Title:

Empathy: it’s Neuropsychological Correlates, Relation to Neuroticism, Emotional Recognition Accuracy, intensity rating and gender.

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Abstract

The current study investigated relationships between empathy, neurological activity, ability to identify facial expressions, subjective intensity rating of expressions and neuroticism, plus gender differences in neurological activity. The study was conducted with 19 participants, 11 male and 8 female. Participants completed two questionnaires, The IRI (Davis 1980;1983), looking at empathy levels and another looking at levels of neuroticism - the Eysenck & Eysenck (1992) PQ and then viewed a number of emotional expressions. Participants were asked to rate these expressions on intensity plus identify the emotion being displayed while cortical activity was measured. Analyses showed that no significant correlations existed between empathy and any of the suggested variables, and that no significant differences exist between the genders in cortical activity.
**Review of current literature**

**Empathy:**

What is empathy? Gu, et al. (2012, p. 2627) state that “Empathy refers to the ability to perceive and share another’s affective state”. Empathy is evidently an essential tool for social interaction. It is vital if we are to navigate the world around us, so much so that a lack or deficiency in empathy is characteristic of chronic mental disorders such as autism (Farrow & Woodruff, 2007, as cited in Rameson, Morelli, Matthew & Lieberman, 2012, p. 1). It can be argued that humans are innately empathic beings, with even one day old babies being found to cry upon hearing the cries of others (Sagi & Hoffman as cited in Gutsell & Inzlicht 2012, p. 596). Empathy is considered to be a motivating force to help our fellow man, that is, to engage in altruistic behaviours, by a number of contemporary psychologists (Batson, 2002, p. 92). It has indeed been demonstrated that several people facing the same situation, such as encountering a person in need, do not respond the same way, empathy seems to be the most important factor in predicting responses (Batson & Olson as cited in Baron, Branscombe & Byrne, 2009, p. 321).

Is it easier to empathise with a group or a single individual? Myers (2012, p. 454) states that we are more likely to identify and feel empathy for the suffering of a single person than we are to feel for the suffering of a large group of people, as they become a “statistic”. It is hoped that this study can overcome this possibility by depicting only one person and one emotion at a time to participants.

It is thought that gender differences exist in empathy, indeed, it has been found that women are more likely to become upset at another person’s distress than men, (Eisenberg & Lennon, as cited in Myers, 2013, p. 165). This is also found in young populations, Garaigordobil (2009) found that overall, female children and adolescents were found, among
other things, to have higher levels of empathy, prosocial behaviours and a higher ability to
cognitively analyse negative emotions than their male counterparts.

There is also a possible developmental component to empathy. Previous research has
shown that parents who report being restrictive of emotional expression tend to have children
who achieve lower empathy scores, (Eisenberg et al., as cited in Jones, Field & Davalos,
2000, p. 190). One study found that a number of factors correlated with the development of
empathy in Japanese children, these included the level of parent and child interaction, the
stability of parenting practices and maternal mental health (Tong et al., 2012). Psychogiou,
Daley, Thompson & Sonuga-Barke (2008, p. 227), found that a low levels of maternal
empathy were associated with conduct disorders in children. This could suggest that being on
the receiving end of empathy at a young age is important, and that a lack of this could have
far reaching consequences.

In this study, it is hoped that the neural correlates of empathy can be identified
through use of electroencephalography equipment, with participants empathising with various
facial expressions. Current trends and research on the neural basis of empathy and emotions
in general will now be examined.

Neural Correlates of empathy and emotions in general:

The brain and emotional recognition (through facial expression):

Some information is known about the areas of the brain involved in the perception of
facial expressions from clinical examples, for instance with Urbach-Wiethe disease, a disease
which often causes calcification of the amygdala and the nearby anterior medial temporal
lobe structures in both the left and right hemispheres (Pineal, 2006, p. 444). One patient with
this disease, who suffered bi-lateral amygdalar damage as a result lost the ability to recognise the facial expression representing fear, however she had no difficulty with other facial expressions (Adolphs et al., as cited in Pineal, 2006, p. 444). Could this finding suggest that particular brain regions process particular emotions? Indeed Canli as cited in Pineal, (2006, p. 445) found that all participants in an MRI study showed increased activity in the amygdala while viewing fearful facial expressions.

Another area, when damaged, has been implicated in the perception of facial expression are the frontal lobes (Kolb & Whishaw, 2009, p. 455-456). It has also been shown that certain cells in the temporal lobes are especially responsive to facial expressions (Kolb & Whishaw, 2009, p. 456). Also an inability to recognize facial expressions has been associated with damage to the right temporal lobe (Kolb & Whishaw, 2009, p. 579). More specific studies looking at the neural underpinnings of empathy will now be discussed.

A reasonable amount of research exists on empathy and the brain, but a large number of these studies have used advanced neuroimaging methods such as fMRI (e.g. Rameson et al., 2012). Gu, et al. (2012) conducted an investigation into patients with lesions in both the anterior insular cortex and the anterior cingulate cortex, these patients were presented with images of another person enduring significant pain, it was found that patients with lesions in the anterior insular cortex show diminished empathy in response to others pain compared to patients with an anterior cingulate cortex lesions, possibly pointing to a neural centre for empathy. The authors note the implications of this finding to better understanding the pathology of a number of neuropsychiatric disorders which are characterised by diminished empathy (Gu, et al., 2012, p. 2726). One major drawback of this research is the small sample size used. Only three participants with anterior insular cortex lesions were used in this study (Gu, et al., 2012, p. 2728).
Rameson, Morelli & Lieberman (2012) investigated, among other things, the neural correlates of subjective empathy during the depiction of sad events, it was found that, across conditions, higher levels of self reported experiences of empathy were consistently associated with a rise in activity in the medial prefrontal cortex (MPFC). Participants completed a diary study, which assessed levels of daily helping (helping others) and then took part in a functional MRI (fMRI) task which used photos of people in sad situations, these photos were presented in three conditions, just observing the photos, being instructed to empathise with those in the photos and under cognitive load, finally participants rated the level of empathy they felt for those in the photos (Rameson et al., 2012, p. 237). Across analysis, heightened activity in the MPFC was found to be correlated with experiencing empathy its behavioural correlates (e.g. helping others) (Rameson et al., 2012, p. 241). The empathy-related behaviour of helping a friend was found to be associated with not just activity in the MPFC, but also with activity in the dorsal anterior cingulate cortex and the anterior insula (Rameson et al., 2012, p. 242). Interestingly, stronger neural responses were seen when participants were told to empathise, suggesting top-down responses that exert a certain amount of effort may increase empathic responses (Rameson et al., 2012, p. 242).

