Feeling Other People's Pain: An Event-Related Potential Study on Facial Attractiveness and Emotional Empathy

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ABSTRACT

Empathy is the ability to understand and react to other people's inner states. Neuroimaging evidence suggests that there are two aspects of empathy which are subserved by distinct brain networks. The emotional aspect of empathy is reflected by bottom-up processes and the cognitive aspect of empathy is influenced by top-down processes. Both aspects can be studied by measuring the reaction of participants exposed to the pictures of models who feel physical pain, for example, having a needle stuck in their cheek. The early event-related potential (ERP) N2 has been reported in observing other's physical pain and has been suggested as a biomarker of the emotional aspect of empathy. The present study investigated the time course of processing other's pain and the influence of face attractiveness on the early ERP component. Participants ($N = 24$) viewed photos of physically attractive and unattractive men and women during painful (a needle in the check) and nonpainful stimulation (Q-tip touching the skin). N1 and P2 components were sensitive to face attractiveness. The amplitude of the N2 component was more positive for the stimuli associated with pain than for neutral stimuli, but only for unattractive faces. Therefore, we suggest that a difference in the N2 amplitude to pain in unattractive faces most likely reflects a difference in emphatic response depending on facial attractiveness.

KEYWORDS

emotional empathy
facial attractiveness
pain
ERP study

INTRODUCTION

"Empathy refers to the capacity to understand and respond to the unique affective experiences of another person" (Decety & Jackson, 2006, p. 54). It is not a unitary concept, but it comprises emotional and cognitive aspects The emotional aspect of empathy refers to affective sharing between the self and others and the cognitive aspect is related to the cognitive capacity to take the perspective of the other person (Decety & Jackson, 2006; Decety & Lamm, 2006; Decety et al., 2015). Affective sharing is based on the perception-action model and activity of mirror neuron systems (Preston, 2007) and, in case of empathy, it means that by observing another person in a particular emotional state, the observer may experience similar feelings. It is based on an unconscious (bottom-up) process. However, the primary affective response needs to be modulated by regulation (top-down) processes, beginning with basic forms of the self-other distinction and ending on emotion control (Decety, 2011; Decety & Jackson, 2006; Decety & Lamm, 2006). All in all, mature empathy is characterized by conscious forms of emotion regulation and advanced forms of cognitive empathy.

Recent brain imaging studies have examined the neural processes involved in empathy by scanning participants during their perceiving of body parts or faces in painful and nonpainful situations (e.g., Lamm & Singer, 2010; Singer et al., 2004). Observing a person experiencing

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pain recruits neural circuits largely overlapping those active when experiencing the pain directly (Jackson et al., 2006; Singer et al., 2004). Also, studies have shown that emotional and cognitive aspects of empathy are based on separate neural networks (Decety & Jackson, 2004, 2006; Decety & Lamm, 2006). This neural empathic response has been found to be correlated with helping behavior (Hein et al., 2010; Singer et al., 2004) and is generally referred to as a marker of empathy for pain in others (Lamm et al., 2011).

However, some studies report that the empathic response is not constant, but is more variable than previously thought. Variables such as the race of the people shown in the pictures (e.g., Contreras-Huerta et al., 2013; Sessa et al., 2014) can modify the empathic response. Researchers postulate that this is caused by the relationship between the observer and others but also by their physical differences (e.g., Contreras-Huerta et al., 2014; Maister et al., 2013). Experiments focusing on the influence of race on the empathic reaction were an inspiration for us to explore facial attractiveness and its influence on empathy for pain.

It has been widely reported that physical attractiveness may influence human social behavior and interaction (Müller et al., 2013; Wilson & Eckel 2006). Attractive individuals are considered to be healthier and to have better genes (Dixson et al., 2003). They are also associated with many positive attributes, such as intelligence (e.g., Moore et al., 2011). Understandably, people might have more compassion for individuals who have such qualities (Müller et al. 2013). However, the results of a study by Jankowiak-Siuda et al. (2015) are not consistent with this statement. In their fMRI study, short movie clips were presented to the participants showing attractive or unattractive people of both sexes experiencing pain. The activity of anterior insula (AI) and the anterior cingulate cortex (ACC) was greater for the less attractive man than for the more attractive man and for the more attractive woman than for the less attractive woman. According to the authors, an unattractive man aroused a stronger empathic response than an attractive one because of the lower intensity of male traits. A higher intensity of male traits may be identified with the manifestation of behaviors such as dominance and emotional coldness, and these features do not facilitate empathy (Jankowiak-Siuda et al., 2015).

