and role
◇ = mean

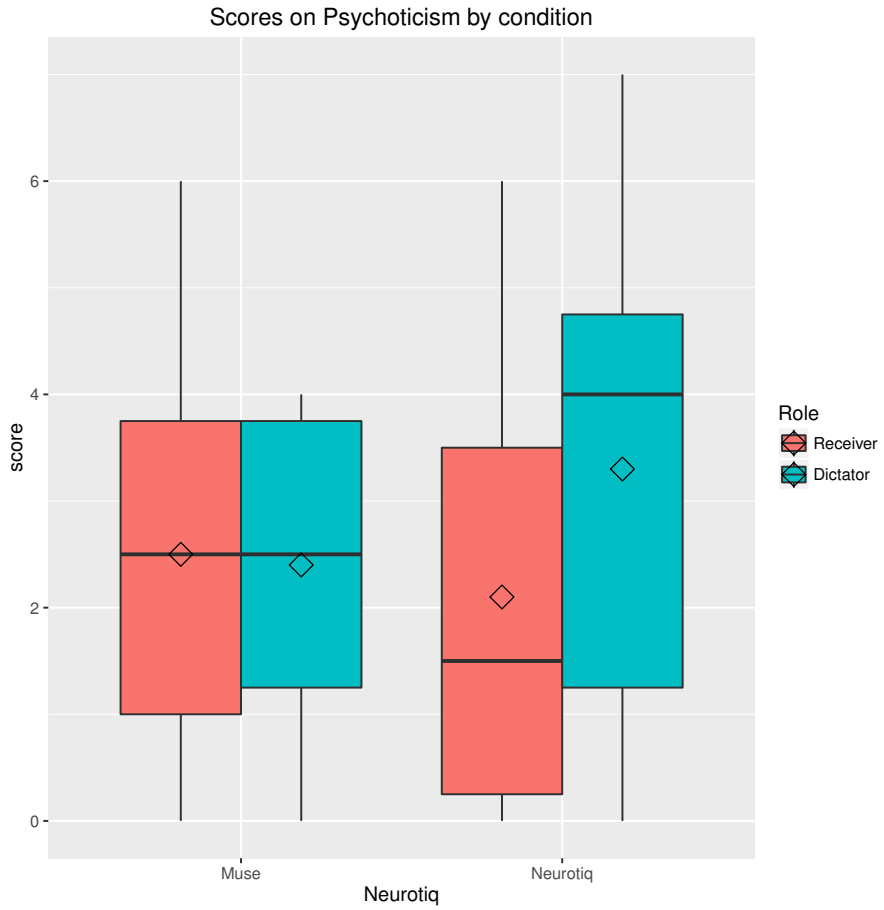


Figure D.2: EPQ psychoticism boxplot by condition and role
◇ = mean

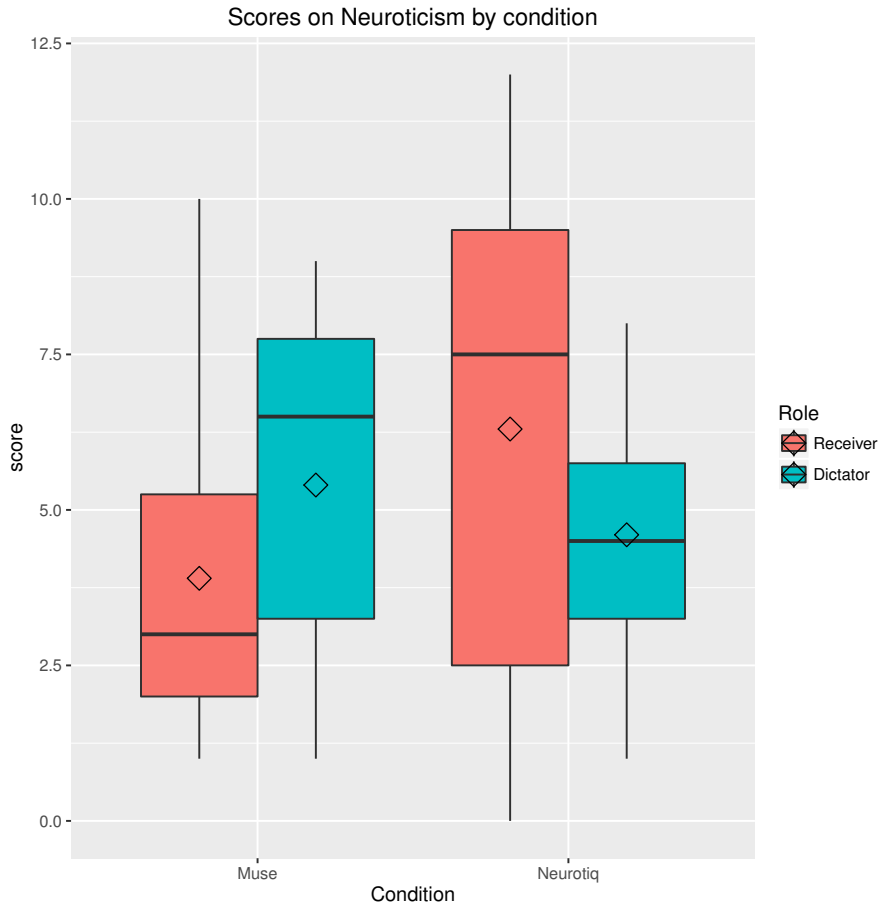


Figure D.3: EPQ neuroticisim boxplot by condition and role
◇ = mean

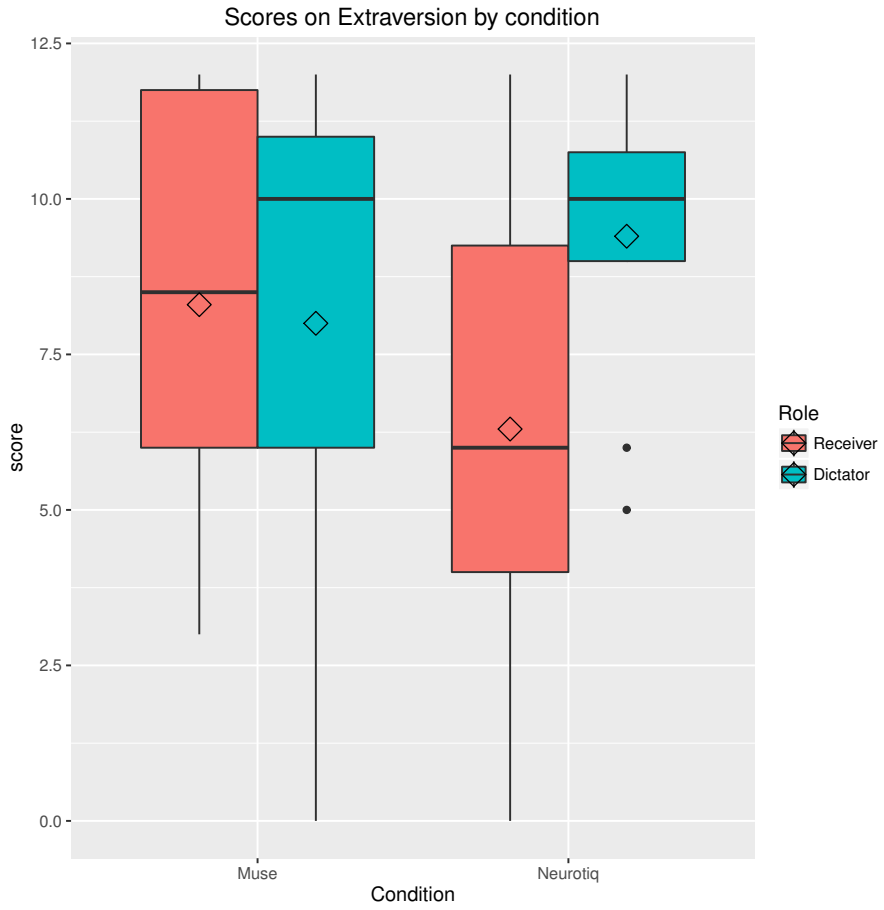


Figure D.4: EPQ extraversion boxplot by condition and role
◇ = mean

Appendix E

Focus group materials

Mail naar participaten met de onderwerpen vooraf

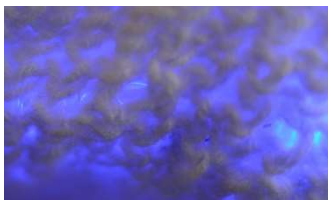
E.1 Mail

Beste participant,

Je krijgt deze mail omdat je aan hebt gegeven mee te willen doen met de focusgroup over wearables en de Neurotiq op *[Datum en tijd invullen]*. De focusgroup zal ongeveer 1,5 tot 2 uur duren. Om er een goede discussie van te maken is het belangrijk dat je je even inleest/voorbereid op het onderwerp, dit kost niet zo heel veel tijd. Sensoree is een bedrijf in Amerika die voornamelijk wearables maakt die een bepaalde lichaamfunctie laten zien aan de omstanders. Als je hier meer over wilt weten kun je kijken op deze website: www.sensoree.com. Een van de artifacts waarvan je tijdens de focusgroup een versie zult testen is de Neurotiq. Deze zal er tijdens de focusgroup iets anders uitzien maar de functie is het zelfde.