Another potential neurological correlate of empathy is the “mirror neuron system”, which is located within the frontal lobe (Kolb & Whishaw, 2011, p. 532). Recently, research has addresses whether mirror neurons play a role in social cognition, since people have a tendency to imitate each other during social interactions, which may serve as a basis for empathising with others (Kolb & Whishaw, 2011, p. 533). Carr et al., as cited in Kolb and Whishaw (2011, p. 533), found that the mirror neuron system becomes active when people observe or imitate emotional faces. Lacoboni & Dapretto, as cited in Kolb & Whishaw, (2011, p. 553) hypothesised that a dysfunctional mirror neuron system could lead to deficits in social behaviour, such as that seen in Autism Spectrum Disorder (ASD), it was found that
individuals diagnosed with ASD, during imitation tasks, had lower frontal lobe activity, it was also found that the lower the mirror neuron activity the greater the ASD symptoms.

Gutsell & Inzlicht (2012) suggested that the most basic feature of empathy, to share others emotional and motivational states, is reserved for people we like, they pose the basic question, “do we have a natural tendency to feel for others outside our social group.” In this study, EEG activity was recorded while participants viewed videos depicting either in-group or out-group members showing sadness, at the end of each video set, participants were asked to complete an emotion induction task which produced sadness, and finally participants completed a number of trait measures of prejudice and empathy (Gutsell & Inzlicht, 2012, p. 598). It was discovered that participants alpha asymmetry scores when experiencing sadness themselves and witnessing members of their group experience sadness did not differ, but when viewing members outside their group participants did not show this prefrontal alpha asymmetry, it was found that participants had significantly higher levels of alpha asymmetry when personally feeling sadness than when witnessing members of an out-group experiencing sadness (Gutsell & Inzlicht, 2012, p. 600). Gutsell & Inzlicht (2012, p. 600) state that “a significant linear trend indicated that alpha asymmetry was highest during personal experience of sadness, followed by the observation of in-group and then by the observation of out-group.....”.

In this study, participants were not vetted for variables that could skew EEG readings, such as neurological or psychiatric illness, these measures were undertaken by other researchers using EEG such as Vecchiato et al., (2011). Furthermore, one potential limitation of the research is that participants were drawn from white, east Asian and south Asian populations, excluding those of black ethnicity (Gutsell & Inzlicht, 2012, p. 598), this gives a limited reading of only three ethnic groups.
Jones et al., (2000) tested the hypothesis that children of depressed mothers would show fewer empathic responses towards the distress of others. 55 Children and their mothers participated in the study, (28 depressed, 27 not depressed). (Jones et al., 2000, p. 191). It was found that differences existed in the frontal regions, in that greater relative right frontal asymmetry in the child participants whose mothers were depressed was discovered (Jones et al., 2000, p. 196). It was also found that the children of depressed mothers showed less prosocial behaviour than the children whose mothers were not depressed taking longer to respond to a distressed infant’s cries (Jones, et al., 2000, p. 196). Also, in relation to their own mother’s distress, children of depressed mothers showed less empathic behaviour than children in the other group (Jones, et al., 2000, p. 196).

Some research has been done into the area of emotions in general and their EEG correlates. Kissler, Herbert, Peyk & Junghofer, (2007) found that emotionally significant words lead to an increase in activity in the occipito-temporal region. These regions are usually associated with the beginning of visual processing (Kolb & Whishaw, 2011, p. 6) and auditory, visual gustatory functions (Kolb & Whishaw, 2011, p. 52), respectively. The researchers selected 180 German nouns (60 pleasant, 60 unpleasant and 60 neutral from a group of 300 nouns, the 180 were selected by a group of 45 participants, who rated the words for arousal and valence, (Kissler, et al., 2007, p. 476). This ensured that the words were truly pleasant, unpleasant or neutral, i.e. that they were a valid stimuli. Participants were shown the on a computer monitor at varying speeds, (Kissler, et al., 2007, p. 477). From the EEG recordings it was discovered that emotional words resulted in enhanced brain responses in mostly left occipito-temporal regions 200 to 300 milliseconds after their presentation (Kissler, et al., 2007). Interestingly ERP’s for pleasant and unpleasant words did not differ (Kissler, et al., 2007, p. 477). Again, one issue with this piece of research is the small sample size. This research only employed 16 participants (Kissler et al., 2007, p. 476).
Vecchiato et al., (2011) investigated the changes in frontal EEG activity during the viewing of commercial video clips which were rated on levels of pleasantness by participants. 11 participants, aged 22-25 took part in this research, while participants wore the electrode cap, a movie was shown that lasted 30 minutes, which in itself acted as a neutral stimulus and 18 commercials were shown throughout (non neutral stimuli), Vecchiato et al., (2011, p. 580). Participants were then asked to rate the commercial clips on levels of pleasantness, (Vecchiato et al., 2011, p. 580).

The EEG signals associated with the lowest pleasantness ratings were grouped into a “DISLIKE” group where as the signals associated with the highest ratings were placed into a “LIKE” group, it was found that these two groups produced different EEG power spectral maps in both the theta and alpha bands, activity in the left frontal hemisphere was associated with the viewing of pleasant rated clips whereas activity in the right frontal hemisphere was associated with the viewing of clips deemed less pleasurable, (Vecchiato et al., 2011, p. 582).

One interesting aspect of this research is that researchers indeed screened for variables that could potentially skew the EEG readings, such as drug use and neurological or psychiatric illness, (Vecchiato et al., 2011, p. 580). Furthermore, the researchers chose commercials which had never been aired in Italy, thus ensuring (to a point) that they were novel stimuli to the participants, (Vecchiato et al., 2011, p. 580). However, again a small sample size was used, the study may have benefitted from a larger number of participants.

