The Influence of Empathy on Emotion Perception: An Electroencephalogram (EEG) Experiment

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Abstract

Empathy is the ability to perceive and feel the emotional states of other people and serves as a base to subsequently act upon these feelings for instance by helping. Since empathy is not only important for social interactions but also for healthcare workers, the present study aimed to see if the relation between empathy and emotion perception was reflected in brain activity. Brain activity was measured with an Electroencephalogram (EEG). The sample consisted of 33 university students, which were divided into a high and a low empathy group according to their empathy scores on the Empathy Quotient (EQ-60) questionnaire. It was hypothesized that the LPP amplitude and the N170 amplitude differ between the high and low empathy groups after viewing positive and negative emotional pictures. Empathy was determined with the EQ-60, while emotion perception was assessed through the International Affective Pictures System (IAPS) task presented on a computer. Furthermore, EEG was applied to the participants during the IAPS task. Independent samples t-test revealed no significant differences regarding the LPP and N170 amplitudes between the high empathy and the low empathy group. This study concluded that there was no significant effect of empathy on emotion perception visible in the brain as reflected by the LPP and N170 amplitudes in EEG. Follow-up research is needed to further clarify the association between empathy and emotion perception reflected in EEG amplitudes.

Keywords: Empathy, Emotion Perception, EEG, EQ-60, IAPS, LPP amplitude, N170 amplitude

The Influence of Empathy on Emotion Perception: An Electroencephalogram (EEG) Experiment

Humans are the most intelligent and evolved species on earth regarding development (Vaughan, 2021). The question remains how did humans develop this intelligence and skills relatively quickly compared to other species and what distinguishes humans from other animals? Evolutionary theories focus on altruism as possible explanation mechanism (Tomasello et al., 2012). It is argued that humankind is a social species rooted in extensive social networks (Gazzaniga, 2000). Furthermore, humans used cooperative strategies to survive for instance sharing resources. Hence, prosocial behavior was favored by natural selection and evolution (Boyd & Richardson, 2009). An important concept enabling cooperative behavior is empathy (Sanchez, 2021). Empathy is defined as inherent ability to understand feelings and emotional experiences of other individuals by mentally taking their perspective and imagining how it is to be in a certain situation (Cambridge Dictionary, 2014). Moreover, the ability to emphasize allows to make interferences about other people mental states and guides social behavior (Schulte-Rüther et al., 2007). Empathy is evoked through various situations like witnessing a situation, seeing photographs or the mere imagination of a particular situation (Zhang et al., 2020). The concept of empathy encompasses two types. On the one hand is cognitive empathy, which is related to theory of mind. It is the capacity to understand the feelings of other people and to act subsequently (Cuff et al., 2014). On the other hand, is affective empathy, which is described as the ability to genuinely feel and comprehend the emotions of other individuals (Cuff et al., 2014). These two constructs can be understood separately from another and are not necessarily related. For instance, a person with solely cognitive empathy is a psychopathic individual, who manipulates his or her surroundings (Suttie, 2014).

To carry out empathic activities, for instance helping, it is important to perceive emotions and feelings of other people. Emotion perception is understood as identification of

an emotional stimulus, which is followed by the production of a certain affective condition. This affective state encompasses autonomic and somatomotor aspects including gestural, facial, and vocal activities. Moreover, these produced affective conditions are regulated through inhibition and alteration adapted to the cultural and social context (Phillips et al., 2003).

Studies investigated the relation between empathy and emotion perception in Magnetic Resonance Imaging (MRI). They reported activation of specific brain areas associated with empathy, including the ventral striatum and insula (Chakrabatti et al., 2006) on the one hand, but also the Medial Prefrontal Cortices (MPFC) on the other hand (Schulte-Rüther et al., 2007).

Literature regarding the influence of empathy on emotion perception reflected in Electroencephalogram (EEG) focuses on the Late positive potential (LPP) amplitude. The LPP amplitude, which is suggested to be an indicator for emotion regulation (Dennis & Hajcak, 2009; Hajcak et al., 2010), peaks at the parietal areas 400 ms until 1000 ms after stimulus onset (Dennis & Hajcak, 2009; Liu et al., 2012). Recent literature showed that the LPP amplitude is understood as a signal for cognitive activity of emotional stimuli during empathic responding and recognition (Lisy, 2020). Furthermore, studies evinced that the LPP amplitude is larger when people observe pleasant or unpleasant stimuli compared to neutral stimuli in the parietal area (Cuthbert et al., 2000). It was evident that people, who demonstrated higher empathic abilities have a more positive LPP amplitude (Choi et al., 2014). Furthermore, a positive correlation was found between empathy and the LPP amplitude when discriminating happy and angry emotions (Choi & Watanuki, 2014). Groen et al. (2013) reported that especially empathetic females show increase LPP amplitudes in response to emotional scenes. Additionally, Decety et al. (2015) concluded that empathy influences the LPP amplitude. Contrary, the opposite concept of empathy, respectively

psychopathy is negatively correlated to the LPP amplitude (van Dongen et al., 2018), which supports the notion that empathy is positively related to LPP amplitudes.

Looking at other event-related potentials (ERP) components, which might be related to empathy, literature yielded an association between empathy and the N170 component. The N170 amplitude is a negative deflection in the ERP waveforms and has its maximum 130 ms until 200 ms after stimulus onset at the occipital electrodes (Bauer et al., 2022). Soria Bauser et al. (2012) concluded that higher empathy scores of the participants are negatively correlated with the N170 amplitude. Furthermore, the N170 component seemed to be more negative when viewing faces compared to other stimuli (Holmes et al., 2003). Moreover, an association was evident between the ERP component N170 and the concept Theory of Mind, (ToM), which is the capacity to take other perspectives and therefore a simple form of empathy (Petroni et al., 2011). According to Ibáñez et al. (2011), the electrophysiological marker N170 is a sensitive predictor of cognitive as well as social performance. Furthermore, the amplitude of N170 appeared to be related to facial mimicry (Achaibou et al., 2008), which is the ability to imitate other peoples' emotional states and therefore an early development stage of empathy (Rymarczyk et al., 2016). A correlation between the empathy trait and larger N170 magnitude was found especially for faces, which depicted negative emotions for instance anger (Soria Bauser et al., 2012).

However, only a few studies used an EEG to assess the relation between empathy and emotion perception (Choi et al., 2014; Valenzi et al., 2014). Given the scarcity of studies this research aimed to clarify the relation between empathy and emotion perception seen in electrical brain activity. Knowing the underlying brain activity of empathy, one could tell about the suitability of a person as therapist or doctor and tailor admission procedures for these professions accordingly. Moreover, exploring the concept of empathy further is especially important for workers in the health care system like general health practitioners and psychologists, since empathy is associated with enhanced treatment outcomes for patients

(Scott, 2011). Additionally, it is crucial for therapists since empathy is one of the basic principles in several therapy forms for example client centered therapy (Witty, 2007), psychoanalytic and self-psychological therapy (Bohart, 1991). However, empathy is not only important for the healthcare system, but it is also essential for the whole humanity in order to create a more peaceful society (Bazalgette, 2017). Empathy might play a vital role in achieving harmony between people because it serves as a base for prosocial behavior (Sanchez, 2021).

In this study the relation between the two key concepts empathy and emotion perception was assessed through the use of the Empathy Quotient (EQ-60) and the International Affective Picture System (IAPS). Additionally, EEG was applied on the participant's head to measure the brain activity during the IAPS.