De Neurotiq werkt op basis van EEG frequenties, hieronder vind je een omschrijving van die banden en de daarmee geassocieerde functies. De kleuren zijn de kleuren die de Neurotiq aanneemt als die hersenband actief is in dat bepaalde deel van je hersenen.

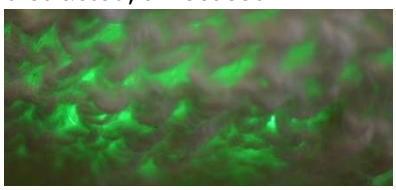
- Delta 0.1 – 3 Hz
  - Subjective feeling states: deep, dreamless sleep, non-REM sleep, trance, unconscious
  - Associated tasks & behaviours: lethargic, not moving, not attentive



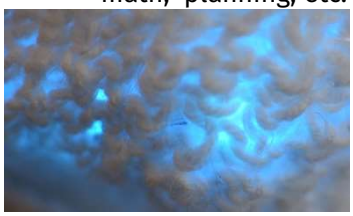
- Theta 4 – 7 Hz
  - Subjective feeling states: intuitive, creative, recall, fantasy, imagery, creative, dreamlike, switching thoughts, drowsy; "oneness", "knowing"
  - Associated tasks & behaviours: creative, intuitive; but may also be distracted, unfocused

- Alpha 8 – 12 Hz
  - Subjective feeling states: intuitive, creative, recall, fantasy, imagery, creative, dreamlike, switching thoughts, drowsy; "oneness", "knowing"

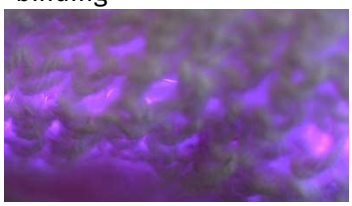
- Associated tasks & behaviours: creative, intuitive; but may also be distracted, unfocused



- Beta 13 – 40 Hz
  - Low Beta 13 – 15 Hz
    - Subjective feeling states: relaxed yet focused, integrated
    - Associated tasks & behaviours: Typically resting yet alert when Low Beta is present.
  - Midrange Beta 15 – 18 Hz
    - Subjective feeling states: thinking, aware of self & surroundings
    - Associated tasks & behaviours: mental activity
  - High Beta 18 – 40 Hz
    - Subjective feeling states: alertness, agitation
    - Associated tasks & behaviours: mental activity, e.g. math, planning, etc.



- Gamma > 40 Hz
  - Subjective feeling states: thinking; integrated thought
  - Associated tasks & behaviours: high-level information processing (such as learning words and doing repetitive subtraction tasks), "binding



Als je vragen hebt mag je die altijd stellen en dan zie ik je op *DATUM* in de *LOCATIE*

Met vriendelijke groetjes,
Anne-Greeth

E.2 Procedure

Participanten: 6 mensen uit het sociale milieu van de onderzoeker, mensen die elkaar kennen en durven hun mening te geven.