As Gu, et al. (2012, p. 2627) state, during empathy we “....share another’s affective state”, so could the viewing of others in a positive (e.g. happiness) situation or a negative (e.g. sadness) situation, put us in a negative affective state? And have a similar effect on the frontal hemisphere as seen in the above study?
Gender differences in cortical activation and empathy:

As previously mentioned, there is believed to be a significant gender difference in empathy levels, (Eisenberg & Lennon, as cited in Myers, 2013, p. 165; Garaigordobil, 2009). Even within caring professions like medicine this gender difference in empathy levels has been observed (Tavakol, Dennick & Tavakol, 2011, p. 300). Given previous studies which have found an alteration of cortical activity with empathic responding (e.g. Carr et al., as cited in Kolb and Whishaw (2011, p. 533) & Rameson, Morelli & Lieberman (2012)), it would not be illogical to be curious about the possible gender differences in cortical activity during empathising. It is hoped that the current study can identify whether a significant difference exists between the genders in neurological activity while empathising.

Ability to recognise facial expressions and empathy

Carr & Lutjemeier (2005, p. 602) note that the anticipation and responding to the emotional cues of others are key elements of social interaction.

Marsh, Kozak & Ambady (2007) hypothesised that differences in the ability to identify the expression of fear would predict differences in anti-social or prosocial behaviour, they tested this hypothesis across three studies. Participants listened to a tape and read documents which described the plight of a young college student, they were then asked to donate money or time to help this girl and completed a measure which shows facial expressions and asks participants to match the expressions to photos (Marsh et al., 2007, p. 241). The data supported the hypothesis: participant’s ability to recognise the expression of fear positively predicted their donations of money and time to help the misfortunate student (Marsh et al., 2007, p. 242). Although this study looked at prosocial behaviour, and a link
between empathy and prosocial behaviour has been previously established (Eisenberg and Miller, as cited in Jones et al., 2000, p. 190), not much previous research has looked at levels of empathy and the ability to recognise facial expressions, at least not with the JACFEE faces. It is hoped that this study can help to fill this apparent gap in the literature.

Carr & Lutjemeier (2005) investigated associations between facial expression recognition, empathy and self-reported offending among youth offenders. The results supported the idea that a link exists between the ability to recognise facial affect, empathy and offending, (Carr & Lutjemeier, 2005, p. 611). Interestingly however, the more the participants reported to have being involved in offending, the more accurate they were at identifying the expression of anger,(Carr & Lutjemeier, 2005, p. 615). However, the more the participants had partaken in acts of violence the worse they scored on the recognition of child emotional expressions and also, the less accurate the participants were at identifying the expression of fear in children, the less empathetic their responses to the experiences of others were (Carr & Lutjemier, 2005, p. 615). This study draws a relationship between youth offending and empathy (Carr & Lutemier, 2005, p. 615).

Rating of intensity of facial expressions and empathy

Green, Tripp, Sullivan & Davidson (2009) examined the relationship between levels of empathy and ratings of observed pain. 130 students took part in this research (Green et al., 2009, p. 382). Participants were informed that they would be observing others experiencing varying levels of pain and were told to rate the images they saw on an 11 point numeric pain rating scale (Green et al., 2009, p. 383). It was found that those reporting higher levels of empathy perceived more intense levels of pain in others (Green et al., 2009, p. 387).
Interestingly the authors used a sub-scale of the Davis (1980, 1983) interpersonal reactivity index (Green et al., 2009, p. 383), the full IRI will be used in the current study.

A significant difference in gender may exist in the interpretation of facial expression intensity. Proverbio, Matarazzo, Brignone, Del Zotto & Zani (2007) investigated the roles of gender and expertise in interpreting the valence and intensity of infant facial expressions. Participants viewed a range of images of infants expressing various emotions such as excitement at varying levels of intensity (e.g. weakly positive or strongly negative), participants then judged these photos by emotion and intensity (Proverbio et al., 2007, p. 479-480). The results of this study indicated a gender difference in decoding the infant’s facial expressions, with women being more accurate in decoding strongly positive, weakly positive and weakly negative expressions (Proverbio et al., 2007, p. 482). It was also found that strongly intense positive facial expressions were the best interpreted by participants, but a greater disagreement was found among the negative expressions which were of weak intensity (Proverbio et al., 2007, p. 479).

Although this study did not examine the role of empathy per se, it can be argued that empathy was at play. Recall Gu et al., (2007, p. 2627)’s definition of empathy: “Empathy refers to the ability to perceive and share another’s affective state”, evidently participants would have had to draw on emotional empathy to assess the valence and intensity of the infants in this study.
Neuroticism and empathy:

Eysenck as cited in Gross (2010, p. 668) factor analysed 39 items of personal data from a large number of soldiers who were deemed “neurotic”, two uncorrelated factors were discovered, “introversion-extraversion” deemed simply as “E” and “neuroticism-stability” or “N”, these dimensions are assumed to be normally distributed, that is, that most people will score somewhere in the middle of the scale and very few will be found at each extreme. One high in N (Neuroticism) could be described as a worrying, anxious and moody person who often experiences depressive episodes with a disposition to sleep disturbances and psychosomatic disorders (Eysenck, as cited in Gross, 2010, p. 668). These people could be described as being overly emotional, reacting too strongly to all kinds of stimuli and finding it hard to get back to normal after an emotionally arousing experience (Eysenck, as cited in Gross, 2010, p. 668). Passer & Smith, (2007, p. 465) describe “unstable” people (as defined by the PEN model) having “....hair trigger nervous systems that show large and sudden shifts in arousal...”. A typical low N scorer or “stable” scorer could be described as calm, even-tempered, in control and not easily worried, emotionally responding slowly and usually weakly to emotional arousal, and returning to normal quickly following emotional arousal, (Eysenck, as cited in Gross, 2010, p. 668). Eysenck’s N and E are not unlike neuroticism and extraversion in the “Big Five” trait theory, (Passer & Smith, 2007, p. 464). A third measure was later added: “Psychoticism” or “P”, which is believed to overlap with various psychiatric disturbances, (Eysenck & Eysenck as cited in Gross, 2010, p. 668).

