The Effect of Facial Attractiveness on the Emotional State of the Perceiver

A Behavioral and EEG Study

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Abstract

This paper delves into the study of emotions by investigating the behavioural and cognitive processes that occur during face perception. Facial attractiveness is used as a tool to investigate whether different attractiveness levels (attractive, medium attractive, unattractive) can induce emotional responses in the perceiver. In addition to measuring a behavioural effect by collecting attractiveness ratings from 58 subjects for a variety of diverse facial images, the subject is also explored from a neurophysiological point of view: During the exposure to the facial images, activity of different event-related potentials (ERPs), including P2 and LPP, was recorded via EEG to attempt to map out in which subcortical areas facial evaluation evokes emotional responses. It was hypothesized that image attractiveness and image gender have a significant main effect on image ratings, as well as on the ERPs that have been associated with emotional processes. The effect of gender was observable on the P2 component, which was higher in subjects looking at male faces than when looking at female faces. The LPP amplitude, which has been implicated with emotional and motivational arousal, was heightened after exposure to unattractive and attractive stimuli. The findings therefore suggest that facial attractiveness can indeed induce emotions.

1. Introduction

Emotions influence our thoughts and behavior to a great extent. They drive our decision-making processes and cause us to take actions throughout our everyday lives. Emotions have a subjective element to them, which is the personal feeling we experience as a response to a stimulus. Emotions emerge as responses to certain stimuli and are often expressed physiologically, as well as behaviorally. Humans are social beings, therefore, emotions do not only affect our perception of stimuli, but our body language and facial expression also convey relevant information which serves as a cue to others in our social surroundings in regards to how we feel (Massey, 2002). However, the subjectivity of one's mental reactions, which we call emotions, makes it challenging to conduct empirical studies or observations in this field (LeDoux & Hofmann, 2018). This study focuses especially on the effect that viewing faces has on one's emotional state. The experiment aims to establish whether facial attractiveness can be used as a tool to reliably induce emotions in an experimental setting by comparing electroencephalography (EEG) data across multiple conditions.

Emotions have been found to serve a bioregulatory function, which attempts to maintain our inner homeostasis, an automatic bodily mechanism that ensures that the body adapts effectively to its environment. An example by Damasio and Damasio (2016) describes our organism as being able to sense the state of being it is in. The emotional experience of not being able to breathe, for example, provokes an immediate motor response as an attempt to recover the ideal quantity of oxygen needed, to restore homeostatic balance. Successful regulation, therefore, does not only improve our chances of survival, but also promotes general well-being. This emphasizes how important emotions are for maintaining a healthy, content state of mind, with which we feel comfortable and secure in our surroundings. Accordingly, proper emotion regulation is essential to social functioning and behavior (Damasio, 2014). Due to emotion's involvement in an array of activities, such as learning, reasoning, creativity and decision-making processes, emotions are even believed to possibly be a key element in the constitution of consciousness (Philipott & Feldman, 2004; Damasio, 2004).

Due to the topic ‘emotion ’and everything surrounding it being so vast and complex, a number of different approaches have been made to it, of which some will be discussed forthwith.

Paul Ekman, for instance, has categorized emotions into distinct groups according to the behavioral, expressive, autonomic and neuroendocrine responses they evoke, as well as according to the situations that precede the particular emotion (Ekman & Cordaro, 2011). He identifies six ‘basic ’emotions, which include joy, surprise, sadness, fear, anger, and disgust, that can be found universally across all cultures. The theory assumes that each emotion triggers unique brain structures and mechanisms that correspond to a certain mental state. That mental state is then believed to consistently generate a measurable, bodily response that always occurs in combination with the specific emotion (Ekman & Cordaro, 2011). This process takes place automatically and fast, and even without involvement of conscious awareness: the sensory stimuli are searched for emotional relevance, which prompts the appropriate neural pathways, that then induce the suitable response (Harris & Isaacowitz, 2015). This theory explains that each specific emotion belongs to one specific neural system, thereby clearly differentiating between the aforementioned different types of emotions (Posner, Russell & Peterson, 2005).

The circumflex model of affect proposes a multidimensional model of emotion. Accordingly, interrelated neural pathways are responsible for all affective states, instead of the independent neural systems that control each emotion separately, as suggested in Ekman’s theories of basic emotion (Posner, 2005). The spatial model refers to two elementary neurophysiological systems, one of which is related to valence, and the other one to arousal (Russell, 1980). The valence axis of this model ranges from pleasure to displeasure, while the arousal, or also alertness axis, extends from activation to deactivation. Therefore, each affective state will consist of varying degrees of valence and arousal which creates a number of possible combinations within the two dimensions (Posner, 2005). Hence, each affective state emerges from a pattern of activation according to these two neurophysiological systems. This creates a spectrum of them, making them more ambiguous and blurring the lines between these various intercorrelated affective states.

The theory of approach and avoidance motivation aims to explain how our tendency to maximize pleasure drives our behavior (Elliot, Martin & Covington, 2001). It states that all living beings strive for pleasure, and our hedonistic tendencies, therefore, act as a reinforcer to our behavior. Simultaneously, we want to avoid and minimize pain which then operates as an inhibitor of certain behavior. All of our behavior is understood to be motivated by approaching all that gives us pleasure, and avoiding all that causes us pain. Similarly to the circumplex model of affect, all of our goals or goal-objects are assigned a valence, which when positive attracts, and when negative induces an aversion in us (Lewin, 1935). Our judgement of what brings us pleasure and what should better be avoided, as well as what valence we ascribe to goal-objects, is largely based on our prior experiences of reward or punishment (Elliot, 2001). Other researchers, however, state that approach motivation encompasses approach behavior towards stimuli, without ascribing any valence to them (Harmon-Jones, Harmon-Jones & Price, 2013). In fact, the they argue that a stimulus is not even necessary to generate approach motivation and that even an unpleasant stimulus can generate approach behavior. For instance, if an organism loses a goal object, experiencing anger can cause the organism to pursue and reclaim their goal (Harmon-Jones et al., 2013).

The human face has sparked immense interest in psychologists and neuroscientists and a large number of research has been conducted to study the interplay between faces and emotion. However, this paper will not focus on emotion contagion, mimicry, or mirrored responses. Instead, it will discuss whether facial attractiveness is a contributing factor in inducing emotion during the observation of faces.

Researchers found that we seem especially drawn to people we think are beautiful, but everyone seems to have a different understanding of facial beauty when it comes to fluctuating, but also static beauty traits (Little, 2014). However, facial features that are deemed attractive across beholders and cultures have been found, which indicates that there might be a biologically based system we all share which judges attractiveness. These features include traits that represent youthfulness, such as a good skin complexion, big eyes, healthy hair, and white teeth. These all are biological markers of someone who is healthy and likely to produce healthy offspring as well. Additionally, facial symmetry, averageness, as sexual dimorphism also have been associated with higher attractiveness of an individual (Little, 2014).