Participanten arriveren, wat te drinken aanbieden (Water + glazen hebben staan)

1. consentforms
    a. Starten opnames
2. Welkom
    a. Welkom allemaal, ik ben Anne-Greeth en zal deze focusgroup leiden en dit is, , hij zal notities maken en er voor zorgen dat ook alle technische dingen goed lopen. Bedankt dat jullie allemaal de tijd nemen om hier aan mee te doen, we gaan het vandaag hebben over wearables, zoals jullie al in de mail hebben kunnen lezen. Het doel is om meer te weten te komen over hoe studenten denken over wearables die je innerlijke staat laten zien en in het specifiek over de Neurotiq Social.

       Jullie zijn uitgenodigd omdat jullie allemaal studenten zijn en natuurlijk een goede eigen mening hebben.

       Tijdens de discussie zijn er geen foute antwoorden, jullie kunnen natuurlijk wel van mening verschillen. Laat ieder in zijn waarde, en alle antwoorden zijn waardevol. Je mag natuurlijk wel op een ander reageren en discussiëren over het punt wat diegene aandraagt. We zijn erg geïnteresseerd in zowel de positieve als de negatieve meningen.

       We gaan alles wat hier gezegd wordt opnemen met de microfoon die in het midden staat. Praat dus niet teveel door elkaar. Zolang het goed gaat mogen jullie gewoon op elkaar reageren, maar af en toe zal ik ingrijpen als iemand niet aan het woord komt. Praat en discussieer vooral met elkaar in plaats van met mij. Jullie data zal anoniem verwerkt worden en gebruikt worden in mijn masterthesis over wearable inner-state displays.

       (Er zijn naambordjes zodat jullie elkaar met de voornaam aan kunnen spreken. We doen nu even een voorstelrondje over wie je bent en wat je studeert) → Alleen als mensen elkaar niet kennen.

    b. Proces uitleggen
        i. Uitleg Neurotiq + opdracht
        ii. Discussie
        iii. Afsluiting

       De focusgroup werkt als volgt, eerst krijgen twee van jullie de Neurotiq Social op en is de rest observator. De mensen met de Neurotiq krijgen drie opdrachten die ze alle 2 minuten lang uitvoeren. De eerste opdracht is gewoon doen waar ze al mee bezig waren, dat mag dus zijn met jullie praten of WhatsAppen. Vervolgens mogen ze 2 minuten lang met hun ogen dicht

ontspannen en daarna mogen ze in twee minuten tijd zo vaak mogelijk 7 van 1000 aftrekken. Ik tik iedere keer op de tafel als de twee minuten om zijn. Nadat dit gebeurt is krijgen jullie allemaal een visualisatie van die zes minuten en gaan we er over discussiëren. Vervolgens zijn er nog een aantal vragen en dan is er de debriefing.

3. Uitleg geven over de Neurotiq + hersenfrequenties
    a. Legenda → uitleg frequenties
    b. Kleuren

    Dit is de Neurotiq Social *[laten zien muts]*, als het goed is hebben jullie op de website uit de mail als wat gezien over de Neurotiq en in de mail ook wat kunnen lezen over EEG en frequentie banden. Ik zal kort nog even iets meer uitleg geven over de Neurotiq Social.

    De Neurotiq Social gebruikt de Muse *[Muse laten zien]*, een consumenten EEG headset, om EEG signalen te krijgen. Deze EEG signalen worden gemeten door deze twee elektroden *[Aanwijzen achter de oren]* en de twee elektroden hier *[aanwijzen voorhoofd elektroden]*. Het EEG signaal wordt ingedeeld in frequentiebanden die jullie ook op de legenda kunnen zien. Op de legenda *[Deelt legendag uit]* staat ook met welke mentale activiteit deze band wordt geassocieerd. De Neurotiq Social laat dus de mentale activiteit van een gebruiker zien. De Neurotiq zet die frequentie banden om in een lichtkleur en laat deze zien op een hersenquadrant.
4. Verdelen Neurotiqs en activeren

    Dan zoek ik nu twee vrijwilligers die de Neurotiq op willen en dan starten we het scriptje op de computer om te kijken of de Muse goed zit en dan zetten we de Neurotiq op. *[Doet bovenstaande]*
5. Opdrachten starten