Very little research seems to have been undertaken which examined empathy in relation to the personality trait of “neuroticism” as defined by Eysenck’s “PEN” model of personality. Among the very few, Hekmat, Khajavi & Mehryar (1974) investigated the extent which neuroticism, psychoticism and extraversion influenced empathy among a sample of American 475 college students. It was found that neuroticism and psychoticism correlated
negatively with empathy scores, and a significant positive correlation was found between empathy and extraversion, (Hekmat et al., 1974, p. 561). Those high in empathy were found to be significantly lower on psychoticism and neuroticism and higher on extraversion scores when compared to those in the low empathy group, (Hekmat et al., 1974, p. 561). It was also found that females scored significantly higher on levels of neuroticism when compared to males, (Hekmat et al., 1974, p. 561). The authors also note that the results of this study supports the idea that propensity toward psychological disturbance brings empathy levels down significantly for both genders, (Hekmat et al., 1974, p. 561). This study, while comprehensive, concise and utilising a large sample, is quite dated, a more up to date study using more recently developed measures of empathy may serve to give more accurate results, which is what we hope to achieve in the course of the current research.
Rationale for this research project

The area of empathy and the brain has been highly researched using advanced neuroimaging methods, (e.g. Rameson et al., 2012), lesion studies, (e.g. Gu et al., 2012), and indeed electroencephalography, (e.g. Gutsell & Inzlicht, 2012 & Jones et al., 2000). However, no research, to the best of the author’s knowledge exists looking at EEG activity and emotional empathy for facial expressions among an Irish population. This study will hopefully fill this gap in existing research by analysing the EEG correlates of the experience of empathy.

Some previous research has focused on facial mimicry and levels of empathy, (e.g. Dimberg, Andreasson & Thunberg, 2011 & Williams, Nicolson, Clephan, de Grauw & Perrett, 2013). To the best of the author’s knowledge, no previous research has looked at the ability to recognise facial expressions and levels of empathy using Matsumoto & Ekman’s, (1998) JACFEE faces with an Irish population.

Currently, there appears to be a gap in the literature regarding levels of empathy and the perception of intensity of emotional facial expressions. With current studies assessing only facial expressions of pain, (Green et al., 2009) and the roles of gender and experience in assessing infant facial expressions, (Proverbio et al., 2007). Could it be that the findings of previous research looking at empathy levels and perception of pain, (Green et al., 2009) will be similar for the emotions displayed in Matsumoto & Ekman (1998)’s JACFEE faces? This study also seeks to build on the sparse existing research and assess if a relationship exists between emotional empathy and the perceived intensity of facial expressions from the JACFEE faces, (Matsumoto & Ekman, 1998).

Given the evident gap in the literature regarding the relationship between empathy and the personality trait “neuroticism” as defined by Eysenck, as cited in Gross (2010, p. 668)
, this study seeks to add to the very small research base. Furthermore, the current research that was found took place over three decades ago, (Hekmat et al., 1974). It is hoped that this study can provide a more modern assessment of the relationship between the variables.

People scoring on the high end of the neuroticism scale have been described as overreacting to all kinds of stimuli, (Eysenck as cited in Gross, 2012, p. 668), perhaps this includes empathy-arousing stimuli? This study hopes to answer this question.

To the best of the author’s knowledge, no research has been conducted looking at gender differences in cortical activity during the presentation of empathy evoking stimuli with an Irish sample using the JACFEE faces (Matsumoto & Ekman, 1998) as a stimulus. This study hopes to fill this apparent gap in the literature.
**Hypotheses:**

**Hypothesis I:**

The first hypothesis is aimed at exploring the link between cortical arousal and empathetic responding.

H1: There will be a significant positive correlation between levels of empathy and neural output upon the presentation of empathy evoking stimuli.

**Hypothesis II:**

The second hypothesis seeks to investigate the relationship between levels of empathy and the ability to accurately identify facial expressions.

H2: A significant positive correlation will exist between empathy levels and accuracy in identifying facial expressions.

**Hypothesis III:**

The third hypothesis seeks to investigate the relationship between the personality trait of “neuroticism” and levels of empathy.

H3: There will be a significant relationship between levels of neuroticism and empathy levels.

**Hypothesis IV:**

The fourth hypothesis seeks to assess if levels of empathy and the perception of intensity of emotions are related.
H4: There will be a positive correlation between levels of empathy and how participants perceive and rate the intensity of emotional facial expressions.

Hypothesis V:

The fifth and final hypothesis hopes to assess if significant differences exist between males and females in neurological activity while viewing an empathy evoking stimulus.

H5: Females will report significantly different levels of general neural activity than males in response to empathy evoking stimuli.
Methodology

Participants

A total number of 19 participants took part in this research project. Participants were taken from both the Dublin Business School part and full time student population and from a group who replied to an online post (via facebook). Thus convenience sampling was utilised for this study. Participants came from a varying background, i.e. the majority of participants were full or part time undergraduate students but a few were classified as working adults. The only exclusion criteria employed was that participants must be over the age of 18 at the time of study. The sample was not exactly evenly distributed gender wise, with 11 male participants and 8 female participants. No incentives were given to encourage participants to partake.

Design

This study utilised a mixed quantitative correlational and comparison/contrast design to assess the relationship between variables. The variables under investigation in this study were empathy, neural activity, the ability to identify facial expressions correctly, the rating of intensity of facial expressions and neuroticism. Furthermore, gender differences in neural activity were studied.
**Materials**

**Empathy:**

In order to measure levels of empathy, the Interpersonal reactivity index (IRI) (Davis, 1980; 1983) was used. Baird, Scheffer & Wilson (2011, p. 329) note that the interpersonal reactivity index is the most commonly used questionnaire in empathy research. The IRI has demonstrated good test-retest reliability, good scale score reliability and convergent validity as well as good construct validity (Gilet, Mella, Struder & Gruhn, 2013, p. 45). The IRI is a relatively short questionnaire (28 items), which asks a series of questions relating to participants empathy levels (e.g. question 2. “I often have tender, concerned feelings for people less fortunate than me.). The IRI breaks down empathy into four aspects: Empathic concern, perspective-taking, personal distress and fantasy). Nine of the items on the scale are reverse scored. The answers are given on a five point likert scale (“A” being this statement does not describe well, “E” being this statement describes me very well and “C” being neutral). Instructions were stated at the top of the page before the questionnaire was completed: “The following statements inquire about your thoughts and feelings in a variety of situations. For each item, indicate how well it describes you by choosing the appropriate letter on the scale at the top of the page: A, B, C, D, or E. When you have decided on your answer, fill in the letter on the answer sheet next to the item number.” (See appendix A.)
Levels of neuroticism:

Levels of neuroticism were measured using the Eysenck personality questionnaire short scale – revised (Eysenck & Eysenck, 1992). The Eysenck personality questionnaire short scale – revised has been found to have good internal consistency, concurrent validity and test-retest reliability, (Sato, 2005). This is a slightly longer measure (48 items) that assesses participant’s levels of neuroticism, psychoticism and extraversion, for the purpose of this study, only levels of neuroticism will be evaluated. Answers are given in a classic “yes/no” format. Questions 1, 5, 9, 13, 17, 21, 25, 30, 34, 38, 42, & 46 evaluate neuroticism levels specifically, (e.g. question 21 “Would you call yourself a nervous person?”). Instructions printed at the top of the page, again before the questionnaire is filled out, read:

“The following statements enquire about your attitudes to a number of situations and about yourself. Please answer (by circling) either “YES” or “NO” to each question.”. (See appendix A.)