The study of this field is relevant because we seem to ascribe positive traits and qualities to attractive people, while we assume that unattractive people lack these. People we find attractive receive favorable treatment and social advantages: They are given more attention and are perceived to be more healthy, extroverted, intelligent and socially skilled than unattractive people (Olson & Marshuetz, 2005). Furthermore we assume attractive people lead better lives, have better occupations and are more competent spouses (Dion, Berscheid & Walster, 1972).

Other findings suggest that attractive faces elicit activity in brain regions associated with reward, such as the amygdala, nucleus accumbens and orbitofrontal cortex. The DLPFC, which plays a role in executive functioning and decision-making, is also involved in aesthetic evaluation (Ferrari, Lega, Tamietto, Nadal & Cattaneo, 2015). Facial attractiveness, especially of the preferred sex, consciously or unconsciously generates pleasure, which in turn translates into a rewarding experience. This conditions us to interpret attractive faces as positive stimuli, which we are more likely to favor or approach as according to the theory of approach and avoidance motivation. Attractiveness is an interesting component to further research emotion because it can be used to induce felt emotion, which is derived internally from the individual experiences we make, rather than perceived emotion, as seen in experiments with emotion contagion. By manipulating the variable facial attractiveness only, we aim to see how attractiveness affects the beholder without the influence of other emotional cues that could influence the subject's emotional state.

Advances in technology have continuously driven the study of emotion. Currently, it is possible to classify facial expressions within controlled environments with fairly high accuracy of 80-90% (Bos, 2006). Additionally, measurements of the subjects' heart rate, skin conductance, and pupil dilation offer further insights to a subject's state of physiological arousal. EEG-based emotion recognition also seems promising: Via electrodes, EEG is able to measure cortical activity such as activity in the temporal lobe and prefrontal lobe. Connected to these are the subcortical structures, such as the limbic system, the hypothalamus, and the amygdala, which all play a crucial role in emotion interpretation and processing but cannot be measured directly by EEG. EEG therefore relies on the influences of subcortical structures on cortical structures to provide a greater understanding of emotional processes (Bos, 2006).

To examine whether attractiveness has an impact on the emotional state of the perceiver, we continuously collect EEG data from our subjects throughout our experiment. Extracting event-related potentials (ERP) from that data allows us to perform research in a non-invasive and safe way to further investigate the neural correlates of affective states, and other cognitive and sensory processes (Blackwood & Muir, 1990). ERPs are generated as a response to specific stimuli or events and essentially are scalp-recorded voltage fluctuations in the brain. Some ERPs, such as P2 and LPP have been associated with emotional processes in relation to assessment of faces and are therefore valuable to this study, as further discussed below.

The visual positive P2 component peaks around 180ms after stimulus onset, and plays a role in selective attention, by being especially sensitive to emotional cues and orienting attention toward them (Kanske, Plitschka & Kotz, 2011). It is involved in affective evaluation of contents, therefore, P2 is augmented following unpleasant or pleasant emotional visual or auditory stimuli, such as emotional words, pictures and facial expressions than during neutral stimuli (Luck & Kappenman, 2012). Also during aesthetic appraisal, P2 has been found to be enhanced: Particularly things that we do not find beautiful cause a higher amplitude in P2. This happens at an early stage of visual processing, which could suggest that humans automatically pay attention to more negatively valenced things (Wang, Huang, Ma, & Li, 2012).

Additionally, the Late Positive Potential (LPP), which occurs 300 -800 ms after stimulus onset and arises from the combined activity of dorsal and ventral visual regions and anterior corticolimbic structures, is of interest for our study (Farkas, Oliver, & Sabatinelli, 2020). The LPP is enlarged following motivated attention toward and subsequent processing of unpleasant or pleasant stimuli, compared to neutral ones (Farkas, Oliver, & Sabatinelli, 2020). This implies that highly arousing content, such as erotic or gruesome scenes or images of adventures and sport, cause an enhanced LPP, and that valence of the arousing stimulus is not relevant (Farkas, Oliver, & Sabatinelli, 2020). Therefore, increased LPP amplitudes suggest increased emotional processing, due to heightened emotional and motivational arousal (Sugimoto & Nittono, 2008 and Werheid, Schacht, & Sommer, 2007).

In this study we want to induce emotion in our subjects by exposing them to faces that vary in degree of attractiveness, while controlling for emotional facial expression, gender, age, sexual orientation, and one's own personal rating of attractiveness. We manipulate the variable attractiveness with 3 levels, including faces of attractive, medium attractive, and unattractive people. Participants are asked to rate the attractiveness of all faces, additionally to rating their own attractiveness and providing information about their age, gender and sexual orientation. To measure the subjects' response, we utilize EEG, and in addition to that also galvanic skin response (GSR), facial electromyography (EMG) and behavioral data to provide us with further clues of the subjects' physiological and neurological state. We aim to investigate whether electrophysiological differences in the response to attractive versus unattractive faces exist, and whether this assessment is influenced by or induces emotional processes. This study is relevant to the examination of to what extent attractiveness influences our emotional perception, emotional state and assessment of others.

1. 2. Hypotheses

To validate our stimulus material, we want to prove that our data is in accordance with the aforementioned studies: it is anticipated that images of attractive males and females will receive higher attractiveness ratings than images of medium attractive or unattractive males and females.

Furthermore, we want to examine whether humans indeed pay more attention to others whom they are sexually attracted to, as suggested by Ferrari et al. (2015). It will therefore be investigated whether the participants' sexual orientation influences their attractiveness ratings, which in this case should be higher for the faces that match the participants' preferred gender (H_1).

For the data gathered through EEG, we anticipate to find distinct ERPs when it comes to viewing attractive, neutral or unattractive faces. More precisely, higher LPP amplitudes are expected for attractive and unattractive facial images, in contrast to neutral facial images (H_2). We will also examine the P2 component and expect its amplitude to increase during the presentation of unattractive and attractive faces overall, when compared to medium attractive faces (H_3). As in accordance with Farkas et al. (2020), however, we anticipate unattractive faces to yield the largest P2 amplitudes out of all attractiveness levels (H_4).

2. Method

2. 1. Participants

This study aims to gain further insights on the influence of facial attractiveness on emotion. For this experiment, a number of 64 participants from Tilburg University, the Netherlands was recruited between the ages of 18 and 30 (M = 21 , SD = 2,4). Only data from 58 participants was utilized in this study, as the remaining 6 did not generate satisfactory EEG data. That left us with 32 female subjects, and 26 male subjects. The majority of the subjects identified as heterosexual with 46 subjects, 5 as bisexual, and 6 as homosexual (one subject was not included in the analysis of H_1 regarding the effect of gender preference on image rating, because they did not specify their sexual orientation). All participants gave their informed consent and were awarded for their participation with course credits.