Considering the results of Jankowiak-Siuda et al. (2015) and the inconsistent behavioral findings (i.e., Fisher & Ma, 2014; Müller et al. 2013), there is no consensus about the impact of attractiveness on empathy. Attractive faces have a linear relationship with positive affect. Also, attractive faces hold attention more effectively than less attractive faces (Valuch et al., 2015) and observing them is considered more pleasant (Langlois & Roggman, 1990; Little, 2014). Therefore, being juxtaposed with a negative painful stimulus (a needle stuck in the cheek), attractive faces might be less coherent for participants. In contrast, unattractive faces evoke less positive affect (Principe & Langlois, 2011), which might be more coherent with the negative painful stimulus. That is why in the context of empathy for pain, it is possible that unattractive faces may have more advantage to being observed in painful situations.

Based on previous electrophysiological studies, there are differences in event-related potential (ERP) components that have been documented when participants perceive another person being intentionally harmed (Han et al., 2008). Perception of painful compared with nonpainful stimuli induces larger early ERPs over the frontal and frontocentral lobes, followed by a long latency empathic response starting around 300 ms over the centroparietal regions (Fan & Han, 2008). The early N1, N2, and P2 potentials are associated with perceptual information first processed at a low-level stage (Decety et al., 2010; Ibáñez et al., 2011; Maekawa et al., 2011). The N1 component relates to an automatic affective arousal and is sensitive to facial attractiveness (Ma et al., 2017), while the P2 component is related to recognition processes (Halit et al., 2000). Its amplitude is higher when attractive faces are presented compared to unattractive ones (van Hooff et al., 2010).

The amplitude of the N2 component reflects the emotional evaluation (Hajcak et al., 2005). Studies on empathy for pain have revealed that the N2 component is present during the observation of pain in others. The amplitude of the N2 is also sensitive to experimental manipulation (Luo et al., 2018; Sessa et al., 2014). For example, its amplitude is more positive when participants see the face in a painful situation (compared to a neutral one), but only when it is of the same race as the participant (Sessa et al., 2014). There was no difference in the amplitude of the N2 component when participants observed other-race people in pain.

The research concerning race and empathy was an inspiration for our study. It seems to be that the appearance of different-race faces influences early ERP amplitude, whereas the later components remain unbiased (Contreras-Huerta et al., 2014; Sessa et al., 2014). Thus, the research presented in this paper aims to verify the influence of facial physical attractiveness on early ERPs, which are an indicator of affective sharing as the emotional aspect of empathy. Considering the results of the previous ERP studies on attractiveness, race, and empathy, we expected that the amplitudes of N1 and P2 components would be greater for attractive faces than for unattractive ones. We also expected that differences in the amplitude of the N2 component may be crucial for the interaction between attractiveness and painful stimulation.

METHOD

Participants

Twenty-four participants (12 females; M_{age} = 22.4, SD = 3.1) were recruited through the John Paul II Catholic University of Lublin, Poland. The respondents agreed to participate in the study voluntarily and were paid the equivalent of $5. The experiment was carried out in accordance with the Declaration of Helsinki and approved by the Ethical Committee of the John Paul II Catholic University of Lublin.