The present study aimed to deepen the knowledge about the relation between empathy and emotion perception, which is seen in EEG and to replicate existing findings. Hence, the research question underlying this study examined the effect of empathy on emotion perception reflected by brain activity visible in EEG. Intending to investigate whether the relation between empathy and emotion recognition is discernable in the brain, four hypotheses were suggested. Based on the aforementioned study results it was hypothesized that the LPP and the N170 amplitude is impacted by empathy. Hence, the first hypothesis stated that people, who obtain a higher score on the EQ demonstrate a more positive LPP amplitude when viewing positive pictures compared to low empathic people. Hypothesis two theorized that people, who score high on the EQ show a more positive LPP amplitude when viewing negative stimuli compared to their counterparts. Furthermore, hypothesis three put forward that people, who score high on the EQ compared to those who score low have a more negative amplitude of the ERP component N170 after viewing positive stimuli, while hypothesis four stated that people, who score high on the EQ compared to those who score low have a more negative amplitude of the ERP component N170 after viewing negative stimuli.

Method

Participants

The participants for this study were students at Tilburg University. They were recruited via the Sona System of Tilburg University and could earn experimental subject hours as reward for their participation. Moreover, they provided written informed consent and knew about their right to withdraw from the experiment at any time. This research was approved by the Ethical Review Board (ERB) of Tilburg University.

The analyzed data were drawn from a total sample of 32 student participants with an age range of 19 to 53 (M_{age} = 22.53, SD_{age} = 5.973). The sample consisted predominantly of females (71.88%). A total of 22 participants (66,67%) were right-handed. Furthermore, the sample contained primarily Dutch (62.5 %) and German (18.75 %) native speakers.

Measurement

The efficacy of the two key concepts empathy and emotion perception was assessed by using different methods.

Empathy

Firstly, the ability for empathy was estimated using the EQ-60, which consisted of 60 items whereby 40 items concerned empathic actions and feeling, and 20 items were control items. All questionnaire items can be found in the Appendix A. It was developed by Baren-Cohen & Wheelwright (2004) based on reviewing several other questionaries concerning empathy for instance Chapin Social Insight test, Empathy Scale by Hogan and colleagues and Questionnaire Measure of Emotional Empathy by Mehrabian and Epstein (Baron-Cohen & Wheelwright, 2004). It was proven to be valid and reliable (Lawrence et al., 2004). The questionnaire had a forced-choice format. To eliminate response bias half of the items were reversed items and therefore demanded the answer agree to score high on the EQ. In contrast the other half demanded the answer disagree. For each item, four answering options were presented ranging from strongly agree to strongly disagree. The participants had to circle the

applicable answer in response to a statement on a computer. In the beginning three examples were given to the subject, which showed how to fill in the questionnaire appropriately. On each item, a person could score 0 (for the least two empathic answers),1, or 2 points. Hence, the highest score possible was 80 (indicating high empathic ability) while the lowest score was 0 (representing low empathic ability). The total score was determined by summing up the points according to the scoring key.

Emotional Response

Secondly, the capacity for emotion recognition was assessed by the IAPS. The IAPS was used to elicit an emotional response from the participants and to measure emotional perception regarding valence and arousal. The set contained images, which are categorized as neutral, pleasant, or unpleasant. Furthermore, the items of the IAPS varied on two dimensions. Firstly, valence, which ranged from unpleasant via neutral to pleasant, and secondly arousal, which can be either high or low. The IAPS was confirmed to be effective in evoking a broad range of emotional reactions (Lang, Bradley, & Cuthebert, 2005). There was no manipulation of the independent variable empathy.

Stimuli

Participants needed to respond to all stimuli by pressing the keyboard numbers from 1 to 9. Pictures, which aimed to elicit an emotional reaction, were shown, for instance a loving couple or a big amount of trash. Example items from the IAPS can be found in the Appendix B. The stimuli were shown in a randomized order. The subjects sat in a sound-proof cabin and the monitor was located approximately 60 cm in front of the subjects. The resolution of the monitor was 1920px x 1080px. Furthermore, the participants had a keyboard in front of them enabling them to respond to the stimuli of the IAPS task, by pressing the number from 1 to 9. All stimuli pictures were presented in front of a black background.

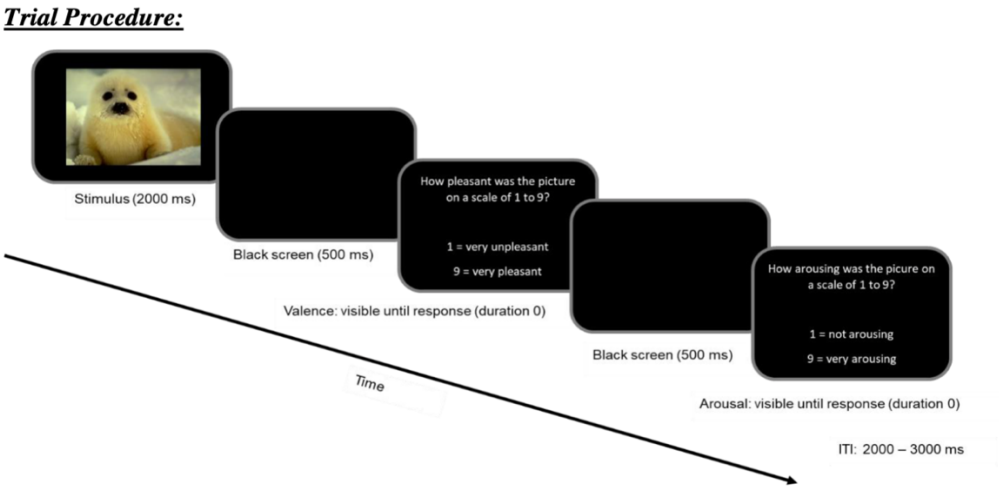
Procedure

Participants were tested individually in a light dimly and sound attenuating cabin.

They were further monitored via Closed Circuit Television (CCTV). The subjects were instructed to follow the commands displayed on the computer screen. Each trial began with a stimulus picture, which was shown for 2000 ms. Sequentially, a black screen appeared for a duration of 500 ms. Participants were then asked to rate the pleasantness of the image on a scale ranging from 1 (very unpleasant) to 9 (very pleasant). After the response, a black screen followed for 500 ms. Finally, the subjects were asked to indicate their level of arousal on a scale from 1 (low arousal) to 9 (high arousal). In total, 150 stimuli pictures were presented. On average the task completion took approximately 20 to 25 minutes. Figure 1 illustrates the procedure of a single stimulus trial.