2. 2. Stimulus Materials

Through an online Qualtrics questionnaire, participants were asked to rate facial attractiveness from 400 photos from unfamiliar individuals. Their scores were averaged and the 40 most attractive, the 40 most medium attractive and 40 most unattractive photo's of each gender were selected. All subjects of this experiment were exposed to a total of 240 facial stimuli across all six categories, including female attractive (FA), female medium attractive (FM), female unattractive (FU), male attractive (MA), male medium attractive (MM) and male unattractive (MU). To ensure that the subjects were assessing the faces' attractiveness, we used a series of mugshots. Facial expressions in mugshots are generally neutral, which enabled us to rule out that the emotional response of the subjects is attributed to emotion contagion. The stimuli are an array of photographs from unfamiliar individuals, with neutral facial expressions, looking forward and with no visible facial tattoos, piercings or scars. The images are cropped to fit the same format and the background has been adjusted or removed. Only the face, hair, ears and neck remain on the image.

2. 3. Design

As depicted in Figure 1, each trial starts with a fixation cross in the center for 1000ms, after which an image of a face is displayed horizontally and vertically centered for another 1000 ms. Then, after a short delay period of 2000ms, the participant is asked to rate the previously shown face by indicating their rating with the mouse on a horizontal bar ranging from 'very unattractive' (left, -3) to 'very attractive' (right, +3). This was designed to be done within a time period of 5000 ms, to capture solely the participants' first impression. However, the subjects can also resume the experiment by clicking a 'next 'button if the rating occurs quicker than that. If no response was given within the 5000ms time window, the program simply continues onto the next trial. In between the trials a jitter ranging from 500ms to 1500 ms is embedded, to give the stimulus more variability to keep the subject engaged.

The experiment begins with a practice block of 12 trials, during which the subjects can familiarize themselves with the task throughout the trials. The experiment consists of 10 blocks of 24 trials, meaning they will be exposed to a total of 240 samples of stimuli. All subjects are exposed to the same stimuli, which appear in a semi-random order, to allow each trial to have an equal amount of images of each condition. In this experiment image gender and image attractiveness are both within subject variables. The sex of the participant naturally is a between-subjects variable, as well as their preferred gender.

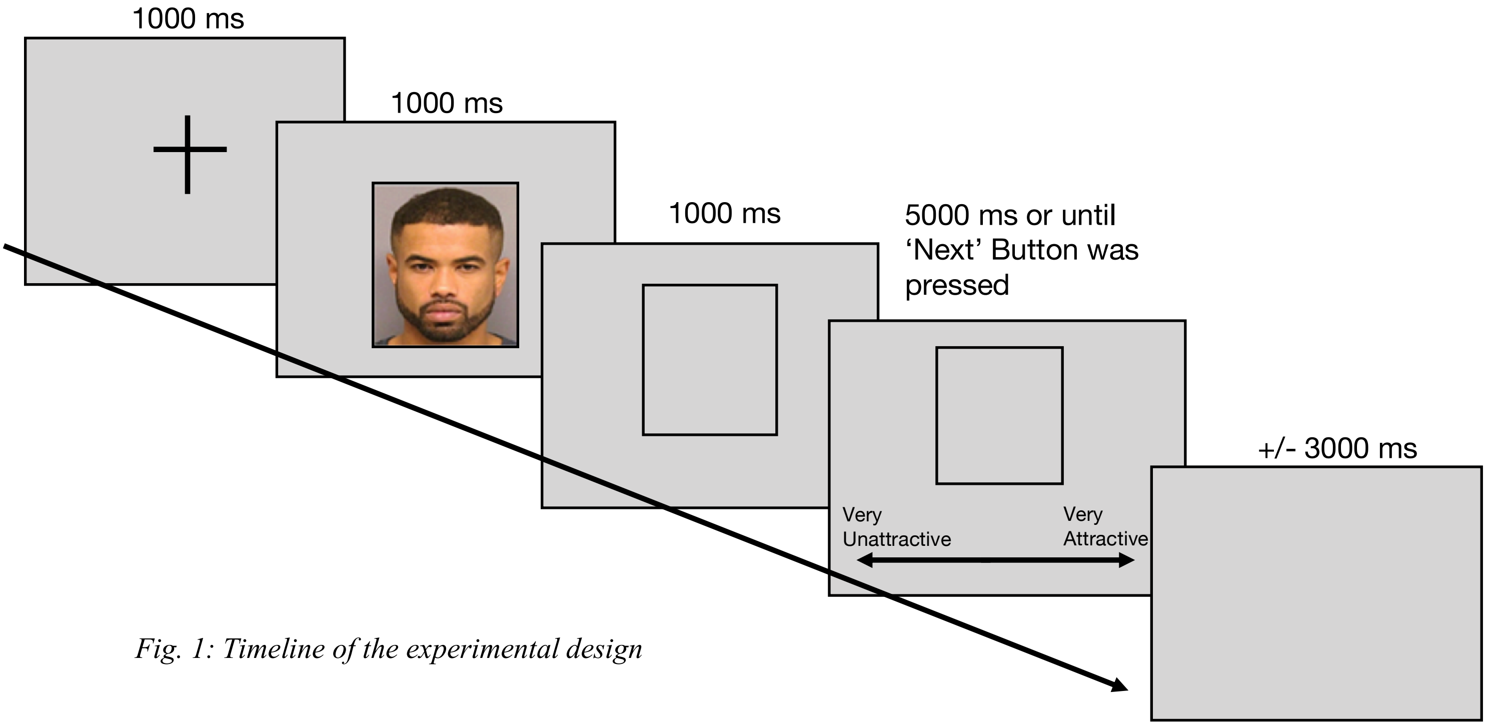

Fig. 1: Timeline of the experimental design

2. 4. Procedure

The experiment was performed in a laboratory setting. Prior to starting it, the participants are given a description of the experiment and sign an informed consent form. The researcher describes again the general procedure and task of the experiment. The participants were placed individually in front of a screen at a distance of 60 cm in an enclosed cabin. They were asked to follow the instructions of the experiment presented on the starting screen, which was designed with the behavioral research software E-Prime (Psychology Software Tools, Inc., Pittsburgh, PA, USA).

After all electrodes had been attached successfully to the subjects, they were connected to a Biosemi AD-Box in an EEG cabin. There, the subjects were placed in front of the screen on which the experiment was carried out. The preparation time took around 15 to 20 minutes, after which the experiment was started.

After every block of 24 trials, the participants were given a short break, in which they could move or reposition themselves, which would otherwise cause interferences in the EEG data during the actual trials. They could choose to resume the experiment whenever they wanted. After every fifth block, the participants were offered a longer break. This time the researcher had to resume the experiment, which gave the researcher the option to come into the cabin and readjust electrodes or check on the subject, if need be. The entire time span of the experiment is approximately one hour. After finishing the experiment, the cap and all other electrodes were carefully removed.

