Manipulating gaze direction and emotion expression to differentiate between beauty and attractiveness

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Abstract

Attractiveness and beauty have been mainly treated as synonyms in the literature. However, the two aesthetic judgments might reflect different motivations. Attractiveness may relate to a mating drive whereas beauty may relate to a general aesthetic appraisal of the face. The former may be more personal whereas the latter may be more general. In the animal and clinical literature, dissociation between wanting (motivation to engage obtain a reward) and liking (pleasure from reward consumption) has been identified. It is possible that attractiveness may reflect the wanting aspect whereas beauty may reflect the liking aspect of an evaluation of a face. Here, we made the first attempt to dissociate beauty and attractiveness in a healthy population. In particular, gaze direction, head position and smiling have been shown to influence attractiveness. Here, we hypothesised that these social cues would be less influential on beauty judgments compared to attractiveness judgments. We varied gaze direction, head position, and facial expression on computer-modelled male faces and asked 92 young (M = 20.92) heterosexual females to [...]

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Manipulating gaze direction and emotion expression to differentiate between beauty and attractiveness

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Abstract

Attractiveness and beauty have been mainly treated as synonyms in the literature. However, the two aesthetic judgments might reflect different motivations. Attractiveness may relate to a mating drive whereas beauty may relate to a general aesthetic appraisal of the face. The former may be more personal whereas the latter may be more general. In the animal and clinical literature, dissociation between *wanting* (motivation to engage obtain a reward) and *liking* (pleasure from reward consumption) has been identified. It is possible that attractiveness may reflect the *wanting* aspect whereas beauty may reflect the *liking* aspect of an evaluation of a face. Here, we made the first attempt to dissociate beauty and attractiveness in a healthy population. In particular, gaze direction, head position and smiling have been shown to influence attractiveness. Here, we hypothesised that these social cues would be less influential on beauty judgments compared to attractiveness judgments. We varied gaze direction, head position, and facial expression on computer-modelled male faces and asked 92 young (M = 20.92) heterosexual females to separately rate attractiveness and beauty of these faces. Results showed that beauty was as malleable by social cues as attractiveness. Specifically, faces looking directly at the observer with their heads turned towards them were rated most positively. Nonetheless, attractiveness scores explained only 51.70 % of variance in beauty judgments. Hence, these two aesthetic appraisals were not identical. Future research is necessary to identify whether beauty and attractiveness are quantitatively or qualitatively different. That is, whether attractiveness is an additional component of beauty or whether in some situations they can be completely dissociable aesthetic appraisals of a face.

Key words: attractiveness, beauty, faces, emotional expressions, eye gaze direction

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Abbreviations

Neuroimaging technologies:

EEG – electroencephalography

fMRI – functional magnetic resonance imaging

PET – positron emission tomography

Brain regions:

dlPFC – dorsolateral prefrontal cortex

FFA – fusiform face area

NAcc – Nucleus Accumbens

OFC – orbitofrontal cortex

PFC – prefrontal cortex

STS – superior temporal sulcus

STS – superior temporal sulcus

VTA – ventral tegmental area

Introduction

"*And beauty is not a need but an ecstasy*" (K. Gibran, 1982)

We can find somebody looking beautiful without being attracted to them. Moreover, when being attracted to somebody, we do not necessarily think they are the most beautiful person to fall in love with. While these observations might find much agreement from the common experiences, understanding the differences between these two experiences is less obvious. In the literature, beauty and attractiveness have been generally treated as synonyms and the terms used interchangeably (e.g. Lindell & Lindell, 2014). Nonetheless, we argue here that beauty can be considered as an aesthetic experience whereas mating-related processes might contribute to attractiveness. Before reasoning on the differences between the two more thoroughly, we will first define the different terms. Here, attractiveness is defined as the drive to get in contact and potentially become short-term or long-term partners. Beauty is defined as a general appraisal of the pleasantness of a face. While attractiveness may be more subjective, beauty may be more objective and rely more strongly on the general beauty standards within the population. Together, attractiveness and beauty will be referred to as aesthetic judgments. Although both attractiveness and beauty can activate neural regions involved in reward processing and aesthetic assessment (Aharon et al., 2001), potentially there are situations in which the judgments of attractiveness and beauty diverge.

We designed the current study to disentangle the relationship between beauty and attractiveness by looking to what extent social cues such as gaze direction and a smile affect each of the aesthetic judgments. Nonetheless, since the dissociation between the two has not been clearly defined, many studies describing attractiveness might be dealing with beauty and vice versa. We made the best attempt to disentangle such potential confusions. This kind of research, also coupled with neuroimaging technologies, fits well into a more general framework of neuroaesthetics (e.g. Chatterjee & Vartanian, 2016; Pearce et al., 2016). With the aim to devise theories of neural processes involved in aesthetic experiences, Chatterjee and Vartanian (2014) proposed that aesthetic experiences emerge from interacting neural systems of sensory-motor processes, reward, and finding meaning.

The thesis will start with the description of attractiveness as attractiveness has received substantially more attention than facial beauty. We will discuss what features are attractive and how evolutionary perspective could inform about the reasons underlying preferences for these facial features. It is assumed that the same or similar features would be also found beautiful but there are not many empirical indications of whether or not this is the case. Then, we will go onto discussing the neural correlates of facial processing and of aesthetic judgments more specifically. Afterwards, we will look at the issue of malleability of the attractiveness judgments. In particular, how perceived attractiveness can be affected by changes in facial expressions, gaze direction, and head position. It is yet to be learnt whether beauty judgments are malleable by these social cues to the same extent as attractiveness judgments. The latter question will be the main focus of the thesis. Finally, we will return to the issue on the differences between attractiveness and beauty and will look at animal studies, clinical research, and brain evidence to draw hypotheses about whether or not these two judgments can be theoretically separated.

Physical attractiveness

Attractiveness is a physical quality of the whole or parts of the body (e.g. face or voice) that evokes an approach response – attraction. Although there is a high agreement among individuals and cultures about which faces are attractive and which are not, it is rather difficult to pin down the exact features that increase perceived attractiveness. Some of the facial features known to increase attractiveness are facial symmetry, averageness, secondary sexual characteristics and skin health (Little, Jones & DeBruine, 2011). Attractiveness can be seen as an evolutionary sexual drive to find the best mating partner and reproduce successfully by also increasing the reproductive fitness of one's offspring. Thus, these attractive facial features should signal that a potential mate has good health and good reproductive abilities. Attractiveness judgments tend to generalise to other areas – a so-called attractiveness halo effect (Langlois, et al., 2000) – as attractive individuals are perceived as more trustworthy or better people in general, for example. Finally, attractiveness influences a number of real-life outcomes such as hiring or dating behaviour. Thus, it is a facial characteristic of high importance both evolutionary speaking and from a modern life perspective.

An evolutionary perspective of attractiveness

From an evolutionary perspective, physical attractiveness is an adaptation that has evolved to facilitate mate selection. If in our evolutionary past there were some distinguishable characteristics about one's genetic quality or social value, then individuals that read those signs would have had a higher evolutionary advantage. Consequently, they would leave more genes behind and, after a number of generations, the majority of individuals would be paying attention to these characteristics (Andersson, 1994). High attractiveness thus indicates good "quality" mates (i.e. those with favourable genetic make-up) and choosing them should increase one's reproductive fitness (defined by a number of offspring surviving into adulthood; e.g. Jokela, 2010). "Quality" of the mates can have direct and indirect benefits (Little, Jones & DeBruine, 2011). Direct benefits are those gained directly to oneself and one's offspring (e.g. shelter, food, etc.) whereas indirect benefits are defined as genetic benefits gained for one's offspring. Both direct and indirect benefits are likely to be important in evolution, yet it is difficult to disentangle their individual contribution to attractiveness.

The general notion of such evolutionary hypotheses is that physical attractiveness indicates general health. There is some correlative evidence suggesting that attractive people live longer (Tooby & Cosmides, 2001), have better physical health (Langlois et al., 2000), marginally better mental health (Feingold, 1992), and a better immune function (Lie, Rhodes & Simmons, 2008) than less attractive people. If this is indeed true, then choosing an attractive mating partner increases both direct and indirect benefits. It is possible, however, that a stronger correlation between attractiveness and general health exists in developing countries. For example, certain illnesses might distort the symmetry of facial features and thus decrease attractiveness (Moller, 1996). Nonetheless, even a slight difference in longevity or health renders an evolutionary advantage to an individual. Furthermore, indices of general health also increase attractiveness ratings. For example, apparent skin health (Jones, Little, Burt & Perrett, 2004) and smoothness (Tsankova & Kappas, 2015) are positively related to attractiveness judgments. Skin is a changeable aspect of the face and can be influence by factors like diet (e.g. carotenoids increase yellowness of the skin, which is attractive; Stephen, Smith, Stirrat & Perrett, 2009). Hence, there is some evidence supporting the link between attractiveness and general health.

Not surprisingly, attractiveness also increases reproductive success. Attractive individuals experience greater dating success (Woll, 1986) and have over 10% more offspring (Jokela, 2010). However, very attractive individuals also have more extra-pair relations (Boothroyd et al., 2008). Higher reproductive success, however, is reflected differently in males and females, due to differential investment (Rhodes, Simmons & Peters, 2005). Attractive males have a larger number of short-term sexual partners because their investment (i.e. sperm) is smaller; hence more short-term mating opportunities maximally increase reproductive fitness. On the contrary, attractive females have a larger number of long-term sexual partners, because their investment is larger (i.e. gestation, lactation); hence, securing a stable partner is more beneficial. Moreover, male facial attractiveness is positively associated to sperm quality in terms of morphology and motility (Soler et al., 2003). Thus, an evolutionary idea that attractiveness signals better "quality" partners seems plausible and benefits of being attractive are seen in a modern dating and reproduction world.

Attractiveness judgments generalise to other types of judgments. This phenomenon is called attractiveness halo effect (Langlois et al., 2000) and it strongly influences first impressions we form about individuals we are not familiar with. Attractive individuals are perceived as good ("what is beautiful is good" stereotype; Dion, Berscheid & Walster, 1972), more competent (Mobius & Rosenblat, 2006), more interesting (Berscheid & Walster, 1974), more intelligent (Zebrowitz, Hall, Murphy & Rhodes, 2002), and more trustworthy (Todorov, Olivola, Dotsch & Mende-Siedlecki, 2014). A recent study reported that students learn better from attractive lecturers (Westfall, Millar & Walsh, 2016). Furthermore, attractiveness judgments influence real life decisions. Attractive individuals are more likely to get hired (for meta-analysis, see Hosoda, Stone-Romero & Coats, 2003), they tend to earn more money (Hamermesh & Biddle, 1994), and are more popular in college (Prestia, Silverston, Wood & Zigarmi, 2002) compared to their less attractive peers. Overall, these observations indicate that attractiveness is an important characteristic which has observable social consequences.

Attractive facial features

A well-known phrase "beauty is in the eye of the beholder" (Hungerford, 1878) suggests that beauty (or attractiveness) is transient and each individual judges attractiveness differently. Darwin (1871) held a similar stand on the matter after having researched different cultures and identified that preferences for skin colour, body fat and body hair differed substantially across cultures. Although cultural differences indeed exist (e.g. Cruz, 2013; Langlois et al., 2000), there is a striking agreement of what is attractive between individuals within the same culture and between individuals of different cultures and age groups (Langlois et al., 2000). The fact that people can judge which faces of a different ethnic background are attractive (Cunningham, Roberts, Barbee & Druen, 1995) indicates that people should be using similar attractiveness standards across the globe. Thus, to some degree, attractiveness judgments are universal. Whether these differences are innate (Lindell & Lindell, 2014) or socially shaped (Hahn & Perrett, 2014) remains a matter of discussion.

While the standards of attractiveness judgments may be universal, it is rather difficult to pin down the exact facial features that are attractive. One of the best-documented attractive facial features is symmetry. Facial symmetry refers to the degree that one half of the face mirrors the other half of the face. While an optimal developmental outcome is symmetry, due to environmental pressures, individuals find it more or less difficult to maintain symmetry during development. From this perspective, higher symmetry reflects better genetic quality (Little et al., 2011). There is some evidence that male body symmetry is positively related to sperm speed and sperm number per ejaculate (Manning, Scutt, Lewis-Jones & 1998) whereas facial asymmetry is positively related to self-reported occurrences of respiratory diseases (Thornhill & Gangestad, 2006). Furthermore, symmetrical faces are indeed preferred to asymmetrical faces and they are rated as more attractive (e.g. Perrett et al., 1999; Rhodes, Proffitt, Grady & Sumich, 1998). In addition to Western societies, preference for symmetry has also been found in African hunter-gatherer society (Little, Apicella & Marlowe, 2007), giving support to the universality of preference for symmetry.

Another attractive facial characteristic is averageness. Averageness refers to how similar a face is to the majority of other faces within a given population. Non-average faces would be the ones with deviant characteristics. People may find average faces attractive because an alignment of features, which is close to a population mean, may reflect genetic diversity (Thornhill & Gangestad, 1993). Indeed, facial averageness has been linked to better health, gathered from actual medical documents (Rhodes et al., 2001). Experimentally, multiple faces can be morphed together to obtain an average face. Observers generally rate the average face as more attractive than each individual face used to compose the average face (Langlois & Roggman, 1990). Furthermore, the larger number of faces is morphed together to make an average face, the higher the attractiveness rating (Langlois, Roggman & Musselman, 1994). Morphed average faces may be attractive because they eliminate small imperfections of the skin (e.g. wrinkles, roughness, redness or spots). Averageness is oftentimes confounded by symmetry, as average faces are also more symmetrical. In one study (Rhodes, Sumich & Byatt, 1999), averageness and symmetry were manipulated independently from each other and both of them could independently predict attractiveness judgments. In another study (Jones, DeBruine & Little, 2007), contribution of symmetry to attractiveness judgments was substantially reduced after controlling for averageness. Thus, averageness may be a more (if not the most) important characteristic when judging attractiveness of faces.

Secondary sexual characteristics also contribute to attractiveness judgments. Adult male and female faces differ in their shapes, which is a result of masculinization of feminization of secondary sexual characteristics occurring in puberty. For example, male faces have larger jawbones, thinner cheeks and more prominent cheekbones (Enlow, 1982). Female femininity has been linked to higher levels of circulating oestrogen (Law-Smith et al., 2006) whereas male masculinity has been linked to higher levels of circulating testosterone (Penton-Voak & Chen, 2004; but see Naeve, Laing, Fink & Manning, 2003). Thus, gender dimorphic features should be evolutionary attractive. Whereas feminine features indeed increase perceived attractiveness of women (Grammer & Thornhill, 1994; Jones & Hill, 1993; Perrett et al., 1998), it is less clear that masculine features increase perceived attractiveness of men. Findings from some studies suggested that women prefer masculine features on male faces (Jones et al., 2005; Penton-Voak, et al., 1999; Penton-Voak & Perrett, 2000) whereas findings from other studies suggested that women prefer feminine features on male faces (Little et al., 2002; Perrett et al., 1998; Rhodes, Hickford & Jeffery, 2000). This apparent discrepancy could be reconciled by looking at female motivations. Femininity in male faces indicates “socially valued” personality traits like honesty, cooperation and warmth as well as a better skill as a parent (Perrett et al., 1998). Feminine men have been shown to have weaker preferences for short-term relationships and stronger preferences for long-term, committed relationships (Boothroyd et al., 2008). On the contrary, masculinity in male faces has been linked to increased physical dominance (Jones et al., 2010). Thus, to get a maximal benefit, women should favour masculine men for their offspring conception and feminine men for raising the offspring. Indeed, women rate masculine men as more attractive during the periods when they have the highest chance of conception (i.e. ovulation) and less attractive during menstrual phases of low chance of conception (or under oral contraceptive pills; Penton-Voak et al., 1999). Women also rate masculine men as more attractive for short-term relationships, and feminine men as more attractive for long-term relationships (Gangestad & Thornhill, 2008). As such a polygamous scenario is socially unacceptable and thus unlikely, women must weigh costs against benefits and trade off certain desirable characteristics for others. This results in a variable preference for masculinity in male faces.