Neural activity and empathy:

Accuracy in identifying facial expressions and intensity rating of the expressions was assessed by using Matsumoto & Ekman’s (1988) JACFEE faces and an answer sheet (See appendix A.). These images were displayed using a PC, a monitor and a computer program which was linked to the EEG equipment (SuperLab). Participants were asked to rate the full 56 JACFEE faces, (Matsumoto & Ekman, 1988), which display seven emotional facial expressions, (anger, contempt, disgust, fear, happiness, sadness and suprise), with 8 images in each set. In each set, four of the images were of Asian faces and the remaining four were of
western Caucasian faces. Furthermore there were two men and two women within each of the Asian or Caucasian face sets. This ensured, to a certain degree, that the gender of the models could not influence results. A major strength of the JACFEE faces is the fact that they do not focus on just one ethnicity (i.e. just caucasian), but incorporate two, allowing, to a certain degree, for cultural differences. On the questionnaire given to participants, they were asked to identify what emotion was being displayed by each slide, they were further asked to rate the intensity of each slide (i.e. how “happy” is this person?) by answering a five point likert scale (1 being not intense at all and 5 being extremely intense). The instructions before this section were as follows: In the following section, a number of faces will be displayed while you wear the electrodes, you will be asked to identify the emotion being portrayed on screen and the intensity of each emotion being displayed. For each image we ask you to circle which emotion you think is being displayed and how intense it is 1 being not very and 5 being very intense. The choices are: Anger, Contempt, Disgust, Fear, Happiness, Sadness & Surprise.

Actual neural activity was measured using three individual electrodes by AD Instruments (MLA2505, shielded lead wires five pack), one positive, one negative and one neutral. Disposable “clip-on” ECG electrodes were added in order to make contact with the scalp. The signal from the electrodes was ran through a PowerLab data acquisition device by AD Instruments (ML4856 PowerLab 26T), which was connected to a separate PC and monitor, results were then displayed on the separate monitor using the computer program LabChart. SuperLab (the program used to display the images) and PowerLab were configured to communicate via StimTracker by AD Instruments (MLE1300) so that a mark indicating what emotion was being displayed could be left on the EEG output on LabChart stating what emotion was being displayed and for how long. This part of the research took part in a room which was mostly soundproof, ensuring minimal interference from outside audio stimulus.
**Procedures:**

Participants were first informed of the nature of the research, and that they would be wearing three electrodes to measure neural activity on the cortex. It was confirmed that each participant was over 18 years old and they were informed that they may withdraw at any time, but however, once data was collected it would be impossible to withdraw their questionnaire as results were totally anonymous, (See appendix 1.). A space was opened up for any questions or comments participants may have had about the research project. Participants were also informed that they would be wearing a number of electrodes both verbally and on paper, (on the front page of the answer booklet, see appendix 1.) Participants were shown the first two questionnaires, (the IRI, (Davis, 1980;1938) and the Eysenck personality questionnaire short scale – revised (Eysenck & Eysenck, 1992) respectively) and told to stop and inform the experimenter when they had reached the EEG section of the study. Participants were given an unlimited amount of time to complete these questionnaires. Once the two initial questionnaires were completed, participants were invited to take a seat in front of the computer monitor running the SuperLab program (the images were displayed on this monitor), the three electrodes were then attached: the neutral electrode was affixed to the left temple, while the negative electrode was affixed to the right temple and finally the positive electrode was affixed at the back side of the head (on the inion). A headband was used to keep the electrodes in place. Participants were then informed that they would see a series of images while neural activity was recorded and to rate each face they see in terms of anger, contempt, disgust, fear, happiness, sadness and surprise and also to rate the intensity of the expression from 1 to 5. Participants were asked to relax and focus on the blank white wall
infront of them to obtain a 10 second baseline EEG reading. Finally participants were informed that they had 10 seconds to rate each image and the experimental part of the study began. The researcher sat beside them monitoring the EEG being generated by LabChart at a separate monitor. When all 56 images had been displayed the EEG recording was halted and participants were told that they could remove the headband and electrodes. Any questions or comments were welcomed and noted and they were thanked for their participation.
**Results:**

Each participant’s data was entered into IBM’s Statistical Package for Social Sciences (SPSS v.21) where all data analysis was carried out.

Firstly, tests of normality were ran to justify the use of either Pearson’s R or Spearman’s Rho to analyse possible correlations and the use of either a independent samples t-test or a Mann Whitney U to analyse differences between males and females. Tests of normality revealed that a number of variables were not normally distributed. The perspective taking aspect of empathy levels as measured by the Davis (1980; 1983) IRI and the mean EEG readings for the empathy evoking stimuli were found by the Shapiro-Wilk test to be abnormally distributed, this was verified by examining the relevant histograms and Q-Q plots. Furthermore, when split by gender (for hypothesis V) it was found by a Shapiro-Wilk test that the mean EEG readings for males were not normally distributed; this was also confirmed by examining the relevant histogram and Q-Q Plot.

Due to the nature of the (Davis, 1980; 1983) interpersonal reactivity index, i.e. that it breaks empathy into four sub-variables (empathic concern, personal distress, fantasy and perspective taking), each variable was tested for correlations separately for ease of interpretation as opposed to giving just one “flat” empathy score.
Descriptive Statistics

Before inferences could be drawn from the data, descriptive statistics were carried out. The mean, standard deviation and the relevant graphs for each variable are presented in this section.