Stimuli

The stimuli were taken from the Chicago Face Database (Ma et al., 2015; http://faculty.chicagobooth.edu/bernd.wittenbrink/cfd/index.html) and the website www.models.com. Two hundred and sixty-eight

photos were evaluated by a separate group of thirty-two participants (16 females; M_{age} = 22.55, *SD* = 2.6) on a scale of 1-5 (1 = *very unattractive*, 5 = *very attractive*). The photographs were in color, presented enface, in 131.22 × 77.5 mm size. For the EEG study, we collected sets of 10 photos presenting attractive women (score: *M* = 4.28, *SD* = 0.62), attractive men (score: *M* = 4.20, *SD* = 0.46), unattractive women (score: *M* = 1.56, *SD* = 0.47), and unattractive men (score: *M* = 1.59, *SD* = 0.47). A total of 40 photographs were used. Each photograph was scaled to fit in a rectangular portion of a computer screen at a viewing distance of approximately 70 cm. Each face was manipulated digitally to be displayed in two different conditions. In the painful stimulation condition, the face was displayed with a needle of a syringe penetrating the cheek (right or left). In the nonpainful stimulation condition, the face was displayed with a Q-tip touching the cheek (right or left; see Figure 1). Also, to vary the stimuli presented in both conditions, the angle at which the syringe or Q-tip touched the cheek and the appearance of the hand holding the tool were randomly changed.

Procedure

Participants were informed that the experiment aimed to collect information about facial perception. They received a misleading instruction in which they were asked to remember the presented faces. The task was defined in this way to engage their attention away from the main independent variables. Each trial started with a presentation of the fixation point in the middle of the computer screen for 1.5 s. Then, for 1 s, a face was presented, and for the next 1.5 s, an empty screen was displayed (see Figure 2). The study was divided into six blocks, with short breaks for participants and checking of the impedance level on the electrodes. There was a total of 800 stimuli divided equally into four categories, derived from two main independent variables: attractiveness (attractive vs. unattractive faces) and stimulation (painful vs. non-painful stimuli)

EEG ACQUISITION AND ANALYSIS

For the signal acquisition, 64 active electrodes (ActiCAP, Brain Products, Munich, Germany) connected to a high-input-impedance amplifier (200 MΩ, GES 300, Electrical Geodesics, Inc., Eugene, OR) were used. The EEG was referenced to an FCz electrode and digitized

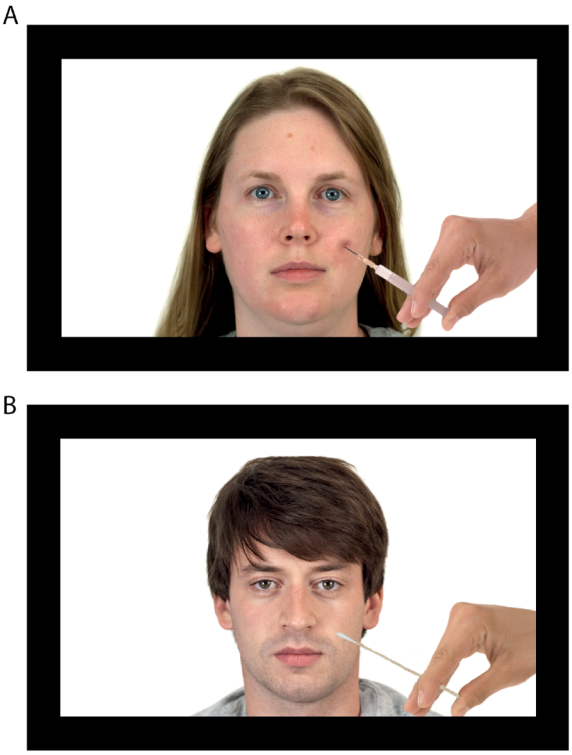

FIGURE 1.
Sample faces used in the study: (a) in the painful stimulation condition, (b) in the non-painful stimulation condition.

at a sampling rate of 250 Hz. Electrode impedances were kept below 5 kΩ. Offline signal processing included band-pass filtering (0.1 to 45 Hz) and common average reference. Muscle artifacts in the EEG signal, including eye movements and eye blinks, were corrected and bad channels were interpolated using the artifact subspace reconstruction method (Mullen et al., 2015). Afterwards, epochs were created, beginning at 100 ms before the onset of stimuli and ending 1000 ms after it. An additional artifact rejection procedure using independent component analysis (ICA; Delorme, & Makeig, 2004) and source localization was applied. We rejected independent components that contained remaining muscle artifacts, components whose source location was outside the brain, or which had unusual spectral power properties.