Overall, attractiveness is an evolutionary mating drive which has reproductive and social consequences. The judgements of attractiveness are universal. Symmetry and averageness are strong predictors of attractiveness but other features such as apparent health or expression of sexually dimorphic features also influence perceived attractiveness. Surprisingly, little is known about whether the same features are found beautiful. Since judgments of beauty are less driven by evolutionary motivations, potentially some facial features (e.g. sexually dimorphic features) should become less important when making the beauty judgment compared to attractiveness judgment. On the other hand, due to high overlap between beauty and attractiveness, there would be an overlap between facial features, which are beautiful and which are attractive. The differences between facial attractive and beautiful facial features should be investigated to more detail in the future studies.

The Neural Mechanisms of Face Perception and Preference

Facial perception is a skill that is particularly well developed in humans. Humans spend an abundant amount of time looking at faces and can process, recognise and extract information from others' faces in a matter of milliseconds (e.g. trustworthiness: Stirrat & Perrett, 2010; attractiveness: Olson & Marshuetz, 2005). There is accumulating evidence to suggest that a specialised neural system exists to process faces (Hahn & Perrett, 2014; Haxby, Hoffman & Gobbini, 2000, 2002; Kanwisher & Yovel, 1997). The neural system of facial processing is widely distributed across the cortex, but to a certain degree lateralised to the right hemisphere (Kanwisher & Yovel, 1997). This system can be divided into the core and the extended systems (Haxby et al., 2000; 2002), with the former extracting the basic features from the face and the latter assigning a certain meaning to the face. Attractiveness judgments can modulate the response of these neural areas performing basic processing of faces (Hahn & Perrett, 2014; Kirsch, et al., 2016). Attractiveness further activates the reward system with the orbitofrontal cortex (OFC) being at its core. Thus, there is a complex network of neural areas involved when looking at the faces and making attractiveness judgments.

The neural mechanisms of face perception

A hierarchical two-module model of facial processing has been proposed (Haxby et al., 2000; 2002). This model distinguishes processing of stable facial features (e.g. gender, identity, age), which are more important for facial recognition, and transient facial features (e.g. gaze direction, facial expression, biological movements), which facilitate social interaction. The hierarchical processing of facial features is comprised of the core system and the extended system. The core system is crucial for the visual analysis of the facial stimuli (see Fig 1. “Haxby’s core system”). The early processing of facial expressions happens in the inferior occipital gyri, which then feeds information into two other brain regions – the lateral fusiform gyrus (location of the “fusiform face area” – FFA) and the superior temporal sulcus (STS). The FFA processes information of the invariant aspects of faces (such as identity or gender) whereas the STS processing information of transient aspects of faces (such as emotional expressions, gaze, or biological movements). The FFA has been suggested to be a module specifically specialised in face processing, which does not process other categories of objects (Grill-Spector, Knouf & Kanwisher, 2004). It is important to have relatively independent representations of facial identity and social cues in the brain because otherwise changes in facial expressions, for example, might be misinterpreted as changes in identity (Haxby et al., 2000). This distinction has also been made in a cognitive model of face perception (Bruce & Young, 1986) and supported by a large number of behavioural evidence (e.g. Young, McWeeny & Hay, 1986; Ellis et al., 1990). Importantly, in addition to forward connections described above, there are also backward connections between these regions, where information is constantly being updated.

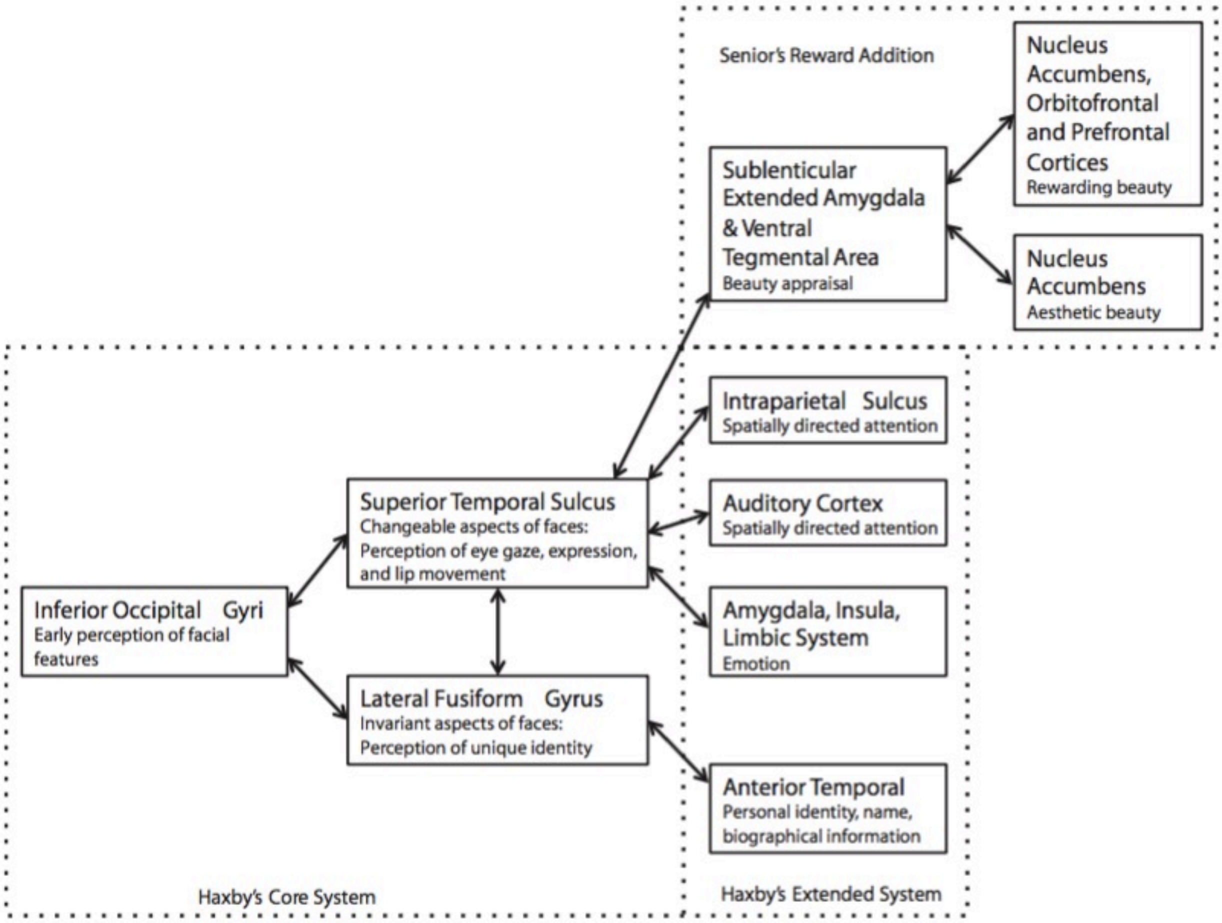

Fig 1. An interactive neural network of facial processing

Haxby et al. (2000) suggested that there is a core system in facial processing, which is more or less exclusively dedicated to facial processing, and the extended system, which is involved in more diverse cognitive functions. Senior (2003) added an additional system of reward processing, which becomes particularly important to judgments of aesthetic aspects (i.e. beauty and attractiveness) of faces (courtesy of Hahn & Perrett, 2014).

The extended system of the Haxby's model includes brain regions involved in more diverse cognitive processing, such as attention or emotion (see Fig 1. "Haxby's extended system"), which are crucial for extracting meaning from faces. For example, amygdala and the limbic system (i.e. hippocampus, thalamic nuclei, fornix, and cingulate gyrus) are involved in emotion processing and may be particularly important when judging the significance of faces, including self-relevance (N'Diaye, Sander & Veuilleumier, 2009). Intraparietal sulcus and auditory cortex process spatially distributed attention and allow to direct attention towards the target. Anterior temporal cortex is important to assign additional information, such as name, biographical history, or preferences, to the observed individual. Senior (2003) proposed an addition to Haxby and colleagues' (2000, 2002) model by including the reward system in the facial processing (see Fig 1. "Senior's reward addition"). Its key component is the orbitofrontal cortex (OFC), which is heavily interconnected with FFA (Fairhall & Ishai, 2007). Senior (2003) also distinguished two types of aesthetic judgments – rewarding beauty (i.e. attractiveness according to our definition), mainly processed in the Nucleus Accumbens (NAcc), OFC and prefrontal cortex, and aesthetic beauty (i.e. beauty according to our definition), processed in the NAcc. Thus, the model gives an indication of which brain areas might be implicated in processing aesthetics of faces (the reward centres) and suggests that there might be different brain regions supporting beauty and attractiveness judgments. These issues will be discussed in the next sections.

The neural mechanisms of attractiveness judgments

Attractiveness is judged early in the cognitive processing stream and can influence subsequent cognitive processes. Attractiveness can be judged very quickly. Olson and Marshuetz (2005) presented attractive and unattractive faces for 13 ms and subsequently masked them with a scrambled face. Although the presentation of the face was below conscious perception, participants still gave significantly higher attractiveness ratings to attractive faces than unattractive faces. Importantly, attractiveness judgments made under time constraint correlate highly with attractiveness judgments made in free-viewing conditions ($r = 0.69$; Willis & Todorov, 2006). Attractiveness judgments are similar when faces are presented in the fovea and in the periphery (Guo, Hong, Liu & Roebuck, 2011), indicating that the visual system has evolved to facilitate the peripheral detection of aesthetic pleasantness in faces. Furthermore, attractive faces attract attention to a greater extent than unattractive faces, as measured with an eye-tracker technique (Leder, Tinio, Fuchs & Bohrn, 2010). Even when attractiveness is irrelevant to the task (e.g. Chen, Liu & Nakabayashi, 2012), the finding that attractiveness still captures attention indicates its privileged status in the attention-related processes. Together, these results suggest that attractiveness immediately attracts attention, whether or not it is presented in the central visual field or is relevant to the task, and can be processed unconsciously.

In addition to modulating behaviour, there is evidence to suggest that facial attractiveness influences neural facial processing. Electroencephalography (EEG) can be used to measure electrical activity of the brain with high temporal accuracy. This method allows to peak into the temporal dynamics of neural processes of attractiveness. Studies using EEG demonstrated that attractive faces elicited larger early components – P1, N170 and P2 – than unattractive faces (e.g. Marzi & Viggiano, 2010; Zhang & Deng, 2012; Zhang et al., 2016). Facial attractiveness also affects later stages face processing. For example, Marzi and Viggiano (2010) observed that attractive faces elicited larger components related to structural encoding and recognition memory at 500-700 ms after stimulus presentation. In general, there is accumulating recent evidence showing that both early and later components are modulated by facial attractiveness of adults and infant faces (e.g. Hahn et al., 2016; Marzi & Viggiano, 2010; Schacht, Werheid & Sommer, 2008; Werheid, Schacht & Sommer, 2007). Involvement of early components indicates that facial attractiveness is appraised rapidly and effortlessly. This observation compliments findings from behavioural studies that attractiveness is appraised by glance (e.g. Olson & Marshuetz, 2005). Involvement of late components indicates that facial attractiveness continues to affect cognitive and attentional higher-order processes. All in all, facial attractiveness seems to modulate neural response to faces throughout all stages of facial processing and potentially influencing various cognitive processes involved in face perception.

While EEG allows to study temporal dynamics of neural processes, it provides limited evidence of where the signal originates from. Functional magnetic resonance imaging (fMRI) is a superior technique to localise neural structures involved in processing attractiveness, as it has higher spatial resolution than EEG. FMRI records the blood-oxygen level-dependent (BOLD) signal, which can be used to infer about the changes in neural activity (e.g. Ogawa, Lee, Kay & Tank, 1990). Several fMRI studies provided evidence that attractiveness modulated the FFA response (Chatterjee, Thomas, Smith & Aguirre, 2009; Cloutier, Heatherton, Whalen & Kelley, 2008; Iaria et al., 2008; Winston et al., 2007; see Fig 2.), which is the core node in processing facial identity. For example, Chatterjee and colleagues (2009) presented a hundred male and female faces and asked participants to decide whether each face was more or less attractive than the average. Attractiveness ratings positively correlated with neural response in FFA. Two meta-analyses further confirmed that attractive faces increase FFA activity to a larger extent than less attractive faces (Bzdok et al., 2011; Mende-Siedlecki, Said & Todorov, 2013). Evidence is somehow more mixed whether attractiveness can modulate all brain regions involved in the core system of face processing, as described by Haxby et al. (2000, 2002). For example, facial attractiveness was shown to modulate STS activity in one study (Kranz & Ishai, 2006) but not another (Iaria et al., 2008). STS is involved in processing variables aspects of the face, such as facial expressions or gaze direction; thus it might become more or less important depending on the social context in which the face appears. Overall, attractiveness seems to affect a neural response of at least some of the core neural nodes of facial processing.

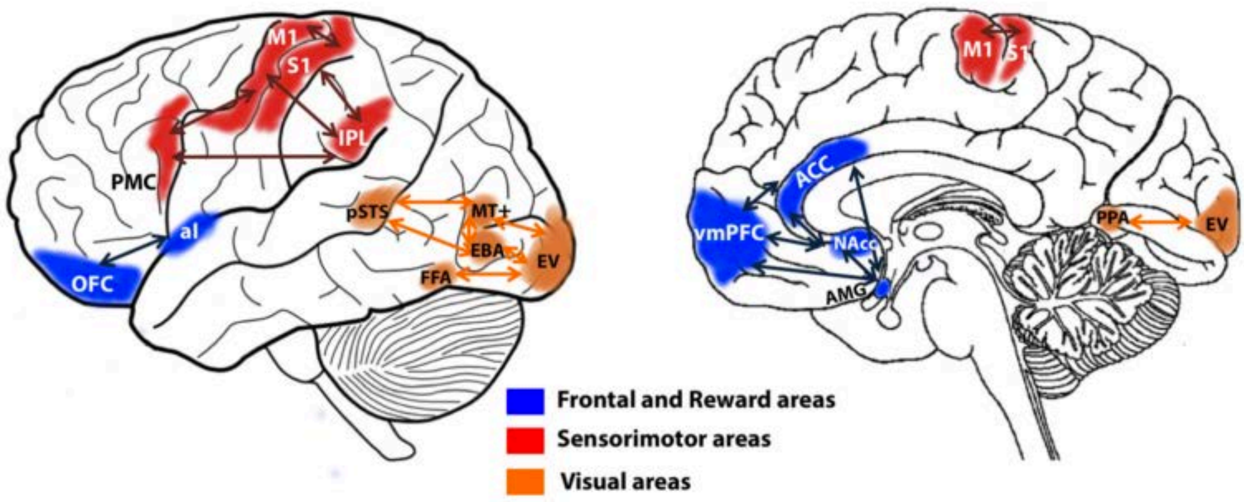

Fig 2. Neural regions involved in attractiveness judgments

Some regions perform basic visual processing, or recognitions of faces; others are part of the reward system. The motor regions and some visual areas (e.g. EBA) might be more important for whole-body attractiveness judgments although involvement of the motor cortex (M1) has been reported for facial attractiveness judgments as well (Cloutier et al., 2008).

