The influence of body composition on social judgements

Xue Lei

University of St Andrews

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Collaboration Statement

Throughout the thesis, the pronoun "we" is used to reflect the collaborative nature of all experiments conducted in the Perception Lab at the University of St Andrews. This work is my own under the support of my supervisor in terms of hypothesis, experimental design, and data analysis. The plural pronoun reflects the fact the if/when published, the following experiments would carry multiple authorship and is used in keeping with intellectual honesty.

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Thesis Abstract

Body Mass Index (BMI; weight scaled by squared height) is a crucial determinant of physical attractiveness, potentially because BMI signals mate value. Yet, BMI does not contain information about body composition, namely fat and muscle, which might be a better indication of mate value. The current thesis explored the potential influence of body composition on attractiveness and other social judgements.

Study 1 investigated the influence of facial correlates of body composition on perceived male facial masculinity. Facial correlates of muscle consistently enhanced facial masculinity, whereas facial correlates of fat increased masculinity perception in underweight to normal-weight men only.

Study 2 investigated women's preferences for facial correlates of body composition in short- and long-term relationships. Women have stronger preferences for facial correlates of muscle in short- compared to long-term relationships, while no discrepancy was observed in preferences for facial correlates of fat.

Study 3 investigated how body composition influences health and kindness judgements from male faces. Perceived health increased with increasing fat and muscle from underweight to normal-weight men but decreased with further increases in fat and muscle. Increase in facial correlates of muscle dramatically diminished perceived kindness, but facial correlates of fat showed a slight detrimental impact on perceived kindness.

Study 4 investigated whether men and women have accurate perceptions of opposite-sex preferences for body shape. Women exaggerated the thinness that men prefer; men exaggerated the heaviness and muscularity that women prefer. Moreover, these misperceptions were larger for short- compared to long-term relationships.

The thesis demonstrates the distinct effects of fat and muscle on social judgements and reveals that men and women misperceive opposite-sex preferences. These findings point out the importance of distinguishing body composition of studies of body size.

Overview of Introductory Chapters

The focus of this thesis is on the perception of body composition as well as its facial correlates. The introductory chapters (Chapter 1−3) will discuss the relevant literature on body size as a cue to attractiveness from evolutionary and sociocultural perspectives.

Chapter 1 introduces the literature on the influence of attractiveness, including positive characteristics associated with attractiveness (the "attractiveness halo") and better treatment in many social contexts. It emphasises the importance of investigating attractiveness. Since the "attractiveness halo" is so prevalent, understanding what constitutes attractiveness and how attractiveness perception is developed is of crucial importance not only to psychologists but also to the public.

Chapter 2 discusses Body Mass Index (BMI: weight scaled by squared height, kg/m^2) as a cue to attractiveness from an evolutionary perspective. It presents evidence that BMI has a substantial impact on physical attractiveness both in men and women. Further, it introduces possible explanations of why BMI has such an enormous influence on attractiveness. In addition to that, this chapter points out the role that body composition (fat and muscle mass) might play in the perception of attractiveness.

Chapter 3 shows a sociocultural perspective on attractiveness. It discusses the mechanisms underlying sociocultural influences on an individual's perception of attractiveness and the social agents transmitting standards of attractiveness.

Chapter 1 Physical attractiveness

1.1 Physical attractiveness and social interactions

The mystery of beauty has fascinated philosophers and poets for a long time, but not until the last century, psychologists (Swami & Furnham, 2007). Willis and Todorov (2006) found that an exposure of 100 ms is enough for humans to form judgements of attractiveness from faces, suggesting that attractiveness judgement is fast and intuitive. Even infants are able to distinguish between attractive and unattractive faces (Langlois et al., 1987; Langlois, Ritter, Roggman, & Vaughn, 1991).

Physical attractiveness has consistently been found to influence numerous life outcomes and social interactions. In general, physically attractive people are perceived more positively and treated better in various contexts. In fact, the positive impacts start as early as infancy. Mothers of attractive babies are more affectionate and show more playful interactions than mothers of less attractive babies (Langlois, Ritter, Casey, & Sawin, 1995; Schein & Langlois, 2015). Moreover, the preference for attractive babies has been overgeneralised to other judgements. For instance, attractive babies are judged to be more intelligent, social, and altruistic than less attractive babies (Griffin & Langlois, 2006). In school, teachers also tend to have high academic expectations of attractive students compared to less attractive students (Parks & Kennedy, 2007). Unsurprisingly, these preferential treatments and positive attributes extend to adulthood, where it becomes more evident. For example, compared to less attractive individuals, attractive individuals get more dating opportunities (Jokela, 2009), are perceived to be more competent (Jackson, Hunter, & Hodge, 1995), have better chances of getting jobs (Jawahar & Mattsson, 2005), are more likely to be helped by strangers (Benson, Karabenick, & Lerner, 1976), and even get more lenient sentences in the court (Ahola, Christianson, & Hellström, 2009; Sigall & Ostrove, 1975). Since physical attractiveness has substantial effects on social interactions, many efforts have been put into the investigation of what constitutes physical attractiveness in psychology.

1.2 Two approaches to explain attractiveness judgements

It has long been held that “beauty is in the eye of the beholder”. Indeed, there are some findings that support this claim. For example, hormones (DeBruine, Jones, & Perrett, 2005; Penton-Voak et al., 1999), personality (Little, Burt, & Perrett, 2006), self-attractiveness (Little, Burt, Penton-Voak, & Perrett, 2001), and pathogen disgust (DeBruine, Jones, Tybur, Lieberman, & Griskevicius, 2010), all of which are individual differences that have been found to influence mate preferences (see Perrett, 2010). Despite evidence for the various perceptions of attractiveness, a large number of psychological studies have revealed that there is high consensus regarding who is attractive and who is not across cultures (Cunningham, Roberts, Barbee, Druen, & Wu 1995; Cunningham, Barbee, & Philhower, 2002; Langlois et al., 2000; Perrett et al., 1998; Rhodes, Harwood, Yoshikawa, Nishitani, & McLean, 2002). This finding has inspired a great number of psychologists to explore the physical features that make people appear attractive and why we find certain features attractive. Two approaches have been developed to answer the “what” and “why” questions: the evolutionary approach and the sociocultural approach.

The evolutionary approach stems from the perspective that physical attractiveness assessments motivate us to engage in behaviour that would increase reproductive success and discourage us from engaging in behaviour that is detrimental to reproduction or fitness (Sugiyama, 2005; Thornhill & Gangestad, 1999). For example, we are attracted to sexually dimorphic features (e.g. muscularity in men and low waist to hip ratio in women) because mating with sexually mature individuals increases chances of reproducing (Frederick et al., 2007; Singh,1993). Conversely, individuals displaying asymmetry cues are perceived to be unattractive as asymmetry signals poor gene quality (Gangestad & Simpson, 2000; but see Pound et al., 2014 for contradictory results), thus copulating with them would decrease reproductive success. In short, from an evolutionary perspective, a feature or individual is perceived to be attractive because this judgement improves the probability of interacting with them, and in turn increase reproductive success in the ancestral environment.

By contrast, some psychologists have taken a sociocultural approach, arguing that physical attractiveness judgement is a result of social learning. Beauty is defined by cultures and transmitted via sociocultural agents like media, parents, and peers. In this view, beauty standards vary across cultures and individuals judge physical attractiveness based on local cultural criteria. Evidence supporting this claim comes from work comparing beauty ideals between cultures. For instance, plumpness or being slightly overweight is preferred in some traditional cultures, like South Pacific islands and some African countries (Becker, 1995; Brewis & McGarvey, 2000; Frederick, Forbes, & Anna, 2008; Furnham & Baguma, 1994). Whereas, thinness and underweight female bodies are perceived as most attractive in Western societies (Smith, Cornelissen, & Tovée, 2007; Swami, Caprario, Tovée, & Furnham, 2006; Swami et al., 2010). Further evidence supporting the sociocultural framework comes from work on the impact of media exposure on shaping body ideals. Exposure to television in populations who did not previously have access to television would result in a decrease in preference for heaviness (Thornborrow, Jucker, Boothroyd, & Tovée, 2018). It suggests that attractiveness perceptions are malleable and can be learned.

It worth mentioning that although there is evidence in support and against the two approaches, the two perspectives are not mutually exclusive. In fact, neither evolutionary nor sociocultural perspective alone is sufficient to explain the human physical attractiveness perception. Attraction to certain physical features might be pre-programmed to increase reproductive success, but to what extent it is preferred is calibrated based on local environments. The following two chapters will discuss how the two approaches explain physical attractiveness judgement in detail.

1.3 Determinants of physical attractiveness

To date, psychologists have identified a great many physical features of the body that influence physical attractiveness, including but not limited to Body Mass Index (BMI; Swami & Tovée, 2005; Tovée, Hancock, Mahmoodi, Singleton, & Cornelissen, 2002; Tovée, Maisey, Emery, & Cornelissen, 1999), height (Pawlowski, Dunbar, & Lipowicz, 2000; Pierce, 1996), leg length (Sorokowski et al., 2011; Sorokowski & Pawlowski, 2008), Waist to Hip Ratio (WHR; Dixson, Dixson, Li, & Anderson, 2007; Furnham, Tan, & McManus, 1997; Singh,1993; Singh, Dixson, Jessop, Morgan, & Dixson, 2010), Waist to Chest Ratio (WCR; Coy, Green, & Price, 2014; Tovée, Maisey, Vale, & Cornelissen, 1999), muscularity (Dixson, Dixson, Bishop, & Parish, 2010; Frederick et al., 2007), the converse to muscularity fatness (Faries & Bartholomew, 2012; Wang et al., 2015), and breast size (Dixson, Grimshaw, Linklater, & Dixson, 2011; Furnham & Swami, 2007; Lynn, 2009). Among all these determinants, BMI might be the one that received most attention and is best documented.

BMI is defined as the weight scaled by squared height (kg/m^2) and commonly used as an index for an individual's body size. In a series of studies examining female physical attractiveness determinants, BMI is argued to be the most important one. For example, BMI was reported to account for 80% variance in female physical attractiveness (Tovée & Cornelissen, 1999, 2001; Tovée, Maisey, Emery, & Cornelissen, 1999; Tovée et al., 2002), with moderately low BMI (~20) is seen as most attractive. Moreover, the role of BMI as the primary predictor of female physical attractiveness was found across cultures including but not limited to the UK, the US, Greece, Russia, Malaysia, Japan (Aghekyan, Ulrich, & Connell, 2012; Swami, Antonakopoulos, Tovée, & Furnham, 2006; Swami, Caprario, et al., 2006; Swami et al., 2010; Swami & Tovée, 2005), implying the importance of it in investigations of physical attractiveness. Nevertheless, it should be noted that BMI captures height and weight but does not take body composition, namely fat and muscle mass into consideration. Given the same BMI, a body may have high body fat or high body muscle, which are differently related to mate values both in men and women. Hence, the impacts of BMI on physical attractiveness should be discussed with regard to body composition. The following two chapters will review previous findings of the impacts of BMI on physical attractiveness from evolutionary and sociocultural perspectives. Body fat and muscle will be discussed separately where necessary.

Chapter 2 An evolutionary perspective on physical attractiveness

2.1 Sexual selection

Sexual selection was first proposed by Darwin in *On the Origin of Species* (1859) and developed in *The Descent of Man and Selection in Relation to Sex* (1871). Darwin proposed sexual selection theory to account for the contradictions to natural selection theory. For example, the peacock's tail and the stag's antlers seem to be harmful to survival. Darwin postulated that these features might increase the chances of mating, thus favoured by sexual selection.

Two mechanisms were proposed that sexual selection operates on. One is intrasexual selection — competition within sex where the victor will win the access to mating with the opposite sex. The victors either enjoy the outcomes directly or indirectly through controlling resources that the other sex desires. As a result, the traits that led to success in competition will be passed on to the next generation due to the higher mating opportunities. For example, the antler of a deer is proposed to work as a weapon in fighting. Especially among polygynous deer, males compete frequently and vigorously for mating access during ruts. The winners of fights will have mating opportunities. As a result of intense competition, male deer can have huge antlers relative to their body size (Lincoln, 1994; Stewart, Bowyer, Kie, & Gasaway, 2000). The other mechanism is intersexual selection — one sex displaying certain traits are preferred by the other sex and chose as mates. As a result, traits that are preferred by the other sex are passed on through each generation. Fisher (1930) argued that exaggerated male ornament which seems to be of little or even detrimental effect to survival is preferred by female and passed on to male offspring. The strong preference for the ornament opposes and undermines natural selection, which results in the runaway selection that leads to greater expression of the ornament as well as the preference over generations. Perhaps the best but also controversial example is peacock's tails, which are thought to be evolved in response to female mate choice. Both observational and experimental studies have shown that peahens show a preference towards male peacocks displaying more eyespots in their trains during courtship, and it has been found that peacocks' mating success decreased when a few eyespots were removed experimentally (Dakin & Montgomerie, 2011; Petrie, Tim, & Carolyn, 1991; but see Takahashi, Arita, Hiraiwa-Hasegawa, & Hasegawa, 2008 for contradictory evidence).

2.2 Mating strategies

Trivers (1972) proposed that a central driving force behind the sexual selection is the degree of parental investment each sex devotes to their offspring. Parental investment is defined as “any investment by the parent in an individual offspring that increases the offspring’s chances of surviving (and hence reproducing) at the cost of the parent’s ability to invest in other offspring” (Trivers, 1972, p.139). Trivers (1972) proposed two related links between parental investment and sexual selection: (a) the sex that invests more in offspring should be choosier or more discriminating about whom they mate with (intersexual competition), and (b) the sex that invests less in offspring should compete more vigorously for access to the valuable high-investing members of the opposite sex (intrasexual competition).

Like most female mammals, women usually invest considerably more than men. This is because some parental investments like fertilisation, gestation, and lactation are internal within women. As these forms of investments usually take a long time, women are constrained with respect to the number of children they can produce. In contrast, the minimum parental investment by men is the contribution of sperm. Consequently, women’s parental investment exceeds men’s contribution to the survival of offspring substantially. The large discrepancy of parental investment between men and women suggest that women should be more discriminating about whom to mate with, whereas men should be less discriminating and make more efforts in intrasexual competition for access to fertile mates.

Based on the parental investment theory, the cost and benefit associated with different mating strategies should have driven men to put more effort in short-term relationships, whereas women should pursue long-term relationships (Buss & Schmitt, 1993; Gangestad & Simpson, 2000). In fact, one study has shown that most men (75%) are willing to accept casual sex when invited by an opposite-sex stranger, while no women accept the offer (Clark & Hatfield, 1989). Nonetheless, it is important to note that the pursuit for short- or long-term relationships are not sex-specific, and there are many exceptions. Human males do invest in their offspring more than donating sperm. For example, men invest in their offspring by providing resources, protecting them from danger, teaching them skills for living (Trivers, 1972). One benefit by doing so is an increasing chance of the survival of his children. Hill and Hurtado (1996) found that the death rate of children without an investing father is 10% higher than children whose father are alive in a hunter-gather society Ache Indians of Paraguay. Likewise, although women should benefit more by pursuing long-term relationships, there are reproductive benefits women could gain from short-term mating. According to assortative mating, women with lower mate value are most likely to find mates with lower mate value as long-term partners. However, such women are able to find men with higher mate values in short-term relationships as men are less discriminating when looking for sexual partners without commitment (Kenrick, Groth, Trost, & Sadalla, 1993; Kenrick, Sadalla, Groth, & Trost, 1990). Similar to men, women could adopt mixed mating strategies or conditional mating strategies and act with tactics matched to the environment.

The mixed or conditional mating strategy should have developed in response to different adaptive problems that short- and long-term mating posed to men and women (Buss & Schmitt, 1993; Gangestad & Simpson, 2000). For example, men would be confronted with the problem of identifying fecund women when pursuing short-term mating strategy as the goal is about reproduction only (Symons, 1979). Consequently, cues signal sexual maturity like breast size and low waist-to-hip ratio in women should be most important (Furnham & Swami, 2007; Singh, 1993). Indeed, it was found that sociosexually unrestricted (who tend to engage in short-term sexual relationships) men perceive women with lower BMI and WHR as more attractive and fertile compared to sociosexually restricted men (who tend to acquire long-term relationships) (Swami, Miller, Furnham, Penke, & Tovée, 2008). According to the strategic pluralism theory, one benefit that women might gain from short-term mating is good genes, which is one's genetic quality that can be passed on to offspring and increase offspring survival and reproductive success (Gangestad & Simpson, 2000). Based on this assumption, signals of good genes like symmetry (and arguably sexual dimorphism) should be valued by women more when pursuing short-term sexual partners than long-term partners. For example, mounting evidence has demonstrated that women show stronger preference for facially masculine men when considering short-term or extra-pair partners than long-term partners (Jones et al., 2018; Little, Jones, Penton-Voak, Burt, & Perrett, 2002; Penton-Voak et al., 2003; but see Marcinkowska et al. (2016)). Hence, research investigating physical attractiveness or preferences for partners should ask specific questions in respect to the relationship context.

2.3 Mate value

No matter what strategies are adopted, there is no doubt that individuals with high mate value are more desirable than individuals with low mate value. Mate value is the sum of traits in an individual that could promote the reproductive success of another individual by mating with him or her. These traits include but not limited to phenotypic traits (e.g. age, health, and fecundity) of which some are heritable, and personalities like kindness and willingness to invest in offspring which could promote the survival and growth in offspring. As mentioned before, men and women face different adaptive problems when pursuing short- and long-term relationships; thus, traits that contribute to mate value should be valued differently by men and women.

2.3.1 Female mate value

Since women are responsible for gestation and producing infants, women's mate value is closely linked to fertility. Women's fertility varies across the reproductive life span, where the peak occurs in the 20s but decreases dramatically after 30 (Broekmans, Knauff, te Velde, Macklon, & Fauser, 2007; ESHRE, 2005; Pfeifer et al., 2017). Hence, advancing age is associated with lower mate value in women, and youth is therefore highly valued by men. Apart from that, gestation and lactation require immense energy (Frisch, 1987; 2004). Therefore, cues to a positive energy balance and good health contribute to women's mate value also (Andrews, Lukaszewski, Simmons, & Bleske-Rechek, 2017).

2.3.2 Male mate value

In contrast to women, men's mate value depends on the relationship context. The main benefit for women pursuing short-term relationships is obtaining better genes for her offspring, which she may not be able to acquire through her long-term partner. Therefore, men's mate value under the short-term relationship context is determined by his genetic quality (Buss & Schmitt, 1993; Thornhill & Gangestad, 2003). In contrast, long-term relationships require more parenting effort. Thus, cues to good parents are assumed to increase mate value in men in long-term relationships. For example, willingness to invest in a woman and offspring, abilities to acquire resources and protection from danger are most valued in long-term relationships (Buss & Schmitt, 1993; Fletcher, Tither, O'Loughlin, Friesen, & Overall, 2004; Li, 2007; Li, Bailey, Kenrick, & Linsenmeier, 2002; Symons, 1979).

2.4 BMI as a cue to mate value

A great number of studies have confirmed the impact of BMI on physical attractiveness and probably is a primary determinant of it (Tovée & Cornelissen, 1999, 2001; Tovée, Maisey, Emery, & Cornelissen, 1999; Tovée et al., 2002). BMI provides potential cues to mate value in men and women. For example, BMI is highly associated with health and strength, and is a perceptually sexually dimorphic trait, which all contribute to mate value. The following sections will discuss the mate value of BMI in details.

2.4.1 BMI as a cue to health

2.4.1.1 BMI as a cue to general health

Health is a particularly important mate value for several reasons. First of all, mating with a healthy mate means a lower risk of getting transmitted diseases. Secondly, a good health condition is the foundation for obtaining resources for survival and for sharing them with a partner. Although a short-term relationship usually does not involve provisions of resources, a long-term relationship is heavily dependent on the ability to provide resources especially in men (Buss & Schmitt, 1993; Fletcher et al., 2004; Symons, 1979; Trivers, 1972). Thirdly, a good health condition reflects the underlying genes condition, which is heritable. Taken together, mating with healthy mates is of crucial importance for reproductive success.

Evidence is mounting that the relationship between health and BMI is curvilinear, where neither very low BMI (<18.5) nor very high BMI (>25) is healthy. WHO defines the normal weight range as between 18.5-24.99 although it varies between ethnicities, BMI <18.5 is classified as underweight, 25 < BMI < 29.9 is classified as overweight, and >30 is classified as obese (WHO, 2004). Many studies have shown that overweight people are at a higher risk for many cardiovascular diseases including heart attacks, stroke, Type 2 diabetes, hypertension (Aune et al., 2016; Bhaskaran, dos-Santos-Silva, Leon, Douglas, & Smeeth, 2018; Chen et al., 2013; GBD 2015 Obesity Collaborators, 2017; Khan et al., 2018) and some cancers like endometrial, breast, and colon cancer (Bhaskaran et al., 2014). Mortality was found to be lowest in the normal BMI range (20-25 kg/m^2), below or above the range was positively associated with overall mortality (Di Angelantonio et al., 2016). In a systematic review, both obesity and underweight were found to be associated with shorter life expectancy (Bhaskaran et al., 2018). It should be noted that not all evidence is pointing towards adverse effects of overweight and obesity on mortality and morbidity. Some studies have shown that coronary heart disease patients with overweight or even obese BMI have lower mortality compared to normal and underweight counterparts (see De Schutter, Lavie, & Milani, 2014). Despite the conflicting findings, the large number of case studies (30 millions) imply that BMI does relate to health in many ways, where normal weight might be most protective (Aune et al., 2016; see Figure 1).

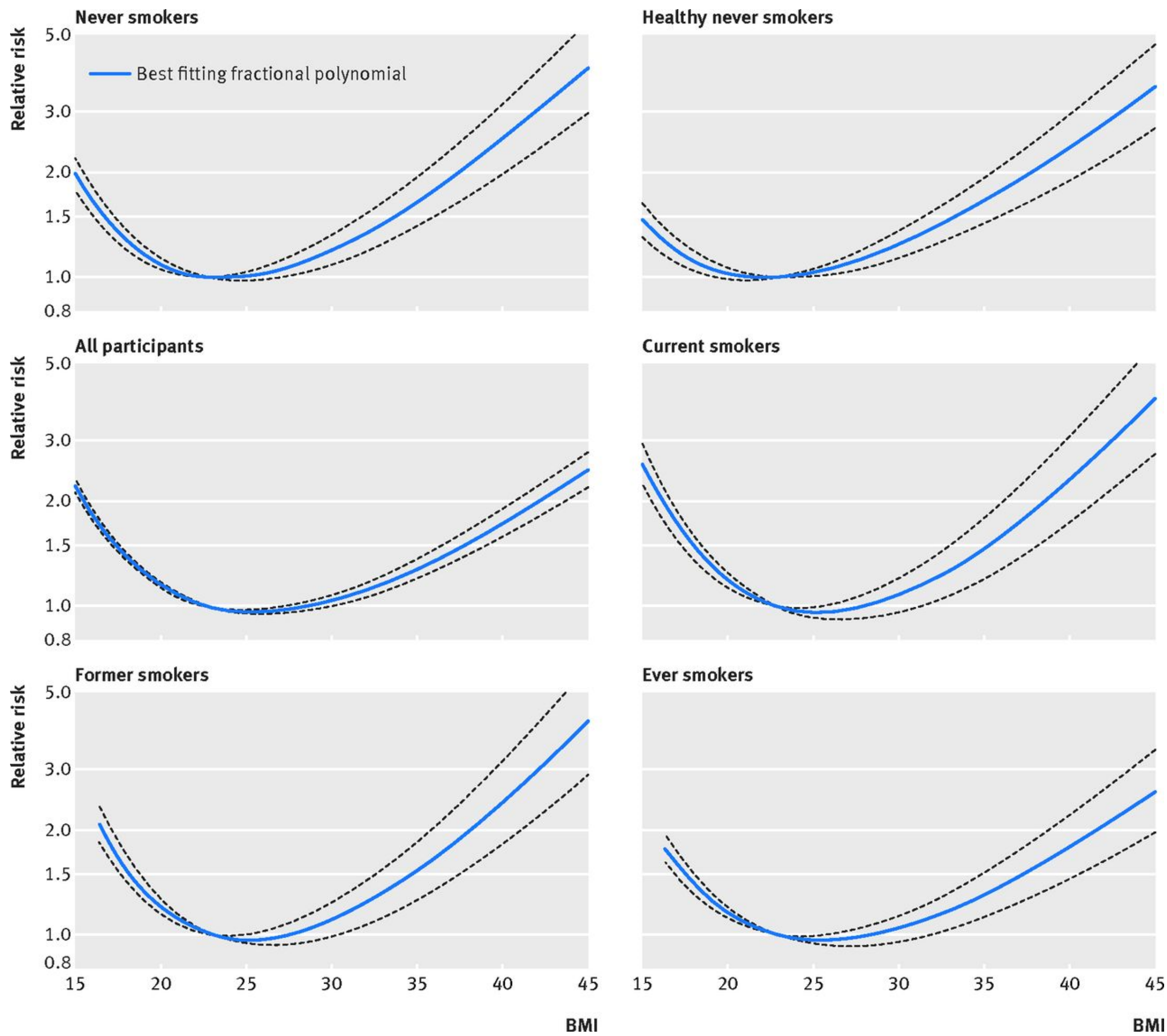


Figure 1. Non-linear dose-analysis of BMI and all-cause mortality among never smokers, healthy never smokers, all participants, current smokers, former smokers, ever smokers. (see Anue et al., 2016).

2.4.1.2 BMI as a cue to fertility health

Apart from the adverse impacts on cardiovascular health, BMI is also highly related to fertility health. A US national longitudinal research has found that both obesity and underweight are associated with lower fertility (Jokela, Elovainio, & Kivimäki, 2008). This study showed that obese men and women are less likely to have their first child by the age of 47 and have more than one child compared to their normal weight counterparts. Although this relationship could be partly explained by the social factor that obese people and underweight men have a lower probability of getting married, there is evidence suggesting that the deleterious effect of BMI on fertility is mainly due to its biological effect (see below) on reproductive functioning.

In men, obesity is closely linked to a reduction in male sex hormone testosterone as adipose cells convert testosterone to female sex hormone oestrogen (Fui, Dupuis, & Grossmann, 2014; Pasquali, 2006). Consequently, obese men usually have lower testosterone levels but higher oestrogen levels compared to normal-weight men (Fui et al., 2014; Hammoud, Gibson, Peterson, Meikle, & Carrell, 2008; Pasquali, 2006). Since testosterone plays a vital role in the production of sperm, obesity could lead to subfertility or infertility in men due to reduced sperm count (Du Plessis, Cabler, McAlister, Sabanegh, & Agarwal, 2010). Apart from that, some studies have shown a negative relationship between obesity and sperm mobility and normality (Fejes et al., 2006; Hofny et al., 2010; Jensen et al., 2004; Kort et al., 2006). Note that underweight men also have lower sperm concentration and total sperm count compared to normal weight men although semen volume and percentage of motile sperm was not affected by low BMI (Jensen et al., 2004). Nevertheless, a meta-analysis in 2009 concluded that there was no strong evidence suggesting that BMI influences sperm concentration or total sperm count (MacDonald, Herbison, Showell, & Farquhar, 2009). Despite the inconsistency in results of studies examining the relationship between obesity and semen parameters, it is clear that obesity is associated with infertility in men, which might be partly due to erectile dysfunction (Andersson, Ekström, & Lehtihet, 2015; Bacon et al., 2006; Du Plessis et al., 2010; Hammoud et al., 2008; Knoblovits et al., 2010).

The impact of obesity on female fertility is well documented. Considerable evidence shows that obesity is positively associated with the rate of miscarriage regardless of the mode of conception. A meta-analysis revealed that obese women have higher odds of miscarriage when conceived naturally or following oocyte donation (Metwally, Ong, Ledger, & Li, 2008). A similar trend is present in patients conceived following ovulation induction, and the risk of recurrent miscarriage is higher in obese women than their normal-BMI counterparts (Lashen, Fear, & Sturdee, 2004). The deleterious effect of obesity is not limited to conception. Obesity is positively linked to birth defects. One meta-analysis showed that obesity increases the risk of neural tube defects (Rasmussen, Chu, Kim, Schmid, & Lau, 2008). A further meta-analysis revealed increased risks of anencephaly, spina bifida, cardiac spetal anomalies l, hydrocephaly, etc. in babies of obese women (Stothard, Tennant, Bell, & Rankin, 2009). Furthermore, obesity was found to be linked to polycystic ovarian syndrome, which could lead to irregular periods, excess androgen levels, and polycystic ovaries, consequently causing fertility problems (Barber, McCarthy, Wass, & Franks, 2006; Lim, Norman, Davies, & Moran, 2013; Vrbikova & Hainer, 2009).

Nonetheless, it should be kept in mind that excessive thinness is harmful to fertility as well. Numerous evidence has revealed that being underweight, excessive weight loss, and excessive exercise are common causes of menstrual dysfunctions like amenorrhoea in the West (Frisch, 1987; 2004; Stokić, Srdić, & Barak, 2005; Støving, Hangaard, Hansen-Nord, & Hagen, 1999). Women who have low BMI (e.g. BMI <19/20) like athletes and those having eating disorders are more likely to develop amenorrhoea, which is due to endocrine alterations, such as lowered oestrogen levels (Ackerman & Misra, 2018; Hamilton-Fairley & Taylor, 2003; Ledger & Skull, 2004; Ziomkiewicz, Ellison, Lipson, Thune, & Jasienska, 2008). When putting on weight, resumes of menstrual cycles were observed (Ackerman & Misra, 2018; Arends, Cheung, Barrack, & Nattiv, 2012; Swenne, 2004).

Taken together, BMI has a profound influence on both general health and fertility health both in women and in men. Undoubtedly, a normal BMI (e.g. 18.5-24.99) is essential for living healthily and successful reproduction. Thus, candidates with normal BMI are at a better position in both intrasexual selection and intersexual selection.

2.4.2 BMI as a cue to perceptual sexual dimorphism

Sexual dimorphism refers to the sex differences in characteristics of the same species. In humans, sexual dimorphism typically occurs at puberty (Wells, 2007). Puberty is marked by a rapid development in body size, shape, composition, all of which varies significantly between males and females. Most importantly, puberty is the period when girls and boys mature sexually under the influence of sex hormones (predominantly testosterone in males and oestrogen in females). Consequently, only after puberty, males and females are able to produce offspring. Obviously, mating with sexually immature conspecifics would not result in reproduction. Since puberty is marked by various changes in bodies that are different in men and women, most if not all sexual dimorphic features are expected to signal sexual maturity. Hence, sexual dimorphic traits should be highly valued as it signals one's ability to reproduce. Indeed, there is considerable evidence supporting this hypothesis.

No matter objectively measuring femininity or experimentally manipulating femininity in female faces, feminine female faces are rated higher in attractiveness (Jones & Hill, 1993; Perrett et al., 1998). Although the finding on women's preference for masculine male faces is relatively mixed, with some reporting that masculine male faces are attractive to women (DeBruine et al., 2006; DeBruine, Jones, Smith, & Little, 2010; Holzleitner &

Perrett, 2017) and others report feminine male faces are attractive (Penton-Voak et al., 1999; Perrett et al., 1998; Welling, Jones, & DeBruine, 2008), masculine body features like muscularity, low waist to chest ratio do contribute to attractiveness in men (Frederick & Haselton, 2007; Tovée, Maisey, Vale, & Cornelissen, 1999).

Sex difference in body size is subtle in infancy, with males are about 1% longer than females at birth (Rodriguez et al., 2005). During childhood, the body size difference remains relatively stable until the onset of puberty (Rogol, Roemmich, & Clark, 2002). When individuals enter puberty, the increase in fat free mass is greater in males than females and usually last for a longer duration, with fat free mass reaching the peak in men at 19 to 20 years old and women at 15 to 16 years old (Malina, Bouchard, & Bar-Or, 2004). Although women also accrue fat mass during puberty, the long-lasting period of muscle growth in men results in a sex difference in body weight (Malina et al., 2004; Siervogel et al., 2003; Wells, 2007). As men also tend to gain more height than women during puberty, the body size or BMI end up not being sexually dimorphic (Malina et al., 2004; Siervogel et al., 2003; Wells, 2007). Despite the world-wide BMI data (WHO, 2016) suggest that there is no consistent sex difference in BMI, humans tend to overgeneralize weight to BMI. For example, perceptual studies revealed that people tend to perceive heavier looking male faces as more masculine than thinner looking male faces (Holzleitner et al., 2014; Phalane, Tribe, Steel, Cholo, & Coetzee, 2017). Given the impact of BMI on the perception of sexual dimorphism, one might expect an influence of BMI on the perception of attractiveness.

To date, a great number of studies have investigated the most attractive female body figures across different populations. The associated BMI of most attractive female bodies is lowest in Asians. For example, this figure is 18.43 among Japanese participants (Swami, Caprario, et al., 2006) and 17.28 among Malaysian Chinese participants (Stephen & Perera, 2014). In comparison, Western populations prefer a higher BMI for attractiveness. For instance, the BMI of most attractive female bodies is 20.97 among British participants, 20.11 among Spanish participants, and 19.51 among Portuguese participants (Swami, Neto, Tovée, & Furnham, 2007). In contrast to a relatively lower BMI being attractive in females, the most attractive male body is associated with a higher BMI. Swami, Smith et al. (2007) reported that male body representing a BMI of 21.34 is perceived to be most attractive in Greek and 23.07 in British. When presented with interactive 3D program, Caucasians set an even higher BMI value for attractiveness in male bodies (24.5 set by women and 25.9 set by men) (Crossley, Cornelissen, & Tovée, 2012). Hence, it is clear that attractiveness is associated with a higher BMI in male than female bodies, thus consistent with the assumption that BMI affects the perception of attractiveness through its' relationship with perceived sexual dimorphism.

2.4.3 BMI as a cue to strength

Evolutionary psychologists argue that women's mate preferences are shaped by both the need to secure good genes and investments from their mate (Buss & Schmitt, 1993; Thornhill & Gangestad, 2003). In the ancestral environment, men's ability to obtain resources depends on their competitiveness, which is argued to be based on their strength (Sell, Tooby, & Cosmides, 2009). Sell and colleagues (2009) found that men with greater strength are more likely to engage in fighting, favour the use of force in conflicts, and have greater success in conflicts than weaker men. Given that, men's attractiveness should be tightly linked to features indicate strength or formidability. Indeed, there is evidence to support this contention. For example, it has been shown that correlates of upper body strength (e.g. broader shoulders, greater handgrip strength) are attractive in men (Fan, Dai, Liu, & Wu, 2005; Fink, Neave, & Seydel, 2007; Furnham & Nordling, 1998; Sell, Lukazsweski, & Townsley, 2017). Furthermore, stronger men (measured by handgrip strength) also self-report that they are more attractive and have greater mating success (Gallup, White, & Gallup, 2007; Hill et al., 2013; Sneade & Furnham, 2016). When asked what features women are attracted to in men, cues to upper body strength were highly valued by women (Franzoi & Herzog, 1987).

Extensive studies have shown that (handgrip) strength is positively related to BMI (Balogun, Akinloye, & Adenlola, 1991; Fink, Weege, Manning, & Trivers, 2014; Sartorio, Lafortuna, Pogliaghi, & Trecate, 2002). Complementing this, Holzleitner and Perrett (2016) reported that even facial correlates of BMI predict both actual and perceived strength. Therefore, one reason that BMI contributes to male attractiveness may be partly because of its association with strength.

In addition to the benefits of securing resources from stronger men, women might also be attracted to strong men due to the protection stronger men are able to provide. Due to the large body size difference between men and women, an average man is stronger than 99.9% women (Lassek & Gaulin, 2009), which puts women in a potentially dangerous position. Women are more likely to be the victim of sexual coercion than men. Consequently, women may be attracted to men who could protect them from dangerous situations.

Several studies suggested that formidable men are appealing to women, especially under dangerous situations. For instance, women in the US placed higher values on men's trait of formidability when they felt at higher risk of being the victim of a crime (Snyder et al., 2011). Similarly, when women walk through crime spots, they display a higher preference for formidability than walking through safe spots (Ryder, Maltby, Rai, Jones, & Flowe, 2016). When asked to rate the importance of different traits in a partner, women rate the ability to provide protection as the most important trait (Buss & Schmitt, 1993; Greiling & Buss, 2000). Nevertheless, it should be kept in mind that the preference for formidability probably occurs only when women feel the danger is from public as shown in the aforementioned studies. When domestic violence is taken into consideration, the results are completely different. Borras-Guevara, Batres, and Perrett (2019) reported that women who have higher perceptions of domestic violence show lower preferences for facial cues to BMI. The link between BMI and strength may make it a reliable cue of mate value in men because BMI indicates men's ability to obtain resources and provide protection, both of which are of particular importance to women.

2.5 More than BMI—Body composition

The effect of BMI on physical attractiveness is well studied partly due to the simplicity of the BMI measure, however, it should be noted that BMI obscures information about body composition. Bodyweight reflects two components: fat mass and fat-free mass or muscle mass. Given the same BMI, individuals might have different body composition. For example, men on average have approximately 61% more muscle mass than women (Lassek & Gaulin, 2009). Specifically, men have 75% more muscle mass in arms and 50% more muscle in legs than women, which unsurprisingly translates into greater upper and lower body strength (Lassek & Gaulin, 2009). The substantial sex differences in body composition imply that the mate value of BMI is differently linked to fat and muscle.