Lastly, the participants also filled out a short survey, in which they were asked about their gender, age, sexual orientation, and a rating of their own attractiveness.

2. 5. Physiological Data Collection

For EEG measurements, each participant wears a fitting cap to which 64 electrodes are attached in accordance with the 10- 20 system, with reference electrodes on the mastoids. A sampling rate of 512 Hz was applied. High- and low-cutoff filters were implemented. The GSR data is measured via two skin conducting electrodes on the index- and middle-finger of the left hand, to assess the subjects' arousal. Facial EMG data is measured through two electrodes placed on the zygomaticus major, two electrodes on the orbicularis oculi, and two electrodes on the corrugator. These provide cues to changes of facial expression, which we can correlate to features of certain affective states. Additionally, electrooculography (EOG) electrodes are placed horizontally and vertically around the eyes to track eye movement. In this paper, however, only EEG data will be analyzed.

2. 6. EEG Data Analysis

The collected EEG data was analyzed via Brain Vision Analyzer (BVA) software. The channels were re-referenced to the left and right mastoids. The eye movements and blinks were measured by bipolar vertical and horizontal EOG channels. We filtered out unwanted frequencies in our EEG data by removing for this ERP analysis irrelevant channels and applying filters that cut off too low frequencies below 0.1 Hz and too high frequencies above 100 Hz. Additionally, only segments that consisted of the exact second following stimulus onset were selected. Intervals before and after the segment were also kept to perform baseline corrections on each segment. That created epochs of 3000 ms, consisting of data 1000 ms before and 2000 ms after stimulus onset. For each channel of every segment the baseline was corrected by using the signal recorded during a small interval of 200 ms prior to stimulus onset. This ensured that the EEG waveforms revolve around the 0μV line.

A regression procedure (Gratton & Coles) was used to correct for the distortions in the data caused by artefacts. Averaging EEG signals of the same condition then enabled us to cancel out additional artefacts that represent neural activity that is unrelated to the stimulus onset and its outcomes. By using an algorithm of a semi-automatic detection procedure, we ensured that trials during which the participant blinked or moved and trials in which muscle tension, movement, loss of contact to an electrode or other electrical interferences occurred, were eliminated. Remaining faulty channels that did not fit our criteria were reconstructed and replaced by interpolating the signals from the surrounding electrodes. After filtering out all frequencies above 30Hz, a baseline correction was performed once more.

Thereafter, all trials of each condition are grouped together, creating separate averages for the six different conditions (AVG of FA, FM, FU, MA, MM, MU). The grand average is also calculated to provide us with the mean amplitudes of the ERP components being investigated in this study. This generates time intervals which indicate when we can anticipate certain ERPs.

2. 7. Statistical analysis

The data analysis was conducted in SPSS. For the analysis of the behavioral data, first a two-way ANOVA was conducted that examined the effect of gender and attractiveness on image ratings. Contrasts were performed to ensure that the effect of differences between all three levels of image attractiveness is tested. The same was done with simple effects test for females and male images separately. The interaction between image attractiveness and image gender was tested as well, and additional simple effect tests revealed which interactions in particular were significant.

To test H_1, which claims that participants' sexual orientation influences their ratings of image attractiveness, a repeated measures ANOVA was performed. For every participant separately, a mean rating score for each of the six conditions was computed. This served as the dependent variable. The within-subject factors 'image gender' and 'attractiveness' and the between-subject factor 'preferred sex' were used. The latter variable was recoded from the information concerning sexual orientation which was gathered through the survey: Male homosexuals' sexual preference was recoded to 'males', the preference of female homosexuals to 'female', heterosexual males and females each were recoded to prefer the gender opposite to their own, and bisexuals were recoded to have no preference toward any of both genders.

The analysis of the two ERP components, P2 and LPP, was performed with a repeated measures ANOVA using the two within-subjects factors 'attractiveness' of three levels (attractive, medium attractive, unattractive) and 'gender' of two levels (male, female). The time interval of the average amplitude of the P2 component occurs at 130-180 ms after stimulus onset, and was measured through 9 channels (F3, Fz, F4, C3, Cz, C4, P3, Pz, P4). The LPP component's grand average amplitude was defined between a 500- 800 ms interval after stimulus onset and measured through 5 channels (Cz, Cp1, Cpz, Cp2, Pz). We then obtain the average amplitudes of our ERPs for all intervals per participant for each condition.

Computing variables that encompassed the average ERP activity in accordance to each of the six conditions enabled us to test the effect the variables and their interaction have on the ERP components. Helmert contrasts were applied to compare the effect of medium attractive images to the mean of the attractive and unattractive levels combined. Thereby H_2 and H_3 were examined, which hypothesize higher amplitudes for the attractive and unattractive condition and lower amplitudes for the medium attractive condition for both, the P2 and LPP.

3. Results

3.1. Behavioral data

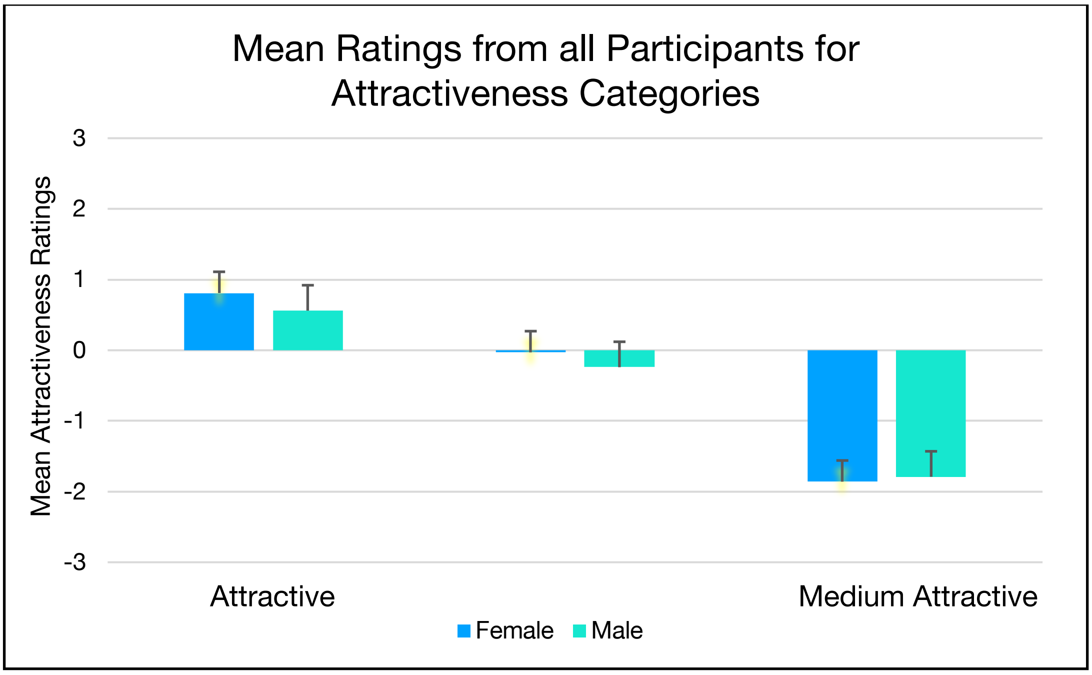

Fig. 2: Mean ratings from all participants on the 6 conditions

A two-way ANOVA revealed a significant effect of gender on image ratings, $F(1,234) = 13.010$, $p < .05$. Differences between genders became apparent, with female images receiving an overall significantly higher average rating (M= -0.36) than male images (M= -0.49).