Frontal and reward areas (in blue): OFC = orbitofrontal cortex; vmPFC = ventromedian prefrontal cortex; ACC = anterior cingulate; AMG = amygdala; aI = anterior insula, and NAcc = nucleus accumbens. Sensorimotor areas (in red): M1 = primary motor area; S1 = primary somatosensory area; IPL = inferior parietal lobule; PMC = premotor cortex. Visual areas (in orange): part of the occipitotemporal cortex – EBA = extrastriate body area, MT = motion integration area, EV = early visual area, PPA = parahippocampal place area, and pSTS = posterior superior temporal sulcus. For the interpretation of the references, see Kirsch et al. (2016). (Courtesy of Kirsch et al., 2016).

Nonetheless, modulation of neural activity does not imply that these activations are necessary or sufficient for an aesthetic experience. It is possible that increase in activity in early visual areas is a result of greater preference for attractive stimuli. As such, people tend to pay more attention to the stimuli they like (Downing & Peelen, 2011). One piece of evidence suggesting that early visual areas of face processing might be causally linked to attractiveness judgments comes from research in prosopagnosia. Prosopagnosia is a clinical condition characterised by an inability to recognise faces. Acquired prosopagnosia is characterised by a lesion in the FFA (Hadjikhani & De Gelder, 2002). Whereas patients suffering from prosopagnosia are able to judge other facial characteristics, such as gender or age (Chatterjee & Nakayama, 2012), they seem to be impaired in attractiveness judgments (Iaria et al., 2008). Hence, FFA may be necessary for achieving attractiveness judgments.

So far it has been discussed how attractiveness affects neural response of brain areas responsible for visual processing of faces. Although these are important, and in some cases (e.g. FFA) even necessary, they may not be sufficient to produce a complete perception of attractiveness. The latter primarily comes from the involvement of the reward system. This idea was introduced above when describing Senior’s (2003) addition to the Haxby’s (2000, 2002) system and received a lot of support from preceding and subsequent neuroimaging studies. Involvement of OFC in making attractiveness judgments has received the highest support (e.g. Cloutier et al., 2008; Bray & O’Doherty, 2007; O’Doherty et al., 2003; Smith et al., 2010, Tsukiura & Cabeza, 2011a, 2011b; Winston et al., 2007; see Fig 2.). OFC codes for a reward value across various domains (Kringelbach & Radcliffe, 2005) including monetary gains (O’Doherty et al., 2001). OFC has been shown to be active even when explicit judgments of attractiveness were not required (O’Doherty et al., 2003). Another reward circuitry node responsive to attractiveness is nucleus accumbens (NACc), which is part of the ventral striatum, which in turn belongs to the basal ganglia. Aharon and colleagues (2001) used region of interest (ROI) analysis to specifically target neural areas involved in reward processing in animals and humans. They reported a higher activation in NAcc in response to attractive as compared to average faces, irrespectively of their gender. Other studies also reported NAcc activity in relation to attractiveness judgments (Cloutier et al., 2008; Kampe, Firth, Dolant & Frith, 2002; Liang, Zebrowitz & Zhang, 2010; Smith et al., 2010; Zaki, Schirmer & Mitchell, 2011). Additional elements of reward circuitry have been further demonstrated to respond positively to higher attractiveness: ventral tegmental area in the mesencephalon, also a node in reward processing (VTA; Aharon et al., 2001; Aron et al., 2005), prefrontal cortex (PFC: Nakamura et al., 1998; medial PFC: Cloutier et al., 2008; ventrolateral PFC: O’Doherty et al., 2003), and the basal ganglia (caudate: Bray & O’Doherty, 2007; putamen: Liang et al., 2010). Hence, there is a large amount of evidence pointing to the important role of reward circuit and beyond when attaining attractiveness judgments.

Some neural regions respond in a linear fashion to attractiveness whereas others respond in a non-linear fashion. Areas that respond linearly to attractiveness are NAcc and OFC. NAcc has been shown to increase its activity with higher perceived attractiveness (e.g. Aharon et al., 2001; Cloutier et al., 2008). OFC can display a positive or a negative relationship with attractiveness depending on precise locations of OFC. Medial OFC was showed an increase in activity with increased attractiveness, whereas lateral OFC showed a decrease in activity with increased attractiveness (Cloutier et al., 2008). This pattern of activity went in line with research of reward outside of facial attractiveness where medial OFC was associated with reward processing and lateral OFC was associated with punishment processing (Kringelbach & Rolls, 2004). There is some evidence that amygdala (Liang et al., 2010; Mende-Sedlecki et al., 2013; Winston et al., 2007; cf. Iaria et al., 2008; Kranz & Ishai, 2006) and cingulate cortex (Tsukiura & Cabeza, 2011a; cf. Cloutier et al., 2008) might respond in a non-linear fashion (i.e. inverted U-shape) to attractiveness. That is, their response is stronger to very attractive and very unattractive faces with rather small-to-none response to average faces. Amygdala has been suggested to be a relevance detector (N'Diaye, et al., 2009) and it is likely that faces on both extremes of the attractiveness dimension are more relevant to the self than faces of average attractiveness. Attractive faces might be relevant as potential mating partners whereas unattractive faces might be relevant as a potential threat.

The large majority of studies reported so far provided correlative evidence that reward circuitry is involved in judging facial attractiveness. It is rather difficult to disentangle which brain regions causally contribute to the attractiveness judgments. In other words, which brain regions are necessary to make attractiveness judgments and which are not. This can be achieved only by directly modulating the neural response through electrical or magnetic stimulation, by pharmaceutically blocking the release of certain neurotransmitters or their matching receptors, or studying patients with focal lesions. The causal role of FFA was interpolated from the lesion study of patients with acquired prosopagnosia, described above (Iaria et al., 2008). In another study, Ferrari and colleagues (2015) applied non-invasive transcranial direct current stimulation over the dorsolateral PFC (dlPFC), which increased excitability of this neural region. Larger excitability of dlPFC consequently increased attractiveness ratings. Thus, it seemed that both FFA and dlPFC causally contributed attractiveness judgments.

To sum up, attractiveness immediately attracts attention and it is appraised by glance. It is processed in a widely distributed neural network which mainly includes visual areas, recruited for various facial and non-facial stimuli, and a reward circuitry. Causal role of some regions has been confirmed (i.e. FFA and dlPFC); others are still waiting for a confirmation. The neural regions involved in the beauty judgments are far less well defined. However, there are indications that beauty is also processed in the reward areas (e.g. NAcc, VTA) but the number of the involved areas is somehow lower than the number of neural areas involved in attractiveness judgments, and the results are mixed (only VTA, reduced activity in NAcc: Aharon et al., 2001; only NAcc: Senior et al., 2003).

Malleability of Attractiveness (and Beauty) Judgments

It is often thought that attractiveness is a stable feature of an individual. Some faces are more attractive, some faces are less attractive, and there is a high agreement between the raters of who is who (Langlois et al., 2000). In recent years, researchers started focusing their attention on more transient facial features which could affect attractiveness. Among several, these are emotional expressions, gaze direction, or clothing colour. For example, red enhances female attractiveness in Western (Elliot & Niesta, 2008) as well as remote societies (Elliot, Tracy, Pazda & Beall, 2013). Positive emotions displayed on one's face tend to increase attractiveness and so does direct gaze. These two features and the combination of them will be discussed in the following section. However, one should keep in mind that while transient facial features can indeed influence attractiveness judgments, their effect is much smaller than that of stable facial features like asymmetry or averageness (Morrison, Morris & Bard, 2013). Hence, attractiveness judgments result from perception of aesthetic pleasantness and an integration of multiple social cues (Hahn & Perrett, 2014).

Facial expressions of emotion

Emotions can be defined as synchronised changes of mental and bodily reactions in response to an internal or external event of high significance (Scherer, 1987). According to the component process model (see Scherer, 2005), there are five main components of each emotion – cognitive, neurophysiological, motivational, motor expression, and subjective feeling. It is very difficult if not impossible to study all the five components at the same time. In this study, we will limit ourselves to the motor expression component, and more specifically facial expressions (smiling in particular). The function of this component is to communicate one's behavioural intentions, and it works via the somatic nervous system.

Smiling is ubiquitous and can have various meanings. Most often it is an expression of happiness or dominance (Hess, 2009) but it can also signal trustworthiness (Schmidt et al., 2012). There are two dimensions along which smiling varies. The first dimension is the intensity of the activity of the *zygomaticus major* muscle, which pulls the lip corners up. The second dimension is presence of activity of other muscles, such as the *orbicularis oculi* muscle, which creates small wrinkles around the eyes (Hess, 2009). If the movement of the latter muscle is present, then the smile is often considered to be genuine and has received a name of the Duchenne smile (Duchenne, 1990). Recognition of happiness is highly influence by the mouth region – smile (Lappanën & Hietanen, 2007), whereas other emotional expressions may be recognised in combination of mouth and eyes region (e.g. Calvo, Fernandez-Martin, Nummenmaa 2014). In general, emotional expressions seem to be processed holistically (i.e. integrating all the facial features together) as well as analytically (i.e. analysing separate facial features, like smile; Meaux & Vuillemier, 2016). This kind of processing has been coined *dual-code*. Recognition of emotional expressions recruits wide spread neural regions and there is functional neuroimaging evidence that distinct neural regions contribute to holistic and analytical processing of emotional expressions (Meaux & Vuilleumier, 2016). Processing of happiness facial expressions was linked to ventro-medial PFC (Ruffman, Henry, Livingstone & Philips, 2008) and cingulate cortex (e.g. Salloum et al., 2007). In some studies, perception of happiness expressions also activated amygdala (Hamann, Ely, Hoffman & Kilts, 2002; Pessoa, McKenna, Gutierez & Ungerleider, 2002; Winston, O'Doherty & Dolan, 2003) which indicated that amygdala has a more general role in directing attention to emotionally relevant stimuli rather than being a simple detector of fear (Vuilleumier, 2005). Furthermore, holistic type of processing recruited fusiform gyrus and inferior occipital areas to a larger extent whereas analytical type of processing recruited STS and frontal regions (inferior frontal gyrus and OFC) to a larger extent. Overall, emotional expressions are processed in visual areas as well as areas involved in social (e.g. STS), reward (OFC), or emotional (e.g. insula, amygdala) processes.

There have been several demonstrations that emotional expressions influence attractiveness judgments. In one of the early studies, Harker & Keltner (2001) collected images of women in the yearbook and tested their various life outcomes. They discovered that smiling women were rated more favourably on a number of personality dimensions including attractiveness. Many other studies also reported that smiling increased attractiveness (Golle, Mast & Lobmaister, 2014; Mueser, Grau, Sussman & Rosen, 1984; Okubo, Ishikawa, Kobayashi, Laeng & Tommasi, 2015; Otta, Abrosio & Hoshino, 1996; Reis et al., 1990; Sun, Chan, Fan, We & Lee, 2015) although sometimes only on female but not male faces (Penton-Voak & Chang, 2008; Tracy & Beall, 2011). Interestingly, whether a smile was fake or genuine (i.e. Duchenne smile) did not change attractiveness judgments and both types of smiles increased perceived attractiveness (Mehu, Little & Dunbar, 2007). Cunningham and colleagues (Cunningham, 1986; Cunningham, Barbee & Pike, 1990) had several studies where they employed the facialmetric assessment of various facial features and correlated them with attractiveness judgments. Smile presence per se did not predict attractiveness judgments. Nonetheless, smile size did. Bigger and wider smiles, also those smiles which moved nostrils, were positively related to attractiveness judgments. Similarly, smiles with slower onset were judged as more attractive (Krumhuber, Manstead & Kappas, 2007). Hence, expression of positive emotions – smiling – seems to increase perceived attractiveness.

There is also some evidence to suggest that smile modulates neural response to attractiveness. In an EEG study, Sun and colleagues (2015) measured an event-related response to attractive and unattractive faces which either displayed a neutral, a happy or a sad expression. They found that attractiveness was processed in the early P2-lateral component whereas emotional expressions were processed in the early P2-medial component. Hence, both types of features were processed early (before 350 ms) but in different spatial locations. An interaction between attractiveness and emotional expressions appeared in the late component (LPP, 450-725 ms) when response was different for extreme stimuli (e.g. happy and attractive faces or sad and unattractive faces) than non-extreme stimuli (e.g. happy but unattractive or sad but attractive). Thus, the results indicated that facial attractiveness and smile were first processed separately and simultaneously. After the initial discrimination of the stimuli, attentional resources were focused on extreme stimuli, which potentially were most relevant. While Sun et al.'s (2015) study shed light on the timing, another study attempted to localise the neural regions that are modulated by attractiveness and emotional expressions. O'Doherty and colleagues (2003) presented images of faces which were neutral or slightly happy and measured the BOLD response using the fMRI. They observed that attractive faces elicited a stronger response in OFC, among other areas, than less attractive faces. Furthermore, this response was modulated by the degree to which participants rated faces as happy. In other words, happier faces evoked a stronger reward response in the OFC, but only in attractive faces. Taken together, these results indicate that attractiveness and facial expressions are combined late in the processing stream and can indeed modulate the neural response of the reward network to attractive faces.

Gaze direction

The eye region of the face provides a great deal of information and it is central to social and non-verbal communication. Direct gaze immediately attracts attention (Yokoyama et al., 2014), and neonates (Farroni, Csibra, SImion & Johnson, 2002) and adults (Dubey, Ropar & Hamilton, 2015) prefer direct gaze to averted gaze. Not surprisingly, people pay more attention to the eye region than any other facial feature (e.g. Henderson, Williams & Falk, 2005; Itier, Villate & Ryan, 2007). Eye gaze indicates the direction of others attention and their targets for intentions. In other words, a direct gaze indicates a potential social interaction, both positive and negative, while an averted gaze shows that the person is focusing their attention on someone or something else (Itier & Batty, 2009). Hietanen and colleagues (2008) reported that a direct gaze was related to approach and an averted gaze was related to avoidance behaviour. However, depending on the context, prolonged direct gaze (i.e. staring) may lead to avoidance behaviours (Elsworth, Carlsmith & Henson, 1972) or be a sign of love and attraction in other situations (Kellerman, Lewis & Laird, 1989). There is a benefit of looking at someone since faces with a direct gaze are better encoded (Mason, Hood & Mcrae, 2004) and better recognised (Vuilleumier et al., 2005) than faces with an averted gaze. Also, a direct gaze increases liking of the other person, which correlates to the length of the gaze (up to 4s; Kuzmanovic et al., 2009). Thus, direct gaze is a powerful informant of social interest and might affect our interactions with others.

The neural basis of gaze perception comprises several brain regions. The superior temporal sulcus (STS) has received a lot of support for its involvement in gaze processing (Bristow, Rees & Frith, 2007; Hoffman & Haxby, 2000). It is, however, unclear whether STS responds more strongly to direct or averted gaze (direct: Pelphrey et al., 2004; averted: Hoffman & Haxby, 2000; equal response to direct and averted: Pageler et al., 2003). The exact role of STS in gaze processing remains unclear. Some researchers suggested that it might be responsive to biological motions in general, and gaze is a specific type of it (Puce & Perrett, 2003). Several neuroimaging studies reported frontal areas to be further involved in gaze processing (Calder et al., 2002; Hooker et al., 2003) including the OFC (Hardee, Thompson & Puce, 2008) and medial PFC (Cavallo et al., 2015). The medial PFC has been linked to self-related processes and theory of mind (Amodio & Frith, 2006). Other areas linked to gaze processing were amygdala (Adams, Gordon, Baird, Ambady & Kleck, 2003; Straube et al., 2010; Wicker, Perrett, Baron-Cohen & Decety, 2003), fusiform gyrus (Calder et al., 2002) and parietal areas (intraparietal sulcus: Hardee et al., 2008; superior and inferior parietal lobules: Calder et al., 2007).