Firstly, it is clear that levels of body fat have a significant effect on women's fertility. A certain amount of fat stores (~22% body fat) is necessary to maintain normal period, get pregnancy, and lactation (Frisch, 1987; 2004; Stokić et al., 2005). For example, it has been documented that female athletes, a population who have very low body fat, are more likely to experience fertility-related problems like amenorrhoea, anovulation, irregular menstrual cycle, and delayed menarche compared to normal weight females (Klentrou & Plyley, 2003; Redman & Loucks, 2005; Torstveit & Sundgot-Borgen, 2005; Zanker, 2006). Interestingly, the association between fatness and fertility in women may start at birth. Women who were born as babies with high levels of fat do not exhibit ovarian suppression in response to physical activity and have higher oestrogen levels at adulthood, in contrast to women born as babies with low levels of fat (Jasienska, Thune, & Ellison, 2006). Although low body fat does not cause infertility directly, the strong correlation between body fat and oestrogen levels make body fat a good indicator of female fertility (Ziomkiewicz et al., 2008).

Secondly, fat and muscle are linked to general health in the opposite direction. Specifically, higher body fat is the cause of multiple diseases (e.g. diabetes, see 2.4.1.1), but more muscle is associated with enhanced fitness and health. Furthermore, despite BMI being positively correlated with strength, body composition may be a better predictor of strength. When controlling for BMI, muscle mass positively predicts strength, while fat mass negatively predicts strength (Holzleitner & Perrett, 2016; Sartorio et al., 2002). Thus, given the same BMI, men with more muscle should be stronger than men with higher fat mass.

The distinct mate value of fat and muscle suggest that they might have a different relationship to physical attractiveness. In fact, evidence is mounting that muscularity or cues to muscularity plays an important role in male attractiveness. For example, cues of muscularity like larger chest in relation to waist (chest to waist ratio) are the primary determinant of male attractiveness and is more important than BMI (Swami, Smith et al., 2007; Tovée, Maisey, Vale, & Cornelissen, 1999). Moreover, several studies have shown that muscular men (Dixson, Halliwell, East, Wignarajah, & Anderson, 2003; Frederick & Haselton, 2007), men have higher chest to waist ratio (Swami, Smith, et al., 2007; Tovée, Maisey, Vale, & Cornelissen, 1999), and men have greater upper body strength (Sell et al., 2017) are more appealing to women. Complementing that, muscular men (Frederick & Haselton, 2007), stronger and physically fit men (Gallup et al., 2007), and athletes (Faurie, Pontier, & Raymond, 2004) report to have a greater number of sexual partners compared to less muscular, weaker and nonathletic counterparts. Complementing this finding, Apicella (2014) presented evidence that upper-body strength is the strongest predictor of men's hunting reputation in Hadza hunter-gatherer society. Most importantly, men with stronger upper-bodies report experiencing greater reproductive success compared to weaker men, which is mediated by hunting reputation (Apicella, 2014).

Similar to the effect of muscle on male attractiveness, body fat was found to be more important than BMI in female attractiveness (Faries & Bartholomew, 2012). Note that unlike the positive relationship between muscle and male attractiveness, the relationship between fat and women's attractiveness is negative with higher body fat levels associated with reduced attractiveness. In Faries and Bartholomew's (2012) study, body fat percentage explained 75.6% variance of female attractiveness and BMI explained 70.4%. Furthermore, when body fat percentage (hereafter Fat%) and BMI were analysed together in the regression model, body fat percentage remained as a significant predictor of female attractiveness while BMI was not.

Previously, much effort has been put into the investigation of the importance and influence of BMI on physical attractiveness. The literature discussed above show that body composition is related to mate value in men and women, thus, should be investigated separately in future studies.

2.6 Summary

In general, evolutionary psychology emphasises the force that sexual selection plays in shaping individuals' perception of attractiveness. From an evolutionary perspective, mate preferences or the perception of attractiveness evolved as a result of sexual selection, which preserves traits that improve reproductive success. BMI is found to be one of those traits, which might be a particularly crucial if not primary determinant of attractiveness. It is possibly because BMI provides cues to general and fertility health, sexual maturity, and strength, which all contribute to reproduction success.

It should be noted that although evolutionary psychology places greater importance on the origin of our preferences and suggests a cross-cultural similarity in the perception of attractiveness, it does not mean mate preferences will be universally agreed. Rather, evolutionary theory argues that the variations that exist in mate preferences should be adapted to local environments. For instance, DeBruine, Jones, Crawford, et al. (2010) found that cross-cultural variation in masculinity preference is predicted by nation's health. In areas where poor health is a primary threat, women have stronger preferences for male facial masculinity. The negative relationship between health and preference for masculinity was found to be independent of cross-cultural differences in wealth and women's mating strategies. Likewise, the cross-cultural variation in preference for BMI is predicted by socioeconomic status (Swami, 2015). Preference for thinner bodies is prevalent in developed countries, perhaps because obesity is the main cause of many diseases. On the contrary, plumpness is desired in undeveloped areas because food insecurity and malnutrition is the cause of multiple diseases and death. These variations in preferences should not be seen as evidence against evolutionary psychology theory but are good examples of adaptations to local environments.

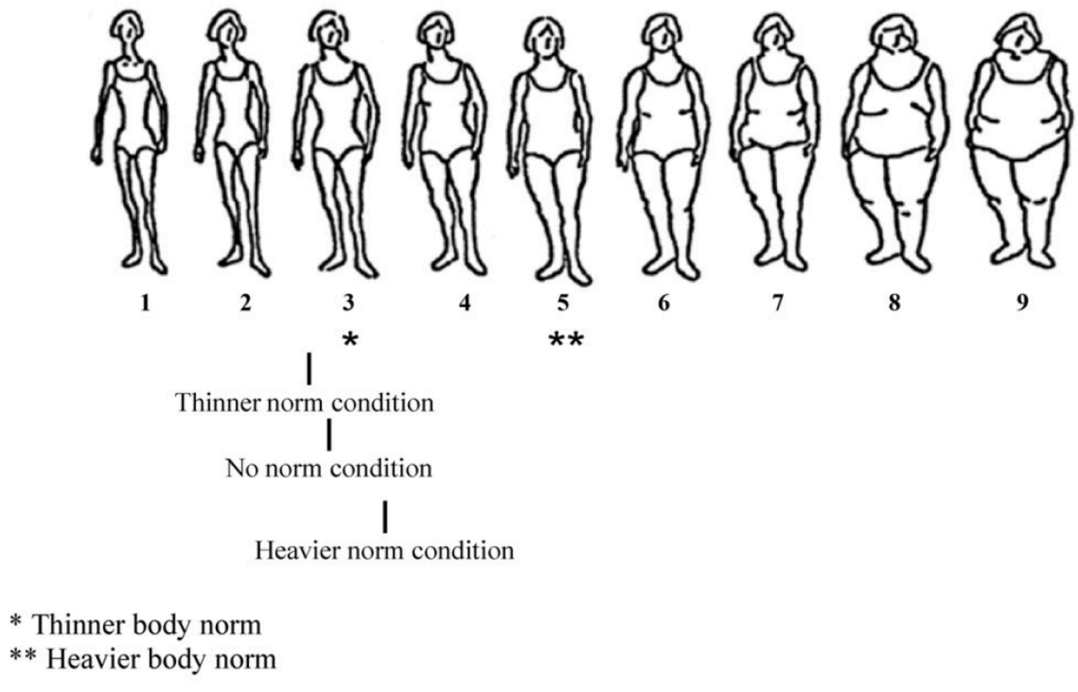
Of course, it is wrong to interpret modern human's mate preferences fully as a result of sexual selection. Evolutionary psychological theory only provides a way of thinking why we are attracted to certain features cross-culturally. It cannot explain all the mate preferences over the world or those that existed for a short period only. For example, Dayak women would blacken their teeth, Karen Padaung women would lengthen their necks, and Kikuyu men would lengthen their earlobes in order to make themselves beautiful according to the standards of their culture (Perrett, 2010). These extreme beauty standards seem like they have nothing to do with adaptations or reproductive success and are adopted within particular cultures. Hence, they can hardly be interpreted from an evolutionary perspective. That is where sociocultural perspective come in. The next chapter will discuss the perception of attractiveness from a sociocultural perspective.

Chapter 3 A sociocultural perspective on physical attractiveness

3.1 The influence of norms

Human behaviour is often strongly influenced by the perceptions of social norms (Lapinski & Rimal, 2005). Generally speaking, social norms refers to what is seen as normal within a given society. The construct of social norms has been divided into two types, injunctive norms and descriptive norms (Cialdini, Reno, & Kallgren, 1990). Injunctive norms refer to the perception of other's approval or disapproval, in other words, what ought to be or ought not to be done (e.g. women should control weight to be thin). Descriptive norms refer to what is actually done or believed by the majority (e.g. most people think thin is attractive). Individuals, however, do not always have accurate perceptions of descriptive norms or injunctive norms, especially in health-related behaviour, which in turn lead to engagement in unhealthy behaviour to meet their perceived social norms. For example, research examining drinking have consistently found that college students who perceive the majority others drink heavily (descriptive norms) are more likely to report heavier drinking themselves (Halim, Hasking, & Allen, 2012; Kypri & Langley, 2003; Lee, Geisner, Lewis, Neighbors, & Larimer, 2007; Neighbors, Dillard, Lewis, Bergstrom, & Neil, 2006). Furthermore, many studies have revealed a positive relationship between friend's or parent's approval of drinking (injunctive norms) and alcohol consumption among college students (Knee & Neighbors, 2002; LaBrie, Hummer, Neighbors, & Larimer, 2010; Lee et al., 2007; Neighbors et al., 2010). Apart from the well-documented effect on drinking, extensive research has demonstrated the significance of social norms across many health-related behaviours, such as smoking tobacco (Pischke et al., 2015), smoking cannabis (Dempsey et al., 2016), gambling (Larimer & Neighbors, 2003), disordered eating (Bergstrom, Neighbors, & Lewis, 2004), unsafe driving (Carter, Bingham, Zakrajsek, Shope, & Sayer, 2014), and risky sexual behaviours (McAlaney & Jenkins, 2017).

Given the strong influence of perceived norms on many domains, it is no surprise that perceived norms have an impact on the perception of physical attractiveness. Mills, Jadd, and Key (2012) for example, found that body size ideals change with the experimentally manipulated perceived norms of body size. Female participants were divided into three conditions (see Figure 2): thin norm condition (a thin figure was labelled as population average); heavy norm condition (a heavy figure was labelled as population average); no norm condition (no population average was indicated). Participants were showed a range of body silhouettes varying in body size and asked to indicate their ideal figure after viewing the "population average" figures. Women in the thin norm condition chose significantly thinner figures as ideal than women in the heavy norm condition, and vice versa for women in the heavy norm condition. In addition, the researchers divided male participants into three conditions (see Figure 3): less muscular condition, no norm condition, and more muscular condition. After viewing the “population average figures”, male participants were presented with a range of body silhouettes varying in muscularity and asked to indicate their ideal figure. Likewise, men selected more muscular figure as ideal in the more muscular norm condition compared to men in the less muscular condition. Also noteworthy is that the ideal figure was thinner than the “average” in the heavier norm condition for women and more muscular than the “average” in the less muscular norm condition. This might be because the priming of norms is contradictory to individuals beliefs about beauty. As the thinness female body ideal and muscularity male body ideal is so pervasive in media saturated environments, priming of knowledge that is contrary to general beliefs may not take effect in a short-term. These findings imply that the perception of normal body size may involve in shaping the attractiveness perception. Yet, this study did not test whether the training phase (i.e. priming



of the norms of body size) did cause differences in the perceived normal body size between the three groups. Thus, it is not safe to conclude that the different body size ideals are due to various perceived norms although it is possible. Moreover, the methods of this study may confound an exposure effect, which is also found to play a significant role in shaping individuals’ perception of attractiveness (see 3.3.2 for detailed discussions of the exposure effect).

Figure 2. Ideal female body size as a function of stated body norms (Mills, Jadd, & Key, 2012).

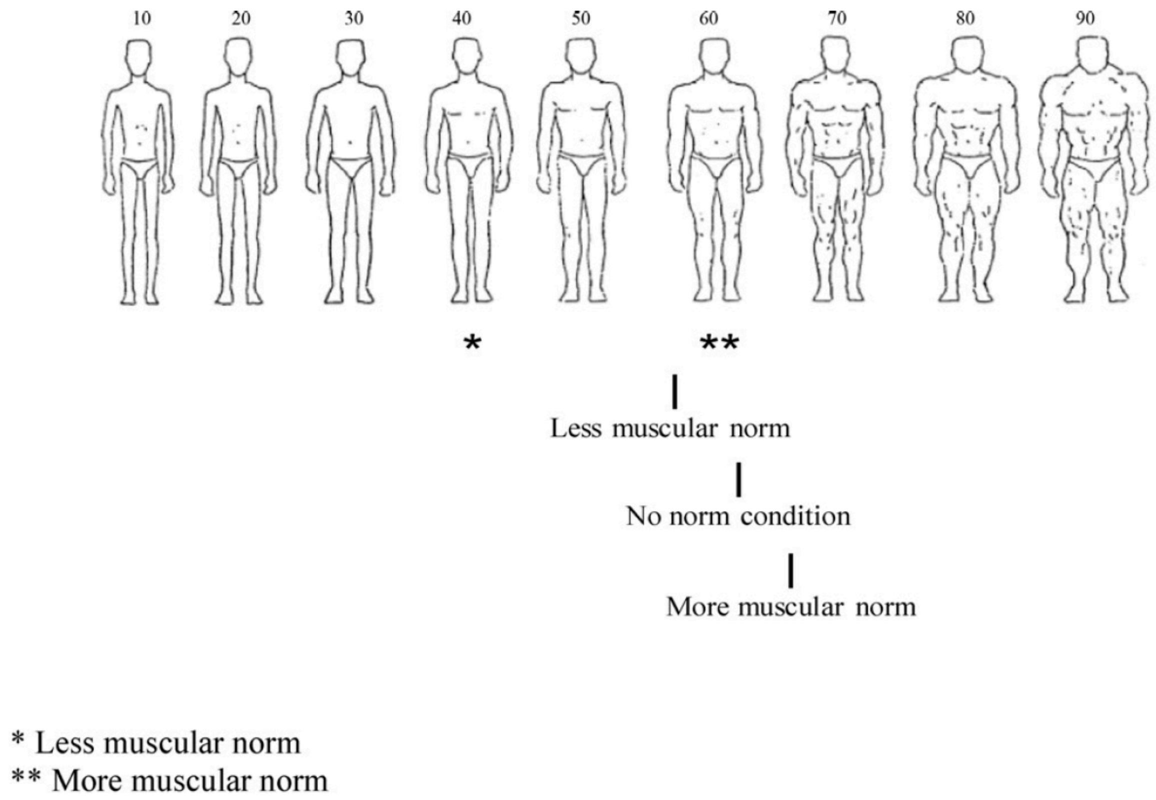


Figure 3. Ideal male body size as a function of stated body norms (Mills, Jadd, & Key, 2012).

Perhaps, the most direct evidence of the causal relationship between perceived social norms and the perception of attractiveness comes from work employing social norms approach as an intervention for body image disturbance. A typical example of this work is research investigating the effect of media literacy on body image. Media literacy generally refers to the ability to think critically about the realism and validity of the messages and content that media conveys (Bergsma & Carney, 2008). Specifically, this approach works through three mechanisms: being sceptical about the realism of media content, being sceptical of the compatibility with personal experience, and thinking critically about the intention of media messages (Rodgers, McLean, & Paxton, 2018). Thus, high media literacy may buffer the pervasive impact of media on body image (Bergsma & Carney, 2008).

In a systematic review, McLean, Paxton, and Wertheim (2016) concluded that there is partial support for the protective role of media literacy on positive body image. Cross-sectional studies that measured participants' media literacy ability and body image concerns with scales revealed a negative relationship between these two, although contrary and null results were reported too (McLean, Paxton, & Wertheim, 2016). The more sceptical of the reality of media messages, the low body concerns, thin-ideal internalisation and upward appearance comparison were reported. Likewise, intervention studies that improved individual's media literacy skills through media literacy-based programs also proved to be effective in reducing body dissatisfaction, thin-ideal internalisation, and drive for thinness. These findings, thus, imply that perceived social norms do have an impact on the perception of attractive body figures.

3.2 Stereotypes and overgeneralisation

Prejudice against overweight and obese people is evident in many areas of our social life, such as health treatment, employment, education, and interpersonal relationships (Puhl & Heuer, 2009). The most frequent sources of prejudice come from parents, friends, and health professionals (Puhl & Brownell, 2006). Often, obese people are believed to be lazy, unintelligent, less competent, non-compliant, and lack of self-discipline (Puhl & Brownell, 2001; Puhl & Heuer, 2009). These weight stereotypes might be an overgeneralisation of the positive relationship between sedentary lifestyle and overeating to body weight (Martínez-González et al., 1999; Ruhm, 2012; Tremblay, Colley, Saunders, Healy, & Owen, 2010). In fact, some studies have demonstrated that it is generally believed that obese people should be responsible for their own weight. Crandall (1994) tried to change the common opinion that weight is controllable by showing twin-studies of the genetic effects on weight, a reduction in anti-fat attitudes were actually observed after the training phase. Likewise, when the positive link between perceived controllability and obesity were experimentally enhanced, people show an increased weight bias (Carels et al., 2013; Teachman, Gapinski, Brownell, Rawlins, & Jeyaram, 2003).

Surprisingly, the increasing obesity rate is accompanied by the popularity of weight stigma in recent years. For instance, a recent study of weight stigma prevalence in the US demonstrated a dramatic increase in weight stigma by 66% from 1995-1996 to 2004-2006 (Andreyeva, Puhl, & Brownell, 2008). Moreover, these weight-related stereotypes are rarely challenged or even socially acceptable in Western cultures (Puhl & Heuer, 2009). Therefore, stereotypes can have a great influence on perceptions of body size.

A well-documented setting where weight stigma is often seen is employment. Evidence is mounting that weight discrimination and stigma occurs at every stage of the employment setting. A qualitative review revealed a weight bias in multiple areas in the workplace (Giel, Thiel, Teufel, Mayer, & Zipfel, 2010). First of all, overweight and obese people face a higher barrier of employment. Experimental studies demonstrated that overweight or obese people are less likely to be offered a position when other qualifications being equal with normal weight applicants (Bartels & Nordstrom, 2013; Flint & Snook, 2014; Flint et al., 2016). Indeed, many surveys have confirmed weight discrimination in the hiring process in the real world. It was found that an increase in BMI is associated with lower rates of employment (Klarenbach, Padwal, Chuck, & Jacobs, 2006; Morris, 2007; Tunceli, Li, & Williams, 2006). Moreover, the discrimination is more pronounced in obese women when applying jobs compared to obese men (Bartels & Nordstrom, 2013; Morris, 2007). Apart from that, obese people also face barriers of certain professions as both obese men and women were underrepresented in management and technology-related positions (Pagan & Davila, 1997). Furthermore, overweight and obese people are treated unfairly during their employment. For example, one study found that obese people in the US are paid 0.7%-6.3% less than normal weight people, and this effect is larger in obese female individuals (Baum & Ford, 2004; Pagan & Davila, 1997). The same adverse effect was observed across many European countries also (Brunello & d'Hombres, 2007; Sargent & Blanchflower, 1994; Sarlio-Lähteenkorva & Lahelma, 1999). Unsurprisingly, obese people reported that they experience prejudice and weight stigma (i.e. being the target of jokes, got insulting comments) from their colleagues, employers or supervisors (Puhl & Brownell, 2006). The unfair treatments or discrimination might result from the weight-related stereotypes, such as obese people are less productive, less competent, less motivated, less intelligent, less reliable, disorganized, lazy, and so on (Giel et al., 2010).

Since overweight or obese people are perceived as unintelligent and lazy, it is not surprising to find weight discrimination in educational settings. Several national surveys revealed that obese people had lower educational attainment than normal-weight people, even after adjustment for intelligence and parental socioeconomic position (Karnehed, Rasmussen, Hemmingsson, & Tynelius, 2006; Wardle, Waller, & Jarvis, 2002). The negative association between obesity and education achievement might be due to weight bias from educators, which in turn influence students' performance (Raudenbush, 1984). For example, some studies have found that teachers hold anti-fat attitudes and negative weight stereotypes towards obese students (Neumark-Sztainer, Story, & Harris, 1999; Price, Desmond, & Stelzer, 1987). Complementing this, a longitudinal study demonstrated that children's weight is negatively associated with teachers' assessment of students' academic performance, although their test scores do not significantly differ from normal weight students (MacCann & Roberts, 2013; Zavodny, 2013).

In fact, the most common sources of weight bias obese people experience are from interpersonal relationships. For instance, both experimental and correlational studies have shown that obese people are less likely to be chosen as sexual partners than normal weight or underweight people, even compared to people with drug problems, mental illness or sexually transmitted diseases (Chen & Brown, 2005; Sitton & Blanchard, 1995; Smith, Schmoll, Konik, & Oberlander, 2007). Perhaps the most shocking finding is that obese people report that the most common sources of weight stigma is from their family members (Puhl & Brownell, 2006). Half obese people report experience weight stigma from their parents. Additionally, friends and spouse are another common source of weight bias (reported by 60% and 47% participants, respectively) (Puhl & Brownell, 2006).

Although a negative weight bias has been extensively documented in adults, there is also a growing literature suggesting that children are another source of weight bias. It was documented that as early as age 3, children are more likely to associate negative characteristics (i.e. mean, stupid, ugly, and lazy) with overweight or obese people (Cramer & Steinwert, 1998; Spiel, Paxton, & Yager, 2012). By contrast, positive traits are attributed to thin and normal-weight people. Unfortunately, the weight bias persists throughout childhood and worsens during adolescence. For instance, one large sample study of 1555 adolescents revealed that 84% participants reported seeing overweight students being teased, and about 65% to 77% observed overweight students being avoided, ignored and excluded from social activities (Puhl, Luedicke, & Heuer, 2011).

While most studies focused on the prevalence and consequences of weight bias, few explored the origin of weight bias. Existing evidence suggests that mothers' attitudes might play a significant role in children's weight stigma development. For example, one study showed that mother's anti-fat attitudes but not fathers' attitudes were related to adolescent dislike of overweight people (O'Bryan, Fishbein, & Ritchey, 2004). Also, mothers' fear of fat (i.e. fear of becoming fat) predicts children's anti-fat attitudes (Holub, Tan, & Patel, 2011). Indeed, a meta-analysis demonstrated that parent's and children's intergroup attitudes are related throughout childhood and adolescence (Degner & Dalege, 2013).

Apart from maternal attitudes, media is very likely to be another agent that transmit weight stereotypes. Compared to thin characters, heavier characters are more likely to be portrayed as the targets of humour and ridicule (Greenberg, Eastin, Hofschire, Lachlan, & Brownell, 2003; White, Brown, & Ginsburg, 1999). The same trend is observed in children's television programs. For example, a content analysis of 4000 cartoon characters showed that socially desirable traits were often associated with thinness, and negative traits were associated with overweight and obese status (Klein & Shiffman, 2005). These presentations, in turn, reinforce negative weight bias. Research showed that media consumption in first to third-grade children and adolescents was correlated to anti-fat attitudes (Harrison, 2000a; Latner, Rosewall, & Simmonds, 2007).

From an evolutionary perspective, stereotypes are pervasive because they help make decisions in an efficient way. Stereotypes are categorized information, thus are simple and easy to retrieve (Tajfel, 2001), which in turn, enable individuals to react quickly. Most importantly, the pervasiveness of stereotypes is psychologically adaptive as it causes people to socialize discriminately (Kurzban & Leary, 2001). Since conspecifics represent both potentially fitness costs and opportunities, discriminating social interactions are particularly essential for survival. Imagining a conflict with a physically strong guy, individuals might save his/her life by avoiding a fight with him based on their stereotype that strong men are aggressive. Although the stereotype may not be necessarily right, the benefits of false alarm exceed costs of failure to detect danger most of the time.

With regard to the weight stereotype, a potential explanation for prejudice against overweight people is interacting with overweight people may represent more costs than benefits. Overweight people are believed (stereotypically) to be lazy and lack of self-discipline, which (if true) might make them less reliable and suitable as an ally. Consequently, people show bias towards overweight people to avoid possible costs. Although this explanation has never been tested, there is some indirect evidence supporting this possibility. As mentioned before, when the assumption that overweight is due to lack of control was changed experimentally, anti-fat attitudes reduced (Crandall, 1994). In fact, several other studies have demonstrated that the belief that overweight status is due to lack of self-control predicts negative attitudes and attributions towards overweight people (Crandall et al., 2001; Crandall & Moriarty, 1995; DeJong, 1993). These findings suggest that weight bias and discrimination might be due to avoidance of interacting with people who might bring costs in cooperation (i.e. laziness means less likelihood of contribution and hard work). Note that I am not claiming that overweight and obese are indeed lazy, or that they lack of self-discipline and are not hardworking. The findings presented aim at illustrating that people, in general, tend to associate negative characteristics with overweight or obesity, these views are not justified but persist.

Taken together, the influence of weight stereotype is so prevalent and powerful that it is difficult to be unaffected by it. Based on the "attractiveness halo", it is reasonable to deduce that overweight people would not be perceived as attractive because attractiveness is perceptually associated with positive characteristics. While weight stereotype implies a negative link between attractiveness and weight, it does not tell what the most attractive weight status is. The following section will discuss the putatively most powerful impact on the perception of attractiveness.

3.3 The impact of media

Mass media is regarded as one of the sociocultural agents (parental pressure, peer comparison) that transmit beauty ideals, and perhaps the most influential factor as it labels the beauty ideal as the sociocultural standard (Heinberg, 1996; Swami, 2015; Thompson & Heinberg, 1999). A considerable amount of research has revealed the effect of media exposure on body ideals in both women and men, adults, adolescents and children (Barlett, Vowels, & Saucier, 2008; Fardouly & Vartanian, 2016; Grabe, Ward, & Hyde, 2008; Harrison & Hefner, 2006; Slater & Tiggemann, 2014, 2015; Tiggemann & Zaccardo, 2015). To be specific, female body ideal is characterised by thinness (Diedrichs & Lee, 2011; Fouts & Burggraf, 2000; Grabe et al., 2008), and male body ideal is defined as muscularity (Baghurst, Hollander, Nardella, & Haff, 2006; Boyd & Murnen, 2017; Pope, Phillips, & Olivardia, 2000). It has been found that women portrayed on media have gradually become thinner over the last 50 years (Garner, Garfinkel, Schwartz, & Thompson, 1980; Seifert, 2005). Likewise, men in the media have become more muscular than before (Leit, Gray, & Pope, 2002; Pope, Olivardia, Borowiecki, & Cohane, 2001; Pope et al, 2000). As a result, women have a drive for thinness and men desire more muscular bodies (Kelley, Neufeld, & Musher-Eizenman, 2010; Murnen & Karazsia, 2017; Cramblitt & Pritchard, 2013). The following sections will present evidence for the effect of media on the perception of physical attractiveness and the mechanisms behind it.

3.3.1 Evidence for the impact of media

One source of evidence for the impact of media comes from correlational studies. This kind of study usually uses a questionnaire (e.g. how often do you watch TV/magazine/specific TV program) to measure participants' media consumption and asks participants for their ideal body or choose a body figure (see Figure 2 and 3) that they perceive as most attractive. Apart from that, there are some studies investigating the media influence on the internalisation of media ideals. Internalisation refers to the extent to which individuals accept socially promoted beauty ideals, express a desire to attain the ideals, and engage in behaviours to meet the ideals (Thompson, Heinberg, Altabe, & Tantleff-Dunn, 1999). Within Western society and body image field, internalisation of media ideals often refers to thin-ideal internalisation, which denotes a thin body figure that seen as ideal in women (Schaefer et al., 2015; Thompson et al.,1999). Usually, thin-ideal internalisation is measured with the Sociocultural Attitudes Towards Appearance Questionnaire (SATAQ), which has been proved to be valid and reliable scale across different countries and ethnicities (Cafri, Yamamiya, Brannick, & Thompson, 2005; Calogero, Davis, & Thompson, 2004; Schaefer et al., 2015; Stefanile, Matera, Nerini, & Pisani, 2011; Warren, Gleaves, & Rakhkovskaya, 2013).

In a large cross-cultural study, general Western media exposure (including television, movies, magazines, and music) was found to predict preference for thin female bodies in men and a thin ideal body size in women (Swami et al., 2010). In addition, the results revealed that the largest difference of ideal body size was not among different cultures or nations but between rural and urban populations of the same culture, perhaps due to different levels of media exposure between rural and urban areas. For example, researchers found that Zulu observers moved to the UK showed substantially lower preferences for BMI compared to local Zulu observers (Tovée, Swami, Furnham, & Mangalparsad, 2006). Instead, they showed a preference more similar to British Caucasians, although Zulu migrants preferred female bodies are still larger than native British. The authors explained this preference difference between local Zulu and Zulu migrants as a result of adaptation to the local environment. As fertility and general health is associated with a lower weight in the UK but a higher weight in South Africa, Zulu migrants should change their preference for better survival and reproductive success. Nonetheless, the researchers did not rule out the possibility that frequent exposure to Western media might play a role in changing Zulu migrants' perception of attractiveness. In line with this finding, Swami, Mada, and Tovée (2012) found that Zimbabwean women who had migrated to Britain have greater weight discrepancy between own and ideal bodies compared to their counterparts in Zimbabwe. It was found that the more exposure to Western media, the larger ideal and own weight discrepancy was. These findings appear to support a possible impact of media on the perception of an attractive body, but there might be socio-economic differences between migrants and non-migrants that could confound the media effect.

As Boothroyd and colleagues (2016) noted, migrants might have higher income and socio-economic status than non-migrants, which was found to closely link to body size ideals or preferences (Swami et al., 2010; Swami, 2015). Further, the difference of food availability between the UK and South Africa as well as Zimbabwe might also account for the body size preference difference as there is evidence that hunger can influence preference for female body (Swami & Tovée, 2006). Besides, the act of migration itself might be a result of Western preference, which means the Western preference might have developed before migration but not a result of migration. To minimize these confounds, Boothroyd and colleagues (2016) investigated body size preference in Nicaragua from three sites with different levels of access to media but shared similar environmental and cultural constraints. It was found that people from areas with low TV access selected a larger female body as their most preferred and they were more tolerant of heavier female bodies than their counterparts from areas with high TV access. Individual-level analysis also showed that TV consumption positively predicts a preference for thinner female bodies (Boothroyd et al., 2016). Although the three sites did vary on food availability, further analysis showed that nutritional status does not contribute to explaining variance in female body size preference. Hence, where food availability and media access are confounded, media access is more likely to be the predictor of female body size preference (Jucker et al., 2017). Although this link could not be referred to as a causal effect, focus group discussions suggested that media exposure might cause a preference for slim female bodies as men in high TV access villages made references to Western celebrities when talking about their preferred female figures (Thornborrow et al., 2018).

Noteworthily, the effect of media on the perception of physical attractiveness was also observed in adolescents and children. In an early survey of 548 preadolescent and adolescent girls, 69% reported magazine images have an impact on their body ideal, and frequent magazine readers were two to three times more likely than infrequent readers to internalise media ideals (Field et al., 1999). A recent study of 1087 adolescent girls revealed that the time spent on the internet was positively associated with internalisation of the thin ideal and a drive for thinness (Tiggemann & Slater, 2013). Evidence from seven to nine years old girls further demonstrated the association between media exposure and body size ideals at the time of testing and one year later (Anschutz, Engels, Leeuwe, & Strien, 2009; Anschutz, Engels, & Van Strien, 2012; Moriarty & Harrison, 2008). Complementing these findings, one study showed that Fiji (a traditional society) adolescent girls developed disordered eating attitudes and behaviours after the introduction of TV for three years (Becker, Burwell, Herzog, Hamburg, & Gilman, 2002). Further interviews of this study suggest that eating disorders were indeed due to the desire for looking like the Western characters they saw on TV.

Another common approach to examine the impact of media exposure on attractiveness perception is experimental research. In this type of work, researchers usually pre-select some body images covering a wide range of weight, present these images to participants, then test their perception of attractiveness or normality. It has been consistently shown that after exposure (400ms to unlimited) to a certain shape of bodies, individuals would shift their perception of normality towards the direction of the bodies been presented (Brooks, Mond, Stevenson, & Stephen, 2016; Glauert, Rhodes, Byrne, Fink, & Grammer, 2009; Hummel, Rudolf, Untch, Grabhorn, & Mohr, 2012; Rhodes, Jeffery, Boeing, & Calder, 2013; Winkler & Rhodes, 2005). Specifically, people viewed thinner models would perceive low weight as normal and vice versa for overweight.

The visual adaptation effect also extends to attractiveness perception (Mele, Cazzato, & Urgesi, 2013; Stephen & Perera, 2014; Winkler & Rhodes, 2005). For example, researchers found that after a short exposure to plus-size or lightweight female models, those who viewed light-weight models chose significantly lower weight for attractiveness than those viewed plus-size models (Cornelissen, Bester, Cairns, Tovée, & Cornelissen, 2015; Stephen & Perera, 2014). Likewise, researchers found that the most attractive body participants chose after exposure to thin bodies were thinner than the bodies they chose before exposure and vice versa after when exposed to large bodies (Boothroyd, Tovée, & Pollet, 2012; Winkler & Rhodes, 2005). Furthermore, this result was replicated in a non-WEIRD (Western, Educated, Industrialized, Rich, and Democratic) population who have little access to media, suggesting that the media exposure effect is not limited to Western population and those surrounded by media information (Boothroyd et al., 2019). Although most of the aftereffects were tested immediately after exposure, there is evidence that this aftereffect is actually durable for as long as 24 hours (Carbon et al., 2007). In fact, Leopold, Rhodes, Müller, and Jeffery (2005) have demonstrated that face identity aftereffect gets stronger as the exposure time is extended but becomes weaker as the duration of exposure to test getting longer.

3.3.2 The mechanism of media effect

Some psychologists argue that the effect of media on body image is mediated by the internalisation of the ideals promoted by media (Thompson et al., 1999). Evidence comes from studies investigating the relationship between media exposure and drive for thinness

(Drive for Thinness Scale; Garner, Olmstead, & Polivy, 1983) in women or muscularity (Drive for Muscularity Scale; McCreary & Sasse, 2000) in men. A considerable number of studies have revealed that media exposure positively correlates with a drive for thinness in women or a drive for muscularity in men in both Western and Eastern Asian countries (Harrison, 2000b; Pritchard & Cramblitt, 2014; Rochelle & Hu, 2017; Stice, Spangler & Agras, 2001; Tiggemann, 2006; Tiggemann & Miller, 2010), suggesting that media exposure fosters media ideal internalisation. Although the ideal internalisation is consistently found to account for the relationship between media exposure and body image in both adolescents and adults, two studies on preadolescent girls failed to find the mediation effect of thin-ideal internalisation (Harrison, 2000a; Sands & Wardle, 2003). Instead, peer and parental pressures to conform to social standards predicted body dissatisfaction in 9-12 years old girls (Sands & Wardle, 2003). Harrison and Hefner (2006) ascribed the failure to detect media effect in adolescents to a methodological problem, which failed to measure children's future body ideals. Since the body figures used to measure body ideals are typically adult body shape, it is not appropriate to measure children's current body ideals. By asking preadolescent girls to choose the body figures they want to look when they grow up, researchers found that television viewing predicted preferences for thin female body figures (Harrison & Hefner, 2006).

Another explanation of the media exposure effect is visual 'diet', meaning that the people seen in the surrounding environment plays an important role shaping individuals' perception of normality, which in turn affects attractiveness perception. For example, Batres, Kannan, and Perrett (2017) found that participants from rural El Salvador and Malaysia preferred heavier looking female faces than participants from urban areas of these two countries. They explained it as a result of visual diet. Although the BMIs of the female participants did not differ significantly between rural and urban areas of El Salvador and Malaysia, rural women's faces were rated as looking significantly heavier compared to women from urban areas (Batres, Kannan, & Perrett, 2017). Hence, the preference for higher adiposity in rural El Salvador and Malaysia might reflect the increased experience with faces displaying higher adiposity, even though there is no overall difference in BMI of the rural and urban populations in El Salvador and Malaysia. By the same token, frequent and long-term exposure to media could lead to changes in perception of normality and attractiveness towards media ideals.

Nonetheless, it should be noted that a great deal of research has shown that what is perceived as attractive or what is desired is substantially thinner than what is perceived as normal (Brown & Slaughter, 2011; Glauert et al., 2009; Winkler & Rhodes, 2005). Such studies usually present participants with a range of body images (usually women) varying in BMI or size and ask them to choose one that looks most attractive and normal (i.e. frequently seen in daily life) to them. Results of these studies consistently show that the most attractive female body is thinner than the perceptually most normal body (Brown & Slaughter, 2011; Glauert et al., 2009; Winkler & Rhodes, 2005). This discrepancy was even observed in children as young as seven years old (Pine, 2001; Truby & Paxton, 2002). Hence, although visual diet would result in a shift of perception of normality towards the direction of stimuli, the perception of attractiveness usually goes beyond what is considered to be normal.