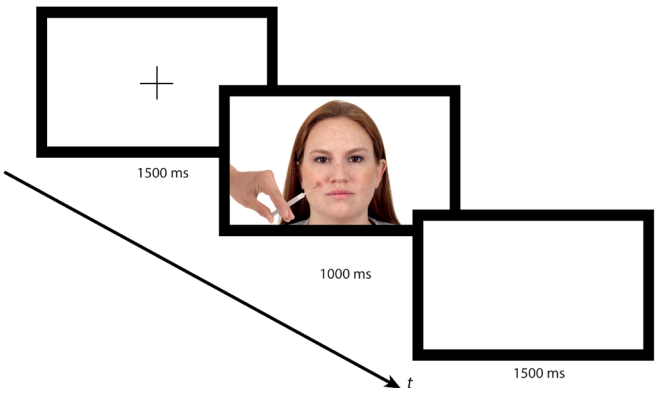

FIGURE 2.
Illustration of the experimental procedure.

Mean N1, P2, and N2 component amplitudes were measured at frontocentral electrode sites in 110–150 ms, 160–220 ms, and 240–280 ms time windows based on a visual inspection and locked to the onset of the face stimuli, respectively. Statistical analyses were conducted on mean amplitude estimates of activity averaged for each of frontal (AF3/AF4, AF7/AF8, Fz, FCz, F1/F2, F3/F4, F5/F6, F7/F8, FC1/FC2, FC3/FC4, FC5/FC6, and FT7/FT8), central (Cz, C1/C2, C3/C4, and C5/C6), and parietal (Pz and P3/P4) electrode sites, as in the procedure by Sessa et al. (2014).

RESULTS

Event-Related Potential: N1 (110–150 ms) and PS (150–220 ms)

The ANOVA for N1 mean amplitude revealed a main effect of attractiveness, $F(1, 22) = 4.691$, $p = .04$, $\eta_p^2 = 0.18$). The attractive faces elicited more negative N1 amplitudes than unattractive faces ($M = -0.760$; $SE = 0.084$). There was a slight tendency towards the main effect of attractiveness on the P2, $F(1, 22) = 3.711$, $p = .067$. The attractive faces elicited more positive P2 amplitudes than unattractive faces (see Figure 3). The ANOVA detected no other main effect or interaction (all $ps > .05$).

Event-Related Potential: N2 (240–280 ms)

The ANOVA for the N2 mean amplitude revealed a significant interaction of stimulation, attractiveness, and localization, $F(1, 23) = 4.203$, $p = .028$, $\eta_p^2 = 0.28$. A Bonferroni post hoc test ($p = .009$) showed that on the frontal electrodes, the amplitude on N2 was more positive in painful compared to nonpainful condition, but only for unattractive faces, $M = -1.125$, $SE = 0.176$. There were no similar differences in attractive faces, $M = -1.277$, $SE = 0.147$ (see Figure 4). The ANOVA detected no other main effect or interaction (all $ps > .05$).

DISCUSSION

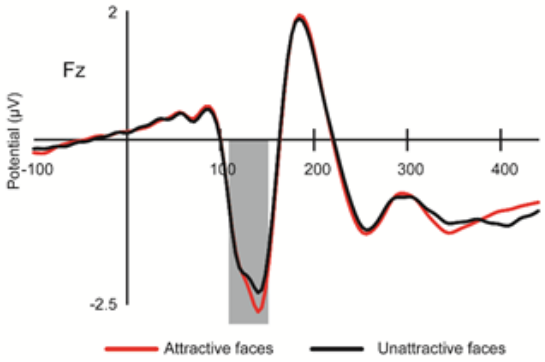

FIGURE 3.
N1 (110- 150 ms) recorded in response to attractive versus unattractive faces.