Figure 1

Example of Trial Procedure



Physiological measurements

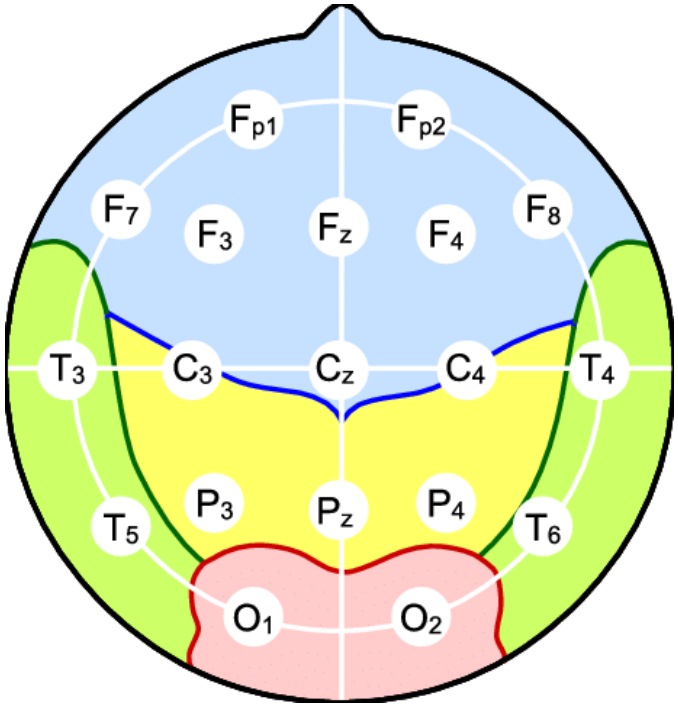
To record brain activity during the IAPS task, EEG was applied. The 32 active electrodes were embedded in an elastic cap, which was placed on the participant's heads corresponding to the 10/20 system (figure 2). The electrodes were connected to a Bio Semi Active-Two amplifier system (BioSemi, Amsterdam, The Netherlands). The common mode

sense (reference electrode) was mounted between Cz and C3 and functioned as the online reference, while the ground electrode was located between Cz and C4. Moreover, two electrodes, which were attached to the right and left sides of the mastoids, served as offline references. The sample rate of the system was 512 Hz.

Using four electro-oculography (EOG) electrodes horizontal and vertical eye movements were captured. One electrode was placed above, and the other electrode was placed below the eye intending to record the vertical EOG signal. Two electrodes were further affixed on the outer canthi of each eye aiming to detect horizontal EOG activity. Additionally, two electrocardiogram (ECG) electrodes were mounted on the participant's body. While one ECG electrode was placed on the center of the sternum, the other electrode was put on the left side of the rib cage under the armpit. Both electrodes were located at the same height.

Figure 2

10/20 electrode system



*(*Oude Bos, 2006).

Preprocessing

To refine the obtained EEG data, the data were preprocessed in the program Brain Vision Analyzer 2.1. (Brain Vision Analyzer Automation Reference Manual, 2013) The acquired data were re-referenced offline in the program to the average of left and right mastoids. Furthermore, all data were filtered offline. The low cut-off was .01 Hz, while the high cut-off was 30 Hz. Moreover, a notch filter was set at 50 Hz intending to eliminate 50 Hz interference.

The filtered EEG data were segmented by extracting data segments that were related to the relative stimulus onset. Therefore, data were segmented into 1100 ms epochs, which contained a 100 ms prestimulus baseline.

The present data were corrected for artifacts (e.g., eye movements, ocular movements, and muscle artifacts) according to the procedure of Gratton et al. (1983). Using this procedure, a propagation factor was attained based on EOG and EEG records during stimulus trials in the experiment. This propagation factor delineated the relationship between the EOG and EEG traces. The factor was calculated after the removal of stimulus related variability. Distinct propagation factors were determined for blinks and eye movements (Gratton et al., 1983).

If within each epoch at any EEG channel the difference between the most negative and most positive value exerted 200 microV, the epochs were disregarded. The maximum allowed voltage step was 50 uV/ms. All epochs were averaged separately per condition and baseline corrected from -100 to 0 ms before stimulus onset. For negative emotional stimuli, the number of averaged segments was 46, while for the positive emotional stimuli the number of averaged segments was 50.

Statistical analysis

The grand average amplitudes for the Late positive potential (LPP) were specified during the interval of 400-1000 ms after stimulus presentation. The topographical maximum

was at the electrode Pz. Furthermore, the time window for N170 was from 140-200 ms and reached the topographical peak at the electrode Oz. For the neutral stimuli no ERP components were scored. The statistical analysis was carried out with SPSS version 27.

Furthermore, a median split was performed. Therefore, scores above the median of 49 belonged to the high empathy group, while scores below the median of 49 were analyzed as low empathy group. Consequently, 17 people belonged to the high empathy group, while 16 belonged to the low empathy group. For each hypothesis an independent sample t-test was conducted to compare the LPP amplitude at the Pz electrode or respectively the N170 amplitude at the Oz electrode between the high empathy and low empathy group in the conditions positive and negative emotions. The statistical significance level was set at 0.05, which meant that statistical significance was accepted when $p < 0.05$. Female and male data were analyzed together since no significant differences appeared, t (30) =-.167, p =869. Two participants were excluded since the behavioral data for the IAPS and the EEG data were not recorded.

Results

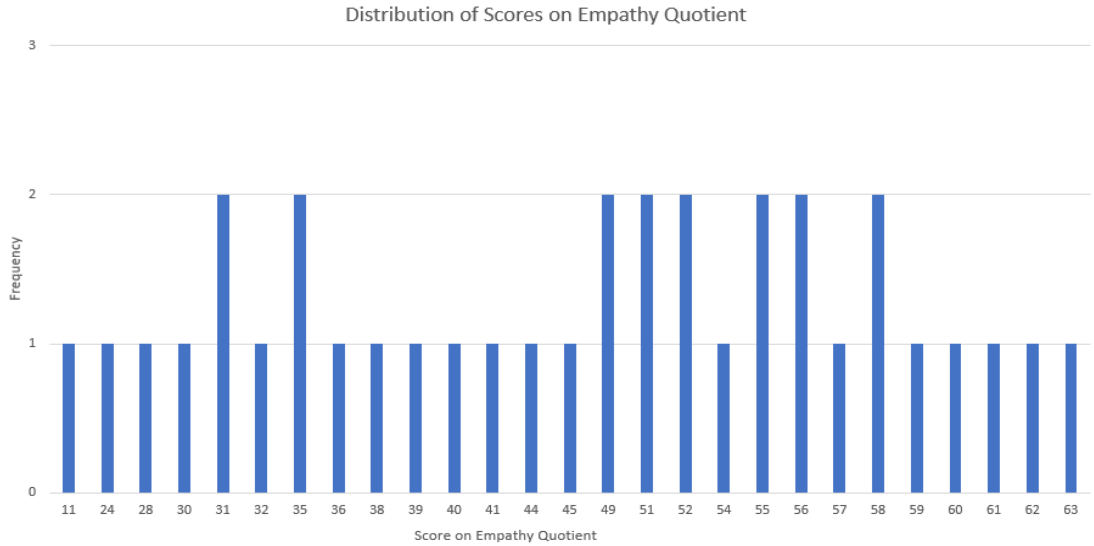
Descriptive Statistics

Empathy Quotient

The descriptive statistics of the Empathy questionnaire revealed a score ranging from 11 to 63 in the entire sample. Throughout the sample, $M_{empathy}$ =45,25 and $SD_{empathy}$ =13,098 applied. The group was divided into a high empathy and a low empathy group according to a median split.

Figure 1

Distribution of Scores on the Empathy Quotient in the entire Sample



IAPS

Emotion perception was assessed by integrating the arousal and valence responses of the participants. The mean proportion of arousal and valence scores across the different conditions was calculated using descriptive statistics (table 1 and table 2).