The analysis also indicated that image attractiveness itself had a significant effect on image rating, $F(2,234) = 1731.880$, $p < .05$. Contrasts between each attractiveness level revealed that the differences between each of them were significant: Attractive images were rated significantly higher than unattractive images, $t(237) = 54.729$, $p < .05$ and medium attractive images, $t(237) = 17.937$, $p < .05$. Medium attractive images were also still rated significantly higher than unattractive images, $t(237) = 36.791$, $p < .05$. This also holds true for additional contrasts that test the significance of the differences between attractiveness levels within each gender separately, $F(2,117) = 985.86$, $p < .05$. Male attractive images were rated higher than male medium attractive images, $t(117) = 13.069$, $p < .05$, and male unattractive images, $t(117) = 38.203$, $p < .05$. Male medium attractive images were rated higher than male unattractive images, $t(117) = 25.134$, $p < .05$.

Equally to their male counterparts, female attractive images were also rated higher than female medium attractive images, $t(117) = 13.686$, $p < .05$, and female unattractive images, $t(117) = 45.531$, $p < .05$. Female medium attractive images were rated higher than female unattractive images, $t(117) = 29.740$, $p < .05$. These findings therefore validate our stimulus material.

Furthermore, this analysis also showed that there is a statistically significant interaction between the effects of image gender and image attractiveness on image rating, $F(2,234) = 8.316$, $p < .05$. This is evidence that the combination of both variables also significantly influenced image ratings. For instance, there was a significant difference in ratings between male and female images within the attractive condition, $F(1,234) = 16.445$, $p < .05$, as well as within the medium attractive condition, $F(1,234) = 11.691$, $p < .05$. There was no significant difference between the ratings for female and male images within the unattractive condition, $F(1,234) = 1.506$, $p = .221$. It becomes noticeable that on average, attractive female images (M= 0.81, SD= 0,31) received higher ratings than attractive male images (M=0.56, SD= 0.36), but that at the same time unattractive female images (M= -1.86, SD= 0.20) were not rated significantly different from unattractive male images (M= -1.79, SD= 0.19). According to that, the gap between attractive and unattractive image ratings was slightly larger for female images than it is for male images. Medium attractive female images (M= -0.03, SD= 0.30) on average turned out to have received higher ratings than medium attractive male images (M= -0.24, SD= 0.25). As anticipated, both female and male attractive stimuli (M= 0.69, SD= 0.36) received significantly higher ratings than female and male medium attractive (M= -0.14, SD= 0.30) and unattractive stimuli (M= -1.82, SD= 0.20) *(Figure 2)*.

In regards to H_1 investigating whether one's sexual orientation and therefore preference toward a certain gender influences one's ratings, a repeated measures ANOVA was performed. There were no difference between the ratings of images from the participants' preferred gender, compared to the less preferred gender, as indicated by a non-significant main effect of preferred gender $F(2,60) = 1.964$, $p = .149$, ηp2 =.061. No significant interactions were found regarding preferred gender either, including the interaction of image gender with preferred gender, $F(2,60) = 1.235$, $p = .298$, ηp2 = .040, of image attractiveness with preferred gender, $F(4,120) = .487$, $p =$

.745, $\eta p2 = .016$, and the three-way interaction between image gender, image attractiveness and preferred gender, $F(4,120) = 2.383$, $p = .055$, $\eta p2 = .074$. This indicates that sexual orientation did not impact the rating of the images, so whether participants preferred females or males did not influence how they rated faces.

3. 2. ERP data

3. 2. 1. P2 component.

As depicted in the figure below (Fig. 3), the grand average reveals that the P2 component was elicited by all 6 conditions $F(1,57) = 9.548$, $p < 0.05$, $\eta p2 = .143$, albeit to a different extent.

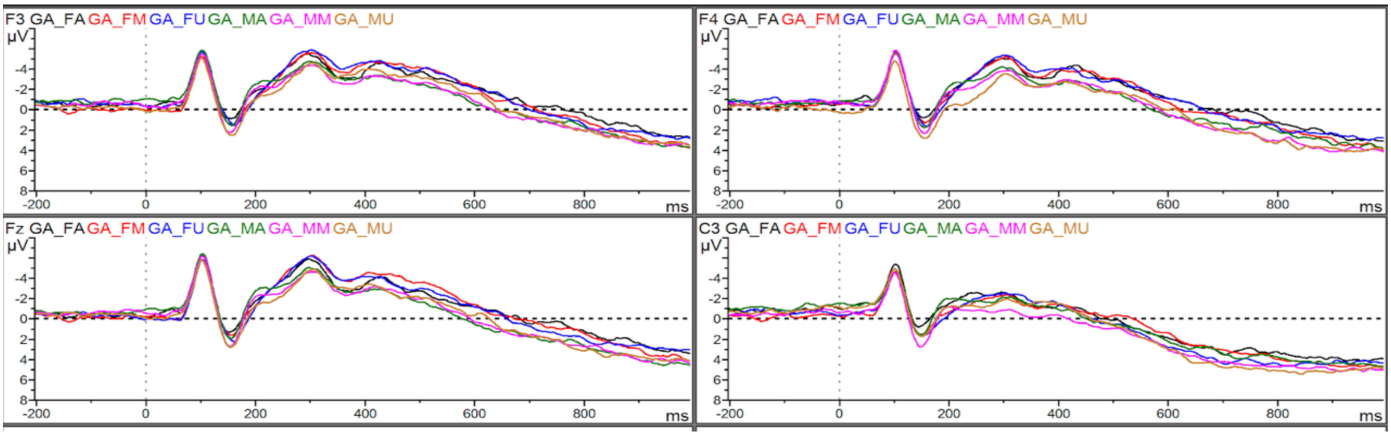

Fig. 3: Grand mean ERPs induced by all three levels of attractiveness for both levels of image gender

Repeated measures ANOVA revealed a main effect for image gender, $F(1,57) = 5.176$, $p < .05$, $\eta p2 = .083$. This shows that on average, male images ($M = 14.570$) caused significantly larger P2 amplitudes than female images ($M = 10.857$).