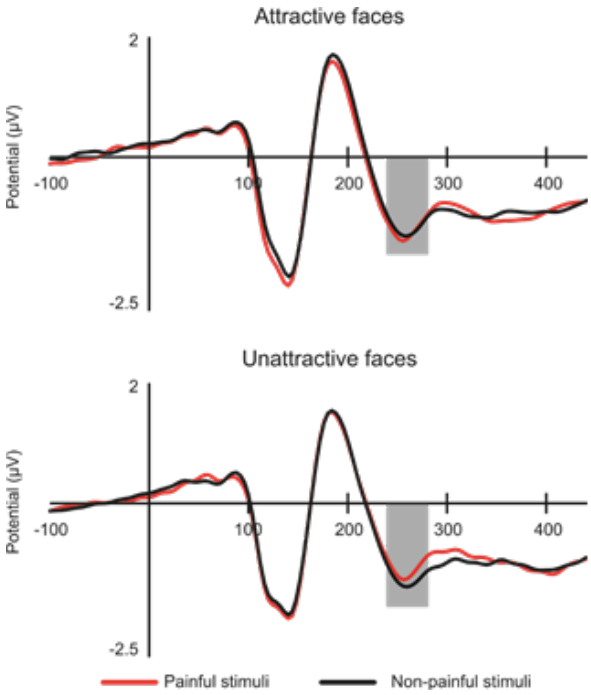

FIGURE 4.
The N2 (240–280 ms), recorded at a selection of frontal electrode F3, relative to the two stimulation conditions (painful vs. no-painful) for attractive faces and unattractive faces.

In this study, we found that facial physical attractiveness modifies the amplitude of early ERP components. Attractive faces elicited a greater neural response than unattractive ones at the time point of 110 ms (N1). Also, in the time window of 240–280 ms (N2), painful stimuli elicited a significantly greater neural response over frontal regions than nonpainful ones, but only in response to unattractive faces. This suggests that a different empathic response was present at early brain activity stages.

The amplitude of the N1 component (110–150 ms) was higher when the subjects viewed attractive faces compared to the unattractive ones. In some studies on empathy for pain, the amplitude of the N1 component was greater for painful than neutral stimuli (e.g., Contreras- Huerta et al., 2014). We may consider the N1 component to be a marker of the early allocation of motivated attention and automatic activation of affective arousal (Decety, 2011). Attractive faces are more pleasant stimuli to look at, and their appearance stimulates the reward center in the brain (Aharon et al., 2001; O'Doherty et al., 2003). It is most likely that at the very early stage, it draws the participants' attention more than the painful stimuli.

The amplitude of the N2 component (240–280 ms) was different for painful versus neutral stimuli, but only for unattractive faces. Even though research concerning empathy for pain and race was only our inspiration, we also found an interaction of physical appearance and pain perception in this component. Therefore, we suggest that the difference in the N2 amplitude to pain in unattractive faces most likely reflects a difference in the empathic response dependent on facial attractiveness.

However, our interpretation is based more on the process related to the perception of the faces rather than stereotypes or attributes.

According to a model of empathy (Decety & Lamm, 2006), there are two key processes: an early, automatic bottom-up process (related to affective sharing) and a later, cognitively controlled top-down process (related to the cognitive capacity to take the perspective of the other person). In empathy for pain studies, the N2 component represents an early bottom-up process. It is possible that low-level information, like attractiveness, is extracted from the faces and may capture more attention than the pain itself. Therefore, in this early stage, painful stimuli might be less important. Conversely, unattractive faces evoke less positive affect (Principe & Langlois, 2011) and capture less attention (Valuch et al., 2015). Thus, unattractive faces might be more coherent for participants (contrasted with a negative painful stimulus) and might facilitate the association of physical information with affective values.

The instructions used in our study may also be of importance. We asked the participants to remember the presented faces. This task was designed to distract attention from the painful stimuli. Interpretation of the results should consider the possible influence of memory on the interaction in the N2 component. It is known that attractive faces are harder to remember than unattractive ones (Light et al., 1981; Wiese et al., 2014). Therefore, the participants may have had greater difficulty in remembering the details of the attractive faces and, consequently, they paid less attention to the pain they empathically felt. However, this issue requires further investigation. According to Cui et al. (2017), painful pictures (a person's hands/forearms/feet in painful situations) elicit significantly larger N2 amplitudes than nonpainful pictures during high working memory load. There was no significant difference in the N2 amplitude between the painful and nonpainful pictures during low working memory load.