Considering the importance of gaze for social interactions, it is not surprising that gaze direction affects attractiveness judgments. Ewing, Rhodes and Pellicano (2010) manipulated gaze direction (direct or averted) on female faces and asked male participants to choose the face they preferred in a forced-choice paradigm. In the majority of trials, males preferred females who were looking directly at them as compared to those who had an averted gaze. Similarly, faces with a direct gaze also received higher attractiveness ratings. Hence, this study provided a behavioural demonstration that a direct gaze can increase attractiveness. As a side note, people have an implicit preference for direct eye contact (Lawson, 2015), thus it comes with no surprise that they rate faces, which look directly at them, more positively than faces, which have an averted gaze. Similar results that direct gaze increases attractiveness were obtained in other studies (Mason, Tatkow & Macrae, 2005; Saegusa & Watanabe, 2016).

Behavioural evidence has been further complimented with neuroimaging evidence. In an fMRI study, Kampe and colleagues (2002) presented attractive faces that were either looking directly or away from the observer and also either had their head turned directly to the observer or away. The researchers reported that faces with a direct gaze indeed received higher attractiveness ratings. Furthermore, they observed an interaction between ventral striatum (i.e. NAcc) activity and the gaze direction. In a direct gaze condition, activity in the ventral striatum positively correlated with the perceived attractiveness. In an averted gaze condition, activity in the ventral striatum negatively correlated with the perceived attractiveness. Thus, these results indicate that attractiveness is rewarding but only when the other person displays social interest. The authors also hypothesised that the profile of NAcc activity might be reversed for unattractive faces. This is because a direct gaze from an unattractive face may be disappointing whereas an averted gaze from an unattractive face may be relieving. This hypothesis has not been tested to our best knowledge, yet it compliments the findings that direct gaze was preferred in attractive faces to a larger extent than unattractive faces (Ewing et al., 2010). Interestingly, people actually look longer and more often at attractive faces than unattractive faces (Leder, Mitrovic & Goller, 2016; Leder, et al., 2010). Hence, a direct gaze might be a validation of ones own attractiveness in addition to displaying social interest.

Combining facial expressions and gaze direction

Gaze direction – direct or averted – can influence how one interprets facial expressions. Moreover, the effect of gaze direction depends on the valence of emotions. For example, angry and joyful faces were categorised quicker when paired with a direct gaze whereas sad and fearful faces were categorised quicker when paired with an averted gaze (Adams & Kleck, 2003; but see Bindemann, Burton & Langton, 2008). Authors suggested that direct gaze facilitated perception of approach emotions (i.e. joy and anger) whereas averted gaze facilitated perception of avoidance emotions (i.e. sadness and fear). Similarly, gaze direction modulates perceived relevance of faces. Angry faces looking directly at the observer are more relevant than angry faces with an averted gaze, since the former signals aggressiveness directed to the observer and not to others or environment. On the contrary, fearful faces with an averted gaze are more relevant than fearful faces with a direct gaze since averted gaze invites to follow the gaze towards a potential source of threat. Relevance can be detected by amygdala, which indeed was more activated for angry faces with a direct gaze and fearful faces with an averted gaze than other gaze and emotional expression combinations (N'Diaye et al., 2009). In general, facial expressions (and relevance) seem to explain why amygdala activation is observed in many neuroimaging studies testing gaze direction (Itier & Batty, 2009). Hence, to some extent gaze direction influences the interpretation of emotional expressions.

There have been several attempts to combine gaze direction and emotional expressions in the study of attractiveness. In one study (Jones, DeBruine, Little, Conway & Freinberg, 2006) participants had to make a forced choice of preference between an attractive and an unattractive face. These faces further varied in their facial expression (neutral or smiling) and gaze direction (direct or averted). In all cases, participants preferred attractive faces over unattractive. However, the extent of this preference was modulated by social signals. While a smiling face was preferred over a neutral face in the direct gaze condition, the opposite was true in the averted gaze condition. Thus, it seemed that smiling increased the preference for a face only if it was also gazing directly to the observer. In a follow-up study (Conway, Jones, DeBruine & Little, 2008), participants showed a higher preference for a direct gaze on a smiling face but not on a disgusted face. Similarly, participants preferred front views of the face (compared to three-quarter views) when the face was smiling but not disgusted (Main, DeBruine, Little & Jones, 2009). Overall, these results indicated that there was an interaction between gaze direction or head position and facial expressions on attractiveness judgments, but that the relationship differed depending on the valence of emotional expressions.

Two Dissociable Judgments of Facial Aesthetics

The discussion so far has focused on attractiveness while neglecting beauty. This is because there is abundant amount of research of facial attractiveness and very little research on facial beauty. In the literature, these two aesthetic judgments have been generally treated as synonyms (among many: Chatterjee & Vartanian, 2016; Langlois et al., 2000; Leder et al., 2016; Lindell & Lindell, 2014; Rhodes, 2006; Schacht et al., 2008; Senior et al., 2003; O'Doherty et al., 2003; Wang et al., 2014). However, beauty and attractiveness might not be equivalent concepts but rather reflect different motivations. In the animal research, a distinction between wanting and liking was made (Berridge, 1996), where wanting is a motivation to obtain a reward and liking is hedonic pleasure experienced during reward consumption. A similar distinction has been observed in clinical populations and potentially there are dissociable brain mechanisms that support wanting and liking. Here, we define attractiveness as a personal desire to approach someone and potentially become short-term or long-term partners, and beauty as an aesthetic appraisal of the pleasantness of the face (Perrett, 2010). Hence, attractiveness reflects personal motivation, it might be more individual and be comparative to the *wanting* aspect of reward processing. Beauty reflects aesthetic pleasure, it may be based on general standards of beauty within the society and be comparative to the *liking* aspect of reward processing.

Wanting vs. Liking

In animal research, an existence of two distinct components of reward processing – *wanting* and *liking* – was proposed (the incentive salience hypothesis; Berridge, 1996; Berridge & Robinson, 1998). *Wanting* is a motivational component that drives an animal to obtain a reward whereas *liking* is hedonic pleasure obtained from reward consumption. *Wanting* can be measured by mobilised effort to obtain a reward (e.g. lever pressing) whereas *liking* can be inferred from the orofacial expressions when the animal is consuming the reward (Pool, Sennwald, Delplanque, Brosch & Sander, 2016). These orofacial expressions are surprisingly similar between different animals (see Fig 3. A). Although highly correlated, *wanting* and *liking* can be dissociated by making an animal seek for a reward from which little pleasure will be derived (Berridge, 2009). The behavioural dissociation derives from the existence of two dissociable neural networks that underlie motivation (i.e. *wanting*) and hedonic pleasure (i.e. *liking*; see Fig 3. B; Berridge & Kringelbach, 2015). *Wanting* seems to be mediated by the dopaminergic pathway whereas *liking* seems to be mediated by the opioid pathway. When dopamine levels in the mesolimbic system increase, more effort is put into obtaining the reward without necessarily modifying the hedonic pleasure experienced through the reward consumption.

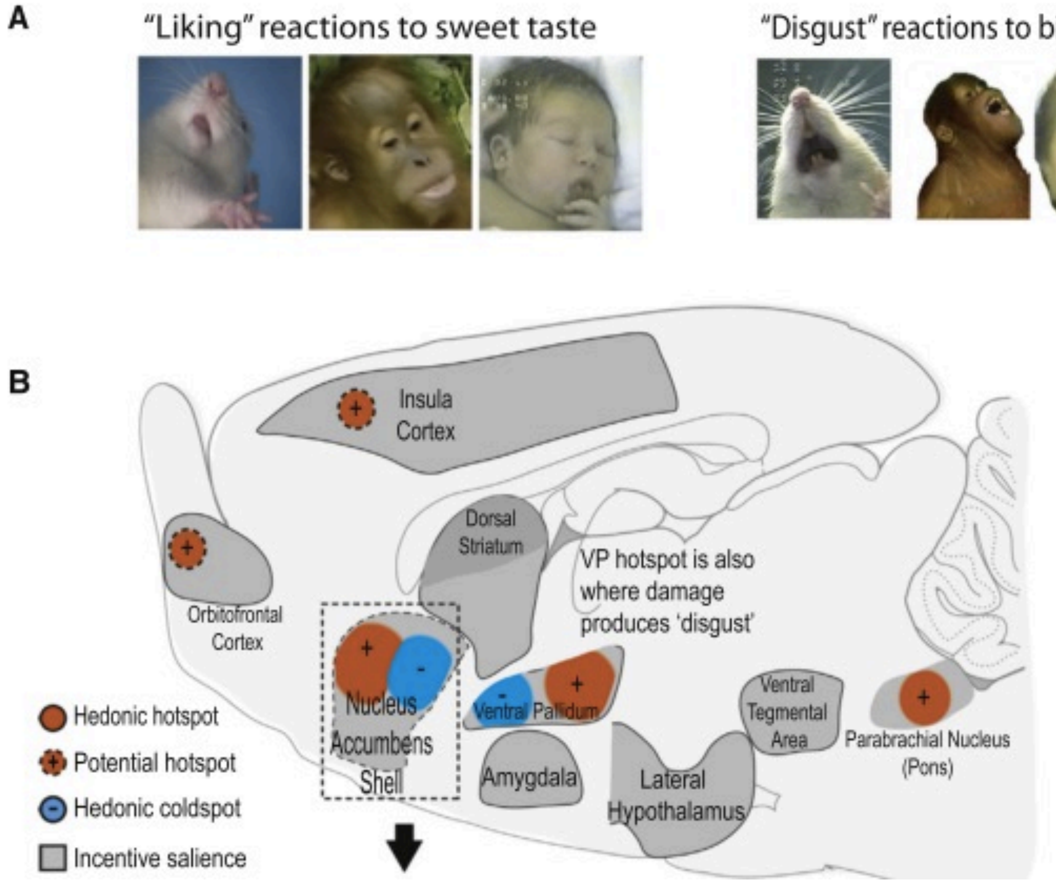

Fig 3. Hotspots of wanting and liking in the rodent brain.

(A) The left image shows the orofacial expressions of liking. The right image shows the orofacial expressions of an aversive reaction (disgust). Both expressions are common to rodents and primates.

(B) Middle sagittal view of the rat brain. Hedonic hotspots are highlighted in red and blue. In red areas, opioid stimulation enhances the feeling of *liking*, which had been elicited by tasting sucrose. In blue areas, opioid stimulation reduces the feeling of *liking*. In grey, areas involved in "*wanting*" are highlighted, potentially mediated by dopaminergic pathway. (courtesy of Berridge & Kringelbach, 2015).

There is accumulating evidence that *wanting* and *liking* also exist in humans (Pool et al., 2016) and that they can be dissociated in some instances. In the example of drug addiction, people may mobilise unbelievable efforts to obtain the substance that will eventually give them no pleasure (Robinson & Berridge, 2003). Similar dissociations might happen in other reward-related disorders (e.g. eating disorders: Pool, Delplanque, Coppin & Sander, 2015, or anhedonia: Berridge & Kringelbach, 2015). Recently, the incentive salience hypothesis has been applied to wider areas of human research. For example, Krishnamurti and Loewenstein (2012) devised a scale to measure sexual *wanting* and *liking* in a partner, and found these two components to be reliably distinct (i.e. correlated with behaviour differently). If sexual *wanting* and *liking* can be treated as two separate components, then potentially nonsexual aesthetic evaluations of the person might be also composed of *wanting* and *liking*. In the case of aesthetic judgments, attractiveness can be loosely seen as *wanting* and beauty can be loosely seen as *liking*. Attractiveness judgments can be seen as *wanting* because they involve more personal evaluations than beauty judgments and motivate to make a move towards an object of attraction. In contrast, beauty judgments rely more on general standards of beauty within the society and derive hedonic pleasure from simply admiring the aesthetic beauty of the face without not necessarily having an intention to get in contact with the person. Hence, beauty can be seen as *liking*.

Indications that beauty and attractiveness are not synonymous

Several behavioural studies provided indications that beauty and attractiveness could be dissociated. Aharon et al. (2001) presented attractive and average male and female faces to heterosexual males. Participants rated the faces on attractiveness and they could also press the key to extend the viewing time of the faces. Attractiveness ratings were higher for attractive faces of both sexes (compared to average faces) whereas exerted effort on a key-pressing task was higher only for attractive female faces. In other words, while heterosexual males perceived other males as beautiful, they did not exert more effort to increase the looking time at them (hence, not attractive). Potentially other males were not seen as suitable partners (i.e. incompatible to their sexual orientation) and so unworthy the effort. Furthermore, overlapping yet partially dissociable neural systems processed beauty and attractiveness, as measured with the fMRI in the same study. Attractiveness (i.e. rewarding beauty of the opposite-sex individuals) recruited an extensive reward network: VTA, OFC, NAcc, and the sublenticular nuclei. On the contrary, beauty (i.e. non-rewarding beauty of the same-sex individuals) recruited VTA but resulted in a reduced activity of NAcc and the sublenticular nuclei. Hence, these results showed that beauty could recruit reward circuitry independent from sexual desire (i.e. attractiveness), yet the recruited network was more restricted than for attractiveness. Senior (2003) also proposed divergent neural network of beauty and attractiveness. However, NAcc was beauty-processing node in Senior's model (see Fig 1), which was not the case in Aharon and colleagues' (2001) study. Thus, beauty and attractiveness seem to sometimes diverge behaviourally and on the neural level, but the exact neural mechanisms underlying these two judgments have not been well determined.

More recently, the difference between beauty and attractiveness was tested in a clinical population of women with low sexual desire (Ferdenzi et al., 2015a). Women with low sexual desire and healthy women rated male faces on attractiveness and beauty. While the correlations between attractiveness and beauty were high for healthy control women (r = .89), they were largely reduced for women with low sexual desire (r = .48). Furthermore, women with low sexual desire showed a reduction of attractiveness but not beauty scores compared to healthy women judgments. Hence, the results indicated that beauty and attractiveness could be dissociated in a clinical population. To what extent beauty and attractiveness are similar in a healthy population remains unclear.

Current Study and Hypotheses

In the current study, we investigated whether facial attractiveness and beauty could be differentiated in a healthy population of heterosexual women. To answer this question, we manipulated gaze direction, head position, and facial expression (neutral or smiling) on attractive and unattractive computer-modelled faces and collected separate judgments of beauty and attractiveness. These social cues (I.e. facial expressions, head position and gaze direction) were shown to affect attractiveness judgments in a way that direct gaze (e.g. Ewing et al., 2010) and straight head position (Main et al., 2009) should result in higher attractiveness judgments. Similarly, we expected to see that smiling would increase perceived attractiveness (e.g. Golle et al., 2014).

If beauty judgments were indeed different, at least to some extent, from attractiveness judgments, then we expected to see that beauty judgments to be less affected by the social cues than attractiveness judgments. The hypothesis of the dissociation between attractiveness and beauty was based on animal literature about differences in *wanting* and *liking* (Berridge, 1996; Berridge & Robinson, 1998; Berridge & Kringelbach, 2015); clinical population of asexual women where attractiveness but not beauty judgments were hampered compared to healthy control women (Ferdenzi et al., 2015a); differences in exerted effort to see beautiful versus attractive faces, with higher effort for attractive faces (Aharon et al., 2001); and partially dissociable neural networks of beauty and attractiveness (Aharon et al., 2001; Senior et al., 2003).