Table 1

Means and Standard Deviations of IAPS Valence Scores across Conditions

		Valence		
		Negative	Neutral	Positive
Arousal	Low	*2.6697*	4.5967	*7.3215*
		(.8279)	(.8142)	*(.8279)*
	High	*1.9862*	*4.26*	*6.6506*
		(.9493)	*(.916)*	*(.8576)*

Table 2

Means and Standard Deviations of IAPS Arousal Scores across Conditions

		Valence		
		Negative	Neutral	Positive
Arousal	Low	*3.279 (1.6398)*	*2.96 (1.320)*	*3.3572 (1.8879)*
	High	*4.7253 (2.3988)*	*4.20 (1.830)*	*4.7369 (2.0758)*

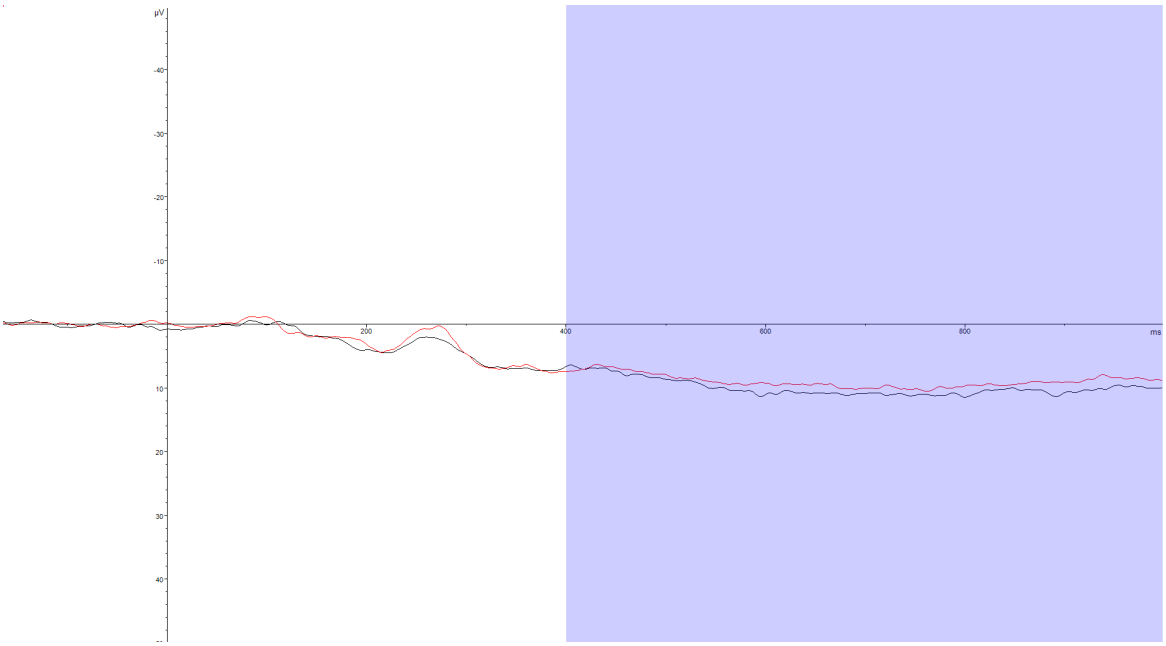
Statistical results

LPP and T-test

Figure 2 compares the grand averages ERP waveforms of the high empathy and low empathy group, which were averaged across the Pz (400ms-1000ms after stimulus onset) following the presentation of a positive item, while figure 3 shows the grand averages ERP waveforms following a negative item.

Figure 2

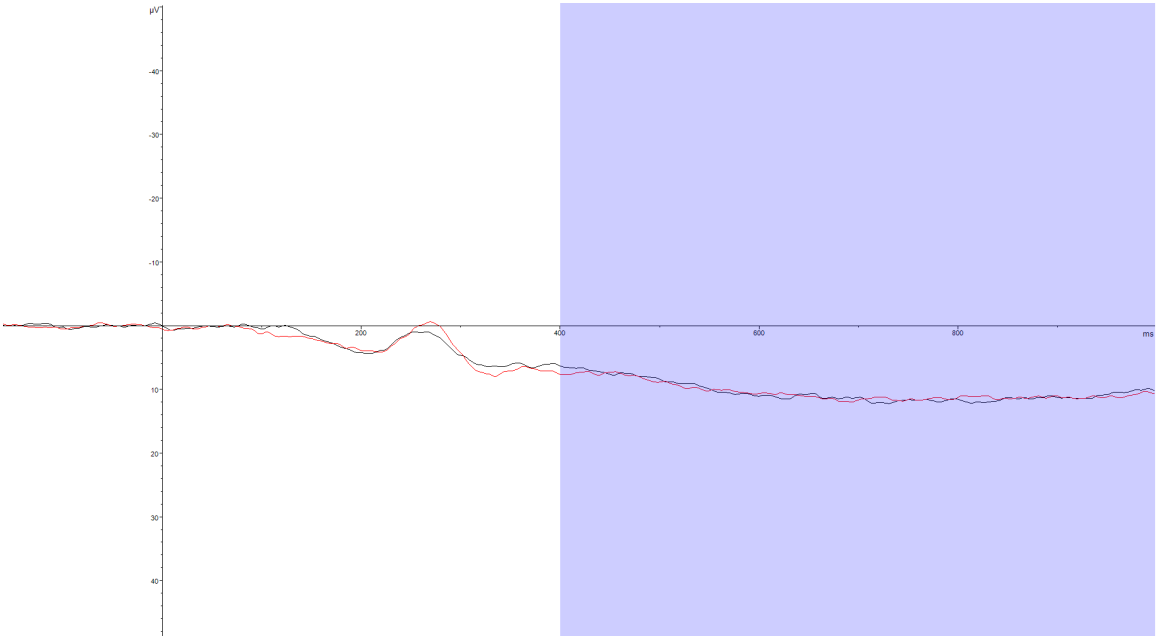
Grand Averages Comparison between High Empathy and Low Empathy Group of LPP Amplitude at Pz Electrode after Positive Stimulus



Note. The black line depicts the high empathy group while the red line depicts the low empathy group. The LPP window is highlighted in blue.

Figure 3

Grand Averages Comparison between High Empathy and Low Empathy group of LPP Amplitude at Pz Electrode after Negative Stimulus

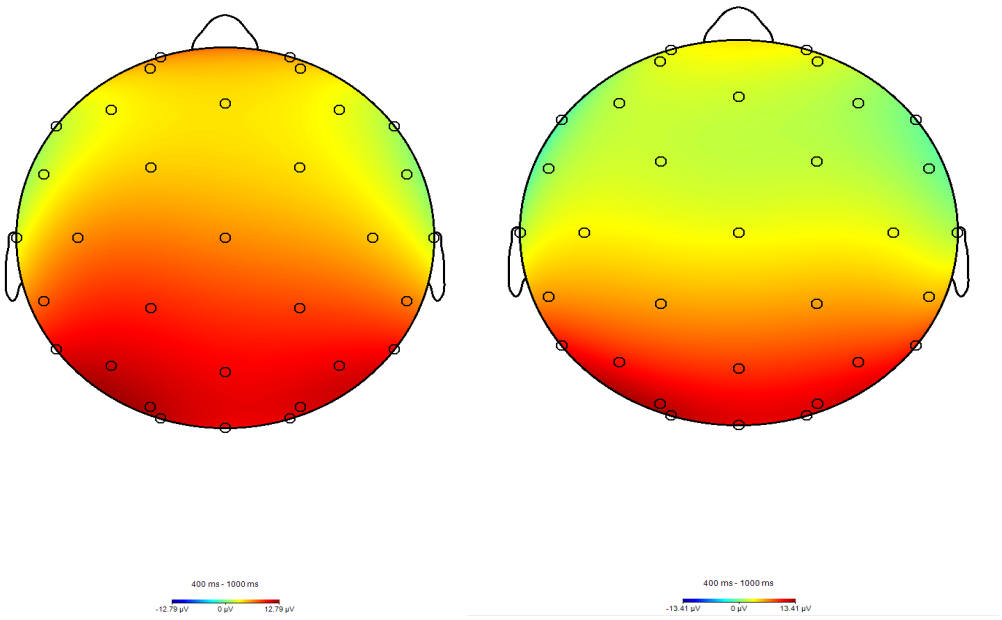


Note. The black line depicts the high empathy group while the red line depicts the low empathy group. The LPP window is highlighted in blue.