Apart from these two explanations, associative learning may also account for the effect of media on an individual's attractiveness perception (Boothroyd et al., 2012). This explanation states that the media influence on attractiveness perception is transmitted via the association between certain body ideals and positive traits. For example, the actors and actresses in movies or TV programs who possess the ideal bodies are usually more attractive than average. As a result, the link between attractiveness and thin-ideal or muscular-ideal may develop. Evidence supporting this explanation comes from two studies trying to break the link between attractiveness and ideal bodies. For instance, researchers pre-selected some fashion model images online, which included faces and covered a wide range of body size. These images were then categorized to four groups based on their body size (light/overweight) and attractiveness ratings (attractive/unattractive). Indeed, in comparison to participants shown overweight unattractive female bodies, participants viewed overweight attractive female bodies (for 5 seconds) showed a reduced preference for thinness (Stephen & Perera, 2014). Similarly, when participants were shown a combination of overweight attractive and underweight unattractive female bodies, participants showed a decreased preference for thinness compared to their preferences before seeing the stimuli (Boothroyd et al., 2012). Hence, the desirability of specific body size or shape might be due to the positive valence associated with it.

3.4 Social role theory

Another sociocultural perspective on mate preferences concerns with the social role theory. According to this theory, men's and women's mate preferences are guided by their expectations for societal gender roles (Zentner & Eagly, 2015). Based on the biological sex differences that men have greater size and strength while women carry the responsibility of gestation and lactation, men and women are expected to perform different roles in everyday life. Men are expected to be responsible for providing resources and protection for families while women are expected to be family oriented (e.g. take care of offspring, do housework) (Eagly, Wood, & Diekman, 2000). These gender roles in turn influence people's behaviour including mate preferences through social norms (Zentner & Eagly, 2015).

According to the gender roles or stereotypes, it is reasonable to assume that men displaying traits of strength and competitiveness would be valued. By contrast women showing traits of good housewife would be preferred. For instance, foot binding in women was popular in ancient China. One folk interpretation of this practice is that it serves as a function of restricting women to home, thus women are much more reliant on their husbands and could spend more time in taking care of family members.

With regard to the preference for body size, a preference for thinness in women and muscularity in men might also reflects the gender stereotypes. As aforementioned, strength and competitiveness are positively correlated with body size and muscularity (Holzleitner & Perrett, 2016; Re & Perrett, 2014), thus, muscular men might be preferred because their appearance is consistent with the masculine gender roles. By contrast, women are not expected to be capable of protecting men, hence, heaviness is not consistent with women's gender roles. Indeed, researchers found that women and men who hold strong sexist beliefs (i.e. acceptance of traditional sex roles: women = home maker, men = bread winner) are more likely to show a preference for thin female bodies and lower tolerance of heavy female bodies (Swami, Coles et al., 2010). This finding suggest that endorsements of gender roles are correlated with (and possibly causal for) preference for thinness in women. Hence the findings are supportive of the social role theory explanation of mate preferences.

3.5 Muscularity as a new beauty standard

For decades, research on body image or physical attractiveness in women has focused on body size or BMI because thinness is usually characterised as the beauty ideal for women (Diedrichs & Lee, 2011; Fouts & Burggraf, 2000; Grabe et al., 2008). Yet a new beauty standard for women emerged recently, with muscular or toned female body seen as attractive (Tiggemann & Zaccardo, 2015, 2018; Uhlmann, Donovan, & Zimmer-Gembeck, 2018). Part of it might be due to the trend "fitspiration" on the Internet. Fitspiration promote women to engage in more exercise and pursue a healthy lifestyle. The outcome of which is a muscular toned and firm body. More recent studies have found that women are not satisfied with a very thin body anymore as they desire a thin and toned but not overly muscular body (Kelley et al., 2010; Uhlmann et al., 2018). Accordingly, research on the perception of physical attractiveness in women should not focus on BMI alone but give more attention to muscularity.

3.6 Summary

Generally, sociocultural theories place greater emphasis on the influence of social factors like social norms, stereotypes, and exposure or experience on the development of attractiveness judgements. Several social agents have been identified responsible for transmitting social standards of beauty like parents, peer and media. In particular, media has received a great deal of attention and is considered the most powerful force. Two mechanisms have been proposed to account for the attractiveness perception development, visual diet and social learning. More importantly, interventions targeting these two mechanisms have provided evidence for the sociocultural influence. For example, by changing an individual’s exposure or perceived social norms, significant changes in body size preferences were observed. Collectively, cross-sectional, prospective, experimental, and interventional studies all yield promising support for the impact of sociocultural factors on the perception of attractive body size.

The scope of the current study

For a long time, researchers tend to focus on either evolutionary or sociocultural perspective of physical attractiveness, little work has tried to integrate the two theories. In their influential study, Langlois et al. (2000) found high agreement of attractiveness judgement across cultures, thus supporting the evolutionary theory as opposed to sociocultural theory. Further, evidence from Swami et al. (2010) large cross-cultural investigation of body size preference appears to provide more support for the evolutionary theory. Nonetheless, it should be noted that many studies have revealed cultural differences in attractiveness perception. Hence, none of the theories alone could explain all aspects of attractiveness perception.

Evolutionary theory may help us understand why certain body size or shape is preferred in many cultures and why attractiveness matters so much in our life. Although evolutionary theory emphasises the importance of fitness and fertility-related traits, it also acknowledges the extent to which certain traits are preferred depends on local environments. As the living environment differs a lot between areas, people from different areas may show different perceptions of attractiveness as a result of adaptations to local environment.

On the other hand, sociocultural theory is helpful in understanding how attractiveness perception is developed and changed. This theory stresses the influence of social groups like society or peer groups. It highlights both implicit and explicit impact that sociocultural factors have on attractiveness perception. Specifically, sociocultural influences work via social norms, stereotypes, and media exposure mechanisms in the development of attractiveness especially body ideals. Importantly, these mechanisms do not merely shape attractiveness perception but also facilitate prejudice against unattractive individuals.

Since both theories do not propose a fixed attractiveness perception, but rather suggest that the perception of attractiveness is flexible, depending on local environments, it is possible to employ both theories to explain findings. For example, the prevalent "thin ideal" is partly due to the prevalence of obesity which damages long-term health. Hence, this preference could be seen as an evolutionary adaptation to the environment. In addition, this "thin ideal" is reinforced by sociocultural factors like media exposure, peer and parent pressure, and prejudice against overweight people. Collectively, the two influences shaped the population's attractiveness perception that thin is beautiful. Hence, the current thesis explains its findings from both perspectives.

The majority of research on body size preference has typically focused on preferences for BMI or facial correlates of BMI. Although BMI is a widely used measurement of body size and might be commonly known, it is not informative in terms of body composition, namely fat and muscle, which are more relevant to health and media ideals. The current thesis therefore aims at investigating preferences for body composition and its facial correlates.

Studies reveal that women desire more muscular men as partners. Interpretation for this preference tends to focus on sociocultural influences like large consumption of media which advocates muscular ideal. Less is explored why muscularity is desirable in the first place. From an evolutionary perspective, muscularity might be preferred because it is a masculine trait which indicates men's gene quality and makes men suitable as a sexual partner. However, less is known about how muscularity is reflected on faces. Study 1 examines how body composition influences the perception of masculinity in male faces.

Based on findings from Study 1, Study 2 further explores women's preferences for facial correlates of body composition. Previous studies investigating men's physical attractiveness mostly focused on BMI or muscularity, but fewer studies examined women's preference for facial correlates of body composition, specifically body fat and muscle separately. Furthermore, evidence is mounting that women have a stronger preference for masculinity in short-term relationship compared to long-term relationships. Hence, Study 2 set out to test women's preference for men's facial correlates of body composition in short- and long-term relationships.

While Study 2 and most prior studies found that women have different mating strategies between relationship contexts, few tested why women show such different preferences. Two theories have been proposed to account for women's mating strategy. The good genes hypothesis argues that women prefer men showing traits indicating good gene quality, especially when choosing a short-term sexual partner. On the other hand, the good parent hypothesis asserts that women prefer men who show willingness to provide paternal care and protection, especially when choosing a long-term partner. Although these two theories are not mutually exclusive, the two theories were usually tested in isolation which made comparisons difficult. In light of these findings and theoretical hypothesis, Study 3 investigates the relationship between men's facial correlates of perceived health and kindness, which were largely used to test the two theories in previous studies.

Research into women's and men's attractiveness tends to focus on preference for the opposite-sex, less is known about whether men and women have accurate perceptions of the opposite-sex desires. From an evolutionary perspective, it is crucial to accurately detect the opposite-sex preference because it enables individuals to choose the right partner so that they would not waste effort pursuing higher quality mates or diminish their reproductive success by choosing a lower quality mate. Hence, Study 4 examines whether men and women have precise perceptions of opposite-sex preferences for body size and muscularity. Furthermore, literature on body dissatisfaction mainly focused on the effect of media exposure, whereas, less literature has investigated whether the perception of opposite-sex preference affects body dissatisfaction. In Study 4, we further explore whether perceptions of opposite-sex preference predict men's and women's body dissatisfaction.

As the main theme of the current thesis is investigating perception of body composition, it is important to develop a valid set of stimuli that accurately depicts body composition differences. Some studies of body image and physical attraction have adopted line drawn figures (see Figure 2 & 3) (Grossbard, Neighbors, & Larimer, 2011; Patt, Lane, Finney, Yanek, & Becker, 2002; Swami et al., 2010). These figures usually depict men and women varying in body weight from very thin to very overweight or varying in muscularity from least muscular to most muscular. One advantage of these stimuli is that they are relatively easy to use and quick to collect information about participant's ideal body. Nonetheless, there are many disadvantages associated with these stimuli. First of all, these figures do not accurately represent morphological changes associated with weight in natural bodies. Furthermore, the differences between each figure in the series are not constant. Moreover, figures in this scale are usually presented in an ascending order (thinnest to heaviest). One consequence of the non-random order is that participants may try to avoid the extremes and compromise to choose items in the middle range. Overall, the line drawn figures lack validity and reality, which could lead to in inaccurate results.

Some researchers have employed real human body photographs (Boothroyd et al., 2016; Jucker et al., 2017; Tovée, Maisey, Emery, & Cornelissen, 1999). A common practice with this method is to take photographs of men and women wearing uniform elasticated clothes (e.g. leotard or tights) standing with the same pose in a constant lighting condition. While most studies used front view photographs, some took profile or three quarters views which have been proven to be more valid in representing BMI changes (Smith et al., 2007; Tovée & Cornelissen, 2001). An obvious advantage of this method is that the stimuli have improved in ecological validity. Moreover, anthropometric measurements like BMI are usually taken along with photographs, which means preferences can be accurately calculated to specific values. Some have taken a step forward to improve the validity and reality of 2D photographs of bodies by employing 3D body scans. This method usually uses a body scanner to capture the full-length body shape, which would then be used to generate a video clip. This allows the body to rotate 360º in viewing (Fan et al., 2005; Jones et al., 2017).

Although the employment of 2D and 3D images of real bodies has improved in validity and reality, it faces another problem that body parameters tend to correlate with each other (for example BMI and WHR correlate in any sample of the population). Hence, contributions of specific parameter to perception are likely to be confounded. Furthermore, the stimuli set usually covers a limited range of body shape (limits being imposed by finite sampling of the population) and the differences in parameters such as BMI between component stimuli are not constant (again due to sampling limitations). To overcome these problems, some studies have taken a different approach. Based on the images of natural bodies, some researchers used software such as PsychoMorph (http://users.aber.ac.uk/bpt/jpsychomorph/) (Tiddeman, Burt, & Perrett, 2001) to automatically interpolate specific aspects of body shape (Stephen & Perera, 2014; Brierley et al., 2016). This method usually requires a relatively large sample of bodies in which researchers are able to select the subjects that are extreme on certain body parameters. For example, a group of bodies that are very low on BMI, are averaged into one body representation referred to as a low BMI prototype. Similarly, a group of bodies that are very high on BMI are averaged into a high BMI prototype. The difference between the low and high BMI prototypes would either be added or subtracted to individual bodies to create shape changes simulating increase or decrease in BMI. This method enables researchers to create stimuli that show continuous and constant changes of body parameters while maintaining realism. This method has not only been used for manipulating the appearance of bodies but also the appearance of faces (Coetzee et al., 2011; Batres et al., 2017).

Faces not only show biological information related to levels of fat but also convey social information such as cues to personality (Oosterhof & Todorov, 2008). Results are thus likely to be confounded by perceived personality from individual faces. Hence, it is more appropriate to use the manipulation method when studying facial correlates of body parameters as it could reduce the confounds caused by employing individual faces.

As discussed, BMI conflates body composition, thus presenting distinct changes in fat mass and muscle mass is of particular interest to the current thesis. Recent studies demonstrated that it is possible to separately manipulate fat mass and muscle mass using morphing software both in bodies and faces (Brierley et al., 2016; Holzleitner & Perrett, 2016). More importantly, this method has proven successful in describing perception of facial shape changes associated with fat mass and muscle mass (Holzleitner & Perrett, 2016). Following previous studies, we therefore decided to utilise the manipulation method to simulate facial correlates of body composition changes. Furthermore, we employed both 2D and 3D face images to check whether they produce similar perceptual results.

Due to the lack of enough body photographs, it was not possible for us to use the morphing technique for body stimuli. We therefore turned to artificial 3D models of the human body. There is a trend to use computer generated 3D human body models in the field of physical attraction (Boothroyd et al., 2012; 2019; Crossley et al., 2012; Thornborrow et al., 2018). These models are based on artificial synthetic specification of skeletal and soft tissue components of bodies. For example, many researchers have used software like DAZ Studio to create human body models. This software also allows researchers to manipulate body parameters (e.g. height and weight) that they are interested in by adjusting corresponding slider bars. Following this practice, we used a software called 3D BMI Pro to create male and female body models that varying in BMI and body fat percentage.

Chapter 4 The influence of body composition effects on male facial masculinity and attractiveness

This chapter is based on the research that is published on Frontiers in Psychology

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Abstract

Body Mass Index (BMI) and its facial correlates influence a range of perceptions including masculinity and attractiveness. However, BMI conflates body fat and muscle mass which are sexually dimorphic because men typically have more muscle but less fat than women. We therefore investigated the influence of facial correlates of body composition (fat mass and muscle mass) on the perception of masculinity in male faces. Further, it has been consistently found that women prefer more masculine looking men when considering short-term relationships compared with long-term relationships. We therefore conducted a second study of heterosexual women's preferences for facial correlates of fat and muscle mass under short- and long-term relationship contexts. We digitally transformed male face shape simulating the effects of raised and lowered levels of body fat or muscle, controlling for each other, height and age. In Study 1, 66 students rated masculinity of shape-transformed male faces. The facial correlate of muscle mass profoundly enhanced perceived masculinity but the facial correlate of fat mass only affected the perception of masculinity in underweight to low normal weight men. In Study 2, we asked two groups of women to optimise male face images (by adjusting the shape correlates of fat and muscle) to most resemble someone they would prefer, either for a short-term sexual relationship or for a long-term relationship. The results were consistent across the two participant groups: women preferred male faces associated with a higher muscle mass for short-term compared with long-term relationships. No difference was found in women's preference for the face shape correlates of fat mass between the two relationship contexts. These findings suggest that the facial correlates of body fat and muscle mass have distinct impacts on the perception of male masculinity and on women's preferences. The findings indicate that body composition needs to be taken into consideration in psychological studies involving body weight.

4.1 Introduction

Facial and body cues to physical attractiveness have been explored widely in evolutionary psychology. It has been argued that physical traits that reflect health should be perceived as attractive from the perspective that sexual selection shaped our preferences (Thornhill & Gangestad, 1999). Over the past decades, many features have been found to influence the perception of attractiveness, potentially due to its association with both physiological health and perceived health. These include but are not limited to Body Mass Index (BMI), waist to hip ratio (WHR) in women, waist to chest ratio (WCR) in men, skin colour, sexual dimorphism and symmetry (Crossley et al., 2012; Henderson, Holzleitner, Talamas, & Perrett, 2016; Singh, 1993; Tovée, Maisey, Vale, & Cornelissen, 1999). However, most research has studied attractiveness without specific contexts, e.g. for a short-term relationship or a long-term relationship, which is important for the understanding of the psychological mechanisms underlying the preferences as it involves different mating strategies.

Buss and Schmitt (1993) proposed that women have evolved distinct strategies to solve different problems they may encounter when pursuing a short-term or long-term relationship. Women's reproductive success is restricted by the resources and protection they can secure from men because women are especially vulnerable during pregnancy and lactation. Therefore, women should prefer long-term partners who are willing to provide paternal care, reliable resources and protection.

Although women are less likely to increase their reproductive success directly by mating with more males because the gestation and lactation process requires considerable time and effort (Buss & Schmitt, 1993), it does not imply that women could not benefit from short-term relationships in some circumstances. Indeed, women need not be restricted by consideration of paternal investment in short-term relationships. Therefore, selection of partners may be guided by cues to 'good genes' for immunity against currently prevalent pathogens that can be passed on to offspring (Gangestad, Thornhill, & Garver-Apgar, 2005), which they could not gain from long-term mating (Gangestad, 1993). In essence, humans tend to choose mates having similar mate values as themselves, reflected in findings that attractive women and women who believe they are attractive showed stronger preferences for signs of quality in the opposite-sex for long-term relationships (Little, Burt, Penton-Voak, & Perrett, 2001; Penton-Voak, Little, Jones, Burt, Tidddeman, & Perrett, 2003; Little &

Mannion, 2006). Therefore, women with lower mate values will end up with men with lower mate values (e.g. poor health), whereas such women are able to find men with higher mate values through extra-pair mating as men are less discriminating under a short-term mating context (Kenrick et al.,1993; Kenrick et al., 1990). Hence, women might pursue extra-pair mating to improve their reproductive success by increasing the genetic quality of her children. One source of evidence supporting this notion comes from Gangestad, Garver-Apgar, Simpson, and Cousins' (2007) finding that women were particularly attracted to features that signal good genes and not possessed by their partners under short-term relationship context and when they were fertile. Likewise, other researchers have found that women have a stronger sexual desire and fantasies to men other than their own partners at peak fertility (Gangestad, Thornhill, & Garver-Apgar, 2002). These findings suggest that women may seek good genes that could be passed on to their children through genetic inheritance in a short-term relationship. This raises the question of what constitutes good genes.

One trait that is is argued to be a cue to good genes is masculinity as part of the immunocompetence handicap hypothesis (Folstad & Karter, 1992). This hypothesis states the development of masculinity comes at the cost of immune function. Hence, masculine men need a strong immune system to resist the immunosuppressive effect. Masculinity may therefore signal a strong immune system in men. Although studies examining the relationship between testosterone and immune function have produced mixed results, a recent cross-species meta-analysis revealed a medium-sized effect from experimental studies which elevate testosterone artificially and find a concomitant decline in immune function (Foo, Nakagawa, Rhodes, & Simmons, 2017). A longitudinal study of Australians also provided evidence for this hypothesis as researchers found that facial masculinity in adulthood is an indicator of immune function during adolescence (Foo et al., 2020).

While great attention has been given to the effect of testosterone on suppressing immune function, testosterone has also been found to play a key role in maintaining men's cardiovascular health. A deficiency in testosterone is associated with increased central adiposity, reduced insulin sensitivity, impaired glucose tolerance and increased cholesterol, which are all found in metabolic syndrome and type 2 diabetes and are detrimental to cardiovascular health (Kelly & Jones, 2013). Although there is debate about whether lower levels of testosterone cause cardiovascular diseases directly or whether decreased testosterone is a by-product of poor health, clinical studies have found that testosterone replacement therapy is effective in improving health in metabolic syndromes (Elagizi, Köhler, & Lavie, 2018). If masculinity is heritable, masculinity may be a cue to current health and to genes for good health. It follows that masculine men should be appealing to women, especially for short-term relationships based on the good genes hypothesis.

On the other hand, masculinity is perceptually associated with some negative personality traits. Perceived facial masculinity was found to increase perceived dominance (Boothroyd, Jones, Burt, & Perrett, 2007), lower perceived paternal investment (Boothroyd et al., 2007) and decrease perceived trustworthiness (Perrett et al., 1998). Apart from that, several studies have found that high testosterone is associated with lower likelihood of marriage, higher divorce rates and higher rates of domestic disputes (Booth & Dabbs, 1993; Julian & McKenry, 1989; Booth, Carver, & Granger, 2000). Hence, masculine men may be disadvantageous for long-term relationships.

Research on women's preference for male facial masculinity over the past two decades is marked by inconsistent findings. Some studies found that masculine faces were preferred by women (e.g., DeBruine et al., 2006; DeBruine, Jones, Smith, et al., 2010; Holzleitner & Perrett, 2017), whereas other studies have reported a preference for femininity in men (e.g., Perrett et al., 1998; Penton-Voak et al., 1999; Little et al., 2002), and yet other studies report no overall preference for sexual dimorphism (e.g., Cornwell et al., 2004; Swaddle & Reierson, 2002).

Variability in methods has been proposed to account for the differences in results (Rhodes, 2006). However, by directly comparing commonly used methods to measure women's preferences for male facial masculinity, DeBruine et al. (2006) found that different methods can produce similar results. Alternatively, individual differences in self-rated attractiveness, relationship status, own-health condition, exposure to violence, pathogen disgust sensitivity and resource availability might contribute to the variation in results (Holzleitner & Perrett, 2017).

Despite the inconsistent findings on women's preference for men's masculinity, studies about masculinity preference under different relationship contexts have produced clearer and more consistent results. Using computer graphics techniques to manipulate masculinity in male facial shape, women show a stronger preference for facial masculinity when choosing short-term partners compared to long-term partners (Little et al., 2002; Penton-Voak et al., 2003; Jones et al., 2018). In addition, context shift is more pronounced in women with partners and not in those taking hormonal contraception pills (Little et al., 2002). This preference for masculinity in men as short-term partners has been found with a range of stimuli and modalities, including face, body, voice and odour (Little, Connely, Feinberg, Jones, & Roberts, 2011).

In spite of the prolific research on the effect of masculine traits (e.g. faces, voices, odours) on attractiveness, it is surprising that few studies have explored the role muscle plays in the perception of attractiveness and masculinity considering the fact that higher muscle mass to lower fat mass is a typical masculine feature in humans (Wells, 2007). Men typically have more muscle mass than women due to the higher levels of testosterone, which promotes muscle mass and bone growth (Mooradian, Morley, & Korenman, 1987). Thus, muscle might be strong a cue to masculinity. It follows that one may expect men with high muscle to be preferred by women, especially for short-term relationships, as women prefer more masculine looking men for short-term relationships. Indeed, muscular men were found to be preferred by women and have greater mating success (Frederick & Haselton, 2007).

Besides the close relationship between testosterone and muscle mass, muscularity may influence masculinity perception through its association with body size, which is also sexually dimorphic. Men on average are heavier compared to women. Indeed, the faces of men with higher Body Mass Index (weight scaled by the square of height, BMI) are perceived as more masculine than men with low BMI (Holzleitner et al., 2014). Therefore, muscular men may be perceived as masculine because they have greater weight. Since body weight is mainly composed of fat and muscle, it raises the question as to whether or not fat mass has a similar effect to muscle mass on male masculinity and attractiveness.

To our knowledge, only one study has explored the role of body composition on the perception of attractiveness in male bodies (Brierley, Brooks, Mond, Stevenson, & Stephen, 2016). The results from this study suggest that men with levels of body fat and muscle mass in the healthy BMI range are most preferred by women. This study did not investigate the context of the attractiveness judgements. More importantly, to our knowledge, no study has tested the effects of facial correlates of body composition (fat and muscle) on the perception of masculinity and facial attractiveness. Humans rely more heavily on facial attractiveness than physical (body) attractiveness when choosing mates (Currie & Little, 2009). In fact, when given the choice, women gave priority to men's faces over bodies when judging dating partners for both short- and long-term relationships (Confer, Perilloux, & Buss, 2010). These findings highlight the importance of investigating the effect of the facial cues to body composition on attractiveness.

In the current studies, we examine (a) the impact of facial correlates of body composition (fat and muscle) on perceived male facial masculinity, and (b) how the facial correlates of body composition influence women's preference for male faces under short-term and long-term relationship contexts.

Considering that testosterone encourages the growth of muscle, we predict that the facial correlates of muscle mass will be positively correlated with perceived facial masculinity (Hypothesis 1). Since men are heavier than women, a heavier body no matter whether the weight is due to fat mass or muscle mass may lead to higher perceived masculinity. We thus predict the facial correlate of fat mass should also contribute positively to the perception of male facial masculinity (Hypothesis 2). Nevertheless, we expect the face shape correlate of muscle to have a larger effect on perceived facial masculinity than the face shape correlate of fat based on the stronger association between muscle and testosterone than the association between fat and testosterone (Hypothesis 3).

Regarding facial preferences, we predict that women should show a stronger preference for facial cues to increased muscle mass under a short-term relationship context compared to a long-term relationship context (Hypothesis 4). Similarly, we predict a stronger preference for facial cues to fat mass in short-term relationships compared to long-term relationships (Hypothesis 5). We also predict that the relationship context effect on preferences will be more apparent for the facial correlates of muscle than the facial correlates of fat (Hypothesis 6). These hypotheses about preferences follow from Hypotheses 1–3 since higher weight, particularly from muscle is expected to increase masculinity.

4.2 General materials and method

4.2.1 Stimuli

To examine the generalisability of findings, we included three sets of faces. One set of three-dimensional (3D) face stimuli, collected using a 3D camera and delineated with 49 landmarks using MorphAnalyser software that included scans of 50 Caucasian men ($M_{age} \pm SD = 21.2 \pm 2.5$ years, see Holzleitner & Perrett, 2016). A second set of two-dimensional (2D) images matched to the 3D scans were also available for the same 50 men (hereafter referred to as the 2D version of 3D face set). These 2D images were captured under a constant lighting condition using a Fujifilm FinePix S5Pro digital SLR camera (60 mm fixed length lens) in a booth painted with standard white paint. Facial images were captured in full colour with participants' hair pulled back. Participants, seated at a set distance from the camera and the same relative eye height to the camera, were asked to maintain a neutral expression. Faces were delineated in PsychoMorph (http://users.aber.ac.uk/bpt/jpsychomorph/) with 189 landmarks and aligned on the left and right pupils (Tiddeman et al., 2001).

A further independent set of 2D face images was collected from 101 Caucasian male participants ($M_{age} \pm SD = 21.44 \pm 3.33$ years) who were recruited from the University of St Andrews. The participants contributing to the 3D face set and matched 2D face set did not contribute to the independent 2D face set.

4.2.2 Anthropometric measurements

Anthropometric data were acquired after removing excess clothing and footwear. Each individual's height was measured with a tape measure (stadiometer), and body composition was measured barefoot using an electrical impedance scale (Tanita SC-330 body composition analyser), which estimates weight, BMI, fat mass and muscle mass (lean fat-free mass). These estimations take into account information about athletic training (>10 h/week) and norms for each gender. The indicator 'muscle mass' refers to an estimate of the weight of fat-free mass excluding bone mass, and includes contributions from skeletal muscles, smooth muscles and cardiac muscles.

4.2.3 Face transformation

Composite faces (prototypes) associated with high or low fat mass or muscle mass were first created separately for 2D and 3D faces. Prototypes were created by choosing 10 faces (9 faces for 3D stimuli set) ranked the highest or lowest on the fat mass or muscle mass dimensions to average on PsychoMorph or MorphAnalyser for 2D and 3D faces, respectively. Specifically, the faces contributing to the 2D prototypes were selected from the 2D faces' pool, while the faces contributing to the 3D prototypes were based on the 3D faces' pool collected by Holzleitner & Perrett (2016). In addition, we took the 2D version of faces used to create 3D prototypes to generate another set of 2D prototypes that resemble the 3D prototypes in 2D versions (matched 2D version of 3D prototypes). This allows a direct comparison between 2D and 3D faces. Since larger individuals usually have higher absolute fat mass and muscle mass than smaller individuals, fat prototypes were created with age, height and muscle mass controlled. Similarly, muscle prototypes were created with age, height and fat mass controlled. Therefore, prototypes differed only in either fat or muscle mass dimension but not in both dimensions. Results of paired-samples t-tests showed that there were significant differences between the body composition figures of the low and high prototypes in the dimension being manipulated but not in the dimensions being controlled, indicating that fat and muscle dimensions had been successfully separated in the contributing individuals (see Table S1&S2 in Appendix 1 for details).

The fat and muscle prototypes were then used to create shape transforms of five individual White male faces. Face shapes were transformed to visualise body composition (fat/muscle mass) differences by adding or subtracting a proportion of the facial shape differences between low and high fat/muscle prototypes. To make the fat- and muscle-transformed images comparable, facial shapes were transformed to the same magnitude in terms of BMI (+/− 4 BMI units) in 15 steps. This process created three sets of transformed images (using 3D prototypes, matched 2D version of 3D prototypes and an independent set of 2D prototypes). Each set of transformed images consisted of five individual male faces transformed to lose/gain fat/muscle mass (Figures 4–6). For 3D images, both the front view and the half profile view were created in the transformation process. These two views were combined in one image (Figure 4).

All images were masked with the black background to display only the face and neck and to remove confounds arising from hair (DeBruine, Jones, Smith, et al., 2010). 2D images were aligned to have the same pupil positions and resized to 500 × 500 pixels.

4.2.3 Perceptual test of the validity of the stimuli

In order to make sure that the constructions of the face shape associated with fat mass and muscle mass are perceived in distinct and appropriate ways, we designed a forced-choice task to measure whether the manipulations of fat and muscle mass can be accurately perceived. Participants consisted of 39 males and 21 females recruited from Amazon MTurk ($M_{\text{age}} \pm SD = 34.60 \pm 9.85$ years). Ten individual faces from the three face sets were transformed in the same manner as aforementioned. Faces transformed to the low and high end of the fat mass and muscle mass dimensions were presented in a two-alternative forced choice task in two different blocks. Participants were asked to choose “which man has more fat” and “which man has more muscle”. In each block, participants were presented with the same 90 pairs of faces: 30 paris of low vs high fat, 30 pairs of low vs high muscle, and 30 pair of high fat vs high muscle. The trials within blocks and the order of the blocks were randomized.

For each task and pair types, the proportion of faces transformed to the high end (fat/muscle) were chosen was calculated. For example, the proportion of trials that high fat faces was chosen over low fat face was calculated. For the pair that consisted of high fat and high muscle faces, the proportion of the high muscle faces chosen was calculated. This resulted in the outcomes ranging from 0 to 1, where 0 indicated that the low fat or low muscle faces were chosen every time and 1 indicated that high fat or high muscle faces were chosen every time. Then, the proportions were tested against no bias (0.5) using one-sample t-tests.

One sample t-tests (see Table 1) against no bias showed that when asked "which man has more fat", high fat faces were significantly more often chosen than low fat faces (*ps* < 0.001) and high muscle faces (*ps* < 0.001) for all face sets. Similarly, for the question "which man has more fat" the high muscle faces were significantly more often chosen than low muscle faces (*ps* ≤ 0.001) for the two 2D face sets but not the 3D face set ($p = 0.917$). When asked "which man has more muscle", high muscle faces were chosen significantly more often than low muscle faces for the matched 2D and 3D face sets (*ps* ≤ 0.011) but not the independent 2D face set ($p = 0.622$). When presented with high muscle and high fat faces, participants did not show a significant bias towards high muscle faces or high fat faces (*ps* > 0.098) except for the matched 2D face set ($p = 0.030$). Similarly, the high fat faces were not chosen more often than the low fat faces for all three face sets (*ps* ≥ 0.059).

Table 1. One-sample t-tests results of perceptions of facial correlates of body composition

Face set	Pair type	Means of proportions (SD)	*t* values	*p* values
		Which man has more fat?		
3D	Low fat VS High fat	0.81(0.20)	11.86	< 0.001
	Low muscle VS High muscle	0.50(0.23)	0.105	0.917
	High fat VS High muscle	0.28(0.21)	-7.812	< 0.001
Matched 2D	Low fat VS High fat	0.87(0.21)	13.67	< 0.001
	Low muscle VS High muscle	0.78(0.19)	10.89	< 0.001
	High fat VS High muscle	0.33(0.23)	-5.82	< 0.001
Independent 2D	Low fat VS High fat	0.89(0.18)	17.01	< 0.001
	Low muscle VS High muscle	0.63(0.29)	3.41	0.001
	High fat VS High muscle	0.26(0.19)	-10.17	< 0.001
		Which man has more muscle?		
3D	Low fat VS High fat	0.58(0.30)	1.93	0.059
	Low muscle VS High muscle	0.68(0.22)	6.34	< 0.001
	High fat VS High muscle	0.56(0.27)	1.68	0.098
Matched 2D	Low fat VS High fat	0.51(0.37)	0.14	0.889
	Low muscle VS High muscle	0.59(0.27)	2.62	0.011

	High fat VS High muscle	0.57(0.24)	2.22	0.030
	Low fat VS High fat	0.50(0.37)	-0.07	0.945
Independent 2D	Low muscle VS High muscle	0.52(0.26)	0.50	0.656
	High fat VS High muscle	0.52(0.26)	0.45	0.656

These findings suggest that faces transformed along the fat mass and muscle mass vectors are perceived as representing more or less fat or muscle mass respectively. Specifically, faces transformed toward the shape associated with high fat mass were perceived as having more fat mass than faces associated with less fat mass. Similarly, faces simulating more muscle mass were perceived as having more muscle mass than faces associated with less muscle mass. In addition, the transformations of the two dimensions of body composition were perceived as relatively separate dimensions. When the pairs consisted of high fat and high muscle faces, participants were able to tell high fat faces had more fat than high muscle faces for most of the time. Likewise, high muscle faces were judged to have more muscle than high fat faces, although it was not significantly higher than the chance level, it was in the right direction. These findings imply that the difference between facial cues to fat and muscle are largely perceivable although people may not be able to accurately classify composition into right categories occassionaly.

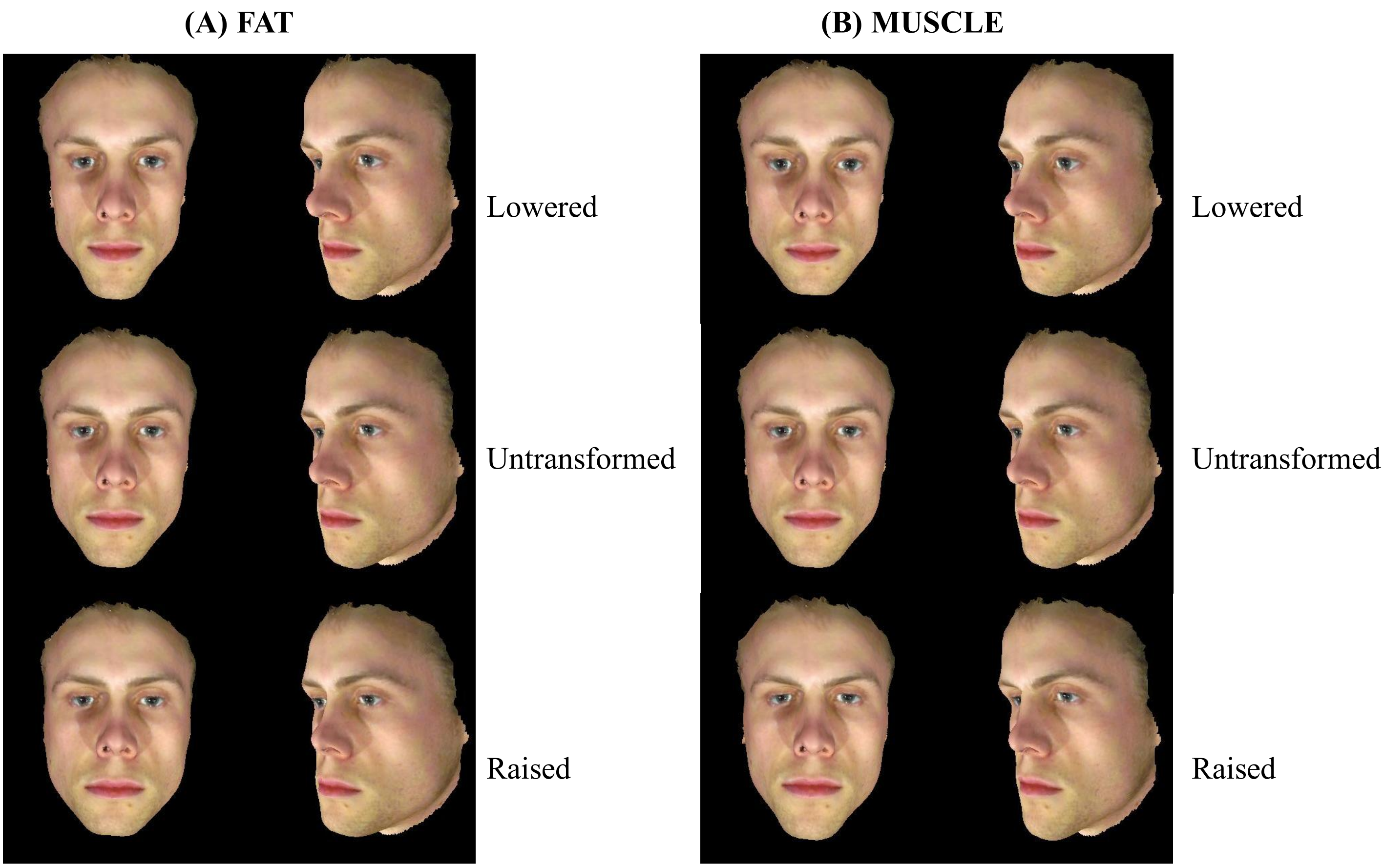


Figure 4. 3D Male face shape associated with fat mass (A) and muscle mass (B). Individual faces (middle) were transformed to reflect face shapes associated with less fat/muscle mass (–4 BMI units, top) or more fat/muscle mass (+4 BMI units, bottom) based on the difference in the face shape between low and high fat/muscle prototypes for the 3D face set. Front and half-profile views of the same face are displayed.