Method

Participants

There were 108 undergraduate students (8 males, mean age = 20.83, SD = 4.54) who voluntarily took part in the experiment in return for course credit. We used the Kinsey scale (Kinsey, Pomeroy, & Martin, 1948) to measure different facets of participants' sexual behaviour (i.e. sexual attraction, sexual fantasies, sexual experience, and sexual orientation). The options ranged from 0 (exclusively heterosexual) to 6 (exclusively homosexual), with 3 indicating a bisexual orientation with no preference for either of the genders. The mean score of their sexual orientation, based on all four sexual orientation facets, was 0.32 (SD = 0.74). Eight females reported a bisexual preference (M = 2.66, SD = 0.90) and all of them chose to rate female faces. These females together with the eight males were excluded from the final sample. The reason for exclusion was to have a homogeneous sample, and these two groups (i.e. bisexual females and males) alone did not have sufficient numbers to constitute a separate group of participants. Hence, the final sample was made of 92 heterosexual females (sexual orientation: M = 0.15, SD = 0.28) with a mean age of 20.92 (SD = 4.85). The study received the ethical approval for the Committee on Research Ethics of the Faculty of Psychology and Education Sciences at the University of Geneva in Switzerland.

Stimuli

Stimuli faces were taken from a database of male and female volunteer photographs compiled for the psychometrically validated database of faces and voices – GEneva Faces and Voices database (GEFAV, see http://www.affective-sciences.org/en/gefav/; Ferdenzi et al., 2015b). Based on the attractiveness ratings during the validation of the stimuli, 16 faces were selected and grouped into two levels of attractiveness (high and low). We then used a FACSGen 2.0 (Krumhuber, Tamarit, Roesch & Scherer, 2012; Roesch et al., 2011) animation software to covert real photographs into three-dimensional (3D) computer-modelled faces (see Fig 4). FACSGen modelled faces were displayed as a mask – without the scalp and hair. These computer-modelled faces had an advantage over real photographs so that we were able to manipulate facial expressions, head position, and gaze direction in exactly the same way (i.e. moving the same facial action units to the same degree). Thus, computer-modelled faces eliminated all non-systematic influences that could have affected aesthetic (i.e. attractiveness and beauty) ratings. Faces measured the size of 20 cm x 30 cm and were displayed in the centre of the screen on the black background.

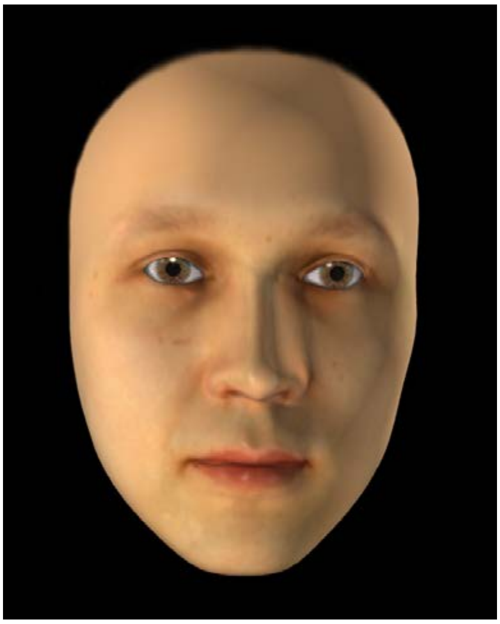

Fig 4. An example of a male stimulus used in the pilot study.
It was modelled from a real photograph using a FACSGen 2.0 software, displays a neutral expression and was rated as relatively unattractive.

In the pilot study, 12 volunteers (2 males; mean age = 23.91, SD = 1.97) rated computer-modelled male and female faces on attractiveness and then on beauty using a linear scale which was later converted into scores from 0 (not attractive at all; not beautiful at all) to 100 (very attractive; very beautiful). Based on these ratings, we chose six male and six female faces for each level of attractiveness (i.e. high and low) for the final design. Attractive faces received an average attractiveness rating of 48.93 (SD=14.05) and a beauty rating of 63.66 (SD = 13.08). Unattractive faces received an average attractiveness rating of 27.12 (SD=15.21) and a beauty rating of 26.32 (SD = 13.36). A two-way repeated measures ANOVA with attractiveness level (high vs. low) and rating type (attractiveness vs. beauty) showed a main effect of attractiveness level ($F(1,11) = 149.91$, $p < 0.001$, partial $\eta^2 = .932$), which confirmed the choice of the stimuli in the two attractiveness levels. Attractive faces indeed received higher ratings of attractiveness and beauty than unattractive faces. These data were not included in the final analyses.

In the final design of the study, participants saw six attractive and six unattractive faces of the opposite gender in eight possible conditions, within-subjects (i.e. 96 stimuli in total). Each face appeared neutral or happy (i.e. smiling), with a direct gaze or an averted to the left gaze, and having their heads straight or turned to the left by 22°. All possible combinations of emotion, gaze direction and head position were displayed (see Fig 5; all stimuli available in a separate document). We used FACSGen software to manipulate gaze direction, facial expression and head position; thus, all the faces had identical characteristics of these social cues. To create happy faces with a Duchenne (i.e. sincere) smile, we moved action unit 6 (mimics the movement of *pars orbitalis* muscle) and 12 (mimics the movement of *zygomaticus major* muscle). The manipulations summed up to 96 stimuli presented twice – to rate attractiveness and beauty. Faces measured 20 cm x 30 cm in size. They were displayed in the middle of the screen on a black background, one at a time.

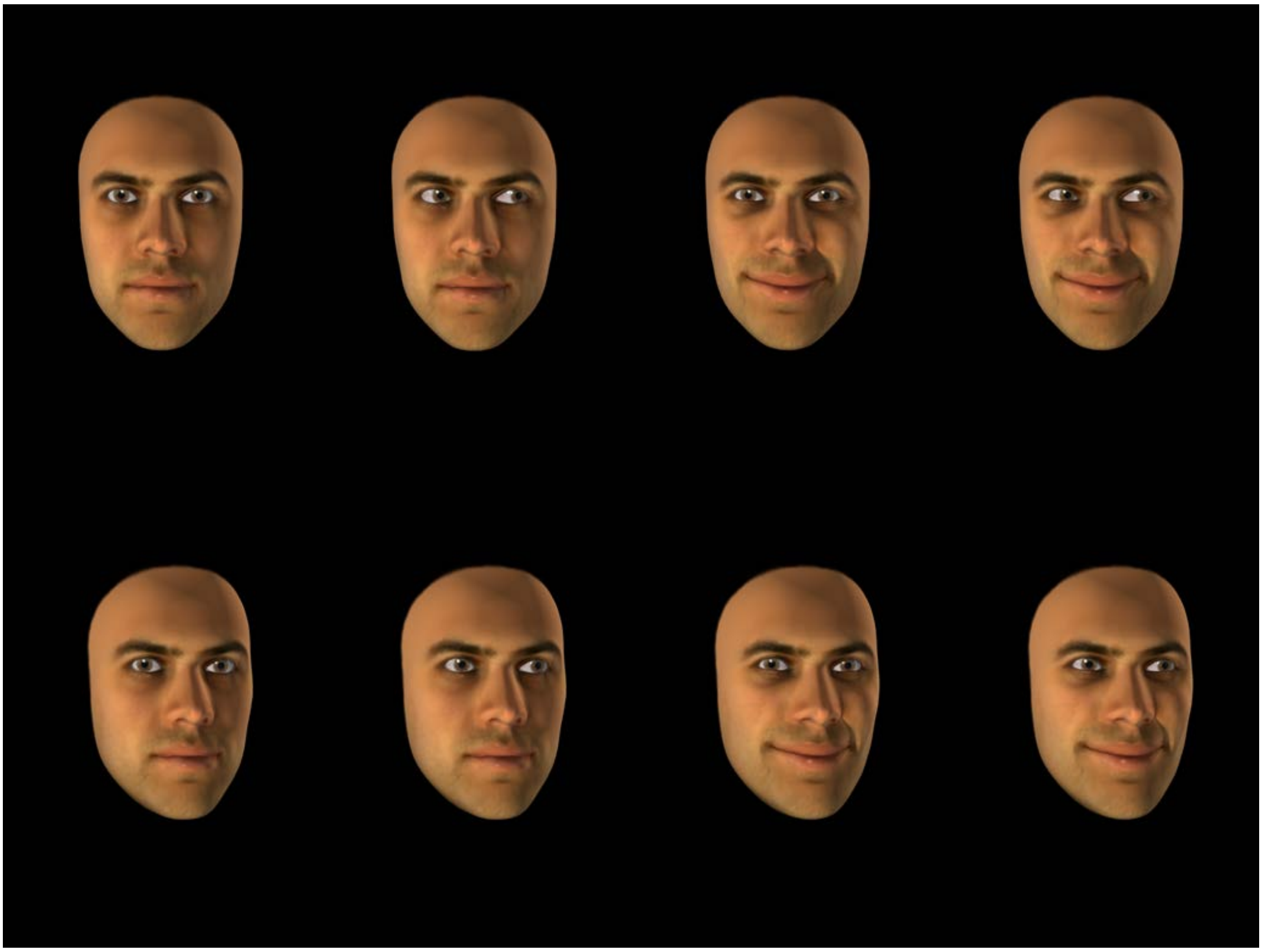

Fig 5. An example of an attractive face in eight different gaze, head position and emotional expression combinations.

Procedure

Participants started the experiment by reading and signing an informed consent form, which provided information about the study and their rights as participants in accordance with the guidelines of the Helsinki Declaration. They then completed the sexual orientation questionnaire (see *Participants* section) and proceeded to the main task.

During the main task, participants were tested in the individual experimental testing boxes, which provided privacy and some isolation from the external noise. Participants had a trial phase with three computer-modeled faces (two males, one female) before starting the actual experiment to ensure that they understood the task and familiarized themselves with the computer-modeled faces.

Participants then rated the faces (see *Stimuli* section) separately on attractiveness and beauty. Before the block of attractiveness judgments, participants were presented with the definition of attractiveness: "*Attractiveness should be understood in a general sense. Does this person attract your attention? If you met this person in real life, would you like to become friends with him and even become short-term or long-term partners?*". Before the block of beauty judgments, participants were presented with the definition of beauty: "*Beauty should be understood in a general sense. Is it pleasant for you to look at this face? Do you think that most people would describe this face as beautiful?*". The aesthetic ratings were made using the linear analogue scales. For each trial, the scale appeared without a cursor and participants were free to move the mouse along the whole length of the scale (see Appendix Fig 1.). The scales ranged from *not attractive/beautiful at all* (later converted as 0) to *very attractive/beautiful* (later converted as 100). Participants were encouraged to use an entire length of the scale. At no point did participants see the numerical equivalents of their ratings. Once the rating was made (i.e. a mouse click made), a triangular cursor appeared and participants were prompted to accept their rating by clicking on the button "Accept?" (see Appendix Fig 2.). This gave them additional time to correct their decision, if necessary, by moving the now-visible cursor. Afterwards, participants would judge the next face. Since the last action would have been the clicking on the "Accept?" button, participants would start making a new decision (i.e. moving the mouse) from a very similar spatial location for each stimulus. The order of making attractiveness and beauty judgments was counter-balanced between participants. Participants had unlimited time to make the judgments. We recorded the beauty and attractiveness responses as well as reaction times for each judgment. Faces were grouped into four sub-blocks of attractiveness and four sub-blocks of beauty, each consisting of 24 randomly presented faces. Participants took small breaks to rest between each sub-block.

Stimuli presentation was programmed with PsychoPy 1.82 (Peirce, 2007; 2008), an open-source programming tool for experiments in psychology and controlled by Microsoft PC, Windows 7. The experiment was performed in a dark room and the screen was displayed at approximately 70 cm distance. The main task took about 15-20 minutes. Afterwards, participants were thanked and debriefed, course credit allocated. We tested up to four participants in a session.

Design and Data analysis

This experiment employed a 2 (type of rating: beauty vs. attractiveness) x 2 (attractiveness level: attractive vs. unattractive) x 2 (facial expression: neutral vs. happy) x 2 (gaze direction: direct vs. averted) x 2 (head position: straight vs. turned) repeated-measures design. We ran two five-way repeated-measures ANOVA models, with ratings and reaction times as different continuous dependent variables. In order to answer how beauty and attractiveness judgments differed, we used post-hoc tests to break down significant interactions (Bonferroni corrected). Ratings (scores from 0 to 100; accuracy to the nearest hundredth – 0.01) and reaction times (in seconds; accuracy to the nearest thousandth – 0.001) were analysed in the same manner. Whenever there was no interaction between a significant result and the type of rating, we took this as an indication that the effect applied to both attractiveness and beauty. In these cases, we referred to attractiveness and beauty combined as aesthetic judgments. Whenever there was an interaction between the effect and the type of rating, we specified which aesthetic judgment – attractiveness and beauty – the results applied to.

We also compiled two hierarchical regression models to measure how much variance in beauty judgments could attractiveness judgments account for and vice versa, and whether additional variables (attractiveness level, emotional expression, gaze direction, and head position) could account for extra variance in these judgments. This gave us an indication of how similar these attractiveness and beauty were. It also demonstrated whether social cues contributed to the same amount of additionally explained variance in each judgment. This would have been true if attractiveness and beauty were processed in the same manner. However, if attractiveness and beauty were not identical, then we would see different contributions of the social cues to the judgments of attractiveness and beauty. Data was analysed using the statistical software programs R (R Core Team, 2016), and SPSS version 22 (IBM Corp., 2013).

Results

A general overview of the data indicated that 45% of participants indeed used the entire response scale (from 0 to 100). Nonetheless, there seemed to be large individual differences in the given aesthetic judgments. Some participants did not go above 20.97 and others started rating from 43.06. In general, aesthetic ratings were rather low. The average aesthetic rating, across attractive and unattractive face, was 37.79 (SD = 27.87). On average, it took 4.02 (SD = 2.72) seconds to rate each face.

Common effects to beauty and attractiveness judgments

Two five-way repeated-measures ANOVA with ratings and reaction times as dependent variables indicated several main effects. As expected, there was a main effect of attractiveness levels on the aesthetic ratings; $F(1,91) = 441.72$, $p < 0.001$, partial $\eta^2 = .829$. Attractive faces (M = 53.25, SE = 1.54) received higher aesthetic ratings than unattractive faces (M = 22.33, SE = 1.32). Attractive faces (M = 4.21, SE = 0.13) also took longer to be judged than unattractive faces (M = 3.82, SE = 0.13), as indicated by the main effect on reaction times; $F(1,91) = 35.84$, $p < 0.001$, partial $\eta^2 = .283$.

There were also a main effects of head position ($F(1,91) = 11.83$, $p = 0.001$, partial $\eta^2 = .115$) and gaze direction ($F(1,91) = 33.14$, $p < 0.001$, partial $\eta^2 = .267$) on the aesthetic ratings. This main effect was qualified by an interaction between gaze direction and head position; $F(1,91) = 34.49$, $p < 0.001$, partial $\eta^2 = .275$. Faces with their heads turned straight to and gazing directly at the observer received higher ratings than any other combination of gaze direction and head position (see Fig 6). There was also a significant interaction between head position and gaze direction on reaction times; $F(1,91) = 7.54$, $p = 0.007$, partial $\eta^2 = .077$. Faces with direct gaze and head position straight were judged slower than faces with averted gaze but head position straight ($p = .048$). No other comparisons were significant (all $ps \geq .060$).