    De opdrachten zijn dus als volgt, eerst twee minuten gewoon praten, daarna twee minuten ogen dicht en ontspannen en daarna twee minuten 7 van 1000 aftrekken. Ik tik na iedere twee minuten op de tafel om aan te geven dat jullie aan de volgende opdracht mogen beginnen. De observers zijn tijdens dit experimentje gewoon stil.
    [Start EEG en start eerste opdracht, tikt daarna bij iedere twee minuten voor wissel van opdracht]
6. EEG visualisatie laten zien
    a. Op laptop EEG visualisatie laten zien, beide personen naast elkaar.
7. Bespreken EEG plaatje + ervaring

    Wat vinden jullie van dit plaatje?
    Hoe interpreteren jullie dit plaatje?
    Welke overeenkomst zien jullie tussen wat jullie geobserveerd hebben en het plaatje?

    Dan gaan we nu door met de vragen met betrekking tot wearables.
8. Vragen
    a. In wat voor situatie zou jij de Neurotiq zien?
    b. Wat zou jij veranderen aan de Neurotiq?
    c. Hoe denk je over het visualiseren van lichaamfuncties? (Misschien filmpjes laten zien van heart sync etc.)

i. In een sociale context
ii. Neurotiq specifiek
    1. Hoe voel je je er bij dat de neurotiq je inner-state laat zien?

De eerste vraag is: Hoe vind jij het als jouw lichaamsfuncties gevisualiseerd worden in een sociale context?
Wanneer zou jij het fijn vinden als een wearable je lichaamsfuncties laat zien?
In wat voor situaties zou jij de Neurotiq social dragen of gebruikt zien?
Wat zou je veranderen aan de Neurotiq?
Hoe denk jij dat de toekomst er uit ziet met betrekking tot inner-state-displays?

Wat vond je het belangrijkste in deze hele discussie?
Samenvatting:....
Zijn er nog dingen die je gemist hebt in de samenvatting of die je nu nog kwijt wilt over het onderwerp?

9. Afsluiting
   Bedankt dat jullie allemaal hebben meegedaan aan deze focusgroup. Je kunt je mailadres achterlaten als je de resultaten wilt ontvangen van deze focusgroup

CONSENT FORM

Participant no.

E.3 Consent form

Doel : Masterthesis Human Media Interaction
Onderzoeker: Anne-Greeth van Herwijnen
Begeleider: Khiet Truong
Uitleg: Dit onderzoek is een focusgroup wat betekent dat er gediscussieerd gaat worden over specifiek onderwerp. Het onderwerp is in dit geval de Neurotiq Social en het algemene concept van wearables die een inner-state laten zien.

De audio en video opnames zullen niet worden gedeeld op sociale media of worden verstrekt aan derden. De audio en video opnames zullen alleen worden gebruikt voor onderzoek en gedeeld worden met anderen als hier toestemming voor is verleend door middel van onderstaande vragenlijst.

Ik, de onderzoeker, heb een mondelinge en schriftelijke toelichting gegeven op het onderzoek. Ik zal resterende vragen over het onderzoek naar vermogen beantwoorden. De deelnemer zal van een eventuele voortijdige beëindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden.

Kruis de vakjes aan (x)	
1. Ik heb de uitleg gelezen en begrijp dat ik tijdens het experiment vragen mag stellen.	
2a. Ik geef toestemming voor het maken van audio en video opnames tijdens dit experiment	
2b. Ik wil onherkenbaar gemaakt worden als mijn video opnames worden gebruikt tijdens een presentatie of in een paper.	
3. Ik begrijp dat ik op ieder moment kan stoppen zonder daar uitleg voor hoef te geven. Mijn data zal dan geen onderdeel uitmaken van het onderzoek.	
4. Ik geef toestemming dat mijn data gebruikt mag worden voor het doel van dit onderzoek.	
5. Mijn data mag ook voor verder onderzoek in het onderzoeksgebied van Human Media Interaction worden gebruikt.	

_____
Naam van de participant

_____ _____
Handtekening participant Datum

_____ _____
Handtekening onderzoeker Datum