In our study, there was no interaction between participant sex and facial attractiveness. It should be noted that, thus far, there have not been found any differences between men and women in the evaluation of physical attractiveness have been found (e.g., Olson & Marshuetz, 2005). Also, in a study by Han et al. (2008) on empathy for pain, it was found that the early ERP effect for the pain-related condition (the positive shift at 140–320 ms elicited by the painful relative to neutral stimuli at the frontocentral electrodes) was the same in women and men.

Behavioral research shows that respondents are more likely to empathize with attractive people (e.g., Müller et al., 2013). However, this result was not fully confirmed by Jankowiak-Siuda et al. (2015), nor was confirmed our in study. Using ERP analysis, we found the influence of facial attractiveness on the emotional aspect of empathy when viewing facial images of people in a painful situation. Our results indicate the need to control the attractiveness of the presented faces in future studies on empathy for pain. The next step in the research on the relationship between attractiveness and empathy, as in the case of experiments related to the effect of race, should verify these results and explore whether facial attractiveness might influence the cognitive aspect of empathy.

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REFERENCES

Aharon, I., Etcoff, N., Ariely, D., Chabris, C. F., O'Connor, E., & Breiter, H. C. (2001). Beautiful faces have variable reward value: fMRI and behavioral evidence. *Neuron, 32*, 537–551. doi: 10.1016/S0896-6273(01)00491-3

Contreras-Huerta, L. S., Baker, K. S., Reynolds, K. J., Batalha, L., & Cunnington, R. (2013). Racial bias in neural empathic responses to pain. *PloS One, 8*, e84001. doi: 10.1371/journal.pone.0084001

Contreras-Huerta, L. S., Hielscher, E., Sherwell, C. S., Rens, N., & Cunnington, R. (2014). Intergroup relationships do not reduce racial bias in empathic neural responses to pain. *Neuropsychologia, 64*, 263–270. doi: 10.1016/j.neuropsychologia.2014.09.045

Cui, F., Zhu, X., Luo, Y., & Cheng, J. (2017). Working memory load modulates the neural response to other's pain: Evidence from an ERP study. *Neuroscience Letters, 644*, 24–29. doi: 10.1016/j.neulet.2017.02.026

Decety, J. (2011). Dissecting the neural mechanisms mediating empathy. *Emotion Review, 3*, 92–108. doi: 10.1177/1754073910374662

Decety, J., & Jackson, P. L. (2004). The functional architecture of human empathy. *Behavioral and Cognitive Neuroscience Reviews, 3*. doi: 10.1177/1534582304267187

Decety, J., & Jackson, P. L. (2006). A social-neuroscience perspective on empathy. *Current Directions in Psychological Science, 15*, 54–58. doi: 10.1111/j.0963-7214.2006.00406.x

Decety, J., & Lamm, C. (2006). Human empathy through the lens of social neuroscience. *The Scientific World Journal, 6*, 1146-1163. doi: 10.1100/tsw.2006.221

Decety, J., Lewis, K. L., & Cowell, J. M. (2015). Specific electrophysiological components disentangle affective sharing and empathic concern in psychopathy. *Journal of Neurophysiology, 114*, 493–504. doi: 10.1152/jn.00253.2015

Decety, J., Yang, C-Y., Cheng, Y. (2010). Physicians down-regulate their pain empathy response: an event-related brain potential study. *NeuroImage, 50*, 1676–1682. doi: 10.1016/j.neuroimage.2010.01.025

Delorme, A., & Makeig, S. (2004). EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods, 134*, 9–21. doi: 10.1016/j.jneumeth.2003.10.009

Dixson, A. F., Halliwell, G., East, R., Wignarajah, P., & Anderson, M. J. (2003). Masculine somatotype and hirsuteness as determinants of sexual attractiveness to women. *Archives of Sexual Behavior, 32*, 29–39. doi: 10.1023/A:1021889228469