Figure 5. 2D Male face shape associated with fat mass (top) and muscle mass (bottom). Individual faces (middle) were transformed to reflect face shapes associated with less fat/muscle mass (–4 BMI units, left) or more fat/muscle mass (+4 BMI units, right) based on the difference in the face shape between low and high fat/muscle prototypes for the matched 2D version of 3D face set.

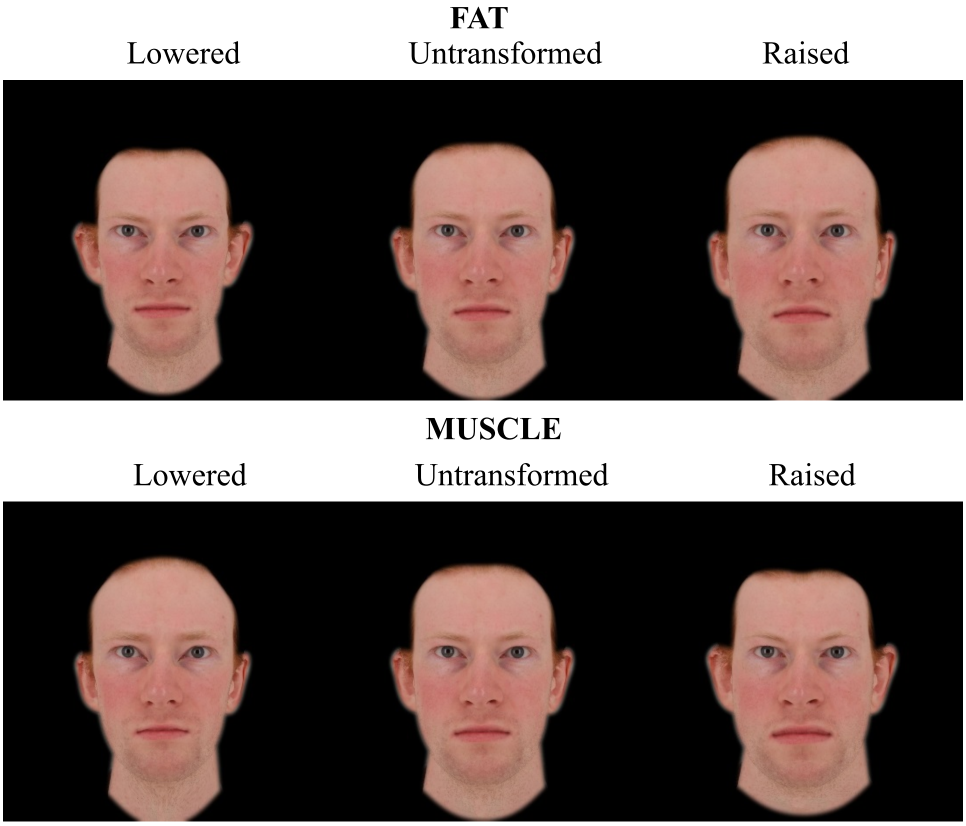


Figure 6. 2D Male face shape associated with fat mass (top) and muscle mass (bottom). Individual faces (middle) were transformed to reflect face shapes associated with less fat/muscle mass (–4 BMI units, left) or more fat/muscle mass (+4 BMI units, right) based on the difference in the face shape between low and high fat/muscle prototypes for the independent 2D face set.

4.3. Study 1: Facial correlates of body composition and perceived masculinity

This study aimed to test whether facial correlates of body composition (fat mass and muscle mass) influence perceived facial masculinity in males. We tested the following hypotheses:

(1) Faces associated with more muscle mass will be perceived as more masculine.
(2) Faces associated with more fat mass will be perceived as more masculine.
(3) The facial correlate of muscle mass has a larger impact on perceived facial masculinity than the facial correlate of fat mass.

4.3.1 Method

Ethical approval was received from University of St Andrews Ethics Committee (PS13092). Participants gave informed consent.

4.3.1.1 Participants

This study was conducted as a practical experiment on first-year psychology students from the University of St Andrews as a course requirement. It was administered as an online experiment that participants completed in their own time and space. The study link was sent via email by the module co-ordinator. In total, 67 students ($M_{age} \pm SD = 19.37 \pm 3.84$ years, range 18–45) including 56 females and nine males (demographics were ommited by two participants; 51 Caucasians) completed all trials of this study.

4.3.1.2 Materials

Stimuli consisted of three face identities transformed to four levels (–4 BMI units, –2.3 BMI units, +2.3 BMI units, +4 BMI units) plus the untransformed image (+0 BMI units). Therefore, there was a total of 81 stimuli: 3 (face identities) × 3 (face sets: 3D face set, matched 2D version of 3D face set, independent 2D face set) × 9 (4 BMI levels x 2 dimensions (fat & muscle) + original face).

4.3.1.3 Procedure

Participants were asked to complete a demographic questionnaire (age, sex, ethnicity and sexual orientation). Then faces were presented one at a time in three blocks (each block consisted of a set of faces with muscle and fat transform). Both the order of the trials within blocks and the three blocks were completely randomized. Participants were asked to rate the masculinity (“Please indicate how masculine you perceive this man to be”) of each stimulus face by dragging the cursor on a sliding bar with anchors (1 = least masculine and 7 = most masculine). The starting point of the cursor along the bar was randomised. There was no time limit to make judgements. The next face was shown only after the participant had adjusted the slider and clicked for the next trial.

4.3.1.4 Statistical analysis

For each stimulus type, the mean ratings were calculated across face identities for each participant. The consolidated data were further analysed in SPSS 24.0. Three-way analysis of variance (ANOVA) was run, with the transform dimension (fat/muscle) and the transform level (five levels: –4 BMI units, –2.3 BMI units, no change, +2.3 BMI units, +4 BMI units) included as the independent variables. Face set (3 sets) was included as an additional independent variable to determine if results were consistent across the different samples of faces.

4.3.2 Results

A three-way ANOVA was run to test the transformation attributions made to fat and muscle mass across the three face sets. The results showed non-significant main effects of the transform dimension ($F(1,66) = 0.44$, $p = 0.507$, $\eta^2 = 0.007$) and face sets ($F(2,132) = 0.94$, $p = 0.392$, $\eta^2 = 0.014$) on masculinity rating, but a significant main effect of transform level ($F(4,264) = 74.80$, $p < 0.001$, $\eta^2 = 0.531$) (see Table 2). As face shape simulated heavier individuals (higher BMI), the masculinity ratings increased. The interaction between transform dimension and face set was not significant ($F(2,132) = 0.41$, $p = 0.665$, $\eta^2 = 0.006$) but a significant interaction was found between transform dimension and transform level ($F(4,264) = 24.75$, $p < 0.001$, $\eta^2 = 0.273$), reflecting a greater impact of muscle transform compared with fat transform on masculinity.

There was a significant interaction between face set and transformed level ($F(8,528) = 2.61$, $p = 0.008$, $\eta^2 = 0.038$). Further, the three-way interaction among transform dimension, transform level, and face set was significant ($F(8,528) = 2.17$, $p = 0.028$, $\eta^2 = 0.032$). To understand the three-way interaction, we conducted two-way ANOVA separately for each face set.

Table 2. Descriptive statistics of mean masculinity ratings (1–7) (SD) for three sets of faces transformed in fat mass and muscle mass dimensions at five BMI levels

Face set	–4 BMI	–2.3 BMI	0	+2.3 BMI	+4 BMI
	M(SD)	*M(SD)*	*M(SD)*	*M(SD)*	*M(SD)*
	FAT				
3D	3.62(0.92)	3.93(0.70)	4.17(0.70)	4.21(0.80)	4.26(0.84)
Matched 2D	3.49(0.92)	3.84(0.83)	4.08(0.76)	4.23(0.86)	4.42(1.01)
Independent 2D	3.75(0.99)	4.00(0.83)	4.27(0.82)	4.22(0.96)	4.32(1.08)
	MUSCLE				
3D	3.47(0.83)	3.91(0.63)	4.17(0.70)	4.27(0.79)	4.54(0.88)
Matched 2D	3.10(0.91)	3.74(0.80)	4.08(0.76)	4.42(0.89)	4.68(1.06)
Independent 2D	3.39(0.99)	3.66(0.85)	4.27(0.82)	4.53(0.92)	4.73(1.12)

3D Face set

For 3D faces, the main effect of the transform dimension was non-significant ($F(1,66) = 1.36$, $p = 0.252$, $\eta^2 = 0.020$). There was a significant main effect of transform level ($F(4,264) = 31.17$, $p < 0.001$, $\eta^2 = 0.321$), which was qualified with an interaction between transform dimension and transform level ($F(4,264) = 4.40$, $p = 0.002$, $\eta^2 = 0.062$, see Figure 7). Paired-samples *t*-tests showed that significant increases in masculinity ratings occurred between all levels of muscle transform ($p \leq 0.004$ each comparison) except between 0 and +2.3 BMI units ($p = 0.186$). By contrast, there were no significant increases in masculinity ratings for fat transform above normal weight (0, +2.3 and +4 BMI units, $p \geq 0.337$ each comparison). There were significant decreases in masculinity ratings between faces associated with decreased fat mass compared to increased fat mass ($p \leq 0.005$ each comparison). These findings provide further support for our Hypothesis 3 that the facial correlate of muscle mass increases perceived facial masculinity more than the facial correlate of fat mass.

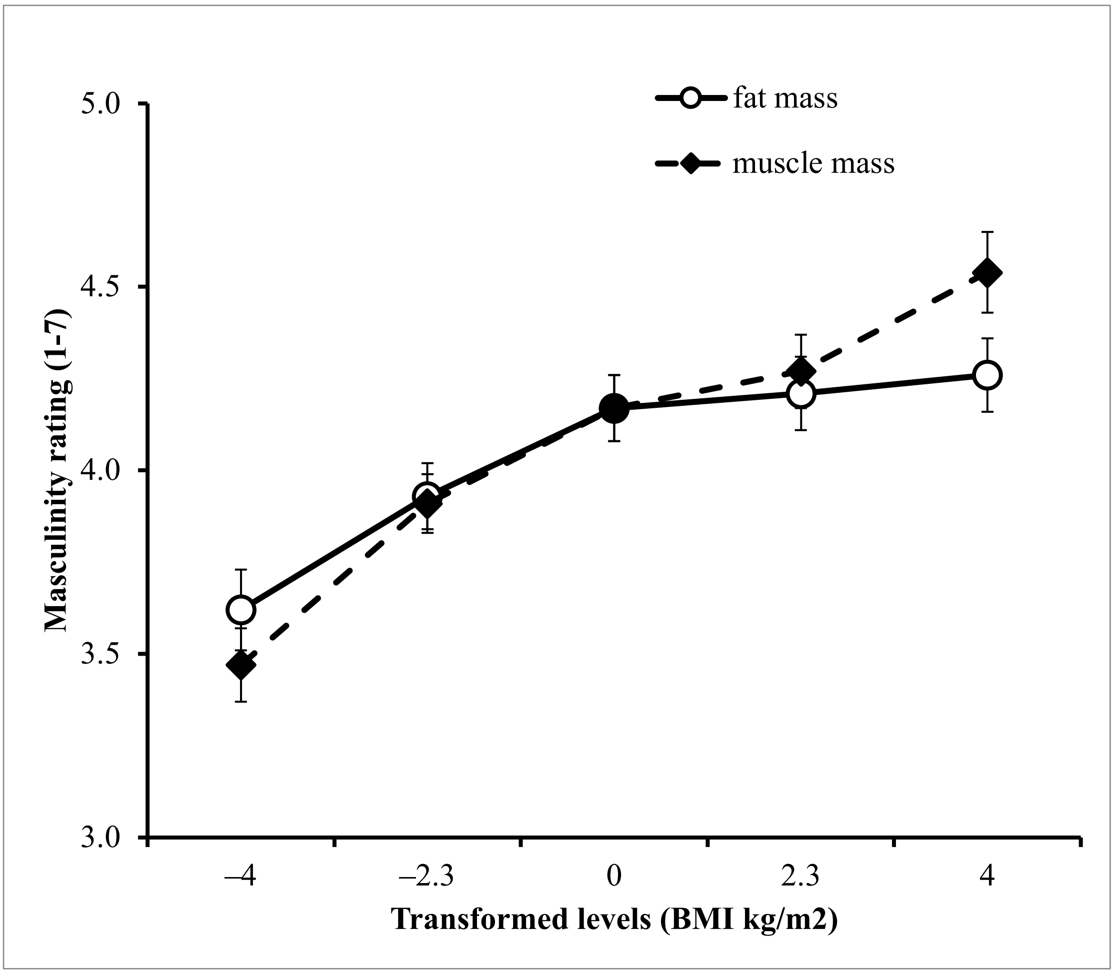


Figure 7. Average masculinity ratings for faces transformed with the face shape correlates of fat and muscle mass for the 3D face set. Error bars represent the standard errors.

Matched 2D face set

For the matched 2D face set, there was no main effect of transform dimension ($F(1,66) = 0.05$, $p = 0.833$, $\eta^2 = 0.001$). The main effect of transform level was significant ($F(4,264) = 50.85$, $p < 0.001$, $\eta^2 = 0.435$) but was qualified by a significant interaction between transform dimension and transform level ($F(4,264) = 8.63$, $p < 0.001$, $\eta^2 = 0.116$, see Figure 8). Paired-samples *t*-tests showed an increase in muscle mass by ~2 BMI units significantly increased masculinity ratings throughout the range (–4 to +4 BMI units, $p \leq 0.002$ each comparison). Significant increases in masculinity ratings with fat mass transform were seen in most comparisons ($p \leq 0.014$ each comparison) but no significant increases were seen in comparisons between faces associated with increased fat mass (0 vs +2.3 BMI units ($p = 0.170$) and +2.3 vs +4 BMI units ($p = 0.070$)). These findings are again in line with our prediction that facial correlates of both fat mass and muscle mass positively influence perceived facial masculinity but that also the facial correlate of muscle mass has a larger impact on masculinity.

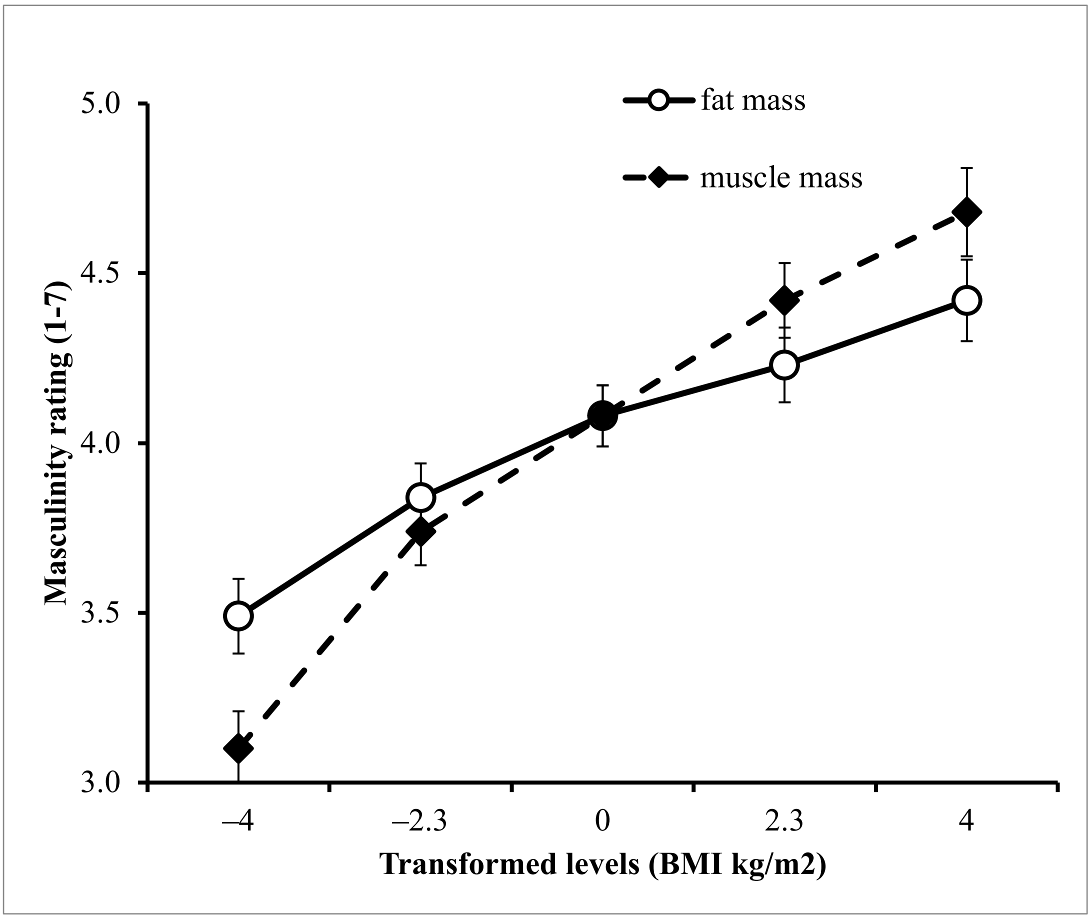


Figure 8. Average masculinity ratings for faces transformed with the face shape correlates of fat and muscle mass for the 2D version of 3D face set. Error bars represent the standard errors.

<u>Independent 2D face set</u>

For face transforms based on the independent 2D face set, the main effect of the transform dimension was non-significant ($F(1,66) = 0.02$, $p = 0.888$, $\eta^2 = 0.000$). A significant main effect of transform level ($F(4,264) = 34.89$, $p < 0.001$, $\eta^2 = 0.346$) reflected faces associated with increased mass (fat or muscle) being considered more masculine. The interaction between transform dimension and transform level was significant ($F(4,264) = 15.82$, $p < 0.001$, $\eta^2 = 0.193$, see Figure 9). This interaction reflects a greater impact of muscle compared with fat on masculinity ratings. Paired-samples *t*-tests showed that participants rated faces with higher muscle mass significantly more masculine for comparisons between all five levels ($p \leq 0.017$ each comparison). In contrast, a significant increase in masculinity ratings for faces associated with higher fat mass was evident only for comparisons between faces with decreased fat mass (–4 BMI units, –2.3 BMI units) and the other levels ($p \leq 0.046$ each comparison). There were no significant differences in masculinity ratings for fat transforms 0, +2.3 or + 4.3 BMI units ($p \geq 0.270$ each comparison). As fat mass increased from low to normal weight, masculinity increased, but for gain in the fat level above normal weight, there was no significant change in masculinity ratings. These findings support our hypothesis that the facial correlate of muscle mass enhances perceived facial masculinity more than the facial correlate of fat mass.

The interaction between face set, transform dimension and transform level arises from the relative size of the muscle and fat transforms across the three face sets, with the fat and muscle differences being most subtle in the 3D face set although the pattern is similar for each face set.

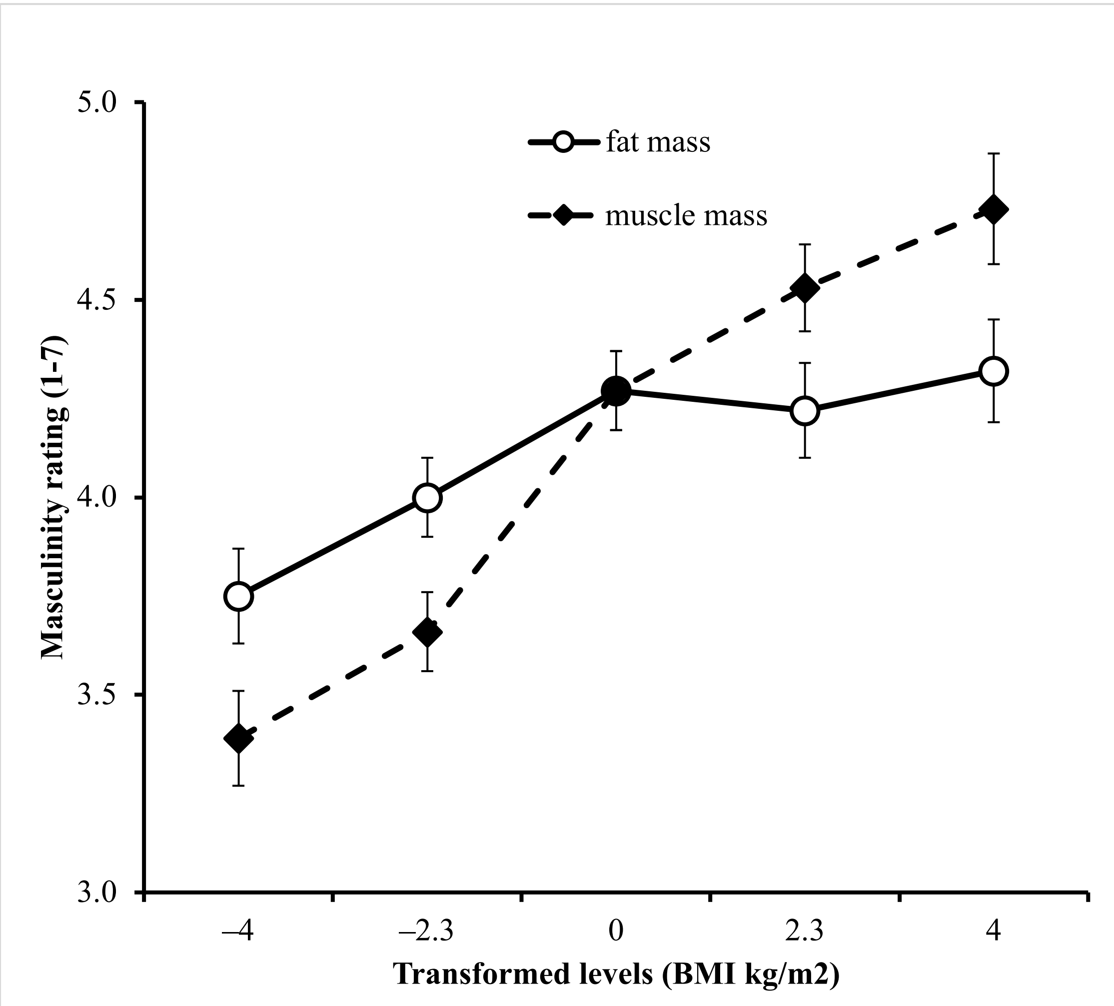


Figure 9. Average masculinity ratings for faces transformed with the face shape correlates of fat and muscle mass for the independent 2D face set. Error bars represent the standard errors.

4.3.3 Interim discussion

As expected, facial correlates of fat mass and muscle mass both positively affected perceived facial masculinity in men. The results are consistent with Holzleitner et al.'s (2014) findings of heavier men being perceived as more masculine. As we hypothesised, muscle mass enhances the perception of masculinity more than fat mass. Specifically, increasing the face shape correlate of muscle mass resulted in higher ratings of facial masculinity across the full weight range (BMI range 18–26). By contrast, increasing the face shape correlate of fat mass only raised masculinity rating from low to normal weight (BMI = 18–22). Further increases in fat mass above normal weight (BMI = 22) had little or no impact on the perception of masculinity. These results imply that the effect of fat on masculinity is more prevalent in men with underweight to normal weight bodies.

4.4. Study 2: Attraction to the facial correlates of body composition

Study 1 found that facial correlates of both fat mass and muscle mass contribute to perceived facial masculinity, which has been found to affect the perception of attractiveness. In this part of the study, we tested the relationship between facial correlates of body composition and facial attractiveness. In addition, we tested the possible influence of media on women's preference for men's facial correlates of body composition. An effect of media on individual's own body ideals has been consitently found (e.g., Swami et al., 2010), hence, we explored whether media influence extends to a more general preference towards media ideals for opposite-sex partners.

As discussed before, higher levels of masculinity are preferred by women more for short-term relationships than for long-term relationships. Hence, we measured heterosexual women's preferences for facial correlates of body composition in male faces in short-term and long-term relationship contexts. Given the findings above that the facial correlates of muscle mass increases perceived facial masculinity, we predicted that *women would show a stronger preference for the facial correlate of muscle mass in a short-term rather than a* *long-term relationship context* (Hypothesis 4). Regarding fat mass, in the introduction we hypothesised that women would show a stronger preference for higher fat mass in short-term relationships than in long-term relationships. In the light of the masculinity ratings we found in Study 1, this hypothesis should be modified. We can now hypothesise that *if women show an overall preference for men with a BMI < 22, we predict women will prefer a face shape associated with more fat mass for a short-term relationship in comparison to a long-term relationship* (Hypothesis 5a). Conversely, we predict that *women will not shift their preference for the facial correlate of fat mass between short-term and long-term relationships if they prefer men with a BMI > 22* (Hypothesis 5b). Nevertheless, we predict the preference shift between short-term and long-term contexts will be more apparent for the facial correlate of muscle mass than the facial correlate of fat mass (Hypothesis 6). Since male body ideal is defined as muscularity (Boyd & Murnen, 2017; Pope et al., 2000), we predict that women who are influenced more by the media would prefer facial correlates of muscle mass more than women who are less influenced (Hypothesis 7).

This study was initially administered with Study 1 as a single experiment consisting of two tasks (masculinity rating and preference) for University students, with the preference task executed before the masculinity task. Considering the students are highly homogeneous groups due to their age and educational background, Study 2 was repeated in a more heterogeneous group to test the generalisability of findings. Hence, we recruited another group of participants through the online recruitment platform, Amazon MTurk (note: they did Study 2 only but not Study 1).

4.4.1 Method

Ethical approval was received from University of St Andrews Ethics Committee (PS13176 and PS13092). Participants gave informed consent.

4.4.1.1 Participants

For the student group, 63 heterosexual female participants ($M_{\text{age}} \pm SD = 18.94 \pm 2.17$, range 18–35 years; 48 Caucasians) completed this study after exclusion of those without demographic information (age, sex, ethnicity and sexual orientation) or who reported to be homosexual or males. For the MTurk workers group, 58 heterosexual women ($M_{\text{age}} \pm SD = 32.09 \pm 6.68$, range 22–45 years; 43 Caucasians) completed this study after exclusion using the same criteria as the students' group and an additional exclusion age criterion. Ten women over age 45 years were additionaly excluded as our prediction was based on the assumption that the key benefit women gain from short-term relationships concerns potential reproductive success. MTurk participants were paid $3 for their time.

4.4.1.2 Materials

The stimuli consisted of face images transformed as described above. For each face identity, 15 images were produced spanning the transformation +/−4 BMI units on fat mass and muscle mass dimensions. The 15 images were presented as an interactive contimuum. For MTurk workers, a total of 30 face continua: 5 face identities × 2 dimensions (fat/muscle) × 3 face sets (3D face set, 2D version of 3D face set, independent 2D face set) were presented twice in separate trial blocks asking about preferences for a short-term sexual relationship and long-term relationship. For the student group, the three face identities were used. Thus, 18 face continua: 3 identities × 2 dimensions (fat/muscle) × 3 face sets (3D face set, 2D version of 3D face set, independent 2D face set) were presented in each of two trial blocks.

In addition, a questionnaire consisted of 5 questions selecting from the Sociocultural Attitudes Towards Appearance Questionnaire (SATAQ) was used to test participants' media internalisations (see Appendix 3). This scale has been proved to be valid and reliable scale across different countries and ethnicities (Schaefer et al., 2015).

4.4.1.3 Procedure

At the beginning of this study, participants were asked, " Please indicate the sex of face that you would like to see (as a sexual partner)" (Note: female faces were also given as an option for heterosexual males, homosexual and bisexual female participants to view, but data from these faces are not analysed here). The participants' demographic information (age, sex, ethnicity and sexual orientation) was collected in an initial questionnaire. Then participants were presented with the stimuli twice in two blocks. They were asked to adjust the slider underneath each stimulus to make the face most resemble someone they would find attractive as a short-term (sexual) partner and as a long-term partner in two separate blocks. The order of the tasks was counterbalanced. Trials with 2D and 3D face stimuli were also grouped in two separate sub-blocks. The order of sub-blocks and the presentation order within each sub-block was randomised. The scroll direction to change the face shape was randomised across trials. The next image would only be shown when participants adjusted the slider and clicked the submit button. For each trial, the BMI level chosen by each participant was saved. After finishing the preference task, participants were asked to fill a questionnaire testing their media internalisation.

Instructions were given prior to tasks as follows (a) Short-term (sexual) relationship: "Please change the face to most resemble someone you would find attractive for a SHORT-TERM (sexual) relationship". (b) Long-term relationship: "Please change the face to most resemble someone you would find attractive for a LONG-TERM relationship".

4.4.1.4 Statistical analysis

The data for the students group and MTurk group were analysed separately in SPSS 24.0. Three-way ANOVA was run with the transform levels (expressed as a BMI equivalent) associated with preferred faces as the dependent variable, the transform dimension, face sets and relationship context included as the independent variable. Pearson correlation test was run to test the media influence on women's preference for facial correlates of muscle mass.

4.4.2 Results

4.4.2.1 Student group

A three-way ANOVA was run to test women's preference for facial correlates of fat mass and muscle mass in different relationship contexts and across the three face sets. The results showed a non-significant main effect of fat/muscle transform dimension ($F(1,62) = 3.18$, $p = 0.079$, $\eta^2 = 0.049$). As expected, a significant main effect of context ($F(1,62) = 9.26$, $p = 0.003$, $\eta^2 = 0.130$) was found, with participants preferring faces of heavier men (with fat mass or muscle mass) for a short-term relationship ($M = 21.42$, $SD = 1.15$) rather than a long-term relationship ($M = 20.98$, $SD = 0.90$). In addition, there was a significant main effect of face set ($F(2,124) = 107.37$, $p < 0.001$, $\eta^2 = 0.634$, see Figure 10). Although we did not expect to find a main effect of the face set, the paired-samples *t*-tests suggest that the effect might simply be due to participants choosing heavier faces in the 3D face set compared with the other two 2D face sets. Paired-samples *t*-tests showed that participants choose heavier faces for the 3D face set ($M = 22.14$, $SD = 1.07$) compared with the 2D version of 3D face set ($M = 20.67$, $SD = 0.99$) ($t(62) = 12.02$, $p < 0.001$) and the independent 2D face set ($M = 20.80$, $SD = 0.93$) ($t(62) = 10.88$, $p < 0.001$).

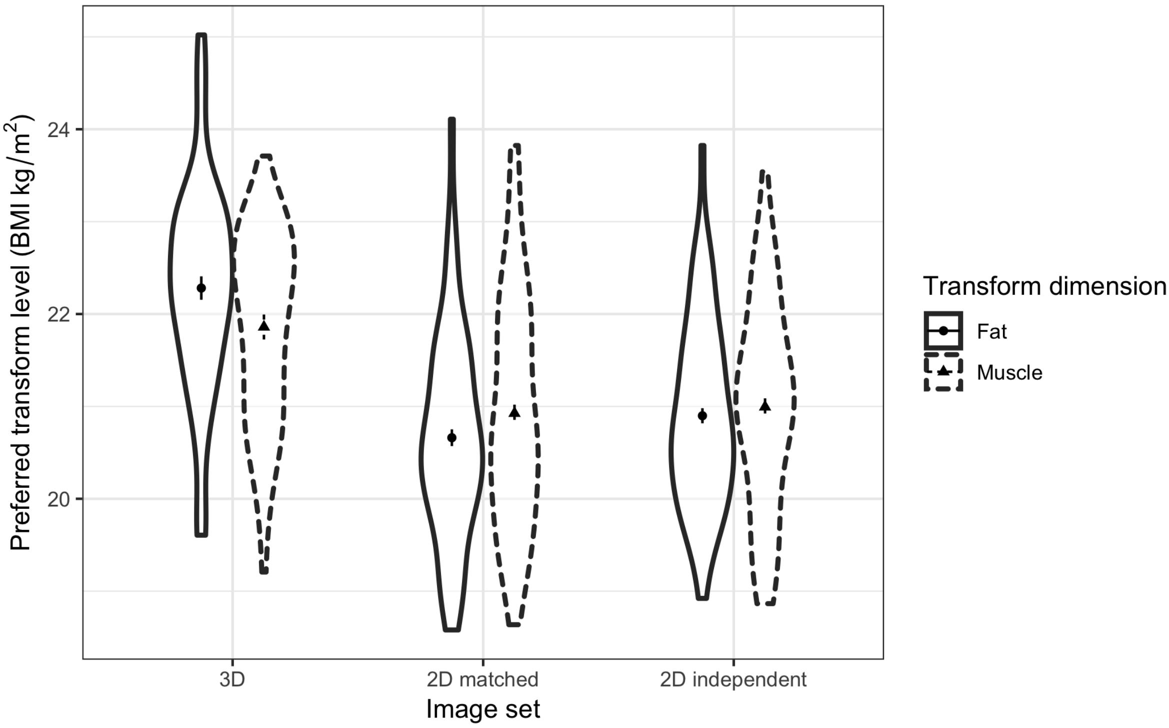


Figure 10. Violin plots showing the distribution of female students' preferences for the facial correlates of fat mass and muscle mass in men. The vertical axis represents the associated BMI of the most preferred faces chosen by the students in short-term and long-term relationship contexts. The error bars represent the standard errors and the symbols indicate means.

In line with our Hypothesis 6, a significant interaction was found between transform dimension and context ($F(1,62) = 4.73$, $p = 0.034$, $\eta^2 = 0.071$, see Figure 11). This result indicates a greater effect of muscle than fat on preference in the two contexts. As expected, paired-samples *t*-tests showed that a higher level of facial correlate of muscle mass was preferred in a short-term ($M = 21.43$, $SD = 1.22$) rather than a long-term ($M = 20.83$, $SD = 1.07$) relationship ($t(62) = 3.49$, $p = 0.001$). By contrast, there was a non-significant trend for a difference between preference for the facial correlate of fat mass in short-term ($M = 21.42$, *SD* = 1.23) and long-term (*M* = 21.13, *SD* = 0.96) ($t(62) = 1.86$, $p = 0.068$) relationships, which provides limited support for Hypothesis 5a.

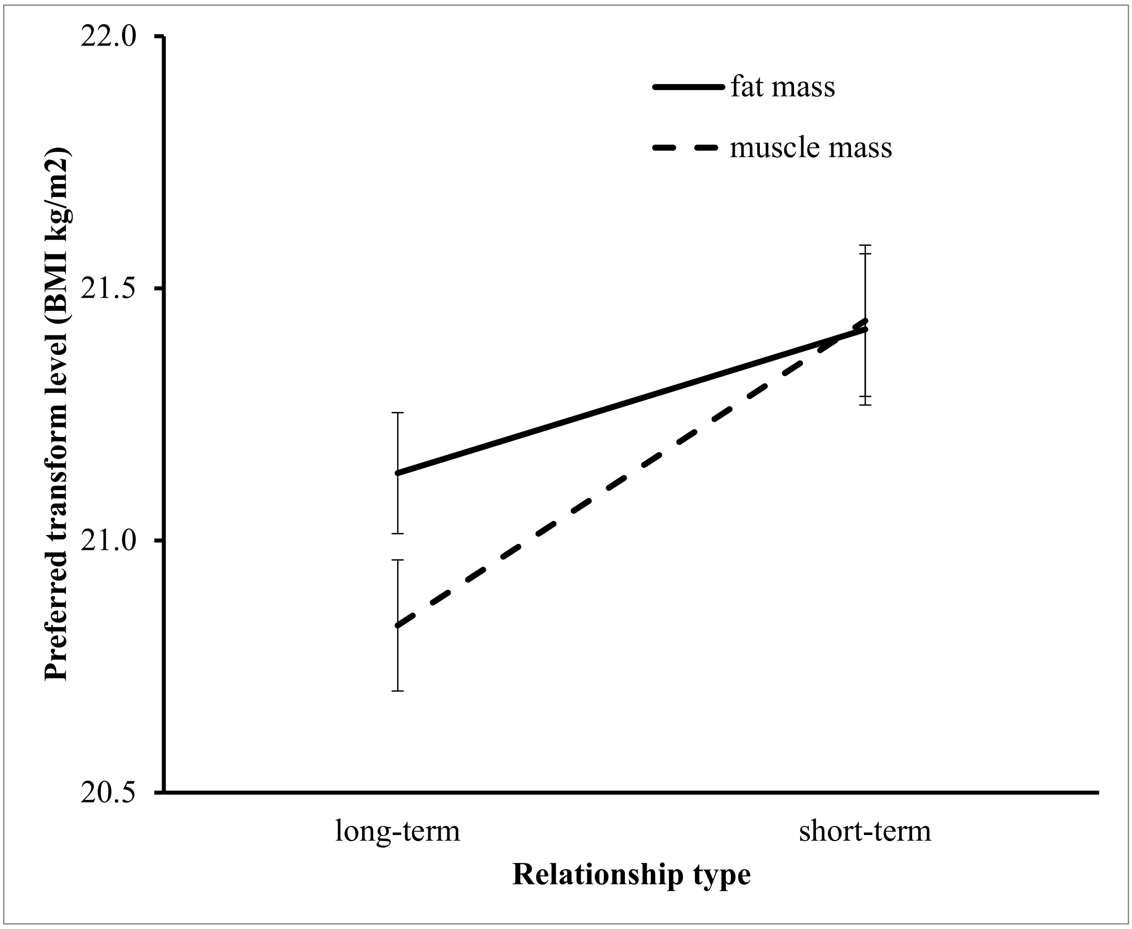


Figure 11. The interaction between relationship type (short-term and long-term) and preferred facial correlates of body composition (fat mass and muscle mass) in student participants. The vertical axis represents the associated BMI of the most preferred faces. Error bars represent standard errors.