Image attractiveness was, however, not found significant, $F(2,114) = .925$, $p = .399$, $\eta p2 = .016$, nor was the interaction between image gender and image attractiveness, $F(2,114) = .893$, $p = .412$, $\eta p2 = .015$. This indicates that the P2 amplitude was fairly similar across all attractiveness levels, but was not similar in regard to image gender. H_4 which hypothesizes that unattractive images cause the largest P2 amplitudes out of all conditions is therefore rejected.

To test H_3, which hypothesizes that unattractive and attractive images cause larger P2 amplitudes than medium attractive images, Helmert contrasts were applied: No significant difference was found between medium versus attractive and unattractive images, $F(1,57) = 1.118$, $p = .295$. This indicates that attractiveness did not significantly impact P2 amplitudes. H_3, which anticipated larger amplitudes for attractive and unattractive images than for medium attractive images, was therefore rejected.

3. 2. 2. LPP component.

Repeated measures ANOVA revealed that all conditions had a significant main effect on the LPP amplitude, $F(1, 57) = 152.673$, $p < .05$, $\eta p2 = .728$.

There was no significant effect found for image gender, $F(1,57)= 1.385$, $p = .244$, $\eta p2 = .024$. Mauchly's test proved that the assumption of sphericity had been violated for the main effects of image attractiveness $\chi 2(2) = 26.036$, $p < .05$. The same was true for interaction effects between image gender and image attractiveness, $\chi 2(2) = 22.637$, $p < .05$. Therefore, a Greenhouse-Geisser correction was applied. After the correction, the data revealed that image attractiveness level, $F(1.458,83.101) = 2.765$, $p = .085$, $\eta p2 = .046$, was not significant. The interaction between image gender and image attractiveness, $F(1.501,85.553) = 2.201$, $p = .130$, $\eta p2 = .037$, also was not found significant in this analysis.

To test H_2, a Helmert contrast revealed that the difference in ERP amplitude between medium attractive faces in comparison to attractive and unattractive faces was significantly different, $F(1,57) = 4.237$, $p = .044$. This indicates that the mean LPP amplitude caused by medium attractive images was different to the mean amplitude of attractive and unattractive images combined. The hypothesis that unattractive and attractive facial images cause higher LPP amplitudes than medium attractive facial images, was therefore accepted.

4. Discussion

This study investigates whether differences in facial attractiveness elicits differences in the emotional state of the observer. This was done by recording participants' ERPs (LPP, P2) via EEG and by obtaining participants' behavioral and personal data through a survey and with the image ratings they had given throughout the experiment. The effects of facial attractiveness on ERP activity were analyzed, while testing for other factors, such as image gender or sexual preference.

Despite the rather small sample size of 58 subject, a number of statistically significant results were found. Regarding the behavioral data, it can be assumed that attractiveness does have a significant effect on image rating: Images of attractive faces were rated significantly higher than medium or unattractive faces, and medium attractive faces also were still rated significantly higher than unattractive faces. This indicates that there seems to be a consensus on facial attractiveness based on certain features that were generally appealing to all the participants, and further supports the notion that beauty is not merely 'in the eye of the beholder', which also is in line with previous literature (Little, 2014). This finding also further validates our stimulus materials and provides the basis for the hypotheses that are being studied in this experiment. Additionally, the gender of the faces displayed also had a significant effect on image rating: Overall, female faces received significantly higher ratings than male faces. Females were rated significantly higher than males in the attractive and medium attractive condition, but their ratings did not differ substantially from the males' ratings in the unattractive condition. This shows, however, that the gap between attractiveness and unattractiveness is larger for female faces than for male faces. The interaction between attractiveness and gender of the faces seen on the images was also found significant. This means that the effect that gender has on ratings can depend on attractiveness, vice versa. It shows that there are significant differences between conditions, and that an images' rating depends on the condition it is from.

The hypothesis claiming that preference toward a gender influences subjects' ratings was not accepted, due to a non-significant main effect of the gender preference variable. Considering that sex is often used to advertise (Reichert & Lambiase, 2005) and sell products, it is curious that sexual preference did not influence attractiveness ratings in this study. As an example, cars marketed toward men are often advertised with attractive women standing beside them, and the notion of ‘sex sells’ is widely accepted. In that case, attractive women serve as an additional positive or enforcing stimulus for heterosexual men within this industry, and the assumption that sexual preference toward a particular gender influences behavior is not unrealistic. In our sample, however, gender preference had no influence on image ratings. This could possibly be due to the sample of facial images of this study simply not being attractive enough to induce sexual attraction in the participants. Replicating this analysis with larger participant samples and more attractive stimuli could be interesting for further research on this topic.

Regarding the ERP analysis, male faces caused a larger P2 amplitude than female faces, implying that different genders evoke different P2 potentials. Attractiveness or the interaction of attractiveness with gender did not further influence the P2 potential. The hypothesis claiming that P2 generates larger amplitudes for attractive and unattractive faces, than for medium attractive faces (H_3) is therefore not accepted, nor the hypothesis claiming that unattractive faces should generate the largest amplitude out of all (H_4). It seems, therefore, that P2 is not sensitive to facial attractiveness when evaluating emotional content, assessing faces, shifting selective attention toward emotional cues, or generally in aesthetic appraisal processes, as suggested by Kanske, Plitschka and Kotz (2011). Their study claims that P2 amplitudes are elicited by attention capture and judgement of emotional and aesthetic content which occurs when viewing faces. Another study by Chen and Wei (2019) implies that the P2 is generated by processing of emotional intensity of stimuli. It is important to note that these studies used faces that were conveying perceived emotions instead of faces with neutral facial expression. It resulted in this study finding that only gender, and not attractiveness, influenced the P2 amplitude. This therefore suggests that facial attractiveness does not induce an emotional response in the observer within the early ERP time frame of 130ms – 180ms after stimulus onset, in which the P2 occurs.

The omnibus test on the LPP component did not generate any significant main or interaction effects, which means that the LPP amplitude does not differ substantially across the six different conditions. However, when contrasting high- and low attractive images with medium attractive images (H_2), larger LPP amplitudes were observed for the former. The LPP is believed to be especially involved in assessment of unpleasant and pleasant stimuli, toward which motivated attention causes a shift (Farkas, Oliver & Sabatinelli, 2020). The increased LPP amplitudes for attractive and unattractive stimuli, in comparison to neutral ones, imply that indeed there is an emotional salience effect, but that the valence of the stimuli, so whether stimuli are positively or negatively valenced, is not relevant. It suggests that both attractive and unattractive stimuli may result in increased emotional salience (Sugimoto & Nittono, 2008 and Werheid, Schacht, & Sommer, 2007). In this study, the LPP was successfully modulated by attractiveness and it can therefore be said that this finding supports the notion that attractiveness and unattractiveness can be used to reliably induce emotions in an experimental setting.