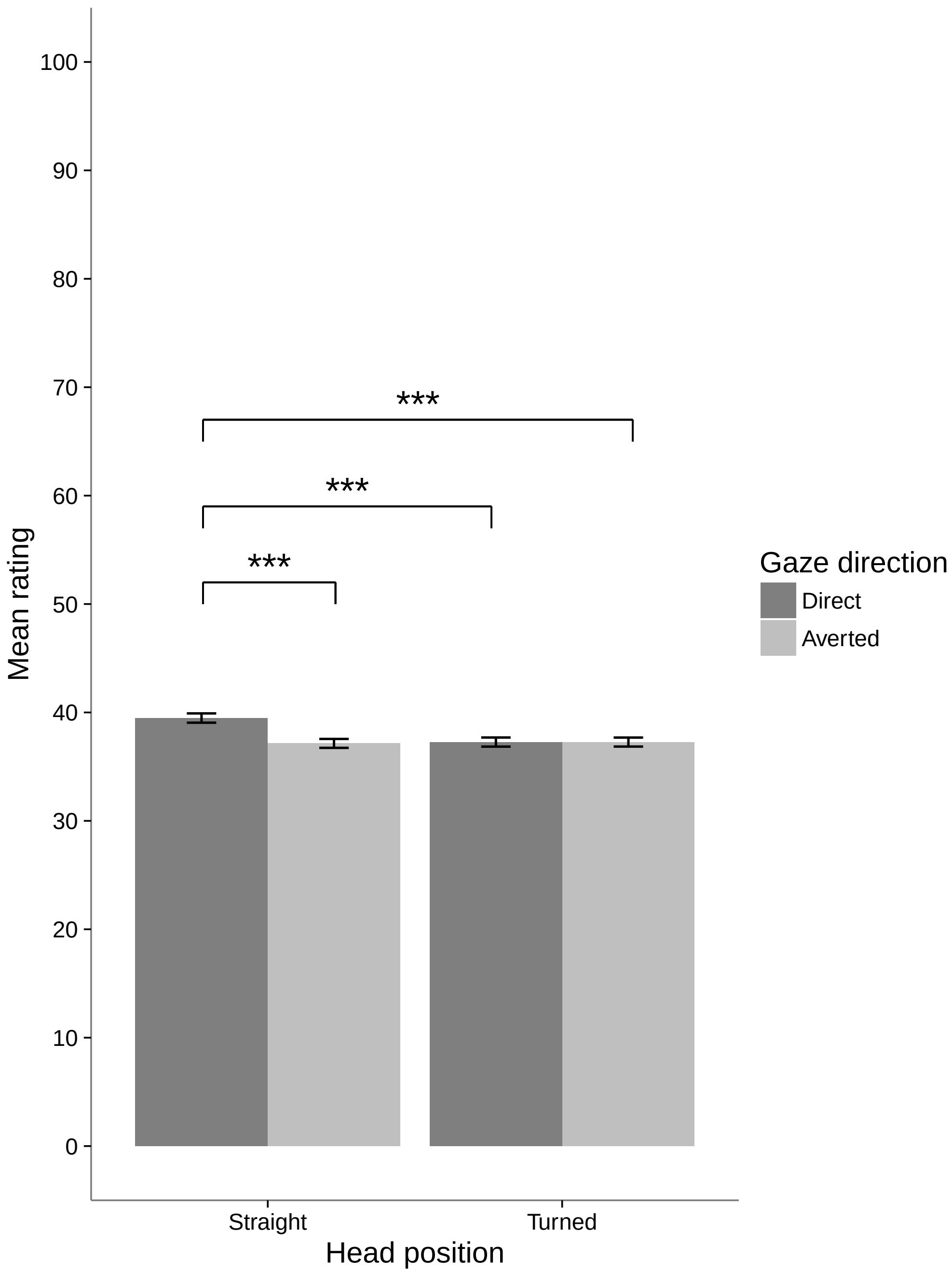

Fig 6. Aesthetic judgment dependence on gaze direction and head position.
Highest attractiveness judgments given to faces which looked directly and had their heads turned to the observer. (*** $p < 0.001$).

Interactions between attractiveness level and gaze direction ($F(1,91) = 26.43$, $p < 0.001$, partial $\eta^2 = .225$) and between attractiveness level and head position ($F(1,91) = 28.55$, $p < 0.001$, partial $\eta^2 = .239$) indicated that attractive faces experienced more gain from social cues in aesthetic judgments than unattractive faces (see Fig 7). In other words, only attractive faces but not unattractive faces were rated as more aesthetically pleasing (i.e. more attractive or beautiful) when they were gazing directly or had their heads turned straight to the observer.

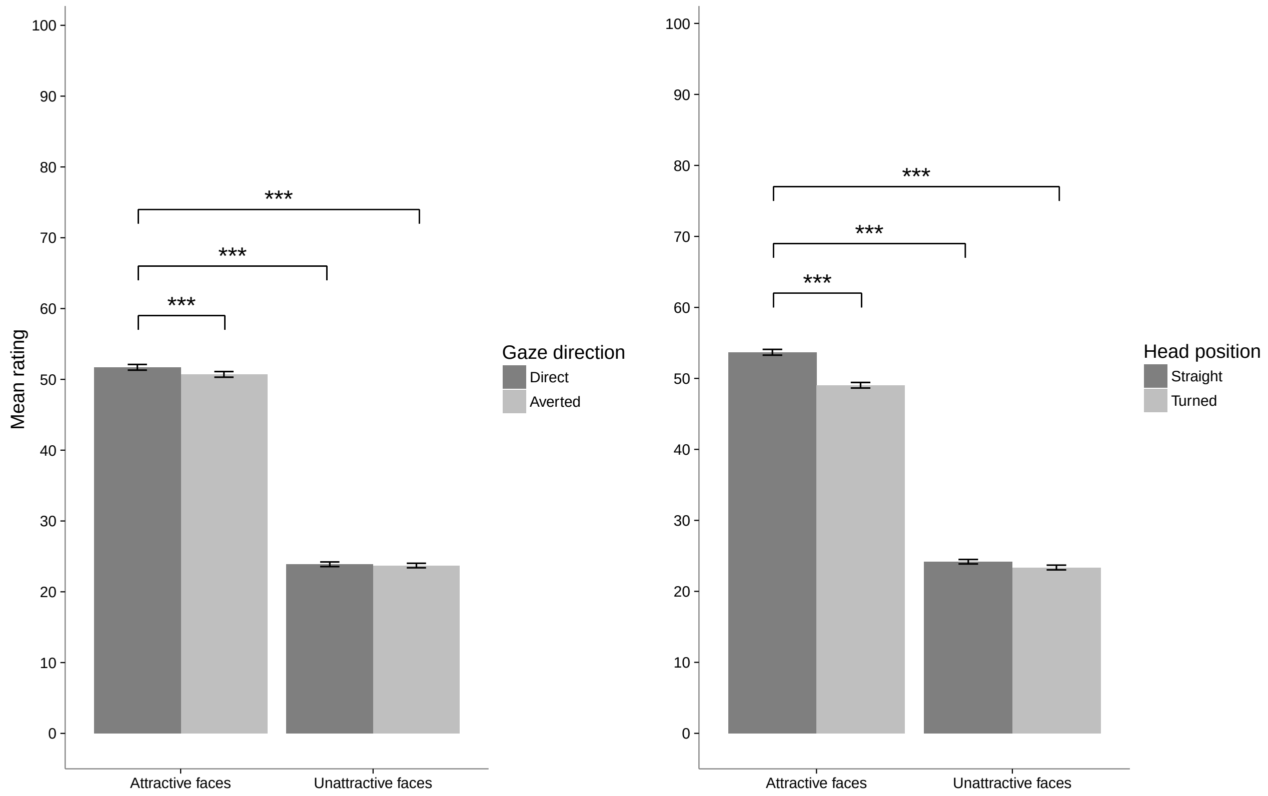

Fig 7. Differential effect of social cues on faces of different levels of attractiveness.
Direct gaze and straight head position increased aesthetic judgments in attractive faces only
*** $p < 0.001$.

Finally, there was no main effect of emotion on aesthetic judgments; $F(1,91) = 1.79$, $p = 0.184$, partial $\eta^2 = .019$. Neutral (M = 38.40, SE = 1.27) and happy (M = 37.18, SE = 1.36) faces were rated as equally attractive. Nonetheless, there was a main effect of emotion on reaction times; $F(1,91) = 7.65$, $p = 0.007$, partial $\eta^2 = .078$. Happy faces (M = 3.97, SE = 0.13) were judged slightly quicker than neutral faces (M = 4.06, SE = 0.13).

Differences between beauty and attractiveness judgments

There was a main effect of the rating type of aesthetic judgments ($F(1,91) = 28.37$, $p < 0.001$, partial $\eta^2 = .238$), which meant that beauty ratings (M = 39.91, SE = 1.26) were overall higher than attractiveness ratings (M = 35.67, SE = 1.26). A similar main effect was observed on reaction times ($F(1,91) = 76.08$, $p < 0.001$, partial $\eta^2 = .455$), as beauty (M = 3.56, SE = 0.12) was judged quicker than attractiveness (M = 4.47, SE = 0.16).

The difference between beauty and attractiveness ratings was qualified by several interactions. There were two two-way interactions. The first interaction was between rating type and attractiveness level; $F(1,91) = 56.36$, $p < 0.001$, partial $\eta^2 = .382$. Beauty ratings were higher than attractiveness ratings for attractive faces but not for unattractive faces (see Fig 8.). A complimentary interaction was observed on reaction times ($F(1,91) = 10.34$, $p = 0.002$, partial $\eta^2 = .102$), where beauty was judged faster than attractiveness but the effect was larger for attractive faces ($p < 0.001$, Cohen's $d = 4.78$) than unattractive faces ($p < 0.001$, Cohen's $d = 2.99$). The second interaction was between rating type and emotion; $F(1,91) = 13.38$, $p < 0.001$, partial $\eta^2 = .128$. Neutral faces were judged as more attractive than happy faces while they were not judged as more beautiful (see Fig 9). Nonetheless, beauty ratings were higher than attractiveness ratings for neutral ($p = 0.003$) and for happy ($p < 0.001$) faces.

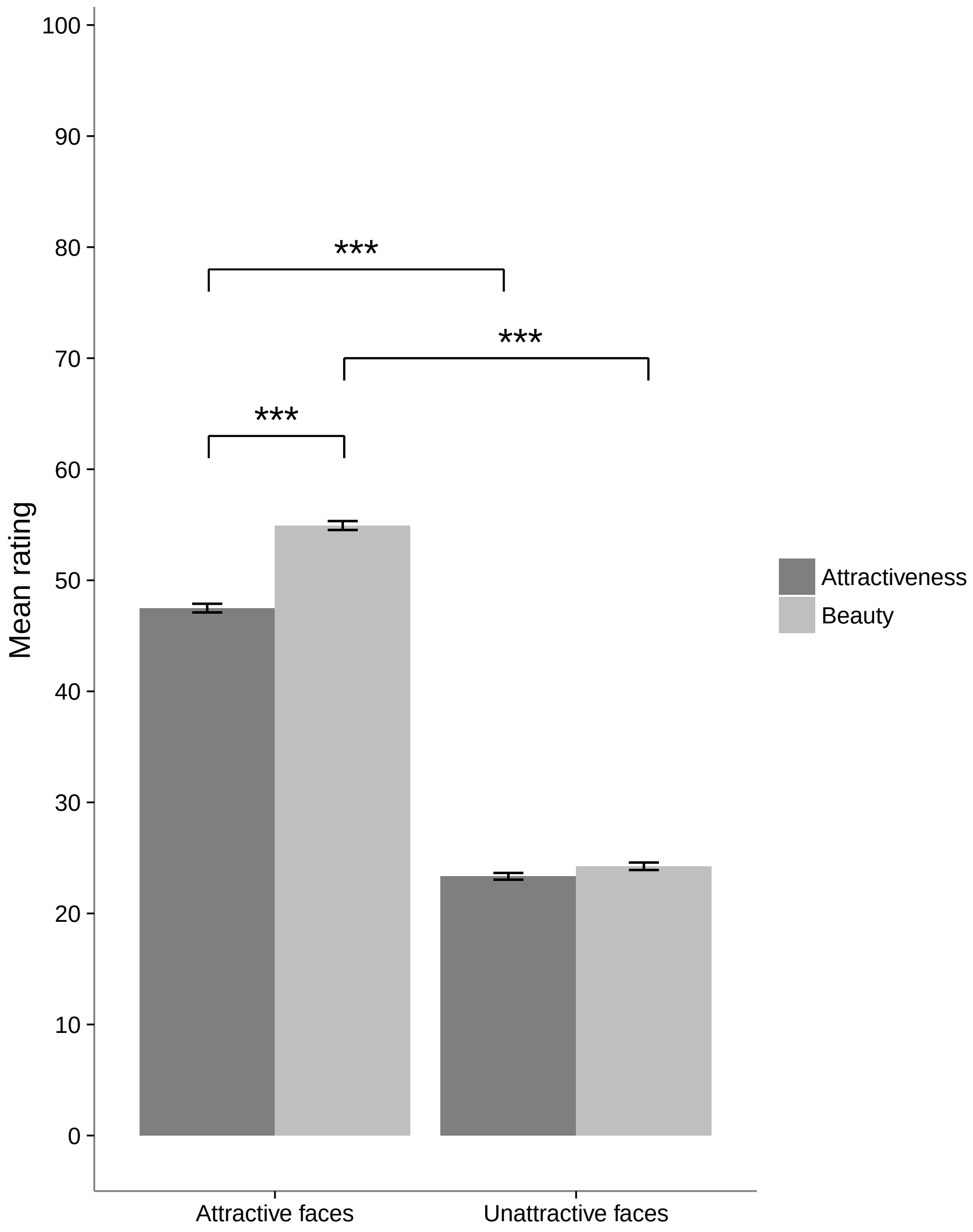

Fig 8. The difference between beauty and attractiveness judgments for attractive and unattractive faces.

(*** p < 0.001).