The three-way interaction (transform dimension × relationship context × face set) was non-significant ($F(2,124) = 0.33$, $p = 0.719$, $\eta^2 = 0.005$). Since the interaction between fat and muscle transform and relationship context was found to be significant and independent of the face set, it was not necessary to analyse the data further for each face set separately. Thus, our main prediction was borne out across the three face sets.

Finally, one-sample *t*-tests compared the preferred BMI (average across the three face sets) with a BMI of 22 (the average of the original starting BMI of the face stimuli) to test whether women show a general preference towards a lower or higher than normal weight.

Significant decreases in preferred BMI below 22.0 were found, reflecting a reduction of fat mass and muscle mass for both short-term (fat mass: $M = 21.42$, $t(62) = –3.78$, $p < 0.001$; muscle mass: $M = 21.43$, $t(62) = –3.70$, $p < 0.001$) and long-term (fat mass: $M = 21.13$, $t(62) = –7.18$, $p < 0.001$; muscle mass: $M = 20.83$, $t(62) = –8.72$, $p < 0.001$) relationships.

Pearson correlation test showed that media internalisations was positively correlated with a preference for facial correlates of muscle mass for short-term relationships ($r(50) = 0.41$, $p = 0.003$) but not long-term relationships ($r(50) = 0.25$, $p = 0.076$). It suggests that women who reported to be more acceptable of media ideals were more likely to indicate a preference for facial correlates of muscle mass.

4.4.2.2 MTurk workers

Similarly, a three-way ANOVA was run to test MTurk women's preference for men's facial correlates of fat and muscle mass across relationship contexts. The results showed non-significant main effects of transform dimension ($F(1,57) = 0.06$, $p = 0.808$, $\eta^2 = 0.001$) and context ($F(1,57) = 1.31$, $p = 0.258$, $\eta^2 = 0.022$). A significant main effect of face set was found ($F(2,114) = 71.58$, $p < 0.001$, $\eta^2 = 0.557$, see Figure 12). Similar to the student group, paired-samples *t*-tests showed that participants chose heavier faces (with higher fat mass or muscle mass) with the 3D face set ($M = 22.07$, $SD = 0.89$) compared with the 2D version of 3D face set ($M = 20.79$, $SD = 1.10$) ($t(57) = 8.89$, $p < 0.001$) and the independent 2D face set ($M = 20.95$, $SD = 0.93$) ($t(57) = 8.68$, $p < 0.001$). Unlike the results from the student group, MTurk participants preferred slightly heavier faces for the independent 2D face set compared to the 2D version of 3D face set ($t(57) = –2.65$, $p = 0.010$).

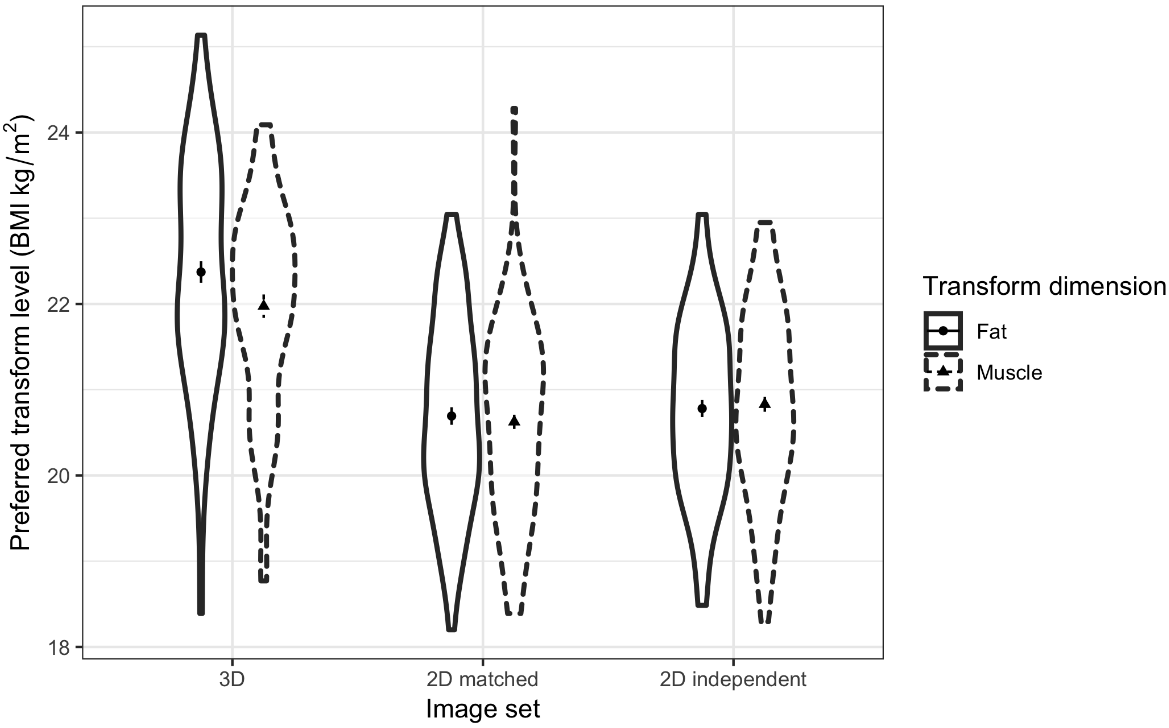


Figure 12. Violin plots showing the distribution of MTurk women's preferences for the facial correlates of fat mass and muscle mass in men. The vertical axis represents the associated BMI of the most preferred faces chosen by the women in short-term and long-term contexts. The error bars represent the standard errors and the symbols indicate means.

In line with our Hypothesis 6, a significant interaction was found between fat and muscle transform dimension and relationship context ($F(1,57) = 7.36$, $p = 0.009$, $\eta^2 = 0.114$, see Figure 13). Paired-samples *t*-tests results suggest that MTurk women showed a stronger preference for the facial correlate of muscle mass in short-term relationships ($M = 21.42$, $SD = 1.12$) compared with long-term relationships ($M = 21.10$, $SD = 0.95$) ($t(57) = 2.33$, $p = 0.024$) but those women did not differ in their preference for the facial correlate of fat mass between short-term ($M = 21.24$, $SD = 0.99$) and long-term relationships ($M = 21.32$, $SD = 0.96$) ($t(57) = 0.70$, $p = 0.488$). Further, the three-way interaction (transform dimension × relationship context × face set) was non-significant ($F(2,114) = 1.52$, $p = 0.224$, $\eta^2 = 0.026$), indicating that the interaction between fat/muscle transform and relationship context was consistent across the three face sets.

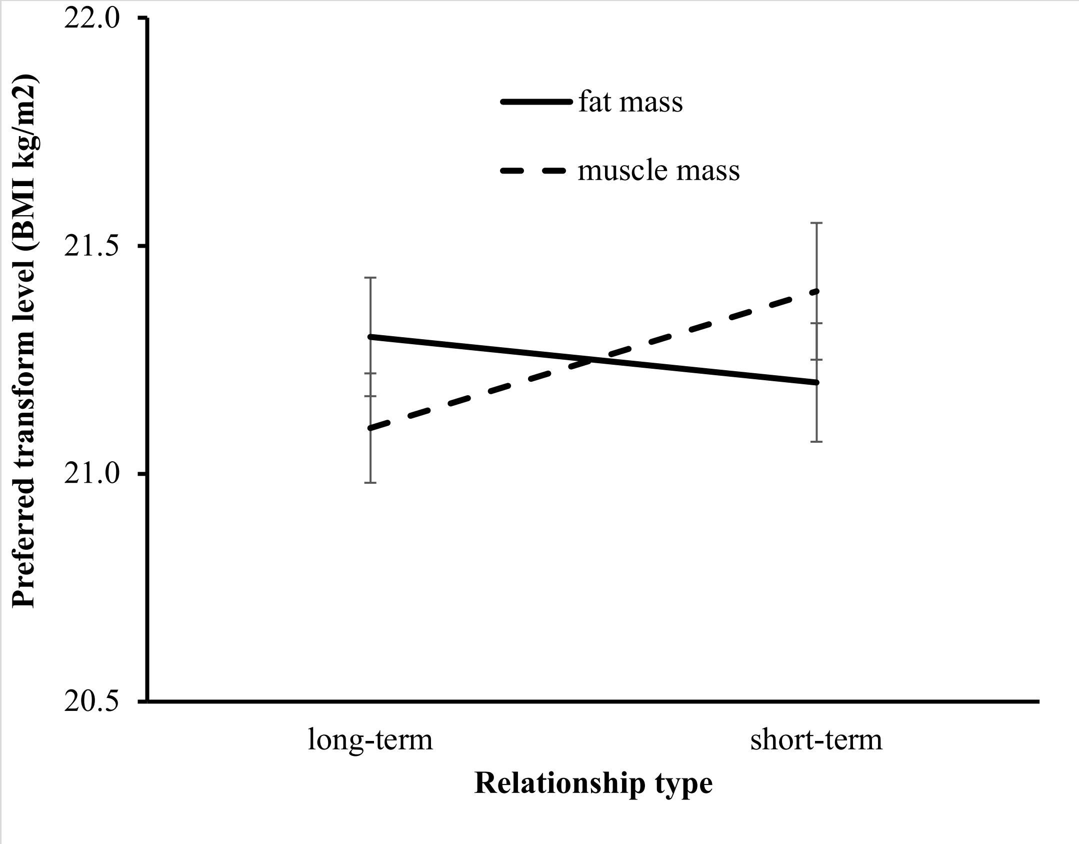


Figure 13. The interaction between relationship context (short-term vs long-term relationship) and preferred facial correlates of body composition (fat mass and muscle mass) in MTurk participants. The vertical axis represents the associated BMI of the most preferred faces. Error bars represent standard errors.

One-sample *t*-tests compared the preferred BMI transform level (average across the three face sets) to a BMI of 22 (the average of the original starting BMI of the face stimuli). MTurk participants preferred a BMI significantly reduced from a BMI of 22 for both fat mass and muscle mass in short-term (fat mass: $M = 21.24$, $t(57) = –5.82$, $p < 0.001$; muscle mass: $M = 21.42$, $t(57) = –3.96$, $p < 0.001$) and long-term (fat mass: $M = 21.32$, $t(57) = –5.37$, $p < 0.001$; muscle mass: $M = 21.10$, $t(57) = –7.17$, $p < 0.001$) relationships.

Different from the student sample, Pearson correlation test showed that media internalisations was not significantly correlated with a preference for facial correlates of muscle mass for both short-term relationships ($r(56) = 0.10$, $p = 0.465$) and long-term relationships ($r(56) = 0.11$, $p = 0.407$).

4.4.3 Interim discussion

This study investigated heterosexual women’s preferences for men’s facial correlates of body composition under different relationship contexts. In line with our Hypothesis 4, women showed a stronger preference for faces associated with higher muscle mass in a short-term relationship compared with a long-term relationship. In contrast, women did not shift their preference for the facial correlate of fat mass between short-term and long-term relationships even though their overall preference lay in the low end of normal weight (BMI~21kg/m^2).

4.5 General discussion

The present study aimed to investigate the attribution of facial correlates of body composition (fat mass and muscle mass) on perceived facial masculinity in men, as well as their effect on women's preferences in terms of relationship context. The findings from Study 1 supported our hypotheses that both facial correlates of fat mass and muscle mass positively affect perceived facial masculinity. While the facial correlate of muscle mass had a pronounced effect on perceived masculinity, the effect of the facial correlate of fat mass increased masculinity only in underweight to lower normal weight men. In interactive preferences tests where women optimised the shape of a male face, we found that there is a context shift of women's preference towards males' facial correlates of body composition, with women preferring facial correlate of more muscle mass under a short-term relationship context compared with a long-term relationship. However, this effect was not found in the facial correlate of fat mass, suggesting that women do not shift their preference for the facial correlate of fat mass between short-term and long-term relationships.

4.5.1 Attribution to perceived facial masculinity

Our findings are consistent with previous findings that heavier men are perceived to be more masculine from faces (Holzleitner et al., 2014). On the other, the results further extend previous findings that 'facial adiposity' (weight perceived from the facial appearance) was positively associated with perceived masculinity mainly in under to normal weight men but not in overweight men (Phalane et al., 2017). It should be noted that the definition of facial adiposity in Phalane's study was a measure of the facial correlate of body weight, which can include two components, namely fat mass and muscle mass. When analysed together, the effect on masculinity perception only worked in underweight to normal weight men. However, by distinguishing the facial correlate of weight into two dimensions, our results showed that the finding in Phalane's work might be mainly driven by the facial correlate of fat mass.

Most importantly, we found consistent results across the three sets of prototypes, meaning our manipulations of face shape do influence males' facial masculinity successfully. Although the relationship between facial correlate of fat mass and masculinity perception is slightly different between faces transformed with the 2D version of 3D prototypes and faces transformed with the other two prototypes, the facial correlate of muscle mass was found to have a larger impact on perceived masculinity across the three prototypes.

The causes of differences between the effects of facial correlates of fat mass and muscle mass on perceived facial masculinity might reflect the sexual dimorphism of body physique because men are generally heavier in body weight and have more muscle mass than women (Wells, 2007). Consequently, heavier men with higher muscle mass are seen as more masculine, as shown in our study. Although men are generally heavier than women, the weight difference is mainly due to the higher muscle mass men possessed. Hence, the excess fat mass does not make male faces more masculine, whereas the decreased weight whether due to loss of fat mass or muscle mass is detrimental to men's perceived masculinity.

It is also possible that the facial correlates of muscle serve as a cue to testosterone levels and thus enhance masculinity perception more than the facial correlate of fat mass. In fact, increased testosterone levels during puberty cause growth of jaw, brow, chin and nose (Marečková et al., 2011). As a result, adult male faces have a relatively longer and broader lower jaw, higher brow ridges, and more prominent cheekbones compared to adult women (Little, Jones, & DeBruine, 2011). The perceptual studies here provide further evidence that the face shape correlates of fat mass and muscle mass are distinct in men. Holzleitner and Perrett (2016) found that observers were able to distinguish the face shape correlates of fat mass and muscle mass using 3D facial stimuli. Here we find further distinctions for the fat and muscle aspects of body composition for both 2D and 3D facial stimuli. A visual adaptation study also suggested that body fat and muscle are processed independently in the brain (Sturman, Stephen, Mond, Stevenson, & Brooks, 2017). The face shape correlates of muscle may not only provide cues to body composition and physique but also may provide a cue to testosterone levels, and hence influence masculinity perception.

Taken together, we have shown that the perception of male facial masculinity is not only based on the cues to body weight. More importantly, muscularity is the aspect of the body composition that has greatest influence on facial masculinity perception.

4.5.2 Context shift in preferences for facial masculinity

The results from Study 2 indicate that women's preference for male's face shape is dependent on the relationship context. We found women prefer male faces associated with muscle mass more for short-term relationships than for long-term relationships but women do not show different preferences for facial cues to fat mass between short- and long-term relationships.

Our findings appear to be in line with the good genes hypothesis, which argues that women are attracted to indicators signalling heritable aspects of immunity and health (e.g. facial masculinity) when seeking short-term partners (Gangestad & Simpson, 2000; Gangestad et al., 2005). We note that we do not have direct evidence suggesting facial correlate of muscle mass indicates good genes, but one could argue that facial correlate of muscle mass reflects the individual's testosterone levels and muscle mass, which was found to be linked with general health and fitness (Wolfe, 2006; Kelly & Jones, 2013; Elagizi, Köhler, & Lavie, 2018). Moreover, increase in testosterone during puberty is reflected in face shape, with enlarged jaws, prominent brows and elongated chins (Marečková et al., 2011). Therefore, women may use the testosterone-dependent trait like facial correlate of muscle mass as a cue to good genes, thus prefer it more in a short-term relationship.

Nonetheless, we do not rule out the alternative interpretation that the context difference in preference for masculinity might reflect avoidance of negative characteristics associated with higher muscularity in long-term relationships. As shown in Study 1, the facial correlate of muscle mass profoundly enhances perceived masculinity, which is negatively associated with many desirable traits that women value in long-term relationships. Previous studies have revealed that men with high testosterone levels and more fat-free mass (greater muscle mass) report having a larger number of sex partners, indicating that these men might devote more effort in mating relative to parenting (Lassek & Gaulin, 2009; Peters, Simmons, & Rhodes, 2008). Further, other studies show that men with high testosterone levels are less likely to get married and more likely to get divorced (Booth & Dabbs, 1993; Julian & McKenry, 1989; Booth et al., 2000). Hence, male faces that reflect high levels of androgen-mediated traits may be less preferred by women in a long-term relationship because of the associated behavioural traits that are inconsistent with paternal investment.

This interpretation may also account for why women do not show different preferences for the facial correlate of fat mass between the two relationship contexts. Although we predicted facial cues to higher fat mass would be preferred for short-term relationships because higher fat mass contributes to facial masculinity (at least in low weight men), the masculinity perception contributed by the facial correlate of fat mass, however, is not testosterone dependent. Therefore, despite the fact that faces associated with higher fat mass are perceived to be more masculine, the same facial cues to fat mass are not necessarily associated with the undesirable testosterone-mediated traits. Consequently, women do not need to shift their preference between short- and long-term relationships since there are no (or fewer) associated costs with preferring masculinity that derives from slightly higher fat mass. Therefore, the relationship context preference differences that we find may reflect women's reluctance to choose very muscular men who appear unsuitable as long-term partners. Future studies investigating the perception of personality traits from facial cues to fat mass and muscle mass may provide better understandings for the context shifts.

It worth mentioning that women generally prefer faces reflecting low fat mass and muscle mass under both contexts. The associated BMI of the most preferred face was significantly reduced compared with the original starting BMI of the facial stimuli (namely BMI of 22.0 kg/m^2). This suggests that men with low-normal body weight but not underweight are most preferred by women as partners. This finding is in line with previous studies on men's attractiveness and BMI, which found that the most preferred male bodies resemble BMI around 21 kg/m^2 (Swami & Tovée, 2008). The findings are also consistent with one prior study, which found an inverted U shape relationship between men's body attractiveness and muscularity (Frederick & Haselton, 2007). Men with medium levels of muscle mass were rated to be more sexually desirable compared with the very low or very high levels of muscularity (Frederick & Haselton, 2007).

By contrast, our findings are less consistent with recent findings that stronger men are seen as more attractive (Sell et al, 2017; Foo, Simmons, Peters, & Rhodes, 2018) with a linear increase in attractiveness reported for the range of men's strength sampled. There are two possible reasons for the inconsistency. Firstly, it should be noted that the two studies mainly focused on attractiveness of men's bodies rather than men's faces. There might be a discrepancy between the attractiveness of men's bodies and faces. Women might find a stronger body attractive but not necessarily the face shape accompanying such a body. Future study may set out to test whether women show consistent preferences for men's body muscularity and the facial correlates of muscle.

Second, the studies that found a positive relationship between strength and attractiveness have adopted a correlational method comparing strength to ratings of natural bodies (Sell et al, 2017; Foo et al., 2018), while we employed an interactive method to let participants optimise the most attractive face shape from stimuli synthesised with computer graphics. Support for the divergence of results reflecting different methods comes from the study of Brierley et al. (2016) who used a similar interactive method to test the attractiveness of men's bodies. Brierley et al. found that a slight decrease of body fat and slight increase of body muscle was optimal for men with normal starting BMI and body composition. In both the experiment of Brierley et al. and the experiment here, men with a high muscular body composition were not the most attractive. Studies comparing ratings of real and computer-manipulated images may help resolve the difference in attraction of strong and muscular men.

4.5.3 Media influence on women's preference

Previously, many studies have shown that long-term exposure to media and internalisation of media ideals could result in a desire for thinness in women (Thompson et al., 1999; Tiggemann & Slater, 2013). Additionally, Swami et al. (2010) found that men reported more exposure to Western media are more likely to report a preference for thin women. With substantial attention to the impact of media on women's body image, few studies have explored the media influence on women's preferences for male bodies. For the student group studied here we showed that women who accept media ideals to a great degree have a stronger preference for facial correlates of muscle than women less acceptable of the media ideals. This finding indicates that the influence of media portrayals of idealized bodies is not only limited to female bodies but also extends to women's preference for men.

In addition, the media influence on women's preferences was found for short-term partners only but not long-term partners. This difference might be because women put higher values on attractiveness for short-term partners than long-term partners (Li & Kenrick, 2006).

It is noteworthy, that the media impact was only found in the student sample but not the MTurk sample. One potential explanation of the difference between samples is age. The student sample are more likely to accept media ideals than older adults (note: the MTurk sample were considerably older than the student sample). Since the majority of portrayals in the media are of relatively young adults, university aged students may feel greater association with those portrayed, thus have a greater desire for attaining the body shapes both for themselves and their partners.

4.5.4 Caveats

Although our hypotheses are supported with the use of both 2D and 3D facial stimuli, we note that a higher BMI (in both fat and muscle dimensions) was preferred in 3D faces compared to 2D faces. This effect of dimensionality might be due to the fact that our 3D stimuli combined both the front and the profile views, whereas our 2D stimuli used the front view alone. The combination of front and profile views may provide more information relating to weight. Alternatively, the profile view may provide information that is distinct from that evident in the front view. Indeed, prior study has shown that women make different choices for attractiveness and dominance when viewing front and profile views of the male faces (Swaddle & Reierson, 2002). Furthermore, Danel et al. (2018) showed that the measured sexually dimorphic facial features show only a moderate correlation across front and profile views (r = .20). These findings imply that further experiments are required to understand the processing of frontal and lateral views of the face.

Also noteworthy is that the manipulation of faces may also represent testosterone based facial changes since testosterone increases during puberty do not only induce facial feature changes like enlarged jaws and prominence of eyebrow ridge but also promote muscle growth (Marečková et al., 2011; Wells, 2007). If that is the case, the results here might reflect masculinity and attractiveness judgement from facial indicators of testosterone rather than body composition. Although that is possible, the manipulation of faces in the current study was based on body composition *per se*. Future study could investigate whether testosterone plays a mediating role in the relationship between body composition and masculinity as well as attractiveness judgement.

4.6. Conclusions

In summary, we have shown the distinct effects that facial correlates of fat mass and muscle mass have on perceptions of masculinity and attractiveness in men. Our findings show that the facial correlate of muscle mass has a profound impact on perceived facial masculinity in men of all weights. By contrast, the facial correlate of fat mass affects masculinity only in underweight to lower normal weight men. Further, we find a contextual shift in women's attraction to the facial correlate of muscle mass but not fat mass, with a stronger preference for male face shapes associated with high muscle mass under a short-term relationship context compared to a long-term relationship context.

Body size and its cues reflected on faces have been documented to have impacts on a variety of judgements, like attractiveness, strength, dominance, leadership and employment (Phalane et al., 2017; Holzleitner & Perrett, 2016; Windhager, Schaefer, & Fink, 2011; Re & Perrett, 2014; Nickson, Timming, Re, & Perrett, 2016). Our findings highlight the importance of differentiating size-related effects separately for body fat and body muscle.

Chapter 5 How weight and body composition affect apparent health and kindness

Abstract

Previous studies have consistently found that women prefer masculine men more for short-term than long-term relationships. In study 2, we found that both facial correlates of fat and muscle contribute to male facial masculinity but have differential effects on face preferences. Hence, the current study set out to answer why women show stronger preference for facial correlates of muscle but not fat. Two explanations have been offered to explain the context shift of women's mate preferences: the good genes hypothesis (higher masculinity may reflect better condition) and the good parent hypothesis (higher masculinity may indicate lower prosociality and care-giving). The present study set out to compare these two accounts by investigating the perception of health and kindness from men's faces. We thus digitally transformed male face shape simulating the effects of raised and lowered levels of body fat or muscle, controlling for each other, height and age. One hundred participants were asked to rate either health or kindness of transformed faces. Additionally, participants were asked to adjust the shape correlates of fat and muscle to make men's faces look most healthy or kind. The results revealed that facial correlates of fat and muscle mass had similar effects on the perception of health in male faces. Men with moderate levels of fat and muscle were perceived to be most healthy: high levels of both muscle and fat were perceived as less healthy. By contrast, high levels of muscle diminished perceived kindness in men's faces far more than high levels of fat. Hence, women's stronger preference for facial correlates of muscle but not fat in short-term partners might be because facial correlates of muscle diminish men's perceived kindness far more than fat. Collectively, these findings lend more support to the good parent hypothesis and suggest that women's mate preference shift between short- and long-term relationships might be due to the desire for good characteristics in long-term partners.

5.1 Introduction

Research in sexual selection theory has focused on women's mate preferences in the past three decades. One finding that has replicated across different studies is the effect of relationship context on women's preferences for masculinity. Women prefer masculine men more as short-term partners than long-term partners (Jones et al., 2018; Little et al., 2002; Little, Connely, et al., 2011; Little, Jones, & Burriss, 2007; Penton-Voak et al., 1999; Provost, Troje, & Quinsey, 2008). Two explanations have been proposed to account for the different masculinity preference between short-term and long-term relationships. The 'good genes' explanation suggests that for short-term relationships, when indirect benefits or heritable traits are most important, women are attracted to men displaying high genetic quality (immune) traits (Gangestad & Simpson, 2000). On the other hand, the 'good parent' explanation proposes that for long-term relationships, women prefer men who show signs of being good parents or providers (Gangestad & Simpson, 2000). Interestingly, masculinity is argued to be a trait perceived as signalling good genes but at the same time also being a poor parent (Roney, Hanson, Durante, & Maestripieri, 2006). Although there is evidence supporting both the 'good genes' and the 'good parent' accounts (Perrett et al., 1998; Thornhill & Gangestad, 2006), the relative importance of the two explanations regarding the greater masculinity preference in a short-term context remains unclear. In Study 2, we found that women prefer higher facial masculinity, as indexed by a facial shape associated with high levels of muscle, for short-term relationships more so than for long-term relationships. The current study aimed to investigate whether facial masculinity as indexed by facial cues to body muscle and fat is perceived as a cue to traits associated with good immune genes or to traits associated with good parenting.

In support of the good genes hypothesis, studies have shown that masculinity is positively linked to aspects of health or perceived health. For example, several studies report that male masculinity is negatively related to disease frequency, (e.g. respiratory infections, Thornhill & Gangestad, 2006), and is positively related to general health during adolescence (Rhodes, Chan, Zebrowitz, & Simmons, 2003), although the link between masculinity and health is weak. In addition, men perceived to be more masculine (or muscular) have been found to have stronger immune response (Rantala et al., 2013; Phalane et al., 2017), have higher semen quality (Foo, Simmons, & Rhodes, 2017) and perceived to be healthier than less masculine-looking men (Boothroyd, Scott, Gray, Coombes, and Pound 2013; Phalane et al., 2017). Nonetheless, Boothroyd et al. (2013) found that masculine facial features negatively predicted future health, at least in terms of flu bouts. Therefore, studies examining the relationship between men's perceived masculinity and health yielded mixed results.

By testing the diversity in innate immune genes, researchers found that facial masculinity did not predict heterogeneity of the major histocompatibility complex genes (Lie, Rhodes, & Simmons, 2008; Zaidi et al., 2019). Moreover, the positive link between facial attractiveness and immune gene diversity was not mediated by masculinity but rather facial averageness (Lie et al., 2008). Likewise, in a study examining men's immune response to hepatitis B vaccination, the association between immunocompetence and facial attractiveness was found to be mediated by facial adiposity rather than facial masculinity (Rantala et al., 2013). These findings suggest that masculinity may not serve as a cue to mate value in terms of heritable immunity (Scott, Pound, Stephen, Clark, & Penton-Voak, 2010). Indeed, these failures to link masculinity with health raise doubts as to whether women's stronger preference for masculine men as short-term partners can be explained as a preference for a cue to heritable health benefits.

In sharp contrast, numerous studies have provided support for the good parent hypothesis. The evidence comes mainly from work investigating the impact of masculinity on men's perceived prosociality. Masculine facial features or higher perceived masculinity are associated with perceptions of increased dominance (Boothroyd et al., 2007; Puts, 2010), poor quality as parents (Boothroyd et al., 2007; Perrett et al., 1998) and decreased trustworthiness (Perrett et al., 1998). All of these traits play important roles in women's mate decisions, especially when considering long-term relationships. In essence, pro-social, altruistic behaviour is highly valued by women. Men displaying altruistic behaviour are more preferred in long-term relationships (Farrelly, 2013; Farrrelly, Clemson, & Guthrie, 2016; Moore et al., 2013). Moreover, women rated potential long-term partners who were high in altruism but low in attractiveness to be more desirable than men high in attractiveness but low in altruism, suggesting that pro-social traits are indeed valued by women in long-term relationships (Moore et al., 2013). Complementing these findings, other research has shown that masculinity or testosterone levels (a hormone which induces phenotypical masculinity expression) predicts lower marriage rates, unfaithfulness, higher domestic disputes and divorce rates, as well as decreased paternal investment (Booth, & Dabbs, 1993; Booth et al., 2000; Foo, Loncarevic, Simmons, Sutherland, & Rhodes, 2019; Julian, & Mckenry, 1989).

The close link between men's sociosexuality and facial masculinity may also contribute to explaining women's preference for less masculine men as long-term partners.

Boothroyd, Jones, Burt, DeBruine, and Perrett (2008) found that the composite faces of men scoring higher on the Socialsexual Orientation Inventory (which measures positive attitude towards uncommitted sexual relationships) were judged to be more masculine than composites men who scored lower on the scale. This finding implies that women may use facial masculinity as a cue to men's sociosexual attitudes and behaviour, which in turn influences women's mate choices. Indeed, there is evidence that masculinity and other testosterone-mediated traits (e.g. muscularity) positively predict men's self-reported number of sexual partners. For example, it has been shown that men with masculine bodies (both rated and measured) report more short-term partners and sexual partners than their low-masculine counterparts (Hughes & Gallup, 2003; Rhodes, Simmons, & Peters, 2005). Similarly, muscular men report having more total lifetime partners, short-term partners, as well as more affairs with partnered women compared to less muscular men (Frederick & Haselton, 2007). These findings not only suggest that masculine men are more attractive to women as short-term partners but also hint that masculine men may devote more effort to mating rather than parenting (Mascaro, Hackett, & Rilling, 2013), which is highly valued by women in long-term relationships. In fact, one study showed that women attribute mating-driven behaviour to men with masculine faces, while men with low masculine faces were judged to be more likely to make efforts in parenting (Kruger, 2006).

Collectively, the literature described above suggests that masculine men may not be suitable as long-term partners because of the associated undesirable personality traits and behaviour. Hence, preferring less masculine men might be more advantageous for long-term relationships as both women themselves, and their offspring are more likely to obtain durable and reliable resources and protection from less masculine men.

To our knowledge, few studies have tested the two hypotheses at the same time, which made direct comparisons difficult. In the current study, we aim to examine whether the good genes or the good parent hypothesis is a better account for the context shift of women's preference for masculinity. Most importantly, the current study set out to answer the question left in the last chapter, which is why women show stronger preference for facial correlates of muscle but not fat for short-term relationships than long-term relationships since both of it contribute to male facial masculinity. We postulated that it might be because muscle is a testosterone-dependant trait, which means a close association with perceived undesirable personality traits that women dislike in long-term partners. Whereas, fat is not a testosterone-dependent trait, thus facial correlates of fat may not correlate with undesirable personality traits that women dislike.

Following Study 1 and 2, we simulated male face shape associated with different body compositions covering a wide range of perceived masculinity. We presented the transformed male faces to participants and asked them to judge the health (to test the good genes hypothesis) and kindness (to test the good parent hypothesis) of images. In addition, we included interactive tasks to determine the facial appearance perceived as healthiest and kindest. Based on the good genes hypothesis, we predicted that there would be a quadratic relationship between the facial correlates of fat mass and perceived health because facial cues to fat have been found to increase perceived masculinity in low to normal weight men but have less or no effect in normal to overweight men (Hypothesis 1). At the same time, based on participants' awareness of links between obesity and illness, we predicted facial cues to high fat would be perceived as less healthy compared to facial cues to low fat since excessive body fat is harmful to health (Hypothesis 2). We also hypothesized that faces representing high muscle would be perceived as healthier than faces representing low muscle (Hypothesis 3) since higher muscle mass is not only positively associated with facial masculinity but also general physical fitness. Based on previous findings that both facial correlates of higher fat and muscle mass enhance male facial masculinity, which has been consistently found to increase perceived dominance, we predicted that facial correlates of higher fat and muscle would weaken perceived kindness (Hypothesis 4). Moreover, we predicted that perceived kindness would be more strongly affected by cues to muscle than cues to fat mass due to the larger effect of muscle mass on perceived masculinity (Hypothesis 5).

5.2 Methods

All work was approved by the Ethics Committee of the University of St Andrews (PS13176). All participants gave informed consent.

5.2.1 Stimuli

The stimuli used in this study is identical to the stimuli in Study 1&2 (see 4.2).

5.2.2 Participants

To avoid participants trying to be consistent throughout judgements, we recruited two independent samples to rate either health or kindness of stimuli.

Health evaluators Sixty participants were recruited via the online recruitment platform Prolific Academic and received £2 as reward. Prescreening criteria were applied as following: age between 18-45 years old and Caucasian ethnicity. Participants who did not finish all trials of a particular type were excluded from further analysis, but participants who finished all trials of either rating or interactive task were included in analysis of that particular task. This resulted in 53 particpants who completed the health interactive task (M_{age} ± SD = 28.21 ± 6.83, range 18–44 years; 26 females) and 51 participants who completed the health rating task (M_{age} ± SD = 28.00 ± 6.88, range 18–44 years; 24 females).

Kindness evaluators An independent sample of 60 participants was recruited from Prolific Academic and received £2 as reward. Health evaluators were restricted from doing the kindness evaluation. The same prescreening criteria were used as for the health eveluators. After exclusion, 52 particpants completed the kindness interactive task (M_{age} ± SD = 30.13 ± 6.49, range 18–43 years; 29 females) and 50 participants completed the kindness rating task (M_{age} ± SD = 30.26 ± 6.45, range 18–43 years; 27 females).

5.2.3 Procedure

At the beginning of the experiment, participants were asked to complete a demographic questionnaire inquiring about age and sex. The experiment included two types of tasks.

One was an interactive task, where the transformed images were presented as continua representing +/–4 BMI units change on fat mass or muscle mass dimensions. Therefore, there were 18 face continua in total (3 identities × 2 dimensions (fat/muscle) × 3 face sets (3D face set, 2D version of 3D face set, independent 2D face set)). The 3D face set and two 2D face sets were presented in separate blocks and in a random order. The trials within blocks were randomized. Participants were instructed to change the face shape until they thought it looked most healthy/kind by draging the cursor on the slider ("Please change the face to make it look most HEALTHY/ KIND"). The scroll direction to change the face shape was randomized across trials to prevent participants trying to find the same point for every stimulus. The transform level at which an image was initially displayed was also randomised across trials. There was no time limit to adjust the face shape. The next image was shown only after the participants had adjusted the face shape and clicked the submit button.

After finishing the interactive task, participants were shown a rating task. In this task, transformed face images were displayed individually with a sliding bar below the images. To keep the number of trials as low as possible, stimuli consisted of faces transformed to four levels (–4 BMI units, –2.3 BMI units, +2.3 BMI units, +4 BMI units) as well as the untransformed image (+0 BMI units). In total, 81 stimuli were shown (3 (face identities) × 3 (face sets: 3D face set, matched 2D version of 3D face set, independent 2D face set) × 9 (4

BMI levels x 2 dimensions (fat & muscle) + original face)). The three face sets were grouped in three blocks. The order of the blocks and trials within blocks were randomized. Pariticipants were asked to rate the health or the kindness of each stimulus (“Please adjust slider to indicate how HEALTHY/KIND you perceive this man to be”) by dragging the cursor on a sliding bar with anchors (1 = very unkind/unhealthy and 7 = very kind/healthy; numerical values were not visible). The starting point of the cursor was randomized. Participants were allowed to make the judgements for as long as they wanted. The next face was shown only after the participant had adjusted the cursor and clicked for the next trial.

5.2.4 Statistical analysis

Data were analysed in IBM SPSS 24.0. Analysis procedures were identical for health and kindness judgements.

Inter-rater reliability was high for both health and kindness ratings (Cronbach’s α health = 0.917, kindness = 0.912). Health/kindness ratings were averaged across the three face identities of a given transform dimension, face set and transform level for each participant. Male and female participants ratings were highly correlated across the 30 facial stimuli (health: $r = 0.87$; kindness: $r = 0.74$). Responses to the interactive tasks did not differ significantly. Therefore male and female ratings were pooled for further analysis.

Three-way ANOVAs were conducted with transform dimension (fat and muscle), transform level (–4 BMI units, –2.3 BMI units, no change, +2.3 BMI units, +4 BMI units) and face set (3D, matched 2D and independent 2D) as within-subject variables, and ratings as dependent variable.