Fan, Y., & Han, S. (2008). Temporal dynamic of neural mechanisms involved in empathy for pain: An event-related brain potential study. *Neuropsychologia, 46*, 160–173. doi: 10.1016/j.neuropsychologia.2007.07.023

Fisher, R. J., & Ma, Y. (2014). The price of being beautiful: Negative effects of attractiveness on empathy for children in need. *Journal of*

Consumer Research, 41, 436–450. doi: 10.1086/676967

Hajcak, G., Moser, J. S., Yeung, N., & Simons, R. F. (2005). On the ERN and the significance of errors. *Psychophysiology, 42*, 151–160. doi: 10.1111/j.1469-8986.2005.00270.x

Halit, H., de Haan, M., & Johnson, M. H. (2000). Modulation of event-related potentials by prototypical and atypical faces. *NeuroReport, 11*, 1871–1875. doi: 10.1097/00001756-200006260-00014

Han, S., Fan, Y., & Mao, L. (2008). Gender difference in empathy for pain: an electrophysiological investigation. *Brain Research, 1196*, 85–93. doi: 10.1016/j.brainres.2007.12.062

Hein, G., Silani, G., Preuschoff, K., Batson, C. D., & Singer, T. (2010). Neural responses to ingroup and outgroup members' suffering predict individual differences in costly helping. *Neuron, 68*, 149–160. doi: 10.1016/j.neuron.2010.09.003

Ibáñez, A., Hurtado, E., Lobos, A., Escobar, J., Trujillo, N., Baez, S., ..., & Decety, J. (2011). Subliminal presentation of other faces (but not own face) primes behavioral and evoked cortical processing of empathy for pain. *Brain Research, 1398*, 72–85. doi: 10.1016/j.brainres.2011.05.014

Jackson, P. L., Rainville, P., & Decety, J. (2006). To what extent do we share the pain of others? Insight from the neural bases of pain empathy. *Pain, 125*, 5–9. doi: 10.1016/j.pain.2006.09.013

Jankowiak-Siuda, K., Rymarczyk, K., Żurawski, Ł., Jednoróg, K., & Marchewka, A. (2015). Physical attractiveness and sex as modulatory factors of empathic brain responses to pain. *Frontiers in Behavioral Neuroscience, 9*, 1–11. doi: 10.3389/fnbeh.2015.00236

Lamm, C., & Singer, T. (2010). The role of anterior insular cortex in social emotions. *Brain Structure and Function, 214*, 579–591. doi: 10.1007/s00429-010-0251-3

Lamm, C., Decety, J., & Singer, T. (2011). Meta-analytic evidence for common and distinct neural networks associated with directly experienced pain and empathy for pain. *Neuroimage, 54*, 2492–2502. doi: 10.1016/j.neuroimage.2010.10.014

Langlois, J. H., & Roggman, L. A. (1990). Attractive faces are only average. *Psychological Science, 1*, 115-121. doi: 10.1111/j.1467-9280.1990.tb00079.x

Light, L. L., Hollander, S., & Kayra-Stuart, F. (1981). Why attractive people are harder to remember. *Personality and Social Psychology Bulletin, 7*, 269-276. doi: 10.1177/014616728172014

Little, A. (2014). Domain specificity in human symmetry preferences: Symmetry is most pleasant when looking at human faces. *Symmetry, 6*, 222–233. doi: 10.3390/sym6020222

Luo, S., Han, X., Du, N., & Han, S. (2018). Physical coldness enhances racial in-group bias in empathy: Electrophysiological evidence. *Neuropsychologia, 116*, 117–125. doi: 10.1016/j.neuropsychologia.2017.05.002

Ma, D. S., Correll, J. & Wittenbrink B. (2015). The Chicago Face Database: A free stimulus set of faces and norming data. *Behavior Research Methods, 47*, 1122–1135. doi: 10.3758/s13428-014-0532-5

Ma, Q., Zhang, L., Pei, G., & Abdeljelil, H'. (2017). Neural process of the preference cross-category transfer effect: evidence from an event-related potential study. *Scientific Reports, 7*, 3177. doi: 10.1038/s41598-017-02795-w