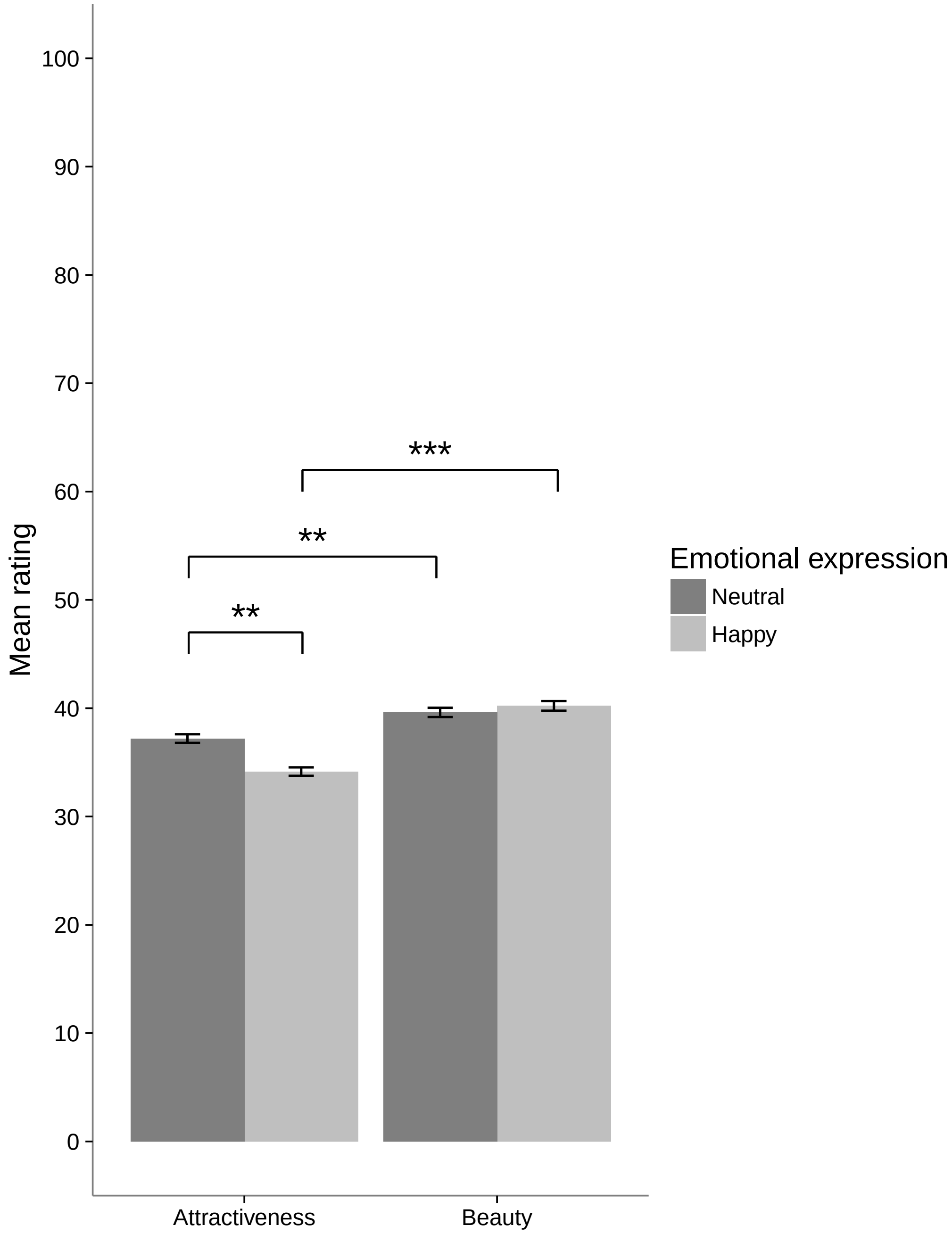

Fig 9. The difference between beauty and attractiveness judgments for happy and neutral facial expressions.

(** $p < 0.010$, *** $p < 0.001$).

There was also a three-way interaction on aesthetic judgments between rating type, attractiveness level, and emotion; $F(1,91) = 5.46$, $p = 0.022$, partial $\eta^2 = .057$. Neutral faces were rated as more attractive than happy faces on attractive faces ($p < 0.001$) but not on unattractive faces ($p = .870$). No further comparisons for attractiveness ratings and no comparisons for beauty ratings were significant (all *ps* ≥ 0.108). However, due to a small amount of explained variance (i.e. 5.7%), the contribution of this interaction to the overall results was probably of a lesser importance than the previously described two-way interactions.

How much beauty is in attractiveness (and vice versa)?

We used a hierarchical regression to estimate how much variance in beauty ratings was explained by attractiveness ratings and whether any additional variables could explain extra amount of variance, previously unaccounted by attractiveness ratings. Although beauty and attractiveness are often regarded as synonyms, attractiveness ratings could account only for 51.70% of variance in beauty ratings; $F(1,8827) = 9451$, $p < 0.001$. Fig 10 graphically demonstrates a strong relationship between beauty and attractiveness but also certain divergence in the ratings. After controlling for attractiveness ratings, attractiveness level ($\beta = 14.52$, $p < 0.001$), emotion ($\beta = 2.33$, $p < 0.001$), and head position ($\beta = 1.19$, $p = 0.004$) but not gaze direction ($\beta = 0.20$, $p = 0.631$) could improve the model further; $F(5,8823) = 262.07$, $p < 0.001$. The change in explained variance (i.e. adjusted R-squared) after including the latter additional variables was 5.11%.

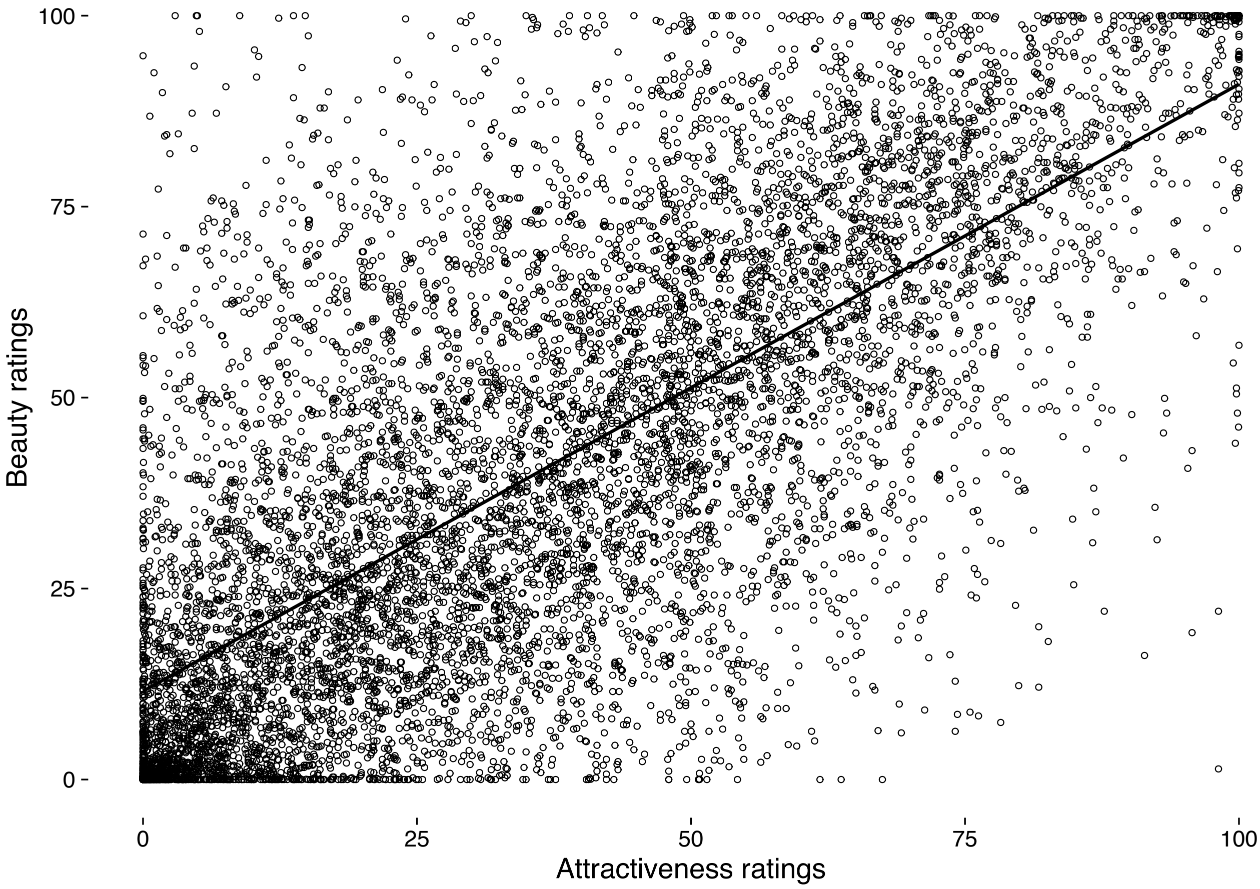

Fig 10. A scatterplot showing a relationship between beauty and attractiveness judgments.
Note that an individual circle indicates a single rated face and not a single participant. Each participant rated 96 faces.

An analogous hierarchical regression model was computed with attractiveness ratings as an outcome variable. Beauty ratings could account for 51.70% of variance in attractiveness ratings; $F(1,8827) = 9451$, $p < 0.001$. After controlling for beauty ratings, attractiveness level ($\beta = 5.95$, $p < 0.001$), emotion ($\beta = 3.53$, $p < 0.001$), and head position ($\beta = 0.85$, $p = 0.027$) but not gaze direction ($\beta = 0.62$, $p = 0.104$) could improve the model further; $F(5,8823) = 63.98$, $p < 0.001$. The change in the explained variance after including the latter additional variables was 1.34%. It can be noted that the change in the explained variance by adding additional variables was larger for beauty than attractiveness judgments (5.11% vs. 1.34%). This could be used to imply that social factors displayed on the face had more importance for beauty than attractiveness ratings.

Discussion

We measured how beauty and attractiveness judgments were affected by transient social cues in the face – facial expression, gaze direction, and head position. We presented attractive and unattractive computer-modelled faces, on which we manipulated the expression (neutral or smiling), gaze direction (direct or averted), and head position (straight or turned). Attractiveness and beauty judgments were attributed very quickly, which went in line with previous observations that attractiveness judgments are automatic and rapid (Olson & Marshuetz, 2005; Willis & Todorov, 2006). We observed that the highest aesthetic ratings, both attractiveness and beauty, were given to faces which looked directly at the observer and had their head turned towards them. Our findings went in line with previous studies (Ewing et al., 2010; Kampe et al., 2002; Main et al., 2009; Seagusa & Watanabe, 2016). Although expected, we did not find that smiling faces were rated as more attractive. When inspecting the literature in more detail, it could have been predicted from some studies that smile would increased attractiveness (e.g. Golle et al., 2014; Mueser et al., 1984; Okubo et al., 2015; Otta et al., 1996; Reis et al., 1990; Sun et al., 2015), whereas more recent studies failed to make this observation in general (Morrison 2013; O'Doherty et al., 2003; Talamas et al., 2016) or failed to make it on male faces only (Penton-Voak & Chang, 2008; Tracy & Beall, 2011). Thus, it is likely that while negative emotional expressions decrease attractiveness ratings, positive emotional expressions do not affect them (e.g. Morrison et al., 2013).

Interestingly, the gain in attractiveness judgments due to positive social cues was present only for attractive faces and not for unattractive faces. Hence, attractive faces benefited more from transient social cues than unattractive faces. The finding went in line with the literature. For example, Ewing and colleagues (2010) observed that direct gaze was preferred to averted gaze on attractive faces to a larger extent than on unattractive faces. Kampe and colleagues (2002) hypothesised that rewarding activity in the ventral striatum would be observable only when attractive faces but not when unattractive faces looked directly at the observer. Our results supported the idea that attractive and unattractive faces were processed differently. A future study could be devised to measure whether variations in gaze direction and head position on unattractive faces would indeed correlate with the activity in the ventral striatum differently than these variations on attractive faces. Furthermore, attractive faces were judged slower than unattractive faces. Similar observations were made in colour preference studies, where favourite colours took more time to select than least favourite colours (Jonauskaite et al., 2015). Potentially, pleasant experiences (e.g. attractive faces and liked colours) led to approach-related behaviours whereas unpleasant experiences (e.g. unattractive faces and disliked colours) led to avoidance-related behaviours.

How did beauty and attractiveness differ?

The main question of this study was whether beauty and attractiveness were different. If beauty is considered as a general appraisal of pleasantness of a face whereas attractiveness is considered as a mating drive, then the question is how objective beauty standards are and how subjective attractiveness judgments are. If the former is really objective, it should remain stable across contexts and unbiased by social cues (e.g. smile or gaze). Hence, we expected to find that beauty would be less malleable by social cues than attractiveness. Contrary to our hypothesis, beauty was as affected by social cues as attractiveness. Hence, it could be concluded that beauty is not a completely objective and detached appraisal of a face but is influenced by personal norms and transient social signals to a similar extent as attractiveness.

Nonetheless, there was evidence that attractiveness was not identical to beauty. In particular, attractiveness judgments were similar to beauty judgments only by 51.70%. This level of similarity (or, in statistical terms, explained variance) would be considered really sufficient (Falk & Miller, 1992), moderate (Hair, Ringle & Sarstedt, 2011) or substantial (Cohen, 1988) in social sciences. However, since beauty and attractiveness have been largely treated as synonyms (see Chatterjee & Vartanian, 2016; Langlois et al., 2000; Leder et al., 2016; Lindell & Lindell, 2014; Rhodes et al., 2006; Schacht et al., 2008; Senior et al., 2003; O'Doherty et al., 2003; Wang et al., 2014; cf. Geldart, 2010), one would expect a large coincidence (around 80-100%) between beauty and attractiveness judgments. In this case, a rather low degree of similarity (i.e. 51.70 %) indicated that participants were employing different criteria when judging beauty and when judging attractiveness. These two judgments also seemed to be influenced by social cues slightly differently, since these cues independently explained some variance in each judgment. Hence, there is a high degree of similarity between attractiveness and beauty and both of these aesthetic judgments are malleable by social cues, yet they are not synonymous and rather reflect different aesthetic appraisals of a face.

Avenues for future research

The next research question would be whether attractiveness and beauty are quantitatively or qualitatively different. In other words, is attractiveness just an addition to beauty judgments or is there something unique in each judgment? When considering the first possibility that attractiveness and beauty are different quantities of the same judgment, one could notice that beauty is judged quicker. Potentially, an aesthetic appraisal which relies on general standards (i.e. beauty) is easier to achieve because it is more fluent compared to a personal appraisal of considering someone as a potential partner (i.e. attractiveness). We also observed that beauty judgments were higher than attractiveness judgments (in line with Ferdenzi et al., 2015a) but this was only true for attractive faces. Potentially, one needs extra characteristics in addition to beauty to consider someone attractive. Thus, one judges beauty first and then, after considering other influential factors, one judges attractiveness. Hence, beauty of attractive faces is a simpler and more fluent (i.e. requiring fewer additional considerations) decision. In contrast, if one sees an unattractive face, then beauty and attractiveness judgments equate. In this case, both of them are easy to achieve, and they are rather low. This kind of reasoning might explain the differences between attractiveness and beauty observed in time and scores. Nonetheless, the reasoning provided above does not exclude the possibility that beauty and attractiveness are qualitatively different. Perhaps, there are situations where these two judgements dissociate. For example, cases might exist when ugly faces are found attractive or beautiful faces are found unattractive. If that were true, these would be signs of double dissociations of attractiveness and beauty and would show that attractiveness and beauty have unique contributions to the aesthetic appraisals of faces. Thus, future research is needed to design studies that could answer whether beauty and attractiveness differ quantitatively or qualitatively.

It would be easier to detect dissociations between beauty and attractiveness if, in addition to presenting a face, one would be given supplementary descriptions of certain personality traits, habits and preferences, past romantic history, future expectations, and so on which are known to influence attractiveness judgments (e.g. Gross & Crofton, 1977; Little, Burt & Perett, 2006; Owen & Ford, 1978). Some descriptions of a person should have the power to boost the baseline attractiveness and others would have the power to reduce the baseline attractiveness. Potentially, this could even compensate for relative unattractiveness (ugliness). On the contrary, beauty judgments should be less affected by these descriptions. It has been shown that humour production (Tornquist & Chiappe, 2015), faithfulness in one's previous relationships (Quist, DeBruine, Little & Jones, 2012), and honesty

(Paunonen, 2006) can all boost attractiveness. In a recent study (Farrelly, Clemson & Guthrie, 2016), females were presented with photographs of males of varying beauty and also given some descriptions of their behaviour in social situations. Some males were described as being altruistic and others as non-altruism. Altruism turned out to be an important determiner of attractiveness when more altruistic males were found more attractive. Importantly here, males who were relatively ugly but altruistic were rated as more attractive for long-term relationships than males who were relatively good-looking but non-altruistic. Thus, altruism compensated for relative ugliness. To see if these males were still objectively perceived as ugly, one would need to collect beauty ratings. This extension of the study would enable researchers to answer the question about the differences in beauty and attractiveness. Following the same line of research but looking at negative character traits, one could find cases where good-looking people with negative character traits would not be seen as attractive as good-looking people without the negative character traits. All in all, attractiveness judgments can be strongly influenced by social knowledge and personality traits of the evaluated person. It is unknown to what extent beauty judgments would be affected in these cases. One would need to specify that outer and not inner beauty is of interest. If beauty judgments were affected to a lower extent than attractiveness judgments, this would give strong supporting evidence for double dissociation between attractiveness and beauty and thus qualitative differences between the two aesthetic judgments.