Moreover, the topographic map of LPP at the Pz electrode depicts the differences in brain activity comparing the high empathy and low empathy group regarding the conditions positive (figure 4) and negative stimulus (figure 5).

Figure 4

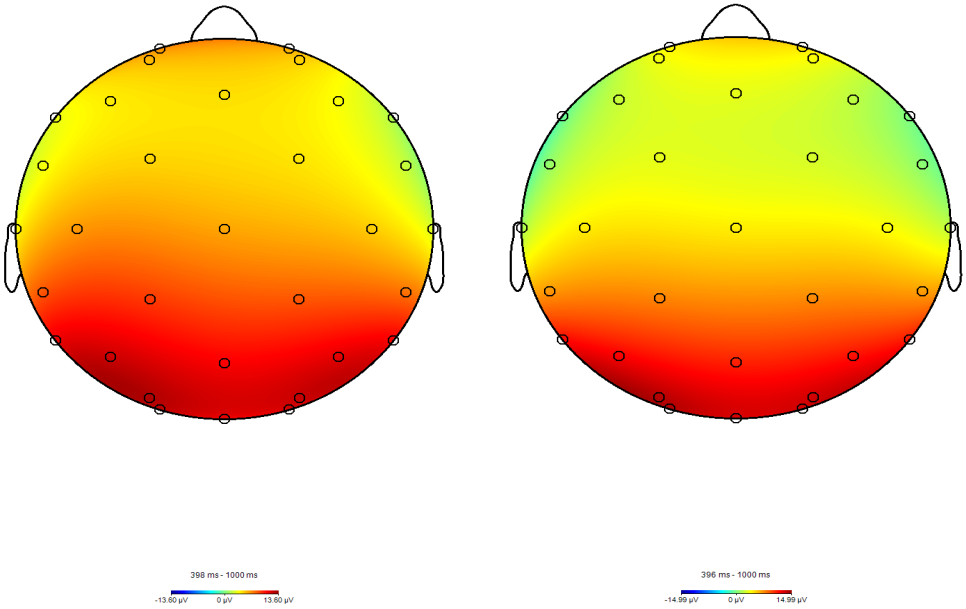
High Empathy LPP Positive Stimulus *Low empathy LPP Positive Stimulus*



Note. Comparison of topographic maps of LPP amplitude (400-1000 ms after stimulus presentation) at the Pz electrode between high empathy group (left) and low empathy group (right) following a positive emotional picture.

Figure 5

High Empathy LPP Negative Stimulus *Low empathy LPP Negative Stimulus*



Note. Comparison of topographic maps of LPP amplitude (400-1000 ms after stimulus presentation) at the Pz electrode between high empathy group (left) and low empathy group (right) following a negative emotional picture.

Hypothesis one stated that people, who score higher on the EQ have a more positive LPP amplitude when viewing positive emotional pictures. The 17 people in the high empathy group (M=9.086, SD=5.852) did not show a higher LPP amplitude than the low empathy group (M=9.891, SD=6.027). No significant positive effect was found, t (31) =.389, p=0.700.

Secondly, it was hypothesized that the LPP amplitudes for the empathy group will be higher for negative emotions. The high empathy group did not demonstrate higher positive amplitudes (M=9.627, SD=6.077) compared to the low empathy group (M=11.295, SD=5.924) with respect to negative emotions. No significant difference in the LPP amplitude was evident, t (31) =.798, p=0.431.

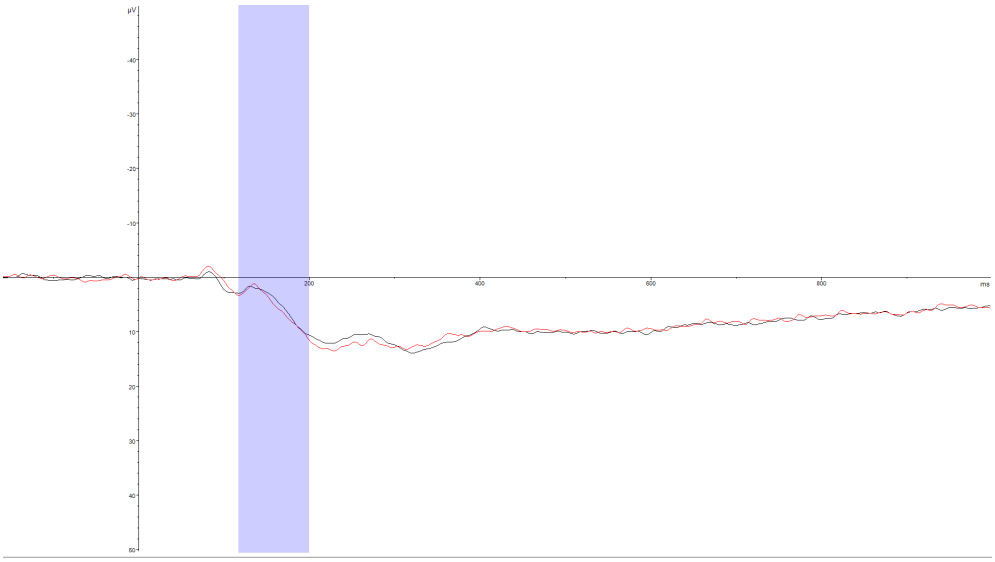
Summarizing the analyses of hypotheses one and two it was concluded that both hypotheses are rejected.

N 170 and T-test

Supplementary, the grand averages of the high empathy and low empathy group for the N 170 amplitudes at Oz (130-200ms after stimulus) are reported after a positive (figure 6) and negative (figure 7) stimulus.

Figure 6

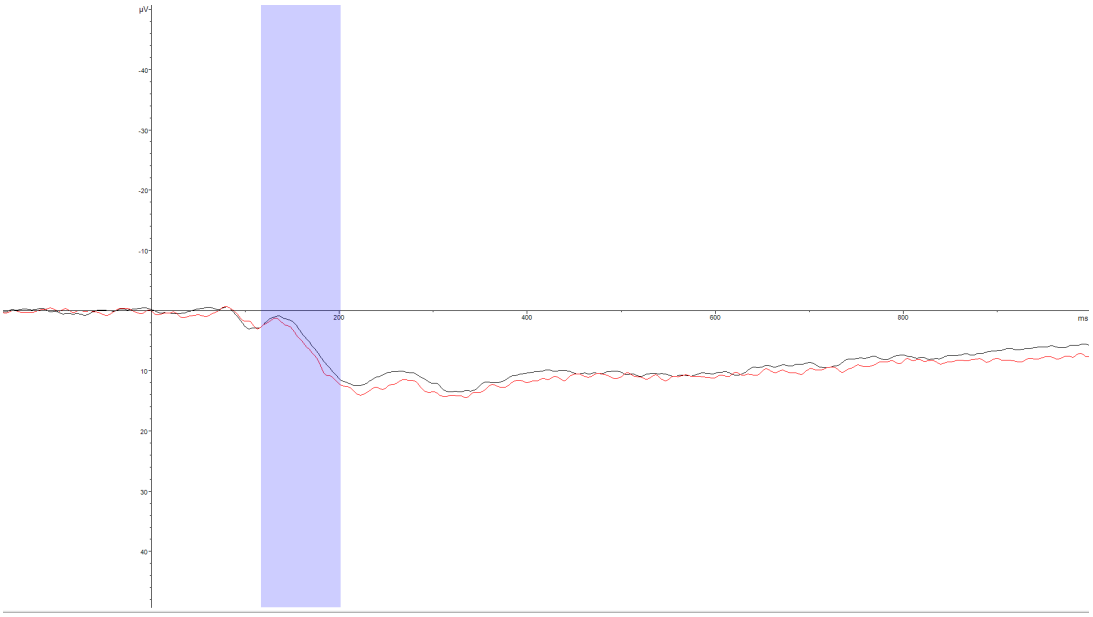
Grand Averages Comparison between High Empathy and Low Empathy Group of N170 at Oz after Positive Stimulus



Note. The black line depicts the high empathy group while the red line depicts the low empathy group. The N170 window is highlighted in blue.