The P2, which is an earlier ERP component, was not affected by facial attractiveness, while the later occurring LPP did display a distinct activity pattern for attractive and unattractive stimuli. This indicates that aesthetic appraisal of facial stimuli might occur later throughout the process of facial evaluation.

This experiment, therefore, partly establishes electrophysiological differences that occur as a response to differing attractiveness levels. While one can observe differences caused by image gender in the P2 component, image attractiveness does not seem to alter this early ERP. The LPP, on the other hand, does show differences in activity between image attractiveness levels. These differences could possibly be connected to emotional activity that is caused by stimuli that have been ascribed positive or negative valence, such as attractive and unattractive images.

This study also contains a number of limitations: Firstly, while this experiment presumably only selected images with neutral facial expressions, emotional facial expression was never controlled for. Secondly, the faces were isolated from their surroundings and therefore did not represent an ecologically valid scenario for facial recognition and evaluation. Next to that, people were specifically asked to rate the faces displayed, which leads to a voluntary evaluation of facial attractiveness, possibly making attractiveness task-dependent. This can be linked to previous research which found that there is differences between controlled and automatic processing (Schneider & Chein, 2003). This experiment operated under controlled processing, in which rating of the images is done with the conscious intention of the subjects as opposed to measuring subjects' ERPs without them deliberately rating images. Conducting the experiment in this way might have a significant impact on neurophysiological processes and compromise the effects attractiveness has on the perceiver, because evaluating attractiveness might possibly be a more subconscious process. Another limitation is that the images used in this experiment are mugshots. As mentioned earlier, people that are perceived as attractive usually are thought to lead more successful and healthy lives, and are perceived more intelligent and socially skilled than unattractive people (Olson & Marshuetz, 2005). A number of studies claim that unattractiveness increases the likelihood of becoming involved in criminal activity (Mocan & Tekin, 2010), of getting arrested and victimized (Teasdale & Berry, 2019), and of receiving considerably higher prison sentences (Landy & Aronson, 1969). Therefore, the stimulus material might not correctly reflect the levels of attractiveness which could influence the effect of this variable. This might also be the reason why the unattractive faces reach much lower lows than attractive faces reach high ratings - more unattractive people might be represented more in the criminal population who get their mugshot taken. It could also occur that mistakenly or by chance the female attractive sample contains more attractive individuals than the male attractive sample, which could lead to unwanted differences in effects which are hard to control for. It is impossible to ensure that there is an equal amount of equally attractive people within each gender group. If mean ratings diverge between men and women, it is not known whether higher ratings for women, for example, are attributed to women on average being classified as 'more beautiful' or if they are rated higher due to the male stimuli simply not having equally as attractive individuals as the female stimuli in it. This continues to be the problem of attractiveness being subjective to the perceiver to some extent, so researchers cannot choose 'ideal' stimuli per condition.

For future research a couple adaptions in this experiment are recommended, such as including a condition which contains faces with an emotional expression. If the proposed condition had a significant influence, it would enable a more controlled research in which we can ensure that emotion contagion is accounted for and not influencing the results. It would allow us to determine the effect size of emotion contagion and validate our neutral facial images as our stimulus material. Placing the facial images in a more ecologically valid context could also cause changes in effects and might also be a viable approach to study the effect of attractiveness on the perceiver's emotion. By placing the faces of the images in a real-world setting, the subjects' behavioral and neurophysiological response could change, thereby altering previous results of image ratings and ERP activity. However, this would mean that the validity of the stimuli might be compromised because additional body segments or different angles of the faces would be shown. Additionally, one could separate the rating task from the EEG data collection, to see whether amplitudes will differ if subjects are asked to first only look at all images while EEG data is collected instead of also rating them simultaneously. A larger sample size that does not merely consist of psychology students of a narrow age range could improve the experiment's validity. Lastly, using a more diverse sample of facial images, which consists of more than just faces of individuals who have been arrested, could provide more reliable results and statistical power overall.

In conclusion, however, the study of ERPs appears to be a very useful research method. Its high temporal resolution allows us to gain more understanding of perceptual and cognitive processes. Research in this field can provide further insights on the timeframe and extent to which aesthetic appraisal takes place during facial processing and examine whether it impacts participants' emotional state. Previous studies have associated distinct later ERPs, such as the LPP, with emotional and motivational arousal (Sugimoto & Nittono, 2008 and Werheid, Schacht, & Sommer, 2007). Our stimuli were neutral in regard to emotion expression, but still evoked an LPP response. We can therefore assume that facial attractiveness can be used as a tool to reliably induce emotions in the perceiver in an experimental setting. The findings of this study imply that attractive and unattractive faces represent pleasant and unpleasant stimuli, which evoke ERP responses that are linked to emotions. It can therefore be assumed that facial attractiveness plays not only a role in facial evaluation but that it very likely also influences our emotional state, as shown by the altered LPP activity.

References

Blackwood, D. H. R., & Muir, W. J. (1990). Cognitive brain potentials and their application. *British Journal of Psychiatry*, *157*(S9), 96–101. doi: 10.1192/S0007125000291897

Blau, V. C., Maurer, U., Tottenham, N., & McCandliss, B. D. (2007). The face-specific N170 component is modulated by emotional facial expression. *Behavioral and brain functions*, *3*(1), 7.

Bos, D. O. (2006). EEG-based emotion recognition. *The Influence of Visual and Auditory Stimuli*, *56*(3), 1-17.

Chen, N., & Wei, P. (2019). Reward association alters brain responses to emotional stimuli: erp evidence. *International Journal of Psychophysiology, 135,* 21-32. https://doi-org.tilburguniversity.idm.oclc.org/10.1016/j.ijpsycho.2018.11.001

Cole, J. (1998). *About face* (Bradford book). Cambridge, Mass.: MIT Press.

Damasio, A. R. (2004). Emotions and feelings. In *Feelings and emotions: The Amsterdam symposium* (pp. 49-57). Cambridge, UK: Cambridge University Press.

Damasio, A., & Damasio, H. (2016). Exploring the concept of homeostasis and considering its implications for economics. *Journal for Economic Behavior & Organization,* 126 (B), 125-129. doi: 10.1016/j.jebo.2015.12.003

Dion, K., Berscheid, E., & Walster, E. (1972). What is beautiful is good. *Journal of personality and social psychology*, *24*(3), 285.

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic. *Emotion review*, *3*(4), 364-370.