To test Hypothesis 1 (that a quadratic function would relate BMI to rated health), planned comparisons were made between the peak point (the BMI level receiving highest average rating) and the lowest weight (–4 BMI units) as well as the highest weight (+4 BMI units) for faces transformed on the fat mass. Similarly, to test Hypothesis 2 (that high weight is more harmful to health judgments than low weight) paired-samples t-test between faces associated with the lowest (–4 BMI units) and highest amount of body fat (+4 BMI units) were conducted. To test Hypothesis 3 (that faces associated with higher muscle mass would be perceived as healthier than faces associated with lower muscle mass), paired-samples t-test between faces associated with the lowest (–4 BMI units) and highest amount of muscle mass (+4 BMI units) were conducted.

In order to test whether faces simulating higher fat mass and muscle mass would be perceived as less kind (Hypothesis 4), paired-samples t-tests were conducted between ratings of the untransformed faces and faces associated with higher fat/muscle mass (+4 BMI units). Further, ratings of faces associated with higher fat and muscle were compared using paired-samples t-tests to test Hypothesis 5 (that high muscle would be associated with less kindness than high fat).

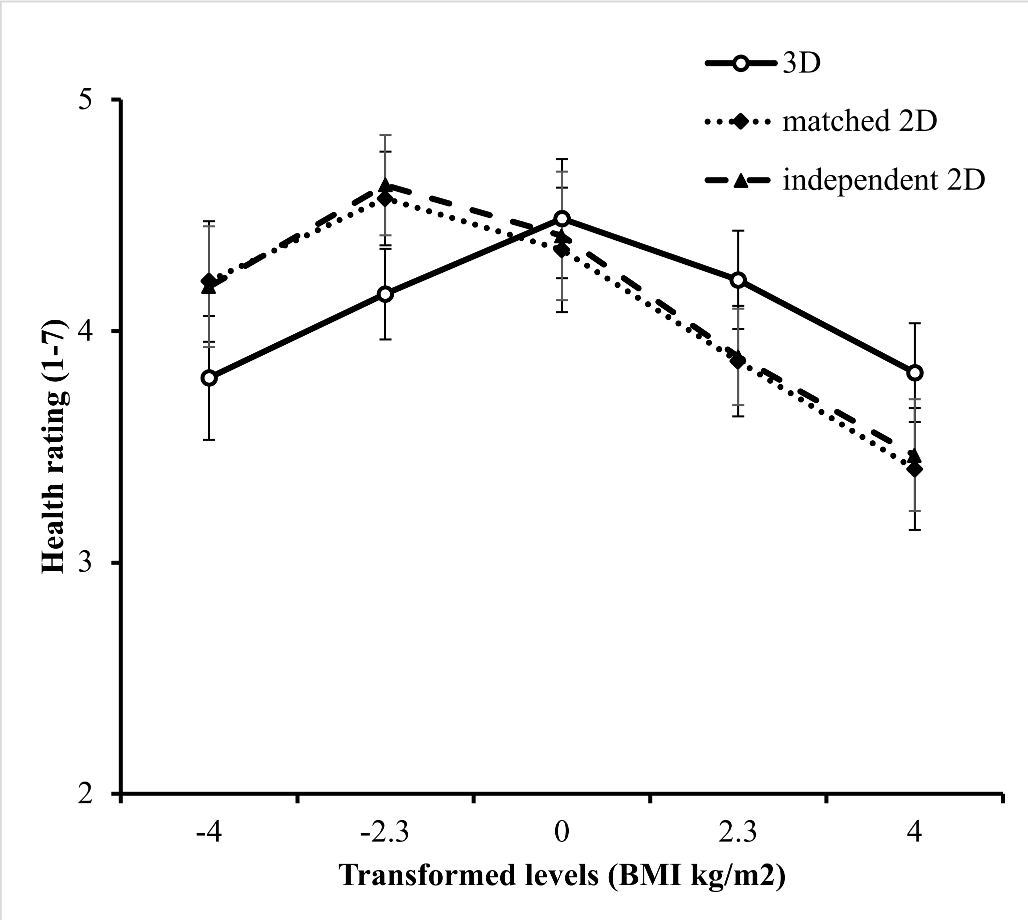
To determine the BMI associated with the healthiest and kindest looking face shape, the transform levels of the images chosen in the interactive tasks were converted back to equivalent BMI units. In order to test whether the associated BMI of the chosen faces were consistent across the three face sets and transform dimension, two-way ANOVAs were run with the transform dimension (fat and muscle) and face set (3D, matched 2D and independent 2D) as within-subject variables and the BMI chosen to be the healthiest/kindest as the dependent variable. Further, one sample t-test were conducted to test whether participants choose faces associated with BMIs significantly different from the starting point (BMI 22).

5.3. Results

5.3.1.1 Health rating

The three-way ANOVA results showed a non-significant main effect of face set ($F(2,100) = 0.9$, $p = 0.913$, $\eta^2 = 0.002$) and transform dimension ($F(1,50) = 3.18$, $p = 0.081$, $\eta^2 = 0.060$), with faces transformed on the fat mass dimension ($M = 4.13$, $SD = 0.57$) rated non-significantly higher in health than faces transformed on the muscle mass dimension ($M = 4.07$, $SD = 0.59$). As expected, there was a significant main effect of the transform level ($F(4,200) = 32.90$, $p < 0.001$, $\eta^2 = 0.397$). Yet, this main effect was qualified by an interaction with face set ($F(8,400) = 10.45$, $p < 0.001$, $\eta^2 = 0.173$) (see Figure 14). Therefore, it was decided to test the effect of transform level effect separately for each face set. Since transform dimension had no significant main effect, data from fat and muscle transformation were combined in subsequent analysis.

Figure 14. Average health ratings for faces at different BMI levels (combined data from fat and muscle mass transforms) for the three face sets. Error bars represent the 95% confidence interval.



<u>3D face set</u>

There was a significant main effect of transform level ($F(4,200) = 13.25$, $p < 0.001$, $\eta^2 = 0.210$). In line with Hypothesis 1, the test of contrasts showed a significant quadratic relationship between transform level and health rating ($F(1,50) = 33.86$, $p < 0.001$, $\eta^2 = 0.404$), the linear term was non-significant ($F(1,50) = 0.153$, $p = 0.698$, $\eta^2 = 0.003$). In line with Hypothesis 1, pairwise comparisons showed that the untransformed faces ($M = 4.49$, $SD = 0.92$) were rated significantly higher in health compared to both the faces transformed to lower weight ($M = 3.80$, $SD = 0.95$) ($t(50) = 5.16$, $p < 0.001$) and higher weight ($M = 3.82$, $SD = 0.76$) ($t(50) = 4.47$, $p < 0.001$). Furthermore, there was no significant difference on health rating between faces transformed to the lower weight compared to faces transformed to the higher weight ($t(50) = -0.22$, $p = 0.830$).

Matched 2D face set

The results showed a significant main effect of transform level ($F(4,200) = 23.96$, $p < 0.001$, $\eta^2 = 0.324$). Test of contrasts revealed both linear ($F(1,50) = 34.08$, $p < 0.001$, $\eta^2 = 0.405$) and quadratic ($F(1,50) = 23.59$, $p < 0.001$, $\eta^2 = 0.321$) components. Inspection of Figure 4 shows that the healthiest appearance for this face set occurred with faces transformed to resemble a slightly lower than original weight: a reduction of 2.3 BMI units ($M = 4.57$, $SD = 0.72$). These faces were rated significantly healthier compared to the faces resembling a 4 BMI unit reduction ($M = 4.21$, $SD = 0.93$) ($t(50) = 4.16$, $p < 0.001$) and a 4 BMI unit increase ($M = 3.40$, $SD = 0.93$) ($t(50) = 8.12$, $p < 0.001$). In line with Hypothesis 2, faces transformed to the higher weight were rated significantly lower on health compared to faces transformed to the lower weight ($t(50) = -5.31$, $p < 0.001$).

Independent 2D face set

There was a significant main effect of transform level ($F(4,200) = 29.15$, $p < 0.001$, $\eta^2 = 0.368$). Similar to the matched 2D face set, test of contrasts showed both linear ($F(1,50) = 42.11$, $p < 0.001$, $\eta^2 = 0.457$) and quadratic ($F(1,50) = 34.56$, $p < 0.001$, $\eta^2 = 0.409$) components. Again, Figure 14 shows that the healthiest appearance occurred for faces transformed to a slightly lower (–2.3 BMI units) than original weight. In line with Hypothesis 1, faces associated with 2.3 BMI unit decrease ($M = 4.63$, $SD = 0.77$) were rated significantly healthier compared to the faces associated with 4 BMI unit decrease ($M = 4.19$, $SD = 0.93$) ($t(50) = 4.55$, $p < 0.001$) and 4 BMI units increase ($M = 3.46$, $SD = 0.86$) ($t(50) = 9.62$, $p < 0.001$). In line with Hypothesis 2, and similar to the matched 2D face set, faces transformed to the higher weight were rated significantly lower on health compared to faces transformed to the lower weight ($t(50) = -5.25$, $p < 0.001$).

5.3.1.2 Health interactive

A two-way ANOVA was run to test the data from the interactive task. The results revealed a significant main effect of the face set ($F(2,104) = 68.02$, $p < 0.001$, $\eta^2 = 0.567$), with participants choosing a higher BMI for the 3D face set ($M = 21.78$, $SD = 1.26$) compared to the matched 2D face set ($M = 20.11$, $SD = 1.14$) and the independent 2D face set ($M = 20.23$, $SD = 0.94$) (see Figure 15). This result is in line with findings from the rating task. In addition, there was a significant main effect of transform dimension ($F(1,52) = 4.78$, $p = 0.033$, $\eta^2 = 0.084$), with participants choosing higher BMI to optimize health for the fat transform ($M = 20.84$, $SD = 1.07$) than the muscle transform ($M = 20.57$, $SD = 0.95$), although no prediction was made regarding the comparison between fat and muscle transform. The interaction between face set and transform dimension was non-significant ($F(2,104) = 1.07$, $p = 0.348$, $\eta^2 = 0.020$).

One sample t-test comparing the healthiest BMI chosen by participants with the original BMI (≈22) shows that on average the healthiest weight corresponded to be a reduction in BMI compared to the original starting weight for both 2D face sets (*ps* < 0.001) but not the 3D face set ($p = 0.207$).

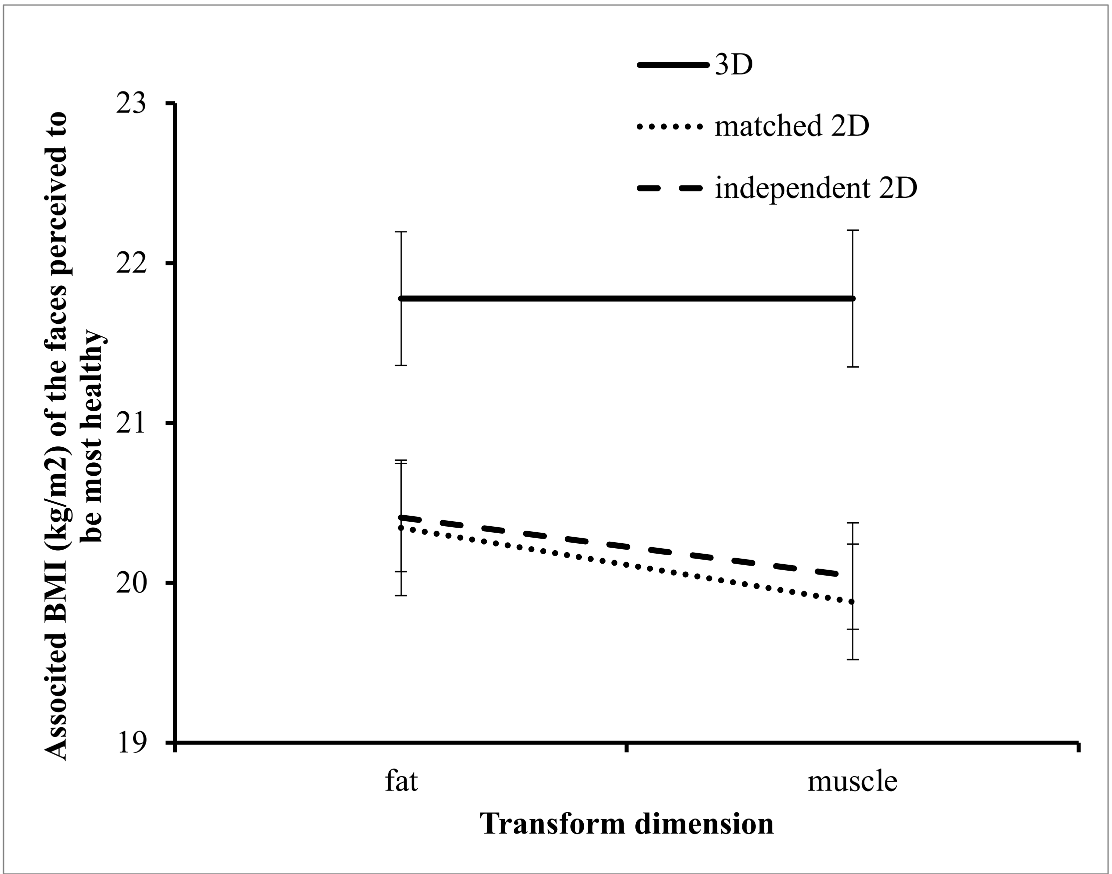


Figure 15. The amount of BMI chosen to optimise health perception of faces transformed with the facial correlates of fat and muscle mass for three face sets. Error bars represent the 95% CI.

5.3.2.1 Kindness rating

The three-way ANOVA results showed significant main effects of the face set ($F(2,98) = 9.80$, $p < 0.001$, $\eta^2 = 0.167$), the transform dimension ($F(1,49) = 16.61$, $p < 0.001$, $\eta^2 = 0.253$) and the transform level ($F(4,196) = 28.57$, $p < 0.001$, $\eta^2 = 0.368$). Moreover, the three way interaction was significant ($F(8,392) = 3.52$, $p = 0.001$, $\eta^2 = 0.067$). Therefore, two-way ANOVAs were conducted separately for the kindness rating of each face set for better understanding.

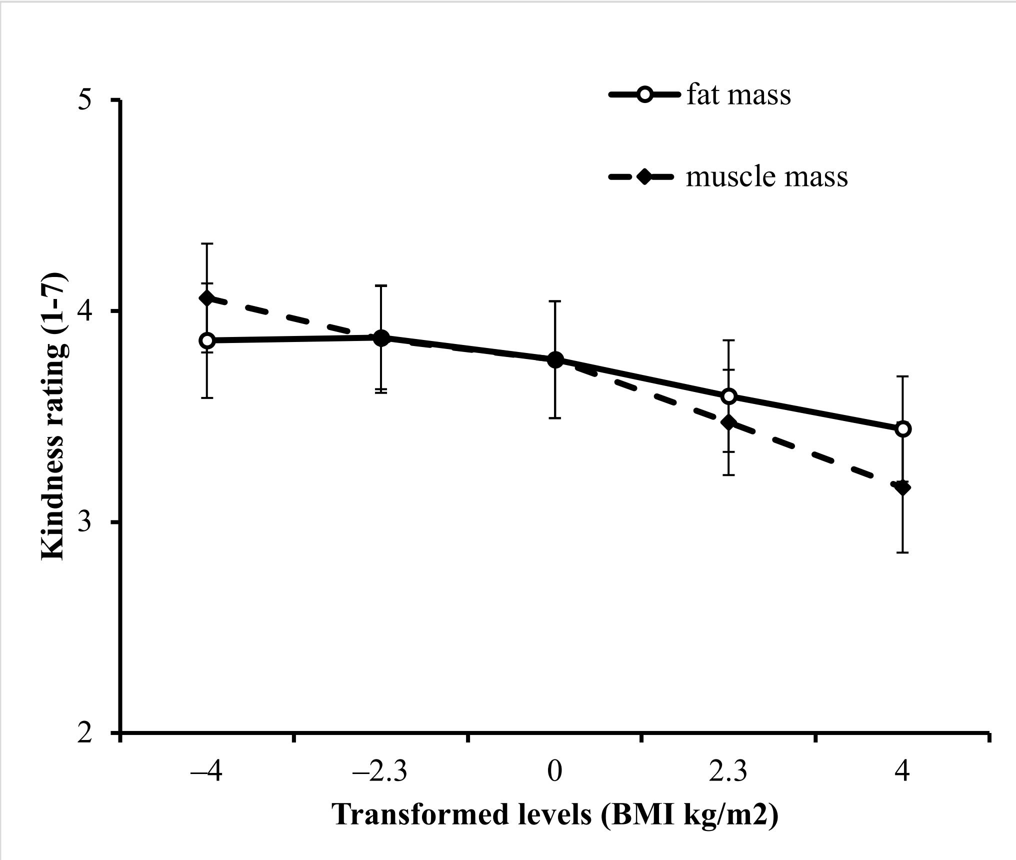
3D face set

The two-way ANOVA showed a non-significant main effect of transform dimension ($F(1,49) = 0.81$, $p = 0.373$, $\eta^2 = 0.016$) but a significant main effect of transform level ($F(4,196) = 12.02$, $p < 0.001$, $\eta^2 = 0.197$) on apparent kindness. Further, the interaction between transform dimension and transform level was significant ($F(4,196) = 2.69$, $p = 0.032$, $\eta^2 = 0.052$) (see Figure 16). This interaction reflects the greater detrimental impact of muscle than of fat on kindness rating. Paired-samples t-test revealed that an increase of 4 BMI units significantly decreased kindness ratings compared to the untransformed original faces, for both fat ($t(49) = -2.63$, $p = 0.011$) and muscle transforms ($t(49) = -3.87$, $p < 0.001$). Consistent with Hypothesis 5, the gain of muscle mass was perceived to be significantly less kind ($M = 3.16$, $SD = 1.09$) compared to the gain of fat mass ($M = 3.44$, $SD = 0.88$) ($t(49) = 2.22$, $p = 0.031$).

Figure 16. Average kindness ratings for faces transformed with the facial correlates of fat and muscle mass for the 3D face set. Error bars represent the 95% CI.

Matched 2D face set

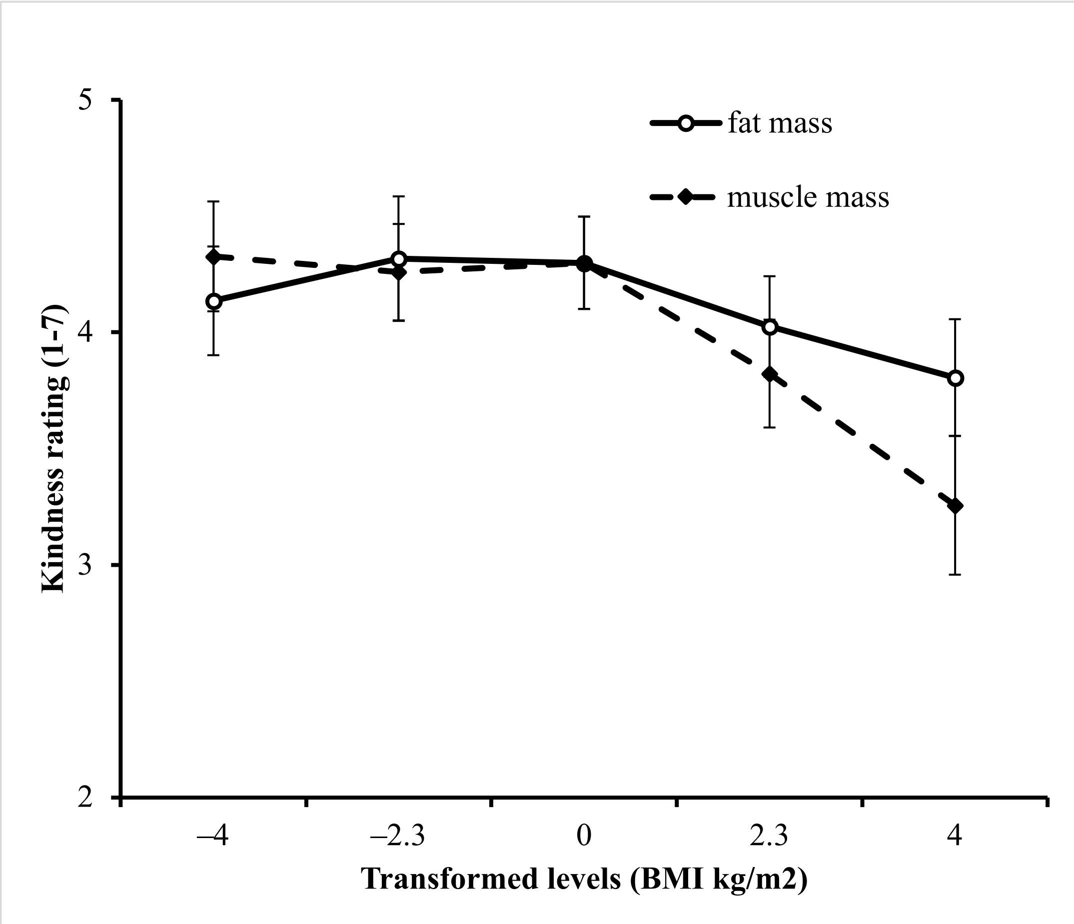
The two-way ANOVA showed significant main effects of the transform dimension



($F(1,49) = 9.42$, $p = 0.003$, $\eta^2 = 0.161$) and the transform level ($F(4,196) = 18.43$, $p < 0.001$, $\eta^2 = 0.273$). Moreover, there was a significant interaction between transform dimension and transform level ($F(4,196) = 4.77$, $p = 0.001$, $\eta^2 = 0.089$) (see Figure 17). Again, this interaction reflects the greater detrimental impact of muscle than of fat on kindness rating. Paired-samples t-tests showed that as the faces simulating a 4 BMI units increase of both fat and muscle transform significantly decreased kindness ratings compared to the untransformed original faces (($t(49) = -3.93$, $p < 0.001$), ($t(49) = 6.28$, $p < 0.001$), respectively for fat and muscle transform). Supporting Hypothesis 5, the gain of muscle mass

(M = 3.26, SD = 1.05) was perceived to be significantly less kind compared to the gain of fat mass (M = 3.81, SD = 0.88) ($t(49) = 3.78$, $p < 0.001$).

Figure 17. Average kindness ratings for faces transformed with the facial correlates of fat and muscle mass for the matched 2D face set. Error bars represent the 95% CI.



Independent 2D face set

The two-way ANOVA showed significant main effects of the transform dimension ($F(1,49) = 4.81$, $p = 0.033$, $\eta^2 = 0.089$) and the transform level ($F(4,196) = 12.78$, $p < 0.001$, $\eta^2 = 0.207$). Moreover, there was a significant interaction between transform dimension and transform level ($F(4,196) = 18.65$, $p < 0.001$, $\eta^2 = 0.276$) (see Figure 18). Similar to the other two face sets, the interaction reflects the greater detrimental impact of muscle than of fat on kindness rating. Paired samples t-test showed that while increases in fat mass (from -4 BMI units to +4 BMI units) had no significant impact on kindness perception, faces resembling increased muscle mass were rated to be less kind compared to the original faces ($t(49) = 7.10$, $p < 0.001$). In addition, faces simulating a 4 BMI units increase on muscle dimension (M =

3.23, *SD* = 0.99) were given significantly lower kindness ratings compared to faces simulating 4 BMI units increase on fat dimension (M = 4.10, SD = 0.84) ($t(49) = 6.36$, $p < 0.001$) supporting Hypothesis 5.

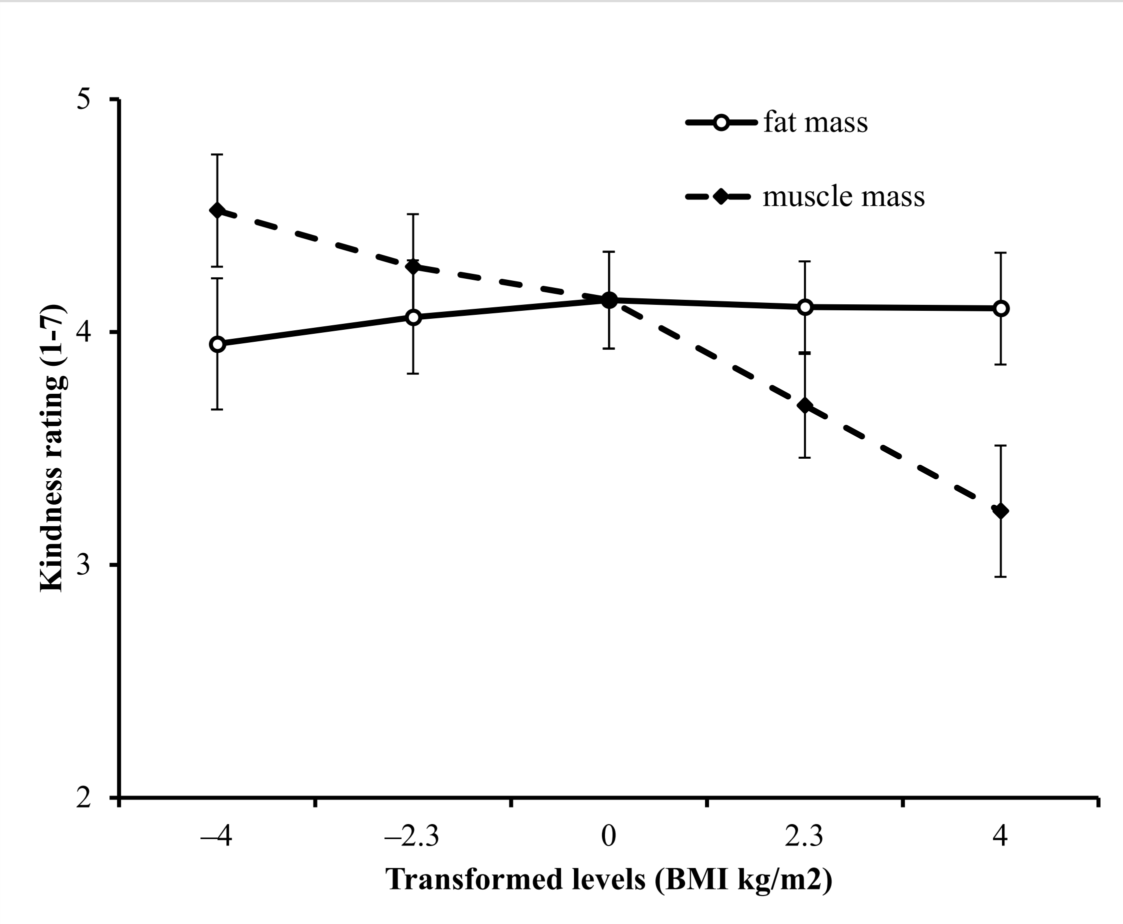


Figure 18. Average kindness ratings for faces transformed with the facial correlates of fat and muscle mass for the independent 2D face set. Error bars represent the 95% CI.

5.3.2.2 Kindness interactive

The results from the interactive task revealed a significant main effect of the face set ($F(2,102) = 5.13$, $p = 0.008$, $\eta^2 = 0.091$), with participants choosing a significantly lower BMI for matched 2D face set (M = 19.99, SD = 1.04) compared to the 3D face set (M = 20.56, SD = 1.42) and the independent 2D face set (M = 20.58, SD = 1.20) (see Figure 19). In addition, there was a significant main effect of transform dimension ($F(1,51) = 36.73$, $p < 0.001$, $\eta^2 = 0.419$), with participants choosing a higher BMI to optimize the kindest looking for faces transformed on fat dimension (M = 20.92, SD = 1.26) than on muscle dimension (M = 19.83, SD = 0.88), consistent with Hypothesis 5. The interaction between face set and transform dimension was non-significant ($F(2,102) = 0.711$, $p = 0.494$, $\eta^2 = 0.014$).

A one sample t-test comparing the associated BMI value of the most kind looking face with the original BMI (≈22) shows that on average the weight of the most kind appearance corresponded to a reduction in BMI compared to the original starting weight for all three sets of faces transformed on fat and muscle dimension (all ps ≤ 0.007).

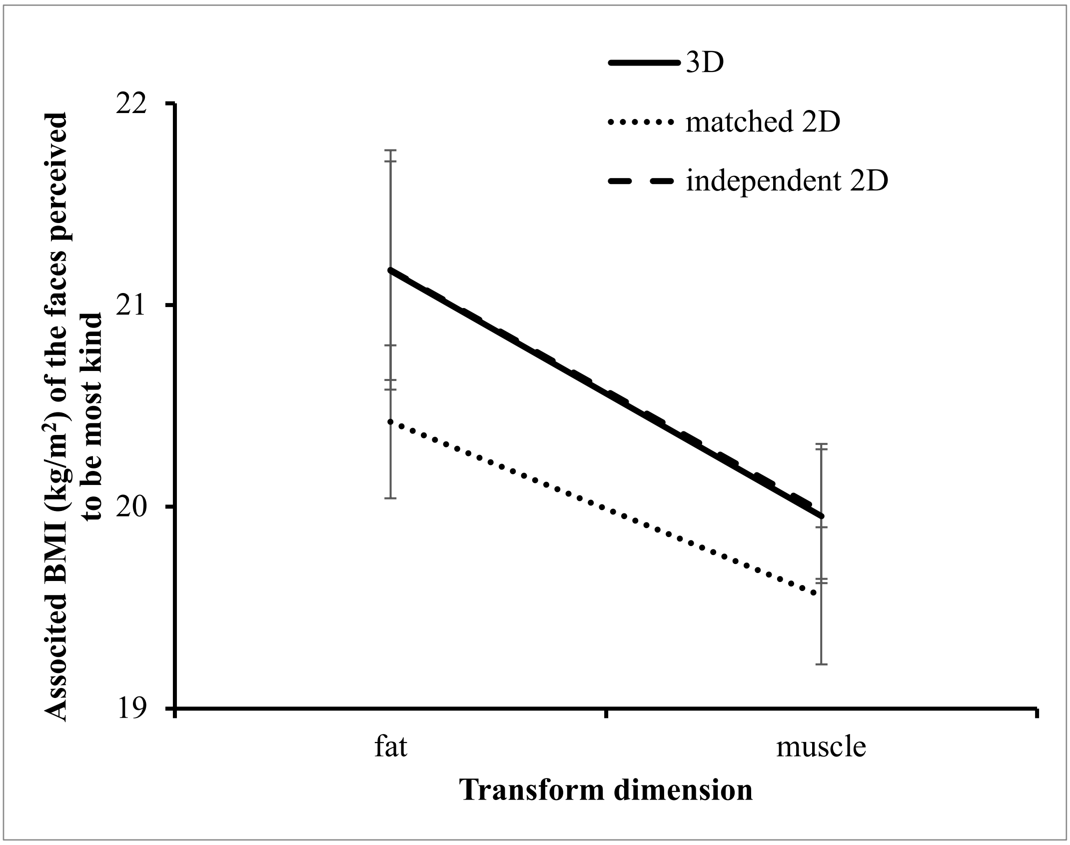


Figure 19. The amount of BMI chosen to optimise kindness perception of faces transformed with the facial correlates of fat and muscle mass for three face sets. Error bars represent the 95% CI.

5.4. Discussion

The present study aimed to investigate whether women's increased preference for men's facial masculinity in a short-term compared to long-term relationship context is better explained by the good genes hypothesis or the good parent hypothesis. We tested the perception of health and kindness of male faces at different levels of masculinity, by separately manipulating face shape correlates of male body fat and muscle mass. Our findings show that perceived health was related to the facial correlates of fat and muscle in a curvilinear fashion. The interactive task revealed the facial shape regarded as optimal for health. Men with a "normal" weight (BMI~20 for 2D faces; BMI~22 for 3D faces) were perceived to be the healthiest. Both lower and higher BMI were detrimental to perceived health, although being overweight was more harmful to the perception of health than being underweight.

We also found a negative effect of masculinity on perceived kindness: increasing facial cues to weight above the normal weight range (BMI>21) was associated with a decrease in apparent kindness. In contrast to our findings on perceived health, body composition did impact on judgments of kindness — increasing facial cues to muscle mass dramatically diminished apparent kindness, whereas the effect of facial cues to fat were much less pronounced. At the same raised BMI (~26), the face shape associated with high muscle mass was perceived to be less kind compared to that associated with high fat mass. An interactive task further supported these findings. To optimize apparent kindness, participants chose to decrease the BMI more for faces transformed on the muscle dimension than faces transformed on the fat dimension.

5.4.1 Facial masculinity shows a quadratic relationship with perceived health

In Study 1, we found that both facial correlates of muscle and fat positively predicted the perception of facial masculinity, but the effect of facial cues to fat disappeared when the body weight was raised above a healthy weight (BMI > 22). Based on that, we predicted there would be a quadratic relationship between facial correlates of fat and perceived health but a positive linear relationship between facial correlates of muscle and perceived health. These predictions were partially supported as the facial correlates of intermediate level of fat (BMI~20-22) was seen as healthier than the facial shape associated with low or high levels of body fat. Contrary to our prediction, the facial correlates of muscle were not linearly associated with perceived health, but rather they were perceived in a similar way to the facial correlates of fat. The face shape associated with high muscle or high fat were both seen as unhealthy. Specifically, faces resembling an intermediate healthy weight (BMI~20-22) were judged to be most healthy irrespective of body composition. In addition, independent of body composition, faces associated with an overweight status were judged to be less healthy than faces associated with an underweight status. These results were further confirmed in the interactive task as the BMI that participants chose to make the faces most healthy was around 21-22.

One might suspect that this result is found because facial correlates of fat and muscle both denote a heavier body which is associated with various diseases. However, the negative relationship between weight and health is more likely to be driven by high fat than high muscle. Higher body fat has been implicated in numerous health disorders including cardiovascular disease, diabetes and some cancers (Ärnlöv, Sundström, Ingelsson, & Lind, 2011; Gómez-Ambrosi et al., 2011; Nicklas et al., 2014). By contrast, high body muscle positively predicts general health and fitness (Hönekopp, Rudolph, Beier, Liebert, & Müller, 2007; Johnson, de Ruiter, Kyvik, Murray, & Sørensen, 2015). Hence, given the same BMI, fat and muscle are linked to health in opposite ways.

Furthermore, our results are in line with a previous study that tested the perceived health of men's bodies (Brierley et al., 2016). Brierley et al. (2016) showed that men's bodies composed of 15% fat were seen as healthiest. In other words, it was neither the most nor least muscular men that were seen as most healthy, which is consistent with our findings that facial cues to very low and very high muscle mass are not perceived as healthy. The reason for this might be that people are aware that a certain amount of body fat is essential for health, particularly in times of food insecurity and famine (Gallagher et al., 2000). Cues to high muscle might indicate extremely low body fat, which harms the perception of health.

5.4.2 Facial masculinity reduces perceived kindness

In contrast to the perception of health, facial cues to muscle and fat have different impacts on perceived kindness. In general, facial cues to very high muscle mass produced a marked reduction in perceived kindness. By contrast, facial cues to very high fat mass had relatively little impact on perceived kindness at higher fat levels. Since facial cues to muscle mass have been found to markedly enhance male facial masculinity, our results appear to be consistent with previous findings that facial masculinity is associated with less desirable perceived personality. Many previous studies have shown that facial masculinity relates to negative characteristics, such as dominance, aggression, violence and poor parental quality (Boothroyd et al., 2007; Kruger, 2006; Perrett et al., 1998). In addition, we not only found a negative relationship between masculinity and kindness, but also determined the weight and body composition associated with the perceived kindest facial appearance. While previous correlational studies found facial masculinity is negatively associated with some prosocial traits, we found that very feminine male faces are not perceived as the most kind either: the kindest-looking faces were those that showed facial cues to low normal weight (BMI~20-22), which is average in terms of masculinity.

The different effects of facial cues to fat and muscle on perceived kindness suggest that these characteristics may reflect different aspects of masculinity. As we discussed in Chapter 4, the mechanisms by which facial correlates of fat and muscle cue masculinity differ. Men are on average heavier than women, therefore, higher weight no matter whether due to increased fat or muscle enhances perceived masculinity (Holzleitner et al., 2014). Nevertheless, the sex difference in weight is mainly due to men's higher muscle mass. Higher levels of anabolic hormones (including testosterone and growth hormone) during puberty not only reshape men's face shape but also lead to increase in muscle mass (Rogol et al., 2002). Therefore, facial cues to muscle are androgen-mediated traits and thus might be more closely related to other androgen-mediated traits or personality characteristics compared to facial cues to fat.

5.4.3 Support for the good parent hypothesis

It is worth noting that we previously found that women showed a stronger preference for facial cues to muscle in short-term compared to long-term relationships but found no such difference in preferences for facial cues to fat in Study 2. Based on the good genes hypothesis, women should prefer cues to high quality genes more when seeking short-term partners than long-term partners. However, our current results show that there is no difference in the impact facial correlates of fat and muscle have on perceived health. If the stronger preference for masculinity in short-term relationships was due to associated health benefits, women should show a preference towards facial cues of both slightly higher levels of fat and slightly higher levels muscle in short- compared to long-term relationships. Taken together, the stronger preference for facial cues to muscle mass in short-term relationships is not well explained as a preference for apparent health or good genes. Hence, our findings do not support the good genes hypothesis.

Instead, we propose that our findings support the good parent hypothesis. This account predicts that women favour men displaying putative cues of high parental quality, especially for long-term relationships. The current study revealed that facial correlates of muscle have a larger negative impact on perceived kindness than facial correlates of fat. That might explain why there is a difference in preferences for facial correlates of muscle but not fat between short- and long-term relationships. Facial cues to high muscle mass are negatively associated with the perception of kindness, a trait which is highly valued by women in long-term relationships. Thus, the different preferences for facial cues to muscle in Study 2 should be interpreted as women avoiding men displaying cues to low kindness more for long- than short-term relationships. We note that facial cues to high fat mass were also deleterious to perceived kindness, however, the effect was small compared to that of facial cues to muscle.