Potential insights from neuroscience

Another open question regarding beauty and attractiveness judgments is whether they can be (partially) dissociated on a neural level, since partial dissociation on a behavioural level has been demonstrated in the current study. If attractiveness and beauty indeed represent distinct aesthetic judgments, then different neural regions should encode them. Obviously, due to a large overlap between attractiveness and beauty behaviourally, one would expect overlapping, at least to a certain extent, neural correlates.

Nonetheless, it would be a challenge to investigate this question using neuroimaging techniques, because they rely on contrasts between two conditions. Both attractiveness and beauty judgments seem to be triggered simultaneously when one is looking at a face. While attention could be directed to one or the other judgment (e.g. by explicitly asking to evaluate attractiveness or beauty like in the current study), it would not necessarily mean that only attractiveness or beauty is being appraised and evaluated. Hence, there would be a huge if not complete overlap between the neural regions involved in attractiveness and beauty judgments. Nevertheless, there are at least two possibilities to resolve this challenge.

The first option would be to test a clinical population. Ferdenzi and colleagues (2015a) demonstrated behaviourally that women with low sexual desire have impaired, compared to matched control women, perception of attractiveness but not of beauty. In other words, women with low sexual desire were able to evaluate men as being more or less handsome, and their judgments did not differ from control women. Women with low sexual desire, however, evaluated all men as being unattractive, because they did not experience sexual drive towards them. Hence, when looking at the male faces, women with low sexual desire should be evaluating beauty only. It would be interesting to employ functional MRI in order to explore which brain regions are involved in assessment of male attractiveness and beauty in women with low sexual desire and matched control women. The differences between the two groups should indicate the differences between attractiveness and beauty judgments. Neural activity in women with low sexual desire looking at male faces would describe which neural regions are responsive to beauty (one could also contrast handsome vs. non-handsome men to identify which regions are modulated by beauty). Neural activity of matched healthy control women looking at male faces would describe neural regions responsive to both beauty and attractiveness. Thus, by subtracting neural activity of the clinical group from the control group, one would identify areas involved in attractiveness judgments alone. One would expect to observe activity in the reward areas (e.g. VTA, NAcc & OFC), potentially to a stronger extent for attractiveness judgments since attractiveness judgments require more investment (in terms of pursuing the person one is attracted to) and therefore may be more rewarding than beauty judgments, which require a simple appraisal of the aesthetic pleasantness of the face. Potentially, areas involved in higher cognition (PFC) and social situations (e.g. STS) would be recruited more when judging attractiveness than beauty since attractiveness requires cognitively evaluating a person as a potential partner and socially attracting and engaging them.

A second option would be to adapt the procedure used in by Aharon and colleagues (2001). They showed male and female faces to heterosexual male participants and recorded the neural activity in response to both. Since heterosexual males were not sexually interested in male faces, their judgments of male faces were non-rewarding. One could infer that non-rewarding beauty reflected beauty judgments in this study, whereas rewarding beauty (i.e. when males looked at female faces) reflected attractiveness. Aharon et al. (2001) observed certain differences in response to attractiveness and beauty (both activated VTA, beauty activated NAcc to a lower extent than attractiveness). Using the same methodology, one could investigate the reverse – heterosexual females judging male and female faces. If looking at the beautiful faces of the opposite sex indeed reflect beauty judgments only, then the neural activity of heterosexual females judging female faces should be similar to neural activity of heterosexual males judging male faces, and be indicative of beauty judgments. Following the same logic, then neural activity observed in heterosexual females looking at male faces, and heterosexual males looking at female faces, should be indicative of attractiveness judgments. One could go further with the same design and also investigate the neural activity of bisexual people looking at male and female faces. In this case, bisexual participants should find male and female faces attractive as well as beautiful and their neural activity to male and female faces should not differ. Furthermore, it should reflect the neural activity of heterosexual people looking at the faces of an opposite gender. Following Aharon and colleagues' findings (2001), we would expect to find more reward areas recruited for attractiveness judgments than beauty judgments – especially in NAcc and potentially OFC.

Furthermore, a double dissociation between attractiveness and beauty on the neural level would indicate that beauty and attractiveness are qualitatively different. However, if the same neural areas were recruited for beauty and attractiveness, and attractiveness would simply recruit additional areas than beauty, then this would be an indication of quantitative differences between attractiveness and beauty. Hence, neuroimaging techniques can further the current knowledge about aesthetics judgments of faces.

Individual differences in attractiveness judgments

In their choice of a romantic partner, women are faced with an evolutionary dilemma. Males with masculine facial features seem to have better health (Thornhill & Gangestad, 2006; Rhodes, Chan, Zebrowitz & Simmons, 2003) and reproductive potential (Rhodes et al., 2005). Unfortunately, oftentimes they are less reliable as long-term partners and have shown increased preference for short-term sexual relationships (Boothroyd et al., 2008). In contrast, males with feminine facial features are associated with cues of investment and stronger preference for committed long-term relationships (Boothroyd et al., 2008). Hormone levels and fertility help females to resolve a trade-off between the costs and benefits associated with choosing a more masculine mating partner. Women would gain the maximum benefit if they selected males with feminine features as long-term partners due to the higher chance of investment and males with masculine features as extra-pair partners. Several studies indicated that women around ovulation (i.e. at the peak of fertility), showed the highest preference for masculine males compared to other phases of the menstrual cycle (Jones et al., 2005; Penton-Voak et al., 1999; Penton-Voak & Perrett, 2000). Furthermore, the cyclic shifts in women preferences for males with masculine features were most strongly expressed in partnered women when women judged male attractiveness for extra-pair relationships (Penton-Voak et al., 1999). On the other hand, being in a relationship might raise a threshold for male attractiveness or lower discrimination. In one study, partnered women rated photographs of attractive males as less attractive and photographs of less attractive males as more attractive (Karremans, Dotsch & Corneille, 2011, but see Wang, Hahn, DeBruine & Jones, 2016). Similarly, women may rate their own partner's attractiveness as higher compared to the ratings of other women. This mechanism could be used to protect one's relationship. Increased preference towards one's own partner has been linked to oxytocin in males (Scheele et al., 2013) and females (Scheele et al., 2015) and with activity in the NAcc – the reward area (Scheele et al., 2013). Hence, in the studies of attractiveness it might important to consider the current fertility of female participants and the relationship status of participants of both genders. It is unknown to what degree these variables would influence beauty judgments and could be used as another way to look for dissociations between beauty and attractiveness. These two variables have not been accounted for in the current research and thus could potentially bias the results (especially attractiveness ratings).

General limitations of facial attractiveness research

Recognition of facial identity is difficult for unfamiliar faces and easy for familiar faces. There have been various explanations put forward of why this might be the case, one of them being that photographs of the individuals vary unsystematically (Burton, Kramer, Ritchie & Jenkins, 2016). That is, each individual's photographs would vary in a different way and learning an identity of someone means learning how their face varies. Hence, facial features must be abstracted in some way to learn a person's identity. Indeed, one study found that people relied more on external features (e.g. hairstyle) when recognising unfamiliar faces but more on internal features (e.g. shape of the eyes) when recognising familiar faces (Longmore, Liu & Young, 2015). Reducing availability of external features encouraged people to pay more attention to internal facial features and facilitated learning of the identity. This meant that different strategies were employed when trying to recognise known versus unknown faces. This variability points to a large problem in research using photographs as stimuli where it is taken for granted that a photograph adequately captures person's appearance. To test how this variability might affect attractiveness judgments, Jenkins, White, Van Montfort & Burton (2011) asked people to evaluate attractiveness of the same individual presented many times with different photographs. Attractiveness judgments given to the same individual were not stable and varied substantially. What was more surprising, within-subject variability exceeded between-subject variability in attractiveness. Hence, it is crucial to understand the source of such variability in order to be able avoid it as much as possible and reduce confounding effect on various types of facial judgments.

Conclusion

Can one be attracted to a person but not find them good-looking? And can one be not attracted to a good-looking person? In this study, we tried to disentangle the relationship between attractiveness (an evolutionary motivation to approach and potentially become partners with the other person) and beauty (an aesthetic appraisal of the pleasantness of a face). By using social cues, we demonstrated that beauty is not an objective judgment and can be as influenced by direct gaze and head turned towards the observer as attractiveness. And yet, attractiveness judgments were not identical to beauty judgments. They coincided by slightly more than a half leaving the other half to be different. Beauty judgments were also higher than attractiveness judgments, but only for attractive faces. Hence, our study showed that beauty and attractiveness are highly similar yet subtly distinct aesthetic evaluations of a face. In the future, one would need to identify situations where these two judgments diverge more strongly in a healthy population and employ neuroimaging techniques to test whether attractiveness and beauty dissociate on a neural level as well as behaviourally.

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Supplementary Material

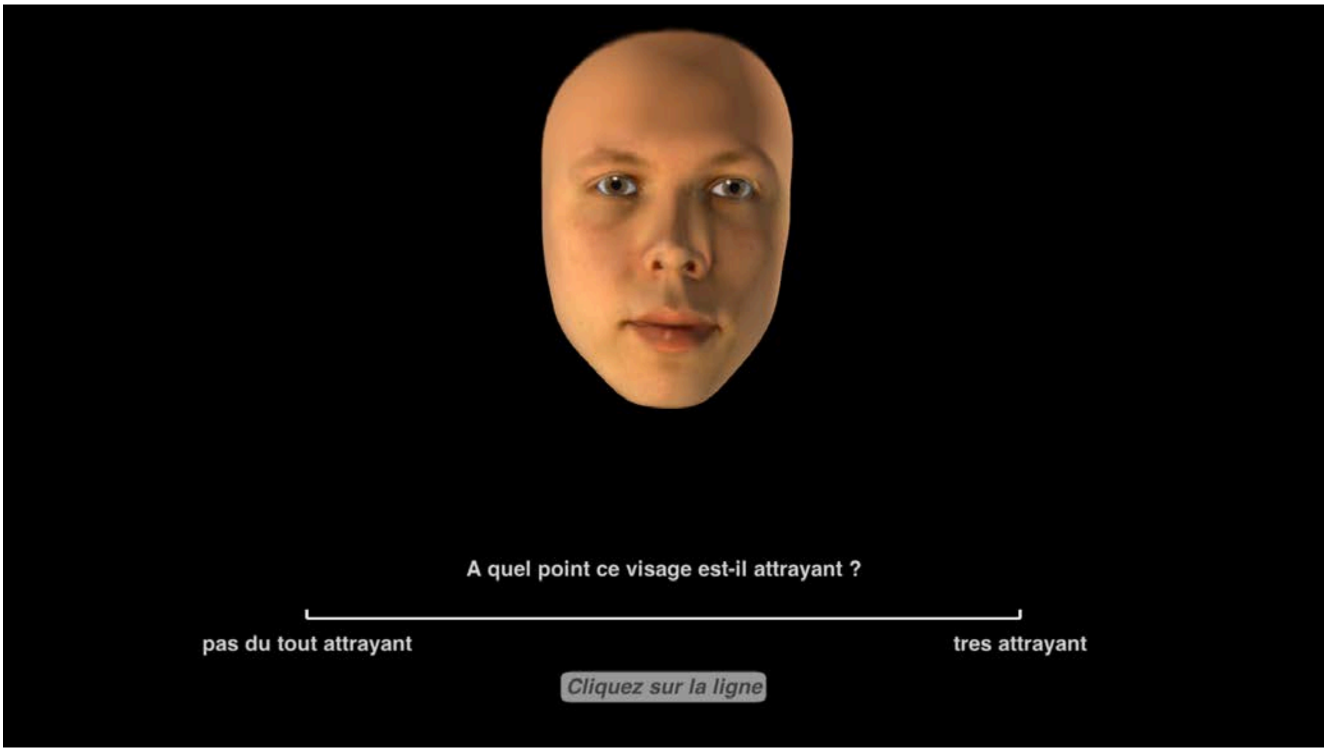

Fig 1. The starting point of each stimulus before the aesthetic judgment has been attributed.

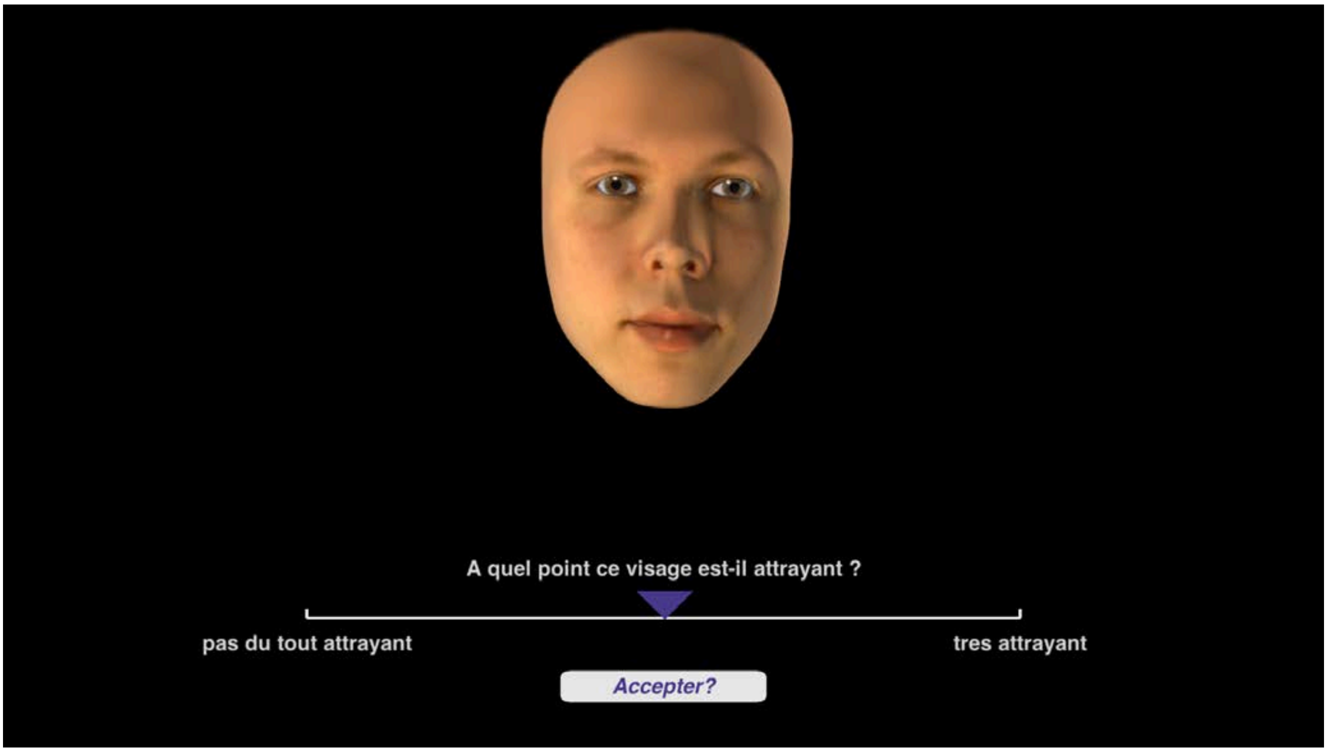

Fig 2. The screen once an aesthetic judgment has been attributed.
Participants can still modify their decision by moving the triangular cursor. Once happy, they confirmed their decision by clicking on "Accept?" button.