Figure 7

Grand Averages Comparison between High Empathy and Low Empathy group of N170 at Oz after Negative Stimulus

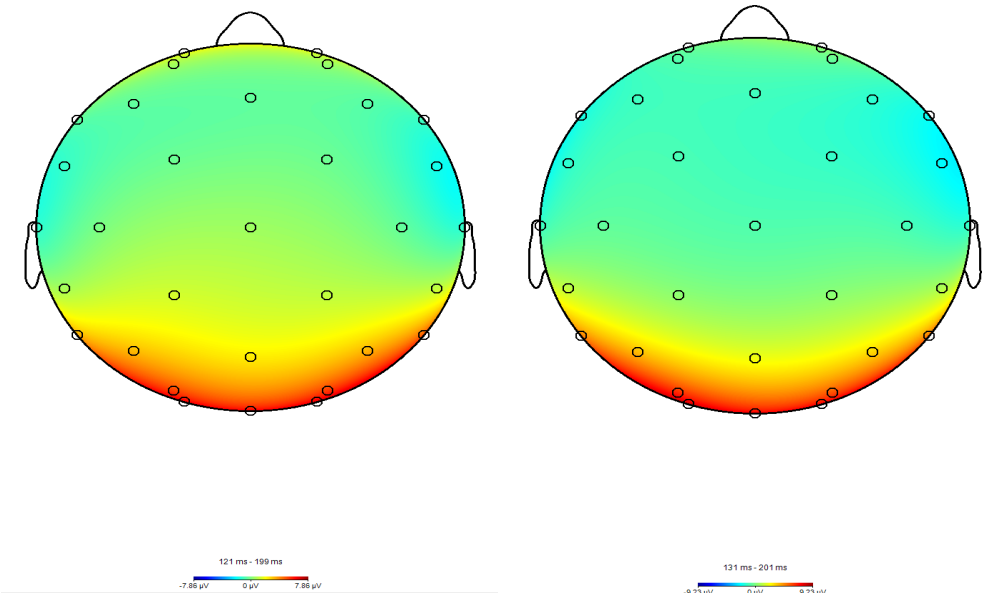


Note. The black line depicts the high empathy group while the red line depicts the low empathy group. The N170 window is highlighted in blue.

Additionally, the topographic map of N170 at the Oz electrode illustrates the differences in brain activity comparing the high empathy and low empathy group after a positive (figure 7) and negative (figure 8) stimulus.

Figure 7

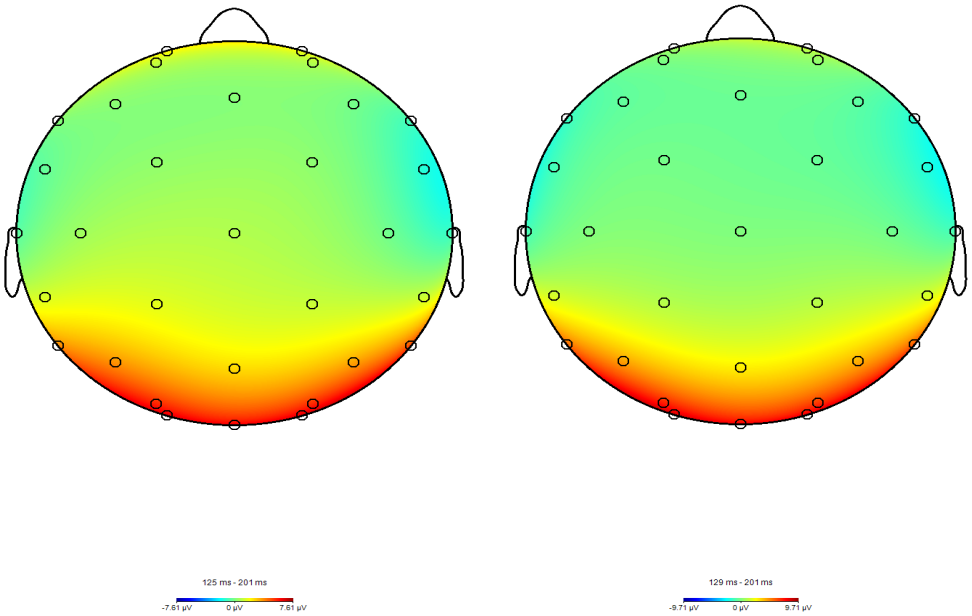
High Empathy N170 Positive Stimulus *Low Empathy N170 Positive Stimulus*



Note. Comparison of topographic maps of N170 amplitude (130-200 ms after stimulus presentation) at the Oz electrode between high empathy group (left) and low empathy group (right) following a positive emotional picture.

Figure 8

High Empathy N170 Negative Stimulus *Non empathy N170 Negative Stimulus*



Note. Comparison of topographic maps of N170 amplitude (130-200 ms after stimulus presentation) at the Oz electrode between high empathy group (left) and low empathy group (right) following a negative emotional picture.

Subsequently, it was hypothesized that people, who score high on the EQ also have a more negative amplitude of N170 at the Oz electrode. The high empathy group did not obtain lower scores (M=5.895, SD=5.689) than the low empathy group (M=5.394, SD=1.343). The independent samples t-test did not reveal significant findings regarding EQ scores for the N170 amplitude in the condition positive emotions, t (31) =-.260, p= 0.797. The fourth hypothesis focused on the influence of negative emotional stimuli on the N170 amplitude. Despite the high empathy group demonstrating a lower mean (M=5.414, SD=5.440) than the low empathy group (M=5.897, SD=5.747), no significant findings were evident in the condition negative emotions, t (31) =.638, p=0.805.

Concluding the results of the N170 amplitudes it can be summarized that hypotheses three and four were rejected.

Discussion

Based on the importance of empathy in clinical settings and in our daily life, this study examined the influence of empathy on emotion perception in EEG. After reviewing literature regarding the influence of empathy on brain activity, the underlying research question inquired if the relation between empathy and emotion recognition is apparent in EEG. Attempting to replicate previous findings it was hypothesized that empathy influences the LPP and N170 amplitudes when recognizing positive and negative emotions. The EQ-60 was used to determine empathy, while the IAPS task assessed emotion perception. The IAPS was carried out on a computer. Furthermore, EEG data of the participants were recorded during the IAPS task. The present study did not find an effect of empathy on emotion recognition reflected in brain activity regarding the LPP and N170 amplitudes. These results suggest that there is no difference in emotion perception due to empathy reflected by electrical brain activity.