5.4.4 Trade-off between competitiveness and kindness

As discussed earlier, our findings are in line with the good parent hypothesis, which argues that women's mate preferences are impacted by the desire to find a good parent and provider. Accordingly, the most attractive faces should be those perceived to be the most kind. However, this was not tested in the current study. A within-subject design would allow for a more comprehensive investigation of the association between women's preferences and perceived kindness of male faces.

It has been proposed that women's preference for masculinity might reflect their preference for intrasexual competitiveness (Scott, Clark, Boothroyd, & Penton-Voak, 2012). The ability to compete with other men is positively associated with social status (Von Rueden, Gurven, & Kaplan, 2010), which indicates men's ability to provide protection and resources to their partners and offspring. Researchers have found that intrasexual competitiveness (as measured by success in conflict) and social status is partly based on strength (Sell et al., 2009), which is positively predicted by facial cues to fat and muscle (Holzleitner & Perrett, 2016). Hence, although facial cues to high fat and muscle (BMI>22) may be associated with reduced willingness to make paternal investment, they also reflect men's potential to provide resources that women desire in long-term relationships (Li et al., 2002). Consequently, women might prefer neither extremely feminine men who may be less capable of providing resources, nor extremely masculine men who may be more able but less willing to provide resources. Yet, they may favour slightly less masculine men (with average levels of muscle and fat) who are both willing and able to provide protection and resources. Thus, future studies should also take perceived competitiveness into consideration when exploring factors driving women's preferences.

5.5 Conclusion

The present study shows that facial masculinity, as indexed by facial correlates of fat and muscle, is linked to perceived health in a quadratic fashion, with highly masculine men being perceived as less healthy compared to less masculine men. Moreover, masculinity has adverse effects on perceived kindness, whereby facial correlates of muscle have a larger negative impact than facial correlates of fat on perceived kindness. In summary, our findings suggest that women's stronger preference for men's facial masculinity in a short-term compared to long-term relationship context may be better explained by the good parent as opposed to the good genes account. In line with previous studies, we have shown that masculine men are indeed perceived as unkind, and especially so if their facial masculinity is linked to cues to higher muscularity. Our findings suggest that future work on women's mating decisions might benefit from focusing more strongly on the link of facial masculinity and perceived pro-sociality rather than on the assumed link of men's masculinity and health.

Chapter 6 Misperceptions of opposite-sex preferences for thinness and muscularity

Abstract

Thin and muscular have been characterised as ideals for women and men, respectively. Little research has investigated whether men and women have accurate perceptions of opposite-sex preferences of thinness and muscularity. Further, no study has explored whether opposite-sex perceptions of thinness and muscularity preferences differ for short-term and long-term relationships. The present study set out to address these questions. We used interactive 3D human models to represent bodies varying in size (Body Mass Index/BMI) and muscularity (body fat percentage/Fat%). University-aged (18-31) White European and Asian Chinese heterosexual men and women were asked to choose their own and ideal body shape, the ideal body shape for a short- and a long-term partner, and the body shape they thought the opposite-sex would most like for short- and long-term partners. Women of both ethnicities overestimated the thinness that men prefer in a partner and men of both ethnicities overestimated the heaviness and muscularity that women prefer in a partner. These misperceptions were more exaggerated for short-term relationships than for long-term relationships. Furthermore, we found that perception of opposite-sex preferences for body size predict body dissatisfaction in men and women. The results illustrate the importance of investigating misperceptions of opposite-sex preferences and raise the possibility that correcting misperceptions might have utility in reducing body dissatisfaction or eating disorders.

6.1 Introduction

Body image is a prevalent concern in men and women in many areas of the world (Kelley et al., 2010; Olivardia et al., 2004; Runfola et al., 2013). Considerable research has established associations between body image concern and physical and psychological problems including depression, low self-esteem and eating disorders (Olivardia et al., 2004; Stice, 2002). The trend for a thin ideal is evident even in childhood (Brown & Slaughter, 2011; Truby & Paxton, 2002).

It is well documented that the ideal female figure is thin in Western countries (Swami, 2015), while leanness and muscularity have recently become an ideal for men in the West (Thompson & Cafri, 2007). As a result, a drive for thinness and low body fat is developed in women and men, respectively (Kelley et al., 2010). Young women take part in unhealthy weight-loss behaviour like dieting, using laxatives, and self-induced vomiting to attain their ideal bodies (Wharton, Adams, & Hampl, 2008), which could damage health in the long run. On the other hand, men are more likely than women to engage in excessive exercise and to take anabolic steroids and protein supplements to build up muscles (Cafri, van den Berg, & Thompson, 2006; Linden, 2002). While exercise and increased muscle are generally associated with health and fitness, taking (non-medically prescribed) anabolic steroids increases mortality, morbidity and infertility in men (Horwitz, Andersen, & Dalhoff, 2019; Mossman & Pacey, 2019).

Media exposure, peer comparison and family pressure have been identified as factors contributing to body dissatisfaction (Smolak, 2009). An additional factor that might lead to body dissatisfaction is the misperception of opposite-sex preferences. Evolutionary psychologists propose that attractiveness is an important determinant of mate decisions (Li & Kenrick, 2006; Symons, 1979). Body size (represented as Body Mass Index/BMI, which is weight scaled by squared height kg/m^2) has been identified as an important cue to attractiveness in women (Tovée, Maisey, Emery, Cornelissen, 1999). Similarly, muscularity affects male attractiveness (Frederick & Haselton, 2007). Therefore, the perception of opposite-sex preferences for body size and body muscularity might have an impact on own body image. Body dissatisfaction might result from the discrepancy between one's own body and the perception of the body shape preferred by the opposite-sex. Indeed, one study has shown that women's misperception of men's preference for thinness is associated with eating disorders (Bergstrom et al., 2004). Specifically, the higher the discrepancy between women's estimate of men's preference for women's thinness and men's actual preference, the more unhealthy eating attitudes women report. Thus, it is important to examine the accuracy of men and women's perception of opposite-sex preferences.

Little research has explored whether the two sexes agree on what is an attractive female physique. Results of such work are not consistent, with some studies reporting that females tend to exaggerate the thinness that men desire (Bergstrom et al., 2004; Grossbard et al., 2011) and other studies stating that men and women have a similar perception of the attractiveness of female body size (Coetzee, Re, Perrett, Tiddeman, & Xiao, 2011; Crossley et al., 2012; Stephen & Perera, 2014). Similarly, the existence of sex differences in the perception of male body attractiveness remains unclear. Some studies report that men tend to exaggerate the muscularity that women prefer (Crossley et al., 2012; Demarest & Allen, 2000; Grossbard et al., 2011), while other studies indicate that both sexes share the same ideal (Bergstrom et al., 2004).

Historically, studies examining sex differences of body attractiveness have focused on body size but it should be noted that there is an increasing trend for women to desire for themselves both a thin and a muscular body physique rather than just a super skinny body (Kelley et al., 2010; Tiggemann & Zaccardo, 2015). Hence, it is necessary to address both body size and body muscularity preferences in men and women.

Another important yet commonly ignored factor which might influence attractiveness judgements is the relationship context. Prior research has shown that women and men have different mating strategies for short-term and long-term relationships (Buss & Schmitt, 1993; Gangestad & Simpson, 2000). Specifically, physical attractiveness is highly valued by both sexes in short-term relationships (Li & Kenrick, 2006). As a result, whatever is seen as attractive might be exaggerated for short-term relationships. It follows that if there is any misperception of opposite-sex preference, it is more likely to occur in the context of short-term relationships. By asking for short-term and long-term preferences, we might be able to find that men and women have accurate perceptions of opposite-sex preferences for long-term relationships and misperceptions for short-term relationships.

Evolutionary psychologists propose that the perception of attractiveness reflects an adaptation for identifying healthy mates to increase the probability of passing good genes to the next generation (Gangestad & Simpson, 2000; Gangestad et al., 2005). Based on this criterion, health judgements should in principle parallel attractiveness judgements. Indeed, the link between overweight status and health disorders (e.g. diabetes, cardiovascular disease) is well established (Gómez-Ambrosi et al., 2011; Nicklas et al., 2004). Likewise, muscularity is found to positively predict general health and fitness (Hönekopp et al., 2007; Johnson et al., 2015). One study, however, found that the most attractive female body was thinner (lower BMI) than the body perceived as most healthy (Stephen & Perera, 2014). More specifically, researchers found that this discrepancy for female bodies was driven by the preference for lower fat mass, as observers did not differ in the amount of muscle mass that was seen as most attractive and healthiest (Brierley et al., 2016). By contrast, the most attractive and healthy male bodies were comprised of a similar amount of fat mass and muscle mass (Brierley et al., 2016). Nonetheless, studies of this kind are limited and the sample size in the study by Brierley et al. (2016) was relatively small (66 participants). Therefore, further examination with larger samples is needed to provide more evidence for the argument that attractiveness judgements reflect the adaptation for identifying healthy mates.

The majority of studies examining body image or body attractiveness are limited to Western populations, while few studies have investigated Asian populations. Swami (2015) argued that a thin ideal for women is prevalent in most developed areas. Differences in the perception of ideal body size may no longer exist between Western and non-Western countries. Instead, the differences may reflect more the distinction between developed and undeveloped areas. Therefore, it is possible that Western and Asian women have same body ideals (particularly when recruited from the internet). Although it is well documented that Western men desire a muscular body physique, whether a muscular male ideal exists in Asian men remains unclear. Hence, one aim here is to find out whether White Europeans and Asian Chinese (UK and Chinese populations) share the same body physique ideals.

In the current study, we used interactive 3D human models to represent variation in male and female body size (defined as Body Mass Index/BMI) and body muscularity (defined as the inverse of Body Fat Percentage/Fat%). We aimed to determine whether or not men and women have accurate perceptions of opposite-sex preferences of body size and body muscularity. If there is a discrepancy, we predict it is more likely to exist in judgements of short-term partners than long-term partners. Specifically, we predict women think men desire thinner and less fat female bodies than men actually do; conversely, men think women desire heavier and more muscular male bodies than women actually do. Additionally, we investigated whether people’s preference for partners reflect their perception of healthiness. Findings from previous studies showed that female bodies perceived as most attractive are thinner than female bodies perceived as most healthy (Stephen & Perera, 2014; Brierley et al., 2016). Therefore, we predict that what men find attractive in female bodies will be thinner than what men regard as healthy. Furthermore, we expect any attractiveness – health discrepancy to be more prevalent when judgements are made about short-term relationships rather than long-term relationships as the criteria for attractiveness is higher for short-term than long-term relationships. By contrast, based on Brierley et al.'s (2016) findings, we predict that there will be no difference in the body size and muscularity between the most preferred and the healthiest male bodies chosen by women.

Furthermore, extensive evidence has demonstrated the crucial role that media plays in shaping body ideals (Swami et al., 2010; Swami, 2015). Indeed, the introduction of television to populations is associated with a remarkable decrease in preference for heaviness (Boothroyd et al., 2019; Becker et al., 2002). Similar to Western populations, the influence of media on body image has been observed in Chinese adults and adolescents (Wang et al., 2020; Xu et al., 2010). Therefore, we also tested possible influence from media on one's body ideals and preference for opposite-sex bodies.

6.2 Method

All work was approved by the Ethics Committee of the affiliated University (PS13176 and PS13092). All participants gave informed consent.

6.2.1 Participants

Participants were White Europeans (hereafter referred to as Europeans) recruited in the UK and Asian Chinese (hereafter referred to as Chinese) recruited in China. European participants were recruited online from Prolific including 75 males and 75 females. All participants received £2 as a reward. Pre-screening criteria were applied as following: age between 18 and 26 years old, heterosexual, White European ethnicity and living in the UK. Another group of female participants were undergraduates recruited from an undergraduate class at the University of St Andrews. Participation was voluntary. The module controller sent out the experiment link via email. These recruitments resulted in 99 White European women (including both Prolific users and St Andrews students) ($M_{age} \pm SD = 20.84 \pm 2.48$, range 18-26 years) and 70 White European men ($M_{age} \pm SD = 21.71 \pm 2.22$, range 18–25 years) after excluding those did not meet the criteria aforementioned. Chinese participants were students recruited from Zhejiang University (located in the developed area in China). Advertisements were made on the University website discussion forum. Participants were paid ¥10 as a reward. After excluding non-heterosexual and non-Chinese participants, the final sample included 99 females ($M_{age} \pm SD = 20.81 \pm 2.14$, range 18–26 years) and 95 males ($M_{age} \pm SD = 21.91 \pm 2.53$, range 18–31 years).

6.2.2 Stimuli

The stimuli consisted of male and female body models obtained from a mobile phone app “BMI 3D PRO”. One male and one female body models (front view) were adjusted covering a wide range of BMI in 1unit intervals (18–30 for male and 16–28 for female). At each BMI level, the body models were then adjusted to represent different levels of body fat percentage (Fat%). For the male stimuli, the body was adjusted to represent body fat percentages from 12% to 22% in 1unit intervals. The female body was adjusted to cover body fat percentages from 22% to 32% with 1unit intervals. It was impossible to adjust the bodies to represent a high body fat percentage for bodies with a low BMI level. In order to make a rectangular matrix of 13 × 11 body images (BMI × Fat%) for body images at low BMI levels, images showing the highest Fat% of that BMI level were duplicated to make the matrix (see Tables S3 & S4 in Appendix 1). This means that the matrix contained only a biologically plausible range of body shapes.

The head was cropped to remove confounding information (see Figure 20 for male body and Figure 21 for female body). The resulting bodies are ambiguous with respect to Chinese or European ethnicity. All images were resized to 540 × 680 pixels.

A questionnaire consisted of 5 questions selecting from the Sociocultural Attitudes Towards Appearance Questionnaire (SATAQ) was used to test participants’ media internalisation (see Appendix 3). This scale has been proved to be valid and reliable scale across different countries and ethnicities (Schaefer et al., 2015). In addition, another 3 questions testing ethnic bias in media source (Asian or Western) that participants were exposed to were also included in the questionnaire (See Appendix 3).

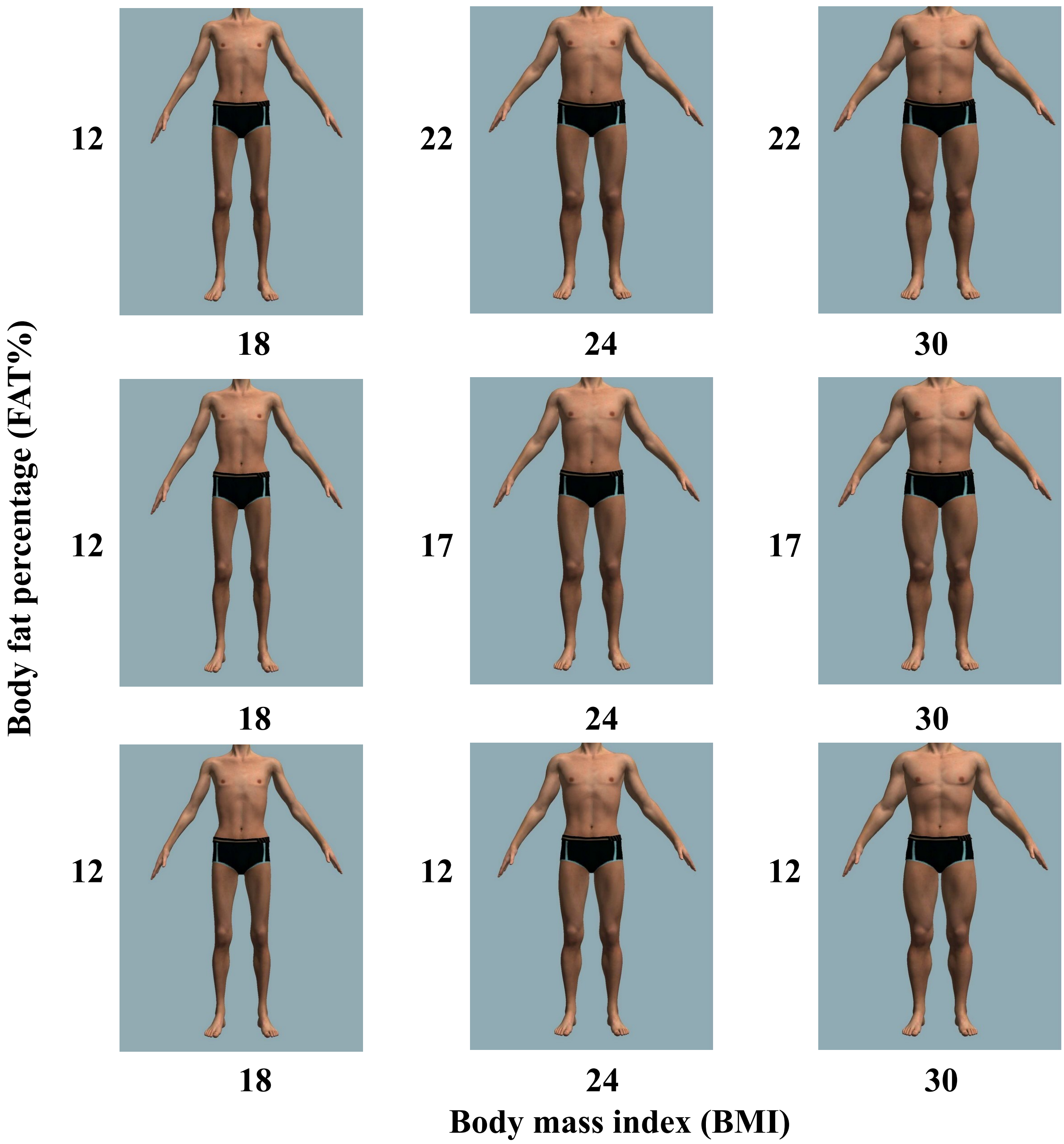


Figure 20. The male bodies represent different levels of BMI and Fat%. This figure depicts the end- and mid-points of the interactive male body images. Left to right depicts BMI increase; bottom to top depicts Fat%increase (bodies at low BMI levels show limited ranges of Fat%). Images were taken from a mobile app “BMI 3D Pro”.

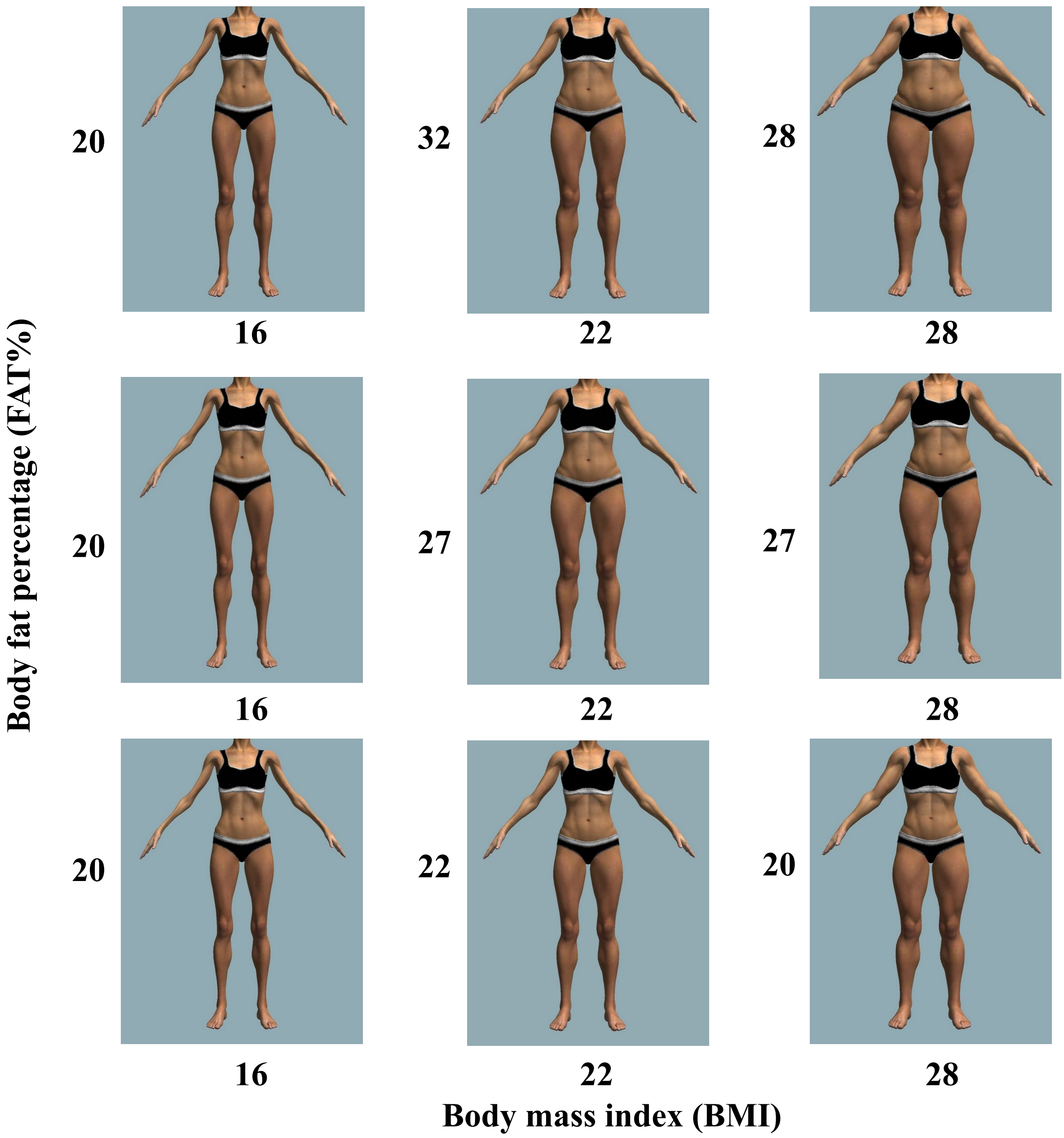


Figure 21. The female bodies represent different levels of BMI and Fat%. This figure depicts the end- and mid-points of the interactive female body images. Left to right depicts BMI increase; bottom to top depicts Fat% increase (but bodies at low BMI levels show limited ranges of Fat%). Images were taken from a mobile app "BMI 3D Pro".

6.2.3 Procedure

Participants were first asked to complete a demographic questionnaire about age, sex, sexual orientation, residence and ethnicity. The male and female bodies were presented as interactive 2D matrices. Moving the mouse vertically adjusted the apparent BMI (13 levels) while moving horizontally adjusted the apparent Fat% (11 levels). The image presented at the start of each trial was randomised. Participants were asked to adjust the body shape following the instruction shown above each image. Participants were not informed as to the nature of the body transformations. First, participants were shown a same-sex body image and asked to adjust the body shape to reflect their own body shape (from the range available). On the next trial they were asked to choose their ideal body shape. After that, the same-sex body image was shown to be adjusted to resemble the body shape that a heterosexual opposite-sex individual would find most attractive for short-term and long-term relationships (in a random order). Then opposite-sex body images were displayed to be adjusted to resemble the participant's preferences for short-term and long-term partners (in a random order). Finally, participants were asked to make the female and male body images look most healthy. This resulted in 8 trials for each participant (1 trial per task). There was no time limit to make adjustments. The next stimulus was shown only after participants had made changes.

After finishing the preference task, participants were asked to complete a questionnaire on a 5-point Likert Scale, which examined the media ideal internalization and whether Western or Asian media has a larger impact on their ideal partner bodies.

6.2.4 Statistical analysis

The BMI and Fat% values selected were saved for each trial. Data were analysed in SPSS 24.0. Data were first checked for distribution and outliers for male and female participants separately. Data values above or below 3 standard deviations from the mean were removed (0.2%). Results of Kolmogorov-Smirnov tests showed that all variables were not normally distributed. Nonetheless, a growing number of studies conclude that tests are robust to non-normality (Fagerland, 2012; Poncet, Courvoisier, Combescure, & Perneger, 2016; Sawilowsky & Blair, 1992; Skovlund & Fenstad, 2001). Considering the sample size was not small and data were not ordinal or ranked, parametric tests were used (note: Non-parametric tests revealed same pattern of results).

Independent-samples tests were conducted comparing women's and men's preferences for body size and muscularity for short- and long-term relationships to test whether participants have accurate perceptions of opposite-sex desires. Paired-samples tests were conducted comparing participants' ideal body shape and their own body shape to test whether there is discrepancy between the ideal and own body; any discrepancy was regarded as a proxy for body dissatisfaction. Paired-samples tests also compared the ideal and the healthiest body shape to test whether the ideal body shape is seen as most healthy. In addition, paired-samples tests were run comparing preferences and health judgements of opposite-sex bodies to test whether attractiveness reflects health perception. Furthermore, paired-samples tests were run comparing men's and women's short-term versus long-term preferences to test whether men and women have different preferences for short- and long-term relationships. Paired-samples tests were also run comparing the perceptions of opposite-sex preferences for short- and long-term relationships to test whether perceptions of opposite-sex preferences are exaggerated for short-term compared to long-term relationships. Besides, paired-samples tests were run comparing European and Chinese mate preferences to test whether the two ethnicities share similar body ideals.

Finally, linear regressions were conducted to test for the possible relationship of misperception of opposite-sex preferences to a proxy for body dissatisfaction. The discrepancy between the participant's choice of an ideal body shape and their choice of their own body shape was used as a proxy measure for body dissatisfaction. The discrepancies between participant's own and ideal BMI and Fat% were entered as dependent variables separately for men and women. Own BMI or Fat% was controlled for when predicting misperceptions of opposite-sex preferences. Since the misperceptions were expected to be exaggerated for short-term relationships compared to long-term relationships, misperception of preferences for short-term partners was used as the independent variable.

Lastly, responses from the 5 media internalization questions (Questions 1–5) and the 3 media source questions (Questions 6–8) were averaged separately. One-sample t-tests were run to assess whether participants internalize media ideals and whether there was an ethnic bias in media influence. These compared question averages against no media influence or bias (a mean score of 3, which was the middle point of the 5-point Likert Scale). Furthermore, correlation tests were run to assess the relationship between media internalization and preferences for opposite-sex body size and body muscularity. Since the data were not normally distributed, Spearman correlations were run for male and female participants separately.

6.3 Results

6.3.1 Misperceptions of opposite-sex preferences

Table 3 shows the descriptive statistics for the BMI and Fat% that women and men preferred and what they thought the opposite-sex would prefer in terms of short- and long-term relationships (see Figure 22 for illustrations). Independent-samples test results (see Table 3 for details) showed that both European and Chinese men overestimated the BMI and underestimated the Fat% that women prefer for both short- and long-term relationships ($ps \leq 0.017$) except Chinese men's judgement of women's preference for men's Fat% for a long-term relationship ($p = 0.241$). Conversely, European and Chinese women underestimated the BMI that men prefer for short- and long-term relationships ($ps \leq 0.022$) except Chinese women's judgement of men's preference for women's BMI for a long-term relationship ($p = 0.055$). The Fat% of female bodies chosen for long- and short-term relationships did not significantly differ between men and women for both European and Chinese.

Table 3. Misperception of opposite-sex body size (BMI) and body muscularity (Fat%) preferences. Short-term = short-term relationship; long-term = long-term relationship

Preference	Judgement	Nationality	Women's choice	Men's choice	*t* values	*p* values	*d* values
BMI	Short-term male body	European	25.80(3.10)	27.14(3.34)	-2.685	0.008	0.42
		Chinese	24.78(3.12)	26.23(2.71)	-3.463	0.001	0.50
	Long-term male body	European	25.64(2.63)	26.78(2.54)	-2.821	0.005	0.44
		Chinese	25.00(2.82)	26.08(2.69)	-2.745	0.007	0.39
	Short-term female body	European	20.70(2.54)	23.01(2.55)	-5.805	< 0.001	0.90
		Chinese	20.89(2.85)	21.84(2.93)	-2.305	0.022	0.36
	Long-term female body	European	22.04(2.47)	23.46(2.49)	-3.663	< 0.001	0.57
		Chinese	21.64(2.29)	22.32(2.66)	-1.934	0.055	0.27
Fat%	Short-term male body	European	14.64(2.32)	13.57(2.03)	3.272	0.001	0.49
		Chinese	14.63(2.22)	13.85(1.80)	2.533	0.012	0.39
	Long-term male body	European	14.99(2.05)	14.22(2.04)	2.408	0.017	0.38
		Chinese	14.95(2.27)	14.40(2.01)	1.175	0.241	0.26
	Short-term female body	European	23.17(1.53)	23.77(1.97)	-1.884	0.061	0.34
		Chinese	23.64(2.28)	23.89(2.67)	-1.199	0.232	0.10
	Long-term female body	European	24.09(1.78)	23.80(1.80)	1.047	0.297	0.16
		Chinese	24.11(1.90)	23.77(2.50)	1.492	0.137	0.15

6.3.2 Comparisons of own and ideal bodies

Table 4 presents the descriptive statistics for the BMI and Fat% of participants' perceptions of their own bodies and ideal bodies (see Figure 23 for illustrations). Paired-samples tests (see Table 4 for details) showed that the BMI and Fat% values of participants' own and ideal bodies are significantly different both in European and Chinese men and women (ps ≤ 0.013). For women, own body BMI and Fat% were higher than their ideals. For men, own BMI was lower than the ideal and the Fat% of their own body was higher than their ideal.

Table 4. Comparison of participants' own body and ideal body shapes

Preference	Sex	Nationality	Own body	Ideal body	*t* values	*p* values	*d* values
BMI	Women	European	22.92(2.55)	21.27(2.45)	5.873	< 0.001	0.59
		Chinese	22.16(2.59)	20.95(2.62)	4.183	< 0.001	0.42
	Men	European	24.59(3.23)	26.77(3.00)	-5.114	< 0.001	0.61
		Chinese	24.40(2.77)	25.44(2.62)	-2.772	0.007	0.28
Fat%	Women	European	25.48(2.51)	23.60(1.51)	7.211	< 0.001	0.72
		Chinese	24.92(2.35)	23.80(2.08)	4.486	< 0.001	0.40
	Men	European	15.04(2.70)	13.65(1.95)	3.942	< 0.001	0.47
		Chinese	14.94(2.32)	14.28(2.01)	2.522	0.013	0.22

6.3.3 Comparisons of ideal and healthy same sex bodies

Table 5 presents the descriptive statistics for the BMI and Fat% of the ideal and healthiest bodies set by participants (see Fig. 23 for illustrations). Paired-samples tests (see Table 5 for details) showed that the BMI and Fat% values of women's ideal bodies were significantly lower than the healthiest bodies (ps ≤ 0.010). Similarly, Chinese men set a lower BMI for ideal than for the healthiest body (p = 0.004), while European men set a higher BMI for ideal than for the healthiest body (p = 0.011). By contrast, neither European nor Chinese men set different Fat% values for the ideal and the healthiest male bodies.

Table 5. Comparison of participants' perceptions of ideal same-sex body shape and healthiest same sex body shape

Preference	Sex	Nationality	Ideal body	Healthy body	*t* values	*p* values	*d* values
BMI	Women	European	21.27(2.45)	23.07(2.41)	-6.262	< 0.001	0.63
		Chinese	20.95(2.62)	22.96(2.60)	-6.202	< 0.001	0.62
	Men	European	26.77(3.00)	25.91(2.53)	2.625	0.011	0.32
		Chinese	25.44(2.62)	26.31(2.38)	-2.932	0.004	0.30
Fat%	Women	European	23.60(1.51)	24.45(1.64)	-4.627	< 0.001	0.46
		Chinese	23.80(2.08)	24.43(1.67)	-2.637	0.010	0.23
	Men	European	13.65(1.95)	13.59(1.63)	-0.361	0.719	0.03
		Chinese	14.28(2.01)	14.59(2.26)	-0.638	0.525	0.11

6.3.4 Comparisons of healthy and preferred opposite-sex bodies

Table 6 presents the descriptive statistics for the BMI and Fat% that participants preferred in partners as well as the corresponding values for the healthiest body perceived for the opposite-sex. Paired-samples tests (see Table 6 for details) showed that Chinese participants showed significantly different judgements for what they preferred in short-term and long-term partners and what they thought was healthy in opposite-sex bodies, while these differences were not shown by Europeans. Specifically, the BMI of the healthiest male body set by Chinese women participants was higher than what was preferred by them for both short- and long-term relationships (ps ≤ 0.001). Similarly, the BMI and Fat% of what Chinese men preferred for short- and long-term relationships were significantly lower than what was thought to be most healthy for females (ps ≤ 0.011) except the preference for Fat% of a short-term relationship.

Table 6. Comparison of participants' perception of the healthiest body shape of opposite-sex and preference for the body shape of opposite-sex for long-term and short-term relationships

Preference	Sex of body	Sex of participants	Nationality	Term	Health	Preference	t values	p values	d values
BMI	Female	Men	European	Short	23.57(2.39)	23.01(2.55)	1.640	0.106	0.20
				Long	23.57(2.39)	23.46(2.49)	0.285	0.776	0.04
			Chinese	Short	23.49(2.85)	21.84(2.93)	4.619	< 0.001	0.47
				Long	23.49(2.85)	22.32(2.66)	3.883	< 0.001	0.40
	Male	Women	European	Short	25.80(2.51)	25.80(3.10)	0.229	0.819	0.00
				Long	25.80(2.51)	25.64(2.63)	0.784	0.435	0.07
			Chinese	Short	26.03(2.78)	24.78(3.12)	4.527	< 0.001	0.45
				Long	26.03(2.78)	25.00(2.82)	3.467	0.001	0.35
Fat%	Female	Men	European	Short	23.97(1.59)	23.77(1.97)	1.372	0.175	0.08
				Long	23.97(1.59)	23.80(1.80)	0.789	0.433	0.09
			Chinese	Short	24.16(2.20)	23.89(2.67)	1.515	0.133	0.10
				Long	24.20(2.20)	23.77(2.50)	2.603	0.011	0.18
	Male	Women	European	Short	14.84(1.81)	14.64(2.32)	1.683	0.096	0.09
				Long	14.84(1.81)	14.99(2.05)	-0.701	0.485	0.07
			Chinese	Short	14.81(2.15)	14.63(2.22)	1.604	0.112	0.07
				Long	14.81(2.15)	14.95(2.27)	-0.041	0.968	0.05

6.3.5 Comparisons of short- and long-term relationship preferences

Table 7 presents the descriptive statistics for men and women's preferences for body size and body muscularity as well as their perceptions of the opposite-sex preferences for short- and long-term relationships. Results of paired-samples tests (see Table 7 for details) showed that participants perceived the opposite-sex to have different preferences for short- and long-term relationships, whereas both men and women did not actually show significantly different preferences for the opposite-sex body shape between short- and long-term relationships. Specifically, European and Chinese women perceived men as preferring lower BMI and Fat% for short-term than for long-term relationships (ps < 0.014). One exception to this is Chinese women's perception of men's preference for Fat% did not differ significantly from men's actual preferences (p = 0.066). Furthermore, European and Chinese men perceived women as preferring lower Fat% for short-term than long-term relationships (ps ≤ 0.025) but perceptions across sexes were aligned for BMI.

Table 7. Comparison of preferences for short-term and long-term relationships

Preference	Sex of body	Sex of participants	Nationality	*t* values	*p* values	*d* values
BMI	Female	Women	European	5.150	< 0.001	0.52
			Chinese	2.492	0.014	0.25
		Men	European	-1.330	0.188	0.16
			Chinese	-1.433	0.155	0.15
	Male	Women	European	-0.590	0.556	0.06
			Chinese	0.739	0.462	0.07
		Men	European	-0.867	0.389	0.10
			Chinese	-0.491	0.624	0.05
Fat%	Female	Women	European	4.215	< 0.001	0.42
			Chinese	1.856	0.066	0.18
		Men	European	0.100	0.920	0.01
			Chinese	-0.474	0.637	0.05
	Male	Women	European	1.538	0.127	0.15
			Chinese	1.399	0.165	0.14
		Men	European	2.396	0.019	0.29
			Chinese	2.278	0.025	0.24

6.3.6 Comparisons of preferences between European and Chinese

Results of independent t-tests (see Table 8 for statistics) indicated that both European men and women prefer significantly heavier partners than Chinese participants (all ps ≤ 0.022). One exception to this is that women's preference for long-term partners. Although Chinese women did prefer thinner partners compared to European women but the difference between the two groups did not reach significance (p = 0.102). By contrast, European and Chinese men and women share similar ideals for body muscularity.

Table 8. Comparisons of preferences for body shape between European and Chinese in short-term and long-term partners

Preference	Judgement	European choice	Chinese choice	*t* values	*p* values	*d* values
BMI	Women's short-term	25.80(3.10)	24.78(3.12)	2.307	0.022	0.33
	Women's long-term	25.64(2.63)	25.00(2.82)	1.642	0.102	0.23
	Men's short-term	23.01(2.55)	21.84(2.93)	2.668	0.008	0.43
	Men's long-term	23.46(2.49)	22.32(2.66)	2.793	0.006	0.44
Fat%	Women's short-term	14.64(2.32)	14.63(2.22)	0.031	0.975	<0.00
	Women's long-term	14.99(2.05)	14.95(2.27)	0.132	0.895	0.02
	Men's short-term	23.77(1.97)	23.89(2.67)	-0.309	0.757	0.05
	Men's long-term	23.80(1.80)	23.77(2.50)	0.257	0.941	0.01

6.3.7 Comparisons of perceived healthiest bodies between Europeans and Chinese

Results of independent tests (see Table 9 for statistics) indicated that European and Chinese show similar perceptions of the healthiest body size and muscularity, but European men perceived a higher body muscularity as the healthiest than Chinese men.