Farkas, A., Oliver, K., & Sabatinelli, D. (2020). Emotional and feature-based modulation of the early posterior negativity. *Psychophysiology, 57*(2), 13484. doi:10.1111/psyp.13484

Ferrari, C., Lega, C., Tamietto, M., Nadal, M., & Cattaneo, Z. (2015). I find you more attractive … after (prefrontal cortex) stimulation. *Neuropsychologia, 72*, 87-93. doi:10.1016/j.neuropsychologia.2015.04.024

Gross, J. J., & Feldman Barrett, L. (2011). Emotion generation and emotion regulation: One or two depends on your point of view. *Emotion review*, *3*(1), 8-16.

Harmon-Jones, E., Harmon-Jones, C., & Price, T. (2013). What is approach motivation? *Emotion Review, 5*(3), 291-295. doi:10.1177/1754073913477509

Harris, J. A., Isaacowitz, D. (2015). Emotion in Cognition. *International Encyclopedia of the Social & Behavioral Sciences,* 2, 461-466. doi: 10.1016/B978-0-08-097086-8.25003-4

Jacobsen, T., Schubotz, R., Höfel, L., & Cramon, D. (2006). Brain correlates of aesthetic judgment of beauty. Neuroimage, 29(1), 276-285. doi: 10.1016/j.neuroimage.2005.07.010

Kanske, P., Plitschka, J., & Kotz, S. A. (2011). Attentional orienting towards emotion: P2 and N400 ERP effects. *Neuropsychologia*, *49*(11), 3121-3129.

Kanwisher, N., McDermott, J., & Chun, M. M. (1997). The fusiform face area: a module in human extrastriate cortex specialized for face perception. *Journal of neuroscience*, *17*(11), 4302-4311.

Kawabata, H., & Zeki, S. (2004). Neural Correlates of Beauty. Journal Of Neurophysiology, 91(4), 1699-1705. doi: 10.1152/jn.00696.2003

Landy, D., & Aronson, E. (1969). The influence of the character of the criminal and his victim on the decisions of simulated jurors. *Journal of Experimental Social Psychology*, *5*(2), 141-152.

LeDoux, J. E., & Hofmann, S. G. (2018). The subjective experience of emotion: a fearful view. *Current Opinion in Behavioral Sciences*, *19*, 67-72.

Lewin, K. (1935). *A Dynamic Theory of Personality*, McGraw-Hill, New York

Little, A. C. (2014). Facial attractiveness. *Wiley Interdisciplinary Reviews: Cognitive Science*, *5*(6), 621-634.

Luck, S., & Kappenman, E. (2012). *Oxford handbook of event-related potential components* (Oxford library of psychology). Oxford: Oxford University Press.

Massey, D. S. (2002). A brief history of human society: The origin and role of emotion in social life. *American sociological review*, *67*(1), 1-29.

Merriam-Webster. (n.d.). Emotion. In *Merriam-Webster.com dictionary*. Retrieved February 16, 2020, from https://www.merriam-webster.com/dictionary/emotion

Mocan, N., & Tekin, E. (2010). Ugly criminals. *The review of economics and statistics, 92*(1), 15-30. https://doi.org/10/1162/rest.2009.11757.

Moser, J.S., Hajcak, G., Bukay, E., & Simons, R. F. (2006). Intentional modulation of emotional responding to unpleasant pictures: An ERP study. Psychophysiology, 43(1), 292-296.

Nakamura, K. , Kawashima, R. , Nagumo, S. , Ito, K. , Sugiura, M. , Kato, T. , Nakamura, A. , Hatano, K. , Kubota, K. , Fukuda, H. & Kojima, S. (1998). Neuroanatomical correlates of the assessment of facial attractiveness. *NeuroReport, 9*(4), 753–757.

Olson, I., & Marshuetz, C. (2005). Facial attractiveness is appraised in a glance. *Emotion, 5*(4), 498-502. doi:10.1037/1528-3542.5.4.498

Partridge, T. T. (2009). Infant EEG asymmetry differentiates between attractive and unattractive faces.

Philippot, P., & Feldman, R. (2004). *The regulation of emotion*. Mahwah, N.J.: Lawrence Erlbaum. (2004). Retrieved February 21, 2020, from Ebook Central Academic

Posner, J., Russell, J. A., & Peterson, B. S. (2005). The circumplex model of affect: an integrative approach to affective neuroscience, cognitive development, and psychopathology. *Development and psychopathology*, *17*(3), 715–734. doi: 10.1017/S0954579405050340

Reichert, T., & Lambiase, J. (Eds.). (2005). *Sex in consumer culture : The erotic content of media and marketing*. Taylor and Francis Group. Retrieved from https://ebookcentral.proquest.com

Russell, J. A. (1980). A circumplex model of affect. *Journal of personality and social psychology*, *39*(6), 1161.

Schneider, W., & Chein, J. M. (2003). Controlled & automatic processing: behavior, theory, and biological mechanisms. *Cognitive Science, 27*(3), 525-559. https://doi-org.tilburguniversity .idm.oclc.org/10.1016/S0364-0213(03)00011-9

Senior, C. (2003). Beauty in the brain of the beholder. *Neuron*, *38*(4), 525-528.

Sugimoto, S., & Nittono, H. (2008, March). Cognitive processing in attractiveness judgment: An electrophysiological study. Poster session presented at the Second International Workshop on Kansei, Fukuoka, Japan (Proceedings, pp. 67–70).

Teasdale, B., & Berry, B. (2019). “Ugly” Criminals and “Ugly” Victims. *Appearance Bias and Crime,* 51. Retrieved from https://books.google.de/books?hl=en&lr=&id=qXuIDwAAQBAJ&oi=fnd&pg=PA51&dq=unattractive+people+criminals&ots=8rshTmqAoo&sig=c2vlJAbZmZe2FHapm8QrtN4wc8s&redir_esc=y#v=onepage&q=unattractive%20people%20criminals&f=false

Trujillo, L. T., Jankowitsch, J. M., & Langlois, J. H. (2014). Beauty is in the ease of the beholding: A neurophysiological test of the averageness theory of facial attractiveness. *Cognitive, Affective, & Behavioral Neuroscience*, *14*(3), 1061-1076.

Van Hooff, J. C., Crawford, H., & Van Vugt, M. (2010). The wandering mind of men: ERP evidence for sex differences in attention bias towards attractive opposite sex faces. Social Cognitive and Affective Neuroscience, 6(4), 477-485.

Wang, X., Huang, Y., Ma, Q., & Li, N. (2012). Event-related potential p2 correlates of implicit aesthetic experience. *Neuroreport, 23*(14), 862-6. doi:10.1097/WNR.0b013e3283587161

Werheid, K., Schacht, A., & Sommer, W. (2007). Facial attractiveness modulates early and late event-related brain potentials. *Biological psychology*, *76*(1-2), 100-108.

Young S. N. (2008). The neurobiology of human social behaviour: an important but neglected topic. *Journal of psychiatry & neuroscience : JPN*, *33*(5), 391–392.