These findings are not in line with current research. The role of empathy regarding emotion perception yielded largely consistent patterns in research, respectively an effect on the LPP and N170 amplitudes (Soria Bauser et al., 2012). Contrary to the findings concerning the LPP amplitude (first and second hypotheses), Choi et al. (2014) as well as Choi and Watanuki (2014) reported a more positive LPP amplitude for empathic individuals in response to emotional pictures. Similarly, to Choi et al. (2014) and Choi and Watanuki (2014), Decety et al. (2015) and Groen et al. (2013) concluded that empathy influences the LPP amplitude, which could not be supported by this research. Contradictory to the results concerning the N170 amplitude (hypotheses three and four), empathy scores correlated negatively with the N 170 amplitude in a study conducted by Soria Bauser et al. (2012). As stated in the introduction, an association was evident between ToM (an early form of

empathy) and the N170 amplitude (Petroni et al., 2011), which could not be seen in this recently conducted study.

Subsequently, reasons, which could account for the different results are mentioned. The study by Groen et al. (2013) found that the LPP amplitude is only associated with affective empathy but not with cognitive empathy. The present study did not differentiate between affective and cognitive empathy, which could account for the null findings. Furthermore, compared to other studies, empathy was assessed differently in this study. While in this study empathy was measured with the EQ-60 questionnaire, the study of Decety et al. (2015) estimated empathy by letting the subjects view pictures in painful situations and focusing on the empathic concern that they have regarding the photographs. Other studies (Soria Bauser et al., 2012; Choi et al., 2014; Choi & Watanuki, 2014) utilized the Interpersonal Reactivity Index to determine empathy contrary to this study, which used the EQ-60 item scale. The EQ-60 aims to measure empathy as a unidimensional construct in contrast to the IRI, which estimates empathy by using multiple subscales (Sindermann et al., 2019). Different methods of assessing empathy could imply a different categorization of empathy groups, which could consequently influence the results. Closing the possible explanation for deviating results it should be mentioned that only a few studies have investigated the topic with the aid of an EEG (Choi et al., 2014; Valenzi et al.,2014). Hence, there are marginally studies to compare with.

This study faced some limitations, which are mentioned consecutively. Firstly, this study used a convenience sample. Consequently, only students from Tilburg University were included in the data set. However, Tilburg University students do not represent the whole society adequately regarding age, education, and culture. Secondly, since this study did not deal with a clinical sample for instance psychopathic individuals nor aimed to contribute to clinical research, it was decided to do a median split instead of using the clinical cut-off. If the groups had been created according to the clinical cut-off score, only a few people (four in

total) would have belonged to the low empathy group. Hence, the sample was split into two groups by putting the people who scored above the median in the high empathy group and the people who scored below the median in the low empathy group. However, not all people of the low empathy group scored in fact low on the EQ and would be considered low empathic according to the cut-off score after Baron-Cohen and Wheelwright (2004). This has important implications, since not all people met the requirements for being low empathic but are evaluated as such. Therefore, the results are difficult to compare with other studies, which used the clinical cut-off score to define their groups. Furthermore, not all emotional stimuli depicted exclusively faces. Since the N170 amplitude is especially sensitive to faces (Bentin et al., 1996; Campanella et al., 2000), this threat to construct validity could have impacted the results especially for the N170 amplitude. Concluding the limitations of the study, the strengths of this study should also be emphasized. All subjects completed the experiment under the same conditions in a quiet cabin in front of a computer. Hence, validity as well as reliability were ensured through the use of confirmed valid and reliable measurement instruments (EQ-60, IAPS, EEG). The EQ-60 demonstrates high construct validity as well as high reliability, especially internal consistency (Zhao et al., 2017). Particularly, the IAPS displays high ecological validity compared to other emotion perception tasks (Herbort et al., 2016), while the EEG is shown to be a reliable instrument to measure brain activity (Gudmundsson et al., 2007). Also, no biased results emerged due to sex differences since a t-test was performed to examine differences between male and female data. Moreover, the data were drawn from a reasonably big sample size (N= 33) compared to other studies (N= 22) investigating the same relation (Choi et al., 2014).

Although the present study reported null findings, it contributes to the research concerning the effect empathy on emotion perception in EEG and enhanced already existing knowledge. Concisely, this study is a good starting point for subsequent research since the ambivalent results demanded further clarification.

Future research should consider that the effect of empathy on emotion perception might differ between age cohorts, gender, and culture. Hence, more heterogeneous sample should be used when assessing the influence of empathy on emotion perception in order to rule out confounds for example age, education, gender and culture. Follow-up research should further include a reasonably big sample size with low empathic individuals according to the clinical cut-off score to strengthen reliability and validity. Furthermore, it should be paid attention to the emotional stimuli presented. When measuring the N170 amplitude, only emotional stimuli containing human faces should be selected to ensure high construct validity.

Coming to theoretical implications it can be noted that under the condition of this experiment empathy did not influence emotion perception reflected in brain activity by the LPP or N170 amplitude. However, these findings do not allow to draw conclusions about the relation between the two variables empathy and emotion perception under different conditions or with different cohorts. These results contradict the assumption that empathy influences emotion perception as seen in brain activity. According to the results there are no differences in brain activity regarding emotion perception between high and low empathic individuals This implies that you cannot tell if someone is high or low empathic based on his EEG amplitudes when recognizing emotions. Consequently, no assumptions can be made about the suitability for certain professions such as therapists and doctors based on EEG amplitudes. However, this does not imply that it is not of considerable importance whether certain occupations such as health practitioners, psychologists and therapists are high empathic or low. Research showed that having an empathic doctor or therapist increased the likelihood of an advantageous outcome for the patient. Furthermore, social psychology research indicated that empathy impacts social relationships positively by diminishing conflict (Batson & Ahmad, 2009). Especially the Covid- 19 crisis and its accompanying lockdowns indicated the importance of social contacts for our (mental) health as well as the importance of caring health practitioners for patients. All these social actions root in empathy, which empathizes its

importance for the whole society.Moreover, the recent war in Ukraine clarifies how valuable peace is for society. Empathy is the foundation for establishing and perpetuating a peaceful environment in which society can live. Given the importance of empathy, further research should investigate the relation between empathy and emotion recognition visible in the brain.

Conclusion

The results of this study did not reveal an effect of empathy on emotion perception reflected in EEG amplitudes. This may imply that empathy does not strongly influence emotion perception as hypothesized. Future research should deepen the knowledge about the influence and importance of empathy on emotion recognition discernible brain activity. Specifically, healthcare professionals such as therapists and doctors could benefit from this knowledge to improve healthcare and therapy. Additionally, this knowledge is advantageous for social relations and society as a whole in order to create and maintain a peaceful society.

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Appendix A

Empathy (EQ-60) Questionnaire

The Cambridge Behaviour Scale

Please fill in this information and then read the instructions below.

ALL INFORMATION REMAINS STRICTLY CONFIDENTIAL

Name:.....…Sex:.....

Date of birth:..... Today's date:.....

How to fill out the questionnaire

Below are a list of statements. Please read each statement very carefully and rate how strongly you agree or disagree with it by circling your answer. There are no right or wrong answers, or trick questions.

IN ORDER FOR THE SCALE TO BE VALID, YOU MUST ANSWER EVERY QUESTION.