Empathy levels

Table 1. Descriptive statistics (means & standard deviations) for empathy levels in all participants.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empathic Concern</td>
<td>17.32</td>
<td>3.37</td>
</tr>
<tr>
<td>Fantasy</td>
<td>18.42</td>
<td>5.11</td>
</tr>
<tr>
<td>Personal Distress</td>
<td>9.89</td>
<td>4.19</td>
</tr>
<tr>
<td>Perspective Taking</td>
<td>19.21</td>
<td>5.89</td>
</tr>
</tbody>
</table>
Figure 1.
Figure 2.

Figure 3.
Table 1 shows the means and standard deviations of the four aspects of empathy as measured by the IRI, (Davis, 1980;1983). These means seem to fall around a similar mark, except levels of personal distress, which seem to be falling lower. Figures 1-4 (bar charts) show the frequency distribution of each empathy variable measured by the IRI (Davis, 1980;1983). This data suggests that the majority of scores are falling in the mid-ranges of each of the scales.
EEG readings:

**Table 2.** Descriptive statistics (means and standard deviations) for EEG readings for all participants.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEG output (μV)</td>
<td>-.35</td>
<td>1.79</td>
</tr>
</tbody>
</table>

**Table 3.** Descriptive statistics for EEG readings split by gender.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Male</th>
<th>Female</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>EEG output</td>
<td>-.60</td>
<td>2.15</td>
<td>-.01</td>
<td>1.18</td>
</tr>
<tr>
<td>(μV)</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Figure 5.
Figure 6.

Figure 7.
Table 2 shows the mean and standard deviation of the overall EEG recordings of all participants whereas Table 3 splits the cohort by gender. Figure 5 Shows a bar chart representing the frequency distributions of the overall EEG activity (in μV), it can be observed that the score which experiences the highest frequency is the .24 μV bracket. Upon separating males and females it can be observed from the relevant histograms (figures .6 & .7) that a clear positive skew exists among the male scores, with the majority of scores falling between .00 μV and 2.00 μV, there is not such an extreme skew with the female scores, with the majority of scores falling between -1.00 μV and 1.00 μV.

**Neuroticism**

**Table 4.** Descriptive statistics for levels of neuroticism for all participants.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
<td>7.16</td>
<td>3.37</td>
</tr>
</tbody>
</table>
Figure 8.

Figure 7 gives the mean and standard deviation for levels of neuroticism in the current sample. Figure 8 shows a bar chart representing the frequency distributions of the levels of neuroticism, it can be seen that the majority of scores fall in the 7-9 categories.
Facial expressions identified correctly:

**Table 5.** Descriptive statistics (mean and standard deviation) for the number of facial expressions identified correctly by all participants.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expressions identified</td>
<td>41.84</td>
<td>7.21</td>
</tr>
<tr>
<td>correctly</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 9.**

Table 5 shows descriptive statistics for the number of facial expressions identified correctly by the cohort of participants. Figure 9 depicts the distribution of scores, it can be
seen that a relatively normal distribution exists, with the majority of scores falling in the 40-50 answered correctly bracket.
Intensity ratings:

Table 6. Descriptive statistics (mean and standard deviation) for the intensity ratings given by all participants for the JACFEE faces (Matsumoto & Ekman, 1998)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating of intensity of facial expressions</td>
<td>180</td>
<td>22.43</td>
</tr>
</tbody>
</table>

Figure 10.
Table 6 presents the mean and standard deviation for participant’s rating of how intense the emotions displayed by the JACFEE faces (Matsumoto & Ekman, 1998) were. Figure 10 depicts a histogram representing the distribution of the intensity ratings, it can be deduced that the majority of scores do indeed fall between 160 to 180.
**Inferential Statistics**

**Hypothesis 1:**

The first hypothesis sought to investigate if a significant positive correlation existed between levels of empathy and the mean neural output (measured via EEG) while the Matsumoto & Ekman’s (1988) JACFEE faces were displayed. The mean score for neural output was −0.35 μV (SD = 1.79), for empathic concern 17.32 μV (SD = 3.38), personal distress 9.89 μV (SD = 4.19), perspective taking 19.21 μV (SD = 5.89) and for fantasy levels 18.42 μV (SD = 5.11). A Spearman’s Rho correlation found that empathic concern had a weak positive, but non-significant correlation with neural output, (rho(17) = .19, p = .220), perspective taking (rho(17) = .19, p = .219) and fantasy levels (rho(17) = .33, p = .083). Finally a Spearman’s Rho found that personal distress had a non significant weakly negative correlation with neural output (rho(17) = −.19, p = .214). In all cases therefore, the null hypothesis cannot be rejected.

**Hypothesis 2:**

The second hypothesis sought to investigate if a significant positive correlation existed between levels of empathy and accuracy in identifying facial expressions. The mean score for the number of facial expressions identified correctly was 41.84 (SD = 7.21), the mean score for levels of empathic concern was 17.32 (SD = 3.38), for levels of personal distress 9.89 (SD = 4.19), for levels of perspective taking 19.21 (SD = 5.89) and for levels of fantasy, 18.42 (SD = 5.11). A Spearman’s Rho correlation (one tailed) found that correct identification of facial expressions was weakly negatively correlated, but non-significantly with levels of empathic concern (rho(17) = −.17, p = .250), and personal distress (rho(17) = -
It was also found using Spearman’s Rho that the number of facial expressions answered correctly was weakly positively, but not significantly correlated with fantasy levels (rho(17) .23, p = .169). Finally a Spearman’s Rho correlation found that the number of facial expressions correctly identified had a weak negative but non-significant correlation with perspective taking (rho(17) -.05, p = .413). In all cases the null hypothesis could not be rejected.

**Hypothesis 3:**

The third hypothesis sought to investigate the relationship between levels of empathy and neuroticism by stating that a significant relationship would exist. The mean score for levels of neuroticism was 7.16 (SD = 3.37), the mean score for empathic concern was 17.32 (SD = 3.38), 9.89 (SD = 4.19) for personal distress, 19.21 (SD = 5.89), for perspective taking 19.21 (SD = 5.89) and for levels of fantasy 18.42 (SD=5.11). A Spearman’s Rho correlation found that levels of neuroticism were weakly negatively and non-significantly correlated with levels of empathic concern (rho(17) -.08, p = .751). The Spearman’s Rho correlation also found that levels of neuroticism had a weak, negative and non-significant correlation with levels of fantasy (rho(17) -.16, p = .526). The Spearman’s Rho correlation found that levels of neuroticism had a weak positive and non-significant correlation with personal distress (rho(17) .35, p = .142). Finally, a Spearman’s Rho correlation found that perspective taking had a non-significant weakly negative correlation with neuroticism (rho(17) -.30, p = .219). Again the null hypothesis cannot be rejected in all cases.