Maister, L., Sebanz, N., Knoblich, G., & Tsakiris, M. (2013). Experiencing ownership over a dark-skinned body reduces implicit racial bias. *Cognition, 128*, 170–178. doi: 10.1016/j.cognition.2013.04.002

Maekawa, T., Tobimatsu, S., Inada, N., Oribe, N., Onitsuka, T., Kanba, S., & Kamio, Y. (2011). Top-down and bottom-up visual information processing of non-social stimuli in high-functioning autism spectrum disorder. *Research in Autism Spectrum Disorders, 5*, 201–209. doi: 10.1016/j.rasd.2010.03.012

Moore, F. R., Filippou, D., & Perrett, D. I. (2011). Intelligence and attractiveness in the face: Beyond the attractiveness halo effect. *Journal of Evolutionary Psychology, 9*, 205–217. doi: 10.1556/JEP.9.2011.3.2

Mullen, T. R., Kothe, C. A., Chi, Y. M., Ojeda, A., Kerth, T., Makeig, S., ... & Cauwenberghs, G. (2015). Real-time neuroimaging and cognitive monitoring using wearable dry EEG. *IEEE Transactions on Biomedical Engineering, 62*, 2553–2567. doi: 10.1109/TBME.2015.2481482

Müller, B. C., Van Leeuwen, M. L., Van Baaren, R. B., Bekkering, H., & Dijksterhuis, A. (2013). Empathy is a beautiful thing: Empathy predicts imitation only for attractive others. *Scandinavian Journal of Psychology, 54*, 401–406. doi: 10.1111/sjop.12060

O'Doherty, J., Winston, J., Critchley, H., Perrett, D., Burt, D. M., & Dolan, R. J. (2003). Beauty in a smile: the role of medial orbitofrontal cortex in facial attractiveness. *Neuropsychologia, 41*, 147–155. doi: 10.1016/S0028-3932(02)00145-8

Olson, I. R., & Marshuetz, C. (2005). Facial attractiveness is appraised in a glance. *Emotion, 5*, 498–502. doi: 10.1037/1528-3542.5.4.498

Preston, S. D. (2007). A perception-action model for empathy. In: T. F. Farrow & P. W. Woodruff (Eds.), *Empathy in mental illness* (Vol. 1) (pp. 428-447). Cambridge University Press

Principe, C. P., & Langlois, J. H. (2011). Faces differing in attractiveness elicit corresponding affective responses. *Cognition and Emotion, 25*, 140–148. doi: 10.1080/02699931003612098

Sessa, P., Meconi, F., Castelli, L., & Dell'Acqua, R. (2014). Taking one's time in feeling other-race pain: An event-related potential investigation on the time-course of cross-racial empathy. *Social Cognitive and Affective Neuroscience, 9*, 454–463. doi: 10.1093/scan/nst003

Singer, T., Seymour, B., O'Doherty, J., Kaube, H., Dolan, R. J., & Frith, C. D. (2004, February). Empathy for pain involves the affective but not sensory components of pain. *Science, 303*, 1157–1162. doi: 10.1126/science.1093535

Valuch, C., Pflüger, L. S., Wallner, B., Laeng, B., & Ansorge, U. (2015). Using eye tracking to test for individual differences in attention to attractive faces. *Frontiers in Psychology, 6*, 42. doi: 10.3389/fpsyg.2015.00042

van Hooff, J. C., Crawford, H., & Van Vugt, M. (2010). The wandering mind of men: ERP evidence for gender differences in attention bias towards attractive opposite sex faces. *Social Cognitive and Affective Neuroscience, 6*, 477–485. doi: 10.1093/scan/nsq066

Wiese, H., Altmann, C. S., & Schweinberger, S. R. (2014). Effects of

attractiveness on face memory separated from distinctiveness: Evidence from event-related brain potentials. *Neuropsychologia, 56*, 26–36. doi: 10.1016/j.neuropsychologia.2013.12.023

Wilson, R. K., & Eckel, C. C. (2006). Judging a book by its cover: Beauty and expectations in the trust game. *Political Research Quarterly, 59*, 189–202. doi: 10.1177/106591290605900202

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