Examples

E1. I would be very upset if I couldn't listen to music every day.	strongly agree	(slightly agree)	slightly disagree	strongly disagree
E2. I prefer to speak to my friends on the phone rather than write letters to them.	strongly agree	slightly agree	slightly disagree	(strongly disagree)
E3. I have no desire to travel to different parts of the world.	(strongly agree)	slightly agree	slightly disagree	strongly disagree
E4. I prefer to read than to dance.	strongly agree	slightly agree	(slightly disagree)	strongly disagree

1. I can easily tell if someone else wants to enter a conversation.	strongly agree	slightly agree	slightly disagree	strongly disagree
2. I prefer animals to humans.	strongly agree	slightly agree	slightly disagree	strongly disagree
3. I try to keep up with the current trends and fashions.	strongly agree	slightly agree	slightly disagree	strongly disagree
4. I find it difficult to explain to others things that I understand easily, when they don't understand it first time.	strongly agree	slightly agree	slightly disagree	strongly disagree
5. I dream most nights.	strongly agree	slightly agree	slightly disagree	strongly disagree
6. I really enjoy caring for other people.	strongly agree	slightly agree	slightly disagree	strongly disagree
7. I try to solve my own problems rather than discussing them with others.	strongly agree	slightly agree	slightly disagree	strongly disagree
8. I find it hard to know what to do in a social situation.	strongly agree	slightly agree	slightly disagree	strongly disagree
9. I am at my best first thing in the morning.	strongly agree	slightly agree	slightly disagree	strongly disagree
10. People often tell me that I went too far in driving my point home in a discussion.	strongly agree	slightly agree	slightly disagree	strongly disagree
11. It doesn't bother me too much if I am late meeting a friend.	strongly agree	slightly agree	slightly disagree	strongly disagree
12. Friendships and relationships are just too difficult, so I tend not to bother with them.	strongly agree	slightly agree	slightly disagree	strongly disagree
13. I would never break a law, no matter how minor.	strongly agree	slightly agree	slightly disagree	strongly disagree
14. I often find it difficult to judge if something is rude or polite.	strongly agree	slightly agree	slightly disagree	strongly disagree
15. In a conversation, I tend to focus on my own	strongly	slightly	slightly	strongly

thoughts rather than on what my listener might be thinking.	agree	agree	disagree	disagree
16. I prefer practical jokes to verbal humour.	strongly agree	slightly agree	slightly disagree	strongly disagree
17. I live life for today rather than the future.	strongly agree	slightly agree	slightly disagree	strongly disagree
18. When I was a child, I enjoyed cutting up worms to see what would happen.	strongly agree	slightly agree	slightly disagree	strongly disagree
19. I can pick up quickly if someone says one thing but means another.	strongly agree	slightly agree	slightly disagree	strongly disagree
20. I tend to have very strong opinions about morality.	strongly agree	slightly agree	slightly disagree	strongly disagree
21. It is hard for me to see why some things upset people so much.	strongly agree	slightly agree	slightly disagree	strongly disagree
22. I find it easy to put myself in somebody else's shoes.	strongly agree	slightly agree	slightly disagree	strongly disagree
23. I think that good manners are the most important thing a parent can teach their child.	strongly agree	slightly agree	slightly disagree	strongly disagree
24. I like to do things on the spur of the moment.	strongly agree	slightly agree	slightly disagree	strongly disagree
25. I am good at predicting how someone will feel.	strongly agree	slightly agree	slightly disagree	strongly disagree
26. I am quick to spot when someone in a group is feeling awkward or uncomfortable.	strongly agree	slightly agree	slightly disagree	strongly disagree
27. If I say something that someone else is offended by, I think that that's their problem, not mine.	strongly agree	slightly agree	slightly disagree	strongly disagree
28. If anyone asked me if I liked their haircut, I would reply truthfully, even if I didn't like it.	strongly agree	slightly agree	slightly disagree	strongly disagree
29. I can't always see why someone should have felt offended by a remark.	strongly agree	slightly agree	slightly disagree	strongly disagree

30. People often tell me that I am very unpredictable.	strongly agree	slightly agree	slightly disagree	strongly disagree
31. I enjoy being the centre of attention at any social gathering.	strongly agree	slightly agree	slightly disagree	strongly disagree
32. Seeing people cry doesn't really upset me.	strongly agree	slightly agree	slightly disagree	strongly disagree
33. I enjoy having discussions about politics.	strongly agree	slightly agree	slightly disagree	strongly disagree
34. I am very blunt, which some people take to be rudeness, even though this is unintentional.	strongly agree	slightly agree	slightly disagree	strongly disagree
35. I don’t tend to find social situations confusing.	strongly agree	slightly agree	slightly disagree	strongly disagree
36. Other people tell me I am good at understanding how they are feeling and what they are thinking.	strongly agree	slightly agree	slightly disagree	strongly disagree
37. When I talk to people, I tend to talk about their experiences rather than my own.	strongly agree	slightly agree	slightly disagree	strongly disagree
38. It upsets me to see an animal in pain.	strongly agree	slightly agree	slightly disagree	strongly disagree
39. I am able to make decisions without being influenced by people's feelings.	strongly agree	slightly agree	slightly disagree	strongly disagree
40. I can't relax until I have done everything I had planned to do that day.	strongly agree	slightly agree	slightly disagree	strongly disagree
41. I can easily tell if someone else is interested or bored with what I am saying.	strongly agree	slightly agree	slightly disagree	strongly disagree
42. I get upset if I see people suffering on news programmes.	strongly agree	slightly agree	slightly disagree	strongly disagree
43. Friends usually talk to me about their problems as they say that I am very understanding.	strongly agree	slightly agree	slightly disagree	strongly disagree

44. I can sense if I am intruding, even if the other person doesn't tell me.	strongly agree	slightly agree	slightly disagree	strongly disagree
45. I often start new hobbies but quickly become bored with them and move on to something else.	strongly agree	slightly agree	slightly disagree	strongly disagree
46. People sometimes tell me that I have gone too far with teasing.	strongly agree	slightly agree	slightly disagree	strongly disagree
47. I would be too nervous to go on a big rollercoaster.	strongly agree	slightly agree	slightly disagree	strongly disagree
48. Other people often say that I am insensitive, though I don't always see why.	strongly agree	slightly agree	slightly disagree	strongly disagree
49. If I see a stranger in a group, I think that it is up to them to make an effort to join in.	strongly agree	slightly agree	slightly disagree	strongly disagree
50. I usually stay emotionally detached when watching a film.	strongly agree	slightly agree	slightly disagree	strongly disagree
51. I like to be very organised in day to day life and often make lists of the chores I have to do.	strongly agree	slightly agree	slightly disagree	strongly disagree
52. I can tune into how someone else feels rapidly and intuitively.	strongly agree	slightly agree	slightly disagree	strongly disagree
53. I don't like to take risks.	strongly agree	slightly agree	slightly disagree	strongly disagree
54. I can easily work out what another person might want to talk about.	strongly agree	slightly agree	slightly disagree	strongly disagree
55. I can tell if someone is masking their true emotion.	strongly agree	slightly agree	slightly disagree	strongly disagree
56. Before making a decision I always weigh up the pros and cons.	strongly agree	slightly agree	slightly disagree	strongly disagree
57. I don't consciously work out the rules of social situations.	strongly agree	slightly agree	slightly disagree	strongly disagree
58. I am good at predicting what someone will do.	strongly	slightly	slightly	strongly

	agree	agree	disagree	disagree
59. I tend to get emotionally involved with a friend's problems.	strongly agree	slightly agree	slightly disagree	strongly disagree
60. I can usually appreciate the other person's viewpoint, even if I don't agree with it.	strongly agree	slightly agree	slightly disagree	strongly disagree

Thank you for filling this questionnaire in.

Appendix B

IAPS picture examples