**Hypothesis 4:**

The fourth hypothesis sought to investigate if a significant positive correlation would exist between empathy levels and the rating of intensity of emotional facial expressions. The mean score for the intensity rating of facial expressions was 9.89 (SD = 4.19), the mean score
for empathic concern was 17.32 (SD = 3.38), for personal distress 19.21 (SD = 5.89), for levels of fantasy 18.42 (SD = 5.11) and for levels of perspective taking, 19.21 (SD = 5.89). A Spearman’s Rho correlation found that intensity ratings had a weak, negative and non-significant correlation with personal distress (rho(17) -.004, p = .494), and with empathic concern (rho(17) -.23, p = .174). Spearman’s Rho also revealed that levels of the fantasy aspect of empathy had a weak, positive but non-significant correlation with the intensity ratings of facial expressions (rho(17) .17, p = .249). Finally a Spearman’s Rho correlation revealed that the rating of emotional facial expressions the perspective taking aspect of empathy had a weak but not significant positive correlation with the rating of intensity of emotional facial expressions, (rho(17) .05, p = .425). In all cases, the null cannot be rejected.

**Hypothesis 5:**

The fifth and final hypothesis sought to investigate if any significant differences exist between males and females on EEG readings. A Mann-Whitney U test was used to test this hypothesis. Male participants had a mean rank of 9.77 compared to the mean rank of 10.31 for female participants. The Mann-Whitney revealed that male and female participants did not differ significantly on levels of neural activity (U = 41.50, p = .836). Therefore, again in this case, the null hypothesis cannot be rejected.
Discussion

Summary

The aim of this research project was to investigate if correlations existed between cortical arousal and empathy, levels of neuroticism and empathy, the ability to identify facial expressions and empathy and intensity ratings of emotional facial expressions and empathy. Furthermore, it was investigated if a significant difference would exist between male and female participants’ neural activity while viewing empathy evoking stimuli. In all cases regarding empathy and its correlates weak, non-significant positive or negative correlations were found. Showing that the variables tested had no relationship. It was also found that no significant difference existed between males and females on neural output while viewing empathy evoking stimuli.

The first hypothesis sought to investigate if a significant positive correlation would exist between levels of empathy and neurological activity. A Spearman’s Rho correlation found that no significant relationship existed between the three aspects of empathy as measured by the interpersonal reactivity index (IRI) (Davis, 1980;1983) and EEG output.

For the second hypothesis, no significant positive correlation between the four aspects of empathy as measured by the interpersonal reactivity index (Davis, 1980;1983) and the number of facial expressions from Matsumoto & Ekman’s (1988) JACFEE faces that were identified correctly was discovered by the Spearman’s Rho test.

No significant correlation was found between reported levels of neuroticism in relation to the Eysenck personality questionnaire short scale – revised (Eysenck & Eysenck, 1992) and the three aspects of empathy measured by the interpersonal reactivity index (Davis, 1980;1983), which was the subject of hypothesis three.
In relation to the fourth hypothesis, no significant positive correlation was found between the three aspects of empathy as measured by the interpersonal reactivity index (Davis, 1980; 1983) and how participants rated the Matsumoto & Ekman (1988) JACFEE faces on the intensity of emotional expression.

Finally, for the fifth hypothesis no significant difference in neural activity as measured by EEG between men and women was found by a Mann-Whitney U non parametric test of difference.

Overall, the findings of the current research mean that the null hypothesis cannot be rejected in all cases, suggesting no significant relationship or difference between the variables examined.

The findings of the current study in light of previous research

The present study contradicts a number of previous studies in the area of empathy and its neurological correlates such as research conducted by Jones et al., (2000), which found that levels of empathy in general were related to differences in EEG output. It also contradicts the findings of research which utilised advanced neuroimaging methods such as fMRI, which found a number of neurological correlates of empathy such as Rameson et al., (2012) who implicated the medical prefrontal cortex (MPFC) in empathy for sad events. Rameson et al., (2012, p. 533) also found that empathy related behaviour was not just associated with the MPFC, but also the dorsal anterior cingulated cortex and anterior insula. The research conducted by Carr et al., as cited in Kolb and Whishaw (2011, p. 533), who found that the
mirror neuron system located within the frontal lobe is implicated in the recognition of emotional stimuli, is also contradicted.

The findings of the current study also go against the findings of the limited previous research in the area of intensity rating and empathy, Green et al., (2009) found with a much larger sample size that higher ratings of pain were related to higher levels of empathy. A possible explanation for this contradiction is that the small cohort of participants utilised in the current research which could have had an impact on results, whereas Green et al., (2009, p. 382) employed 130 participants.

Furthermore, the results contradict research by Hekmat et al., (1974) which found that neuroticism correlated negatively with levels of empathy. However, Hekmat et al., (1974, p. 559) again utilised a vastly larger sample size (n = 475) than the current study. Also, Hekmat et al., (1974, p. 559) used the full 60-item PEN inventory, which may have provided a better and more in-depth measure of neuroticism.

The current study further contradicts current research in the area of the ability to identify facial expressions and empathy and pro-social behaviour. Marsh et al., (2007) found that the ability to identify the expression of fear predicted participant’s level of pro-social behaviour, which has an established link to empathy (Eisenberg and Miller, as cited in Jones et al., 2000, p. 190), whereas the current study found that most empathy variables were negatively but not significantly correlated with the ability to identify facial expressions, the exception is levels of fantasy, which were found to have a weak but non-significant positive correlation with the ability to identify facial expressions.

The findings in relation to hypothesis five were also very surprising. As previously mentioned, it is believed that a significant difference in empathy levels exists across gender. Recall the findings of Eisenberg & Lennon as cited in Myers (2013, p. 165) who found that
women are more likely to be disturbed by another’s distress than men. This finding has been
backed up by further research (e.g. Garaigordobil, 2009). Given that empathy has known
neural correlates, (e.g. Jones et al., 2000 & Rameson et al., 2012), it was expected that a
significant difference would be detected. As with the other hypothesis, one possible
explanation of the findings of the current research is the lack of a large, evenly divided by
gender sample along with the limited EEG equipment that was available. This is further
discussed in the limitation section of this discussion.

Limitations of the current study:

While these results are indeed surprising, they must be interpreted carefully. This
study was limited by a number of factors including a small sample size (n = 19) and the use
of only three electrodes to record general cortical arousal (one negative, one positive and one
neutral). Another limitation of this research is that, with the given equipment, it could not be
detected which areas of the cortex were undergoing changes in activity. Further research
could attempt to utilise a larger sample size and methods which use more than three
electrodes, which would no doubt give a more accurate reading of cortical activity.
Furthermore the sample size in the current research was quite small for correlational research,
in relation to hypotheses 2, 3 and 4 a larger sample size would be advisable, if a larger
sample had been utilised, perhaps more significant results would have been found.
Participants may also have been frustrated at the length the whole procedure took, especially
the EEG part of the research, perhaps in future a smaller image set or an abridged version of
the JACFEF faces, (Matsumoto & Ekman, 1988) should be used. Another factor that may
have limited the findings of this study is gender differences in relation to the perception of
facial expression intensity. Recall the findings of Proverbio et al., (2007) that significant
gender differences may exist in the interpretation of facial expression intensity, future research should control for this by having an equal number of male and female participants or perhaps evaluating gender differences, which was beyond the scope of the current research.

One variable that was not controlled for was possible neurological/psychiatric illnesses that may have skewed the EEG readings. These measures were employed by previous researchers employing EEG such as Vecchiato et al., (2011, p. 580). It is recommended that future research in this area take these variables into account.

Conclusion

The current research gives a good insight into possible relationships between these variables and may pave the way for more in-depth research utilising larger, more evenly divided sample sizes and more accurate and expansive equipment (i.e. the equipment used to collect neurological data). As previously mentioned, the findings of this research must be taken onboard carefully, and the results can in no way be described as definitive. Further research in this area will no doubt provide a better understanding of the relationships and differences between the variables in question.
References:


Appendix A. Full answer booklet.

My name is Conor Briody; I am a final year student on the BA (Hons) Psychology programme in Dublin Business School. I am conducting research which is looking at empathy.

No personal information will be collected during the course of this research, so I kindly ask you not to put any personal details such as name or student number on this booklet. Participation is voluntary and you have the right to withdraw at any time, however once the data has been collected, I cannot remove it due to the anonymous nature of this research.

Please note that as part of this research you will be required to wear a number of electrodes for a short time to record brain activity, this is usually not uncomfortable, but a small amount of sticky conductant (gel) will be used to affix the electrodes.

By completing this questionnaire and the subsequent experiment you give your consent to be a participant and have data collected from you.

During the questionnaire sections I ask you to please READ EACH ITEM CAREFULLY BEFORE RESPONDING and answer as honestly as you can.

Remember, there are no right or wrong answers.

Age: _______
Gender: _______

Please tick to confirm that you are over 18 years old: _______

If you have any questions or comments please do not hesitate to contact me or my supervisor:

Email:

Phone:

Supervisor: Dr. Rosie Reid.

Email:
Interpersonal Reactivity Index (IRI) (Davis, 1980; 1983)

The following statements inquire about your thoughts and feelings in a variety of situations. For each item, indicate how well it describes you by choosing the appropriate letter on the scale at the top of the page: A, B, C, D, or E. When you have decided on your answer, fill in the letter on the answer sheet next to the item number.

Answer Scale:

A  B  C  D  E
DOES NOT  DESCRIBES ME
DESCRIBE ME  VERY
WELL  WELL

1. I daydream and fantasize, with some regularity, about things that might happen to me ________

2. I often have tender, concerned feelings for people less fortunate than me. ________

3. I sometimes find it difficult to see things from the "other guy's" point of view. ________
4. Sometimes I don't feel very sorry for other people when they are having problems. 

5. I really get involved with the feelings of the characters in a novel. 

6. In emergency situations, I feel apprehensive and ill-at-ease. 

7. I am usually objective when I watch a movie or play, and I don't often get completely caught up in it. 

8. I try to look at everybody's side of a disagreement before I make a decision. 

9. When I see someone being taken advantage of, I feel kind of protective towards them. 

10. I sometimes feel helpless when I am in the middle of a very emotional situation. 

11. I sometimes try to understand my friends better by imagining how things look from their perspective. 

12. Becoming extremely involved in a good book or movie is somewhat rare for me. 

13. When I see someone get hurt, I tend to remain calm. 

14. Other people's misfortunes do not usually disturb me a great deal. 

15. If I'm sure I'm right about something, I don't waste much time listening to other people's arguments. 

16. After seeing a play or movie, I have felt as though I were one of the characters.
17. Being in a tense emotional situation scares me.

18. When I see someone being treated unfairly, I sometimes don't feel very much pity for them.

19. I am usually pretty effective in dealing with emergencies.

20. I am often quite touched by things that I see happen.

21. I believe that there are two sides to every question and try to look at them both.

22. I would describe myself as a pretty soft-hearted person.

23. When I watch a good movie, I can very easily put myself in the place of a leading character.

24. I tend to lose control during emergencies.

25. When I'm upset at someone, I usually try to "put myself in his shoes" for a while.

26. When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me.

27. When I see someone who badly needs help in an emergency, I go to pieces.

28. Before criticizing somebody, I try to imagine how I would feel if I were in their place.
In the following section, a number of faces will be displayed while you wear the electrodes, you will be asked to identify the emotion being portrayed on screen and the intensity of each emotion being displayed.

For each image we ask you to circle which emotion you think is being displayed and how intense it is 1 being not very and 5 being very intense. The choices are:

Anger, Contempt, Disgust, Fear, Happiness, Sadness & Surprise.

1. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
2. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
3. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
4. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
5. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
6. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
7. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
8. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
9. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
10. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
11. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
12. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
13. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
14. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
15. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
16. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
17. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
18. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
19. ANGER CONTEMPT DISGUST FEAR HAPPINESS SADNESS SURPRISE 1 2 3 4 5
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<tr>
<th></th>
<th>ANGER</th>
<th>CONTEMPT</th>
<th>DISGUST</th>
<th>FEAR</th>
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I would like to thank you for your participation, any questions or comments are highly valued

Appendix B. JACFEE faces. (Matsumoto & Ekman, 1988) (In reverse order).