Table 9. Comparisons of ideal and perceived healthiest male and female bodies between British and European

	Sex of participants	Sex of body	European choice	Chinese choice	*t*	*p*	*Cohen's d*
BMI	Female	Female	23.07(2.41)	22.96(2.60)	0.312	0.756	0.04
		Male	25.80(2.51)	26.03(2.78)	-0.617	0.538	0.09
	Male	Female	23.57(2.39)	23.49(2.85)	0.180	0.858	0.03
		Male	25.91(2.53)	26.31(2.38)	-1.037	0.301	0.16
Fat%	Female	Female	24.45(1.64)	24.43(1.67)	0.086	0.932	0.01
		Male	14.84(1.81)	14.81(2.15)	0.108	0.914	0.02
	Male	Female	23.97(1.59)	24.16(2.20)	-0.597	0.552	0.10
		Male	13.59(1.63)	14.59(2.26)	-3.138	0.002	0.51

6.3.7 Effects of misperceptions of opposite-sex preferences on body dissatisfaction

Results (see Table 10 for details) indicated that body dissatisfaction was predicted by misperceptions of opposite-sex preferences both in men and women. Specifically, for women, the more they think that men prefer lower BMI for short-term partners, the more dissatisfied they are with their bodies. For European men but not Chinese men, the more they think that women prefer higher BMI for short-term partners, the more dissatisfied they are with their bodies. The results suggest that misperceptions of opposite-sex preferences for body shape do affect an individual's body image.

Table 10. Results of regression analyses of the effects of misperceptions of opposite-sex preferences on body dissatisfaction

Dependent Variables	Independent Variables	*B*	*SE*	*p*	*CI*	*F*	R^2
EUROPEAN							
Women's own–ideal BMI	Own BMI	.449	.071	<.001	[.308, .590]	26.232	.353
	Perceptions of men's BMI preference	-.349	.071	<.001	[-.491, -.207]		
Women's own–ideal FAT%	Own FAT%	.584	.056	<.001	[.473, .695]	54.482	.532
	Perceptions of men's FAT preference	-.101	.092	.276	[-.283, .082]		
Men's own–ideal BMI	Own BMI	-.433	.075	<.001	[-.583, -.284]	19.520	.372
	Perceptions of women's BMI preference	.238	.073	.002	[.093, .383]		
Men's own–ideal FAT%	Own FAT%	.651	.074	<.001	[.503, .799]	38.946	.541
	Perceptions of women's FAT% preference	-.049	.099	.618	[-.246, .148]		
CHINESE							
Women's own–ideal BMI	Own BMI	.269	.069	<.001	[.132, .406]	9.938	.172
	Perceptions of men's BMI preference	-.153	.062	.016	[-.278, -.029]		
Women's own–ideal FAT%	Own FAT%	.414	.074	<.001	[.267, .560]	15.673	.246
	Perceptions of men's FAT preference	-.014	.076	.854	[-.165, .137]		
Men's	Own BMI	-.296	.092	.002	[-.478, -.114]	5.347	.103

own–ideal BMI	Perceptions of women's BMI preference	.021	.094	.824	[-.165, .207]		
Men's own–ideal FAT%	Own FAT%	.566	.078	<.001	[.411, .722]	26.175	.360
	Perceptions of women's FAT% preference	-.043	.101	.669	[-.157, .244]		

6.3.8 Media influence

One sample t-tests showed that both samples' body ideals were influenced by media (European: $M \pm SD$ = 3.36 ± 1.03, $t(153) = 4.39$, $p < .001$; Chinese: $M \pm SD$ = 3.10 ± 0.76, $t(180) = 1.93$, $p = .056$). Moreover, participants were influenced by own culture's media more than media of other culture (European: $M \pm SD$ = 3.34 ± 1.03, $t(153) = 4.11$, $p < .001$; Chinese: $M \pm SD$ = 2.18 ± 0.84, $t(185) = -13.39$, $p < .001$; higher number represents more influence from Western than Asian).

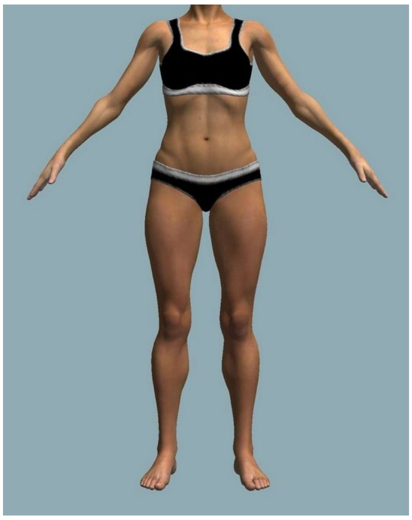
Spearman correlation tests (see Table 11) showed that media internalisation was not correlated with preferences for opposite-sex body size and muscularity in both male and female participants.

Table 11. Results of Spearman correlation tests of the relationship between media internalisation and preferences for opposite-sex body shape

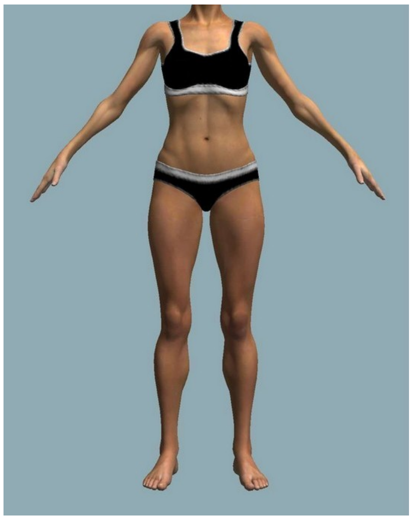
Judgements	Women (N = 179)		Men (N = 156)	
	r	p	r	p
Short-term BMI	0.036	0.635	0.024	0.770
Long-term BMI	-0.042	0.578	-0.124	0.124
Short-term Fat%	0.042	0.582	-0.024	0.764
Long-term Fat%	0.037	0.622	-0.082	0.316

(A)

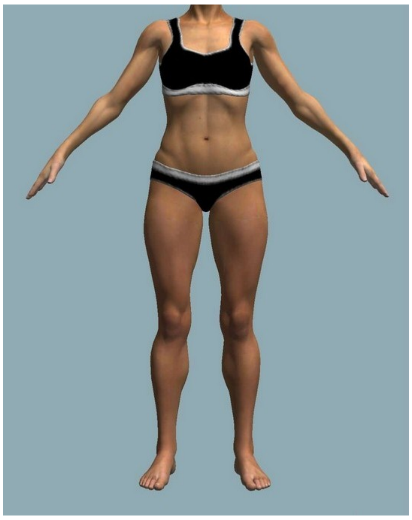
White European



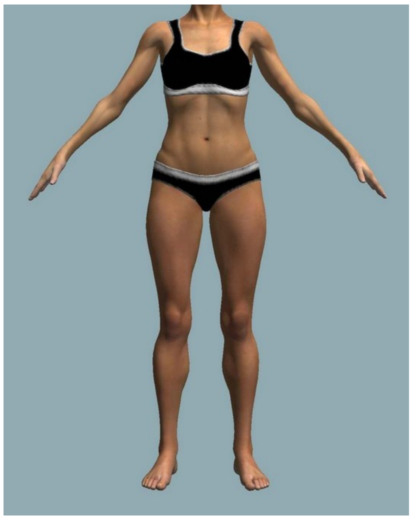
23—23
Men’s preference for short-term relationships



21—23
Women’s estimate of men’s preference for short-term relationships



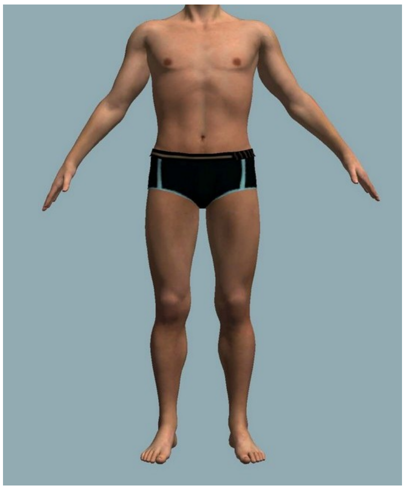
23—24
Men’s preference for long-term relationships



22—24
Women’s estimate of men’s preference for long-term relationships

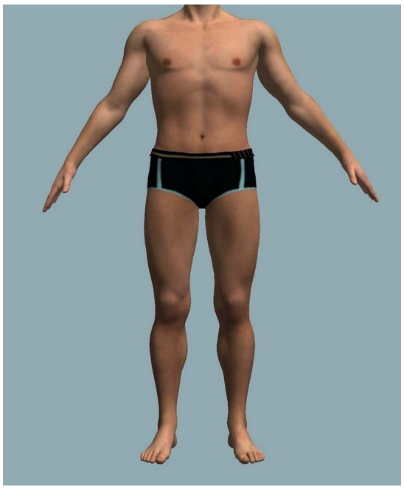
(B)

White European



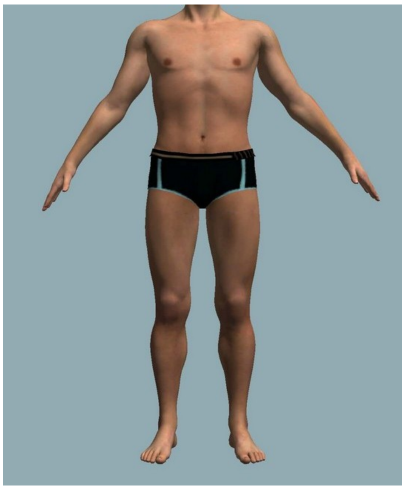
26—15

Women's preference for short-term relationships



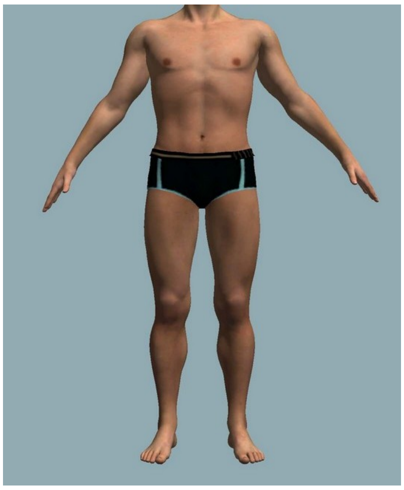
27—14

Men's estimate of women's preference for short-term relationships



26—15

Women's preference for long-term relationships

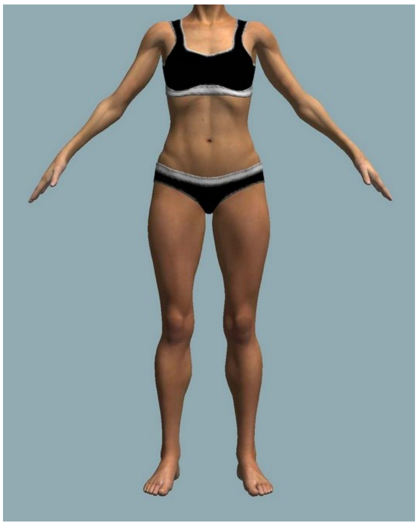


27—14

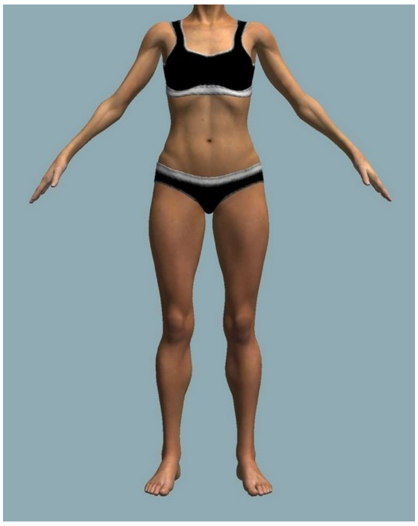
Men's estimate of women's preference for long-term relationships

(C)

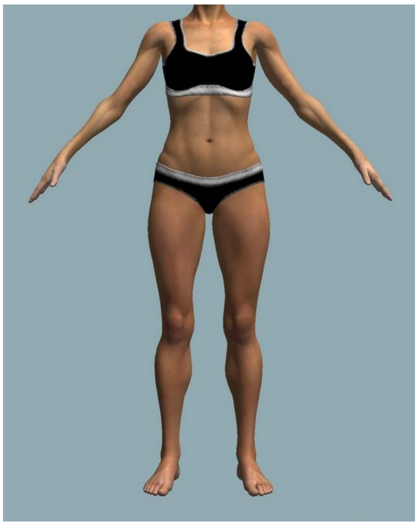
Asian Chinese



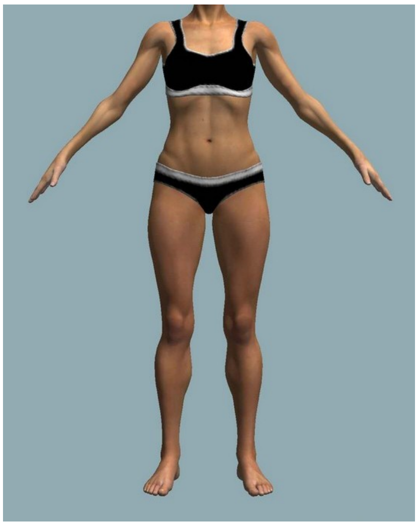
22—24
Men's preference for short-term relationships



21—24
Women's estimate of men's preference for short-term relationships



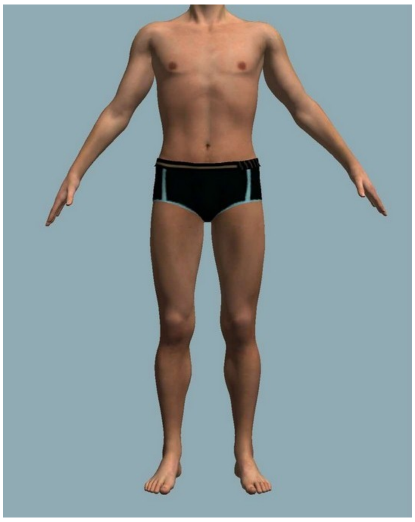
22—24
Men's preference for long-term relationships



22—24
Women's estimate of men's preference for long-term relationships

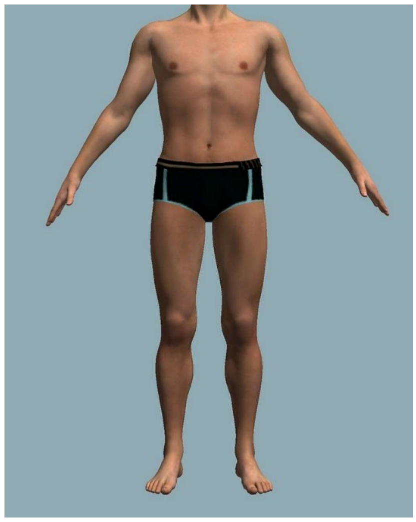
(D)

Asian Chinese



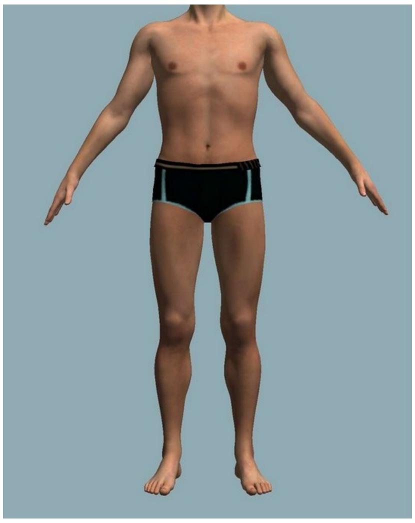
25—14

Women's preference for short-term relationships



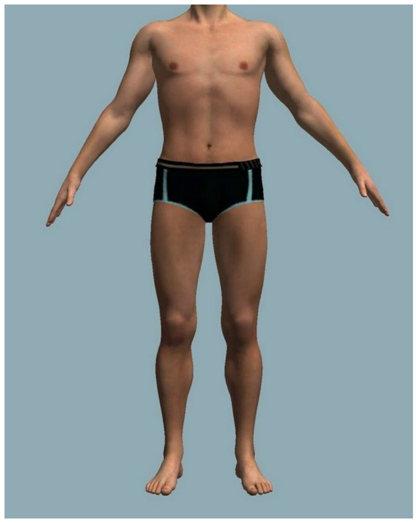
26—14

Men's estimate of women's preference for short-term relationships



25—15

Women's preference for long-term relationships

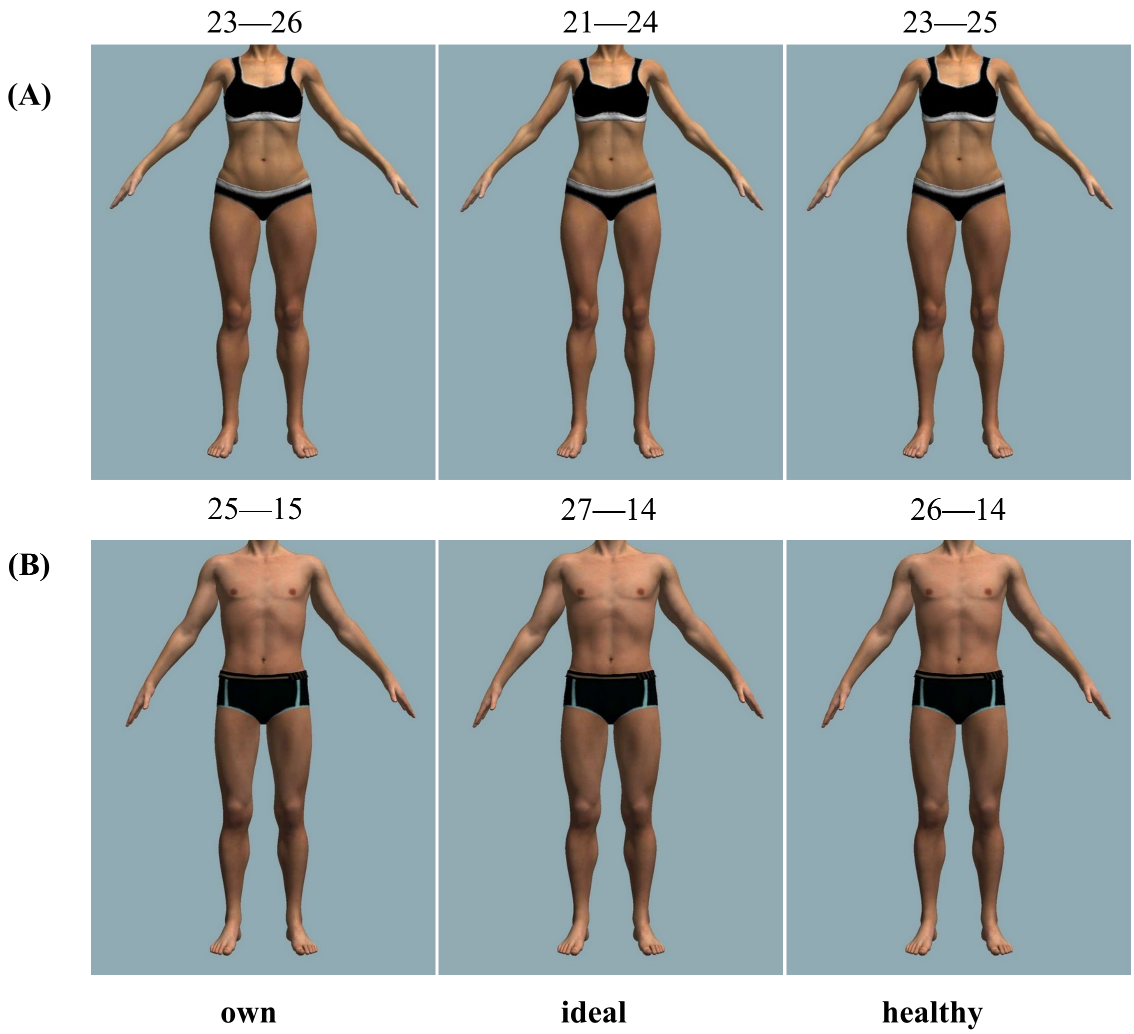


26—14

Men's estimate of women's preference for long-term relationships

Figure 22. Body shape preferred for short- and long-term relationships. The first number represents BMI and the second number represents Fat%. Panel (A) shows the female bodies that European men actually preferred (left column) and women think men preferred (right column) for short-term (top row) and long-term (bottom row) relationships. Panel (B) shows the male bodies that European women actually preferred (left column) and men think women preferred (right column) for short-term (top row) and long-term (bottom row) relationships. Panel (C) shows the female bodies that Chinese men actually preferred (left column) and

women think men preferred (right column) for short-term (top row) and long-term (bottom row) relationships. Panel (D) shows the male bodies that Chinese women actually preferred (left column) and men think women preferred (right column) for short-term (top row) and long-term (bottom row) relationships.



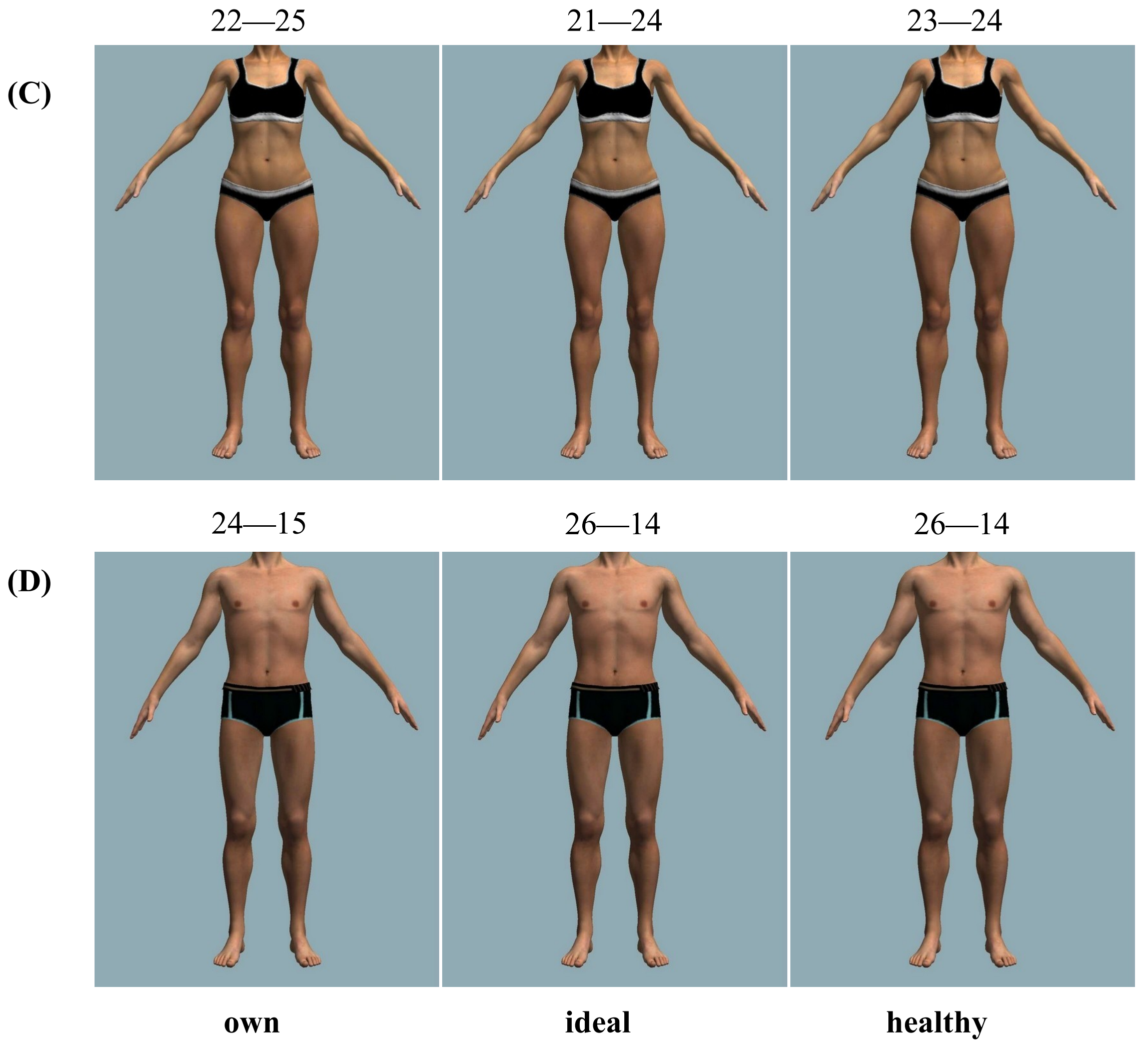


Figure 23. Participants' own bodies (left column), ideal bodies (middle column), and perceived healthiest bodies (right bodies) set by White European (A, B) and Asian Chinese (C, D) female (A, C) and male (B, D) participants. The first number represents BMI and the second number represents Fat%.

6.4 Study 5: Preference for facial adiposity cross-culturally

Although not expected, the results from Study 4 showed that there are cross-cultural differences in preference for body size. As facial information was removed from the body stimuli, we further explored whether the cross-cultural difference in preference for body size exists is reflected in preferences for face cues to body shape. In Study 5, we used same ethnicity and other-ethnicity face stimuli to compare Chinese and White European preference for facial correlates of body size.

6.4.1 Method

Ethical approval was received from University of St Andrews Ethics Committee (PS13176). Participants gave informed consent.

6.4.1.1 Stimuli

We recruited 56 Chinese females ($M_{age} \pm SD = 21.50 \pm 2.21$), 23 Chinese males ($M_{age} \pm SD = 22.72 \pm 1.99$), 74 White females ($M_{age} \pm SD = 22.57 \pm 1.51$) and 35 White males ($M_{age} \pm SD = 22.69 \pm 1.59$) from the University of St Andrews. 2D facial photographs were taken from all participants. 168 out of 188 images were taken in the lab under a constant lighting condition with a Nikon camera. Facial images were captured in full colour with hair pulled back. Participants were seated at a set distance from the camera and asked to maintain a neutral expression. 20 out of 188 images were taken in the sports center of University of St Andrews using a Canon Eos Rebel XT camera under constant conditions, which were similar to the lab except of the lighting which was slightly darker. Each individual's height (measured with a tape) and BMI (measured with Tanita SC-330 body composition analyser) were recorded with bare feet.

Facial shape was manually delineated by defining 189 feature points in the face and aligned on the eyes using PsychoMorph (Tiddeman et al., 2001). Eight composite images, each comprising 3 different individuals were produced for each category (Chinese female, Chinese male, White female and White male), resulting in 32 composite images in total. The aim of producing these composite images was to mask participants' identity and reduce the possibility of them being recognized.

Low and high BMI prototypes were created by separately averaging 10 faces ranking the lowest on BMI and 10 faces ranking the highest on BMI for the four face categories. The ethnicity and sex matched prototypes were then used to create face shape transforms of the 32 composite faces. Face shapes were transformed to visualise BMI differences by adding or subtracting a proportion of the facial shape differences between low and high BMI prototypes while keeping skin colour and texture constant.

To make transformed faces created from the White and Chinese prototypes comparable, facial shapes were transformed to the same magnitude in terms of BMI in 21 continuous steps. Along the continuum, step 0 was reduced in apparent BMI by 8.59 units for females and 4.7 units for males, step 10 was the original image and step 20 was increased in apparent BMI by 8.59 units for females and 4.7 units for males. The reason for the variation in transformation of BMI for females and males was trying to maximise the magnitude of the transformed face shape while maintaining its reality. All transformed images were cropped and resized to 370×400 pixels using Faststone software.

6.4.1.2 Participants

66 Chinese and 51 White participants were recruited via Perceptionlab website and spreading the link of the study on social media like Facebook and Wechat (White and Chinese media platforms, respectively). The age distribution of participants was 33 Chinese females ($M_{age} \pm SD = 27.39 \pm 7.07$, range 22-49 years), 33 Chinese males ($M_{age} \pm SD = 26.67 \pm 6.23$, range 19-56 years), 38 White females ($M_{age} \pm SD = 27.52 \pm 9.35$, range 18-56 years) and 13 White males ($M_{age} \pm SD = 25.31 \pm 4.80$, range 19-37 years).

6.4.1.3 Procedure

Participants were first asked to fill a questionnaire about their age, sex, country of birth, country of residence and ethnicity. Then participants were presented with 4 blocks of transformed facial images (each block contains 8 composite images from one set of transformed images) and asked to optimize the attractiveness of these composite faces by moving the mouse horizontally across the images along a continuum that portrays the BMI changes. There was no time limit to make the judgements. The order of the blocks and trials within the blocks were presented in random order.

6.4.1.2 Statistical analysis

The numbers of the frame chosen for each face were saved, thus, each trial had a number from 0-20. For each category of faces (Chinese female, Chinese male, White female, White male), the frame number chosen were averaged across face identities for each participant. Ten was subtracted from each number, and they were divided by 10, thus, these numbers were converted to a scale from -1 to 1, where negative scores mean a reduction in BMI, a positive score represented an increase in BMI, and 0 means no change in BMI. These converted scores were multiplied by the transformed BMI units (8.59 units for females and 4.7 units for males) to give a number of BMI units change. The numbers of BMI units change were then added to the average BMI of each category to give an optimal BMI value chosen for each category for each participant.

Data were analysed in SPSS 24. Repeated measurement was run to test preference for facial correlates of BMI. The BMI value chosen was included as the dependent variable. Ethnicity of face and sex of face were within-subject variables, while ethnicity of participant and sex of participant were between-subject variables.

6.4.2 Results

Results of repeated measurement showed non-significant main effects of the ethnicity of participants ($F(1,113) = 0.739$, $p = 0.392$, $\eta^2 = 0.006$) and sex of participants ($F(1,113) = 0.31$, $p = 0.579$, $\eta^2 = 0.003$). The main effects of the ethnicity of face ($F(1,113) = 152.95$, $p < 0.001$, $\eta^2 = 0.575$) and sex of face ($F(1,113) = 593.92$, $p < 0.001$, $\eta^2 = 0.840$) were significant. Furthermore, these two variables were found to interact ($F(1,113) = 116.76$, $p < 0.001$, $\eta^2 = 0.508$). Pairwise comparisons showed that participants preferring significantly lower BMI for Chinese ($M = 16.20$, $SD = 1.84$) than White female faces ($M = 18.41$, $SD = 2.11$) ($t(116) = -15.21$, $p < .001$), but the preference for Chinese ($M = 20.45$, $SD = 1.07$) and White ($M = 20.55$, $SD = 1.11$) male faces was not significantly different ($t(116) = -1.14$, $p = 0.257$). All other interactions were not significant.

6.4.3 Interim discussion

The results from this study showed that Chinese and White men and women have similar preference for facial correlates of BMI. Moreover, this preference is dependent on the ethnicity of faces. Female faces that were perceived to be most attractive were associated with lower BMI in Chinese compared to White faces, whereas the most preferred male faces were aligned between the two ethnicities.

6.5 Discussion

One aim of the present study was to find out whether there are misperceptions of opposite-sex preferences of body size and body muscularity. The current study extended previous research on perceptions of opposite-sex preferences by generalising the findings to Chinese populations. Consistent with some prior studies, the results showed that women misperceive and exaggerate the thinness that men prefer for both short- and long-term partners (Bergstrom et al., 2004; Grossbard et al., 2011). Men also misperceive women's preferences and overemphasise the heaviness and muscularity of bodies that women actually prefer (Crossley et al., 2012; Grossbard et al., 2011). Additionally, the misperceptions of men and women were more exaggerated for short-term relationships than long-term relationships. Most importantly, these misperceptions were consistent across European and Chinese participants.

Furthermore, our results indicated that both European and Chinese women as well as Chinese men's ideal body is thinner and lower in body fat compared to their perceived healthiest body, while European men's ideal body is heavier than their perceived healthiest body. It was salient that men and women were aware that their ideal body did not reflect the healthiest state. Interestingly, what European men and women actually preferred in opposite-sex bodies was concordant with what *was* perceived as healthiest. The female and male bodies that Chinese men and women preferred, respectively, were thinner than those perceived as the healthiest. Moreover, it was found that perceptions of opposite-sex preferences predict body dissatisfaction in men and women.

6.5.1 Misperceptions of opposite-sex desires

The misperceptions of opposite-sex preferences might result from the differences in the ideals portrayed on media targeting men and women. For example, Frederick, Fesseler, & Haselton (2005) found that men portrayed in magazines targeted at male audiences are more muscular than men portrayed in magazines targeted at women. Since media exposure plays an important part in shaping body ideals (Smolak, 2009), the different body models presented to men and women might explain the discrepancy between what women want and what men think they want. Nevertheless, it is unknown whether the female body shapes portrayed in media targeted at men and women are different or not. Future studies should examine this issue to help define possible causes of misperception.

An alternative account of the misperception is that perception of opposite-sex desires is accurate but that own preferences are under-emphasised. For instance, women may accurately perceive men's preference for thinness, though men may under-report their preference for thinness for social desirability reasons. As thinness and muscularity are characterized as ideals for women and men respectively, men and women may feel pressure to conform to the social forms. Consequently, they may report a preference towards the social ideals although they probably do not have a preference for that. Future studies could test people’s implicit attitudes towards the body ideals.

We note that our findings are not completely consistent with prior studies as some studies showed that both sexes have similar perceptions of attractiveness (Coetzee et al., 2011; Crossley et al., 2012; Stephen & Perera, 2014). The divergence in results might result from the different questions asked. Participants in the experiments of Coetzee et al. (2011) and Stephen and Perera (2014) were simply asked to rate attractiveness without reference to what the other sex would like. In contrast, participants in the current study were specifically asked to judge what heterosexual opposite-sex individuals would prefer for short- and long-term relationships. Collectively, these findings suggest that men and women have similar notions of the way in which an ideal male or female body differs from average but the extent to which that ideal differs from average gets exaggerated when considering opposite-sex preferences, particularly in a short-term relationship context.

Evolutionary psychologists argue that there are different mating strategies for different mating contexts. Physical attractiveness was found to be particularly important for both sexes when considering short-term relationships (Li & Kenrick, 2006). Therefore, standards of attractiveness should be higher when choosing short-term partners. In fact, many studies have revealed that women have a stronger preference for masculinity when considering short-term partners compared to long-term partners (Little et al., 2002; Penton-Voak et al., 2003; Jones et al., 2018). Likewise, men prefer more feminine female faces when considering short-term partners compared to long-term partners (Little, Jones, Feinberg, & Perrett, 2014). Yet, in the current study, no differences in preferences for partner's body size and muscularity were found for short- and long-term relationships in either sex. Nevertheless, both men and women showed misperceptions of opposite-sex preferences. To be specific, women mistakenly believed that greater thinness and lower body fat was required by men for ideal attractiveness in a short-term partner and men believed more muscularity was desired by women for an ideal short-term partner. The misperceptions imply that people are aware of dual mating strategies and believe the opposite-sex has higher beauty standards for short-term than for long-term relationships. Literature on men and women's short-term and long-term preferences for body size and body muscularity is limited, therefore our findings warrant further investigation.

6.5.2 Health and attractiveness

Sexual selection theory proposes that attractive features signal health and should be perceived as healthy. Upon examination of preferences and perceived health of bodies, we found that both Chinese men and women chose heavier opposite-sex bodies to optimise health rather than to optimise attractiveness, but this difference was not seen for European participants. These results are partially in agreement with some previous studies. One study showed that Malaysian men and women chose a lower BMI in female bodies for attractiveness than for health (Stephen & Perera, 2014). Similarly, another study indicated that undergraduates from Australia also discriminate between perceptions of attractiveness and health in women's bodies by preferring a lower BMI for attractiveness than for health (Brierley et al., 2016), which is not in line with our findings in European populations. The discrepancy between perceptions of attractiveness and health suggests that the argument that perception of attractiveness reflects perceived health warrants further investigation. It is more likely that other socio-cultural factors like media exposure play a major role in influencing attractiveness perception. A thin female ideal has been portrayed by the media and may have been internalised across the world in the past few decades (Swami, 2015). Thus, media might have shaped the preference towards thin female bodies. Nevertheless, no study has found that media influences individuals' perception of healthy body. Women on average have higher body fat percentage than men due to the need for normal ovulation, fertility, gestation, and lactation (Frisch, 1987; Norgan, 1997). Since body fat percentage is positively associated with body weight, underweight or very skinny women possibly do not have enough body fat for normal ovulation and fertility. Consequently, very thin (e.g. BMI < 17) women would not be seen as healthy, whereas moderately thin is attractive (e.g. BMI 18).

On the other hand, lean muscularity has been characterised as a male body ideal. Just like the media influence on the female body ideal, a preference for lean muscularity of male bodies might also be shaped by the media. Indeed, it has been shown in previous studies that lean muscular men were preferred by women (Brierley et al., 2016; Crossley et al., 2012). It should be noted that there is evidence to suggest that media plays a major role in shaping an individual's ideal body or attractiveness perception, but little suggestion that the media influences health perception. Therefore, a discrepancy between the most attractive and healthiest male BMI may be produced by media exposure.

6.5.3 Culture differences

That still leaves the question of why the discrepancy of BMI between the healthiest and most attractive body was seen only in Chinese but not Europeans. This might be partly explained by the ethnic difference of body size preference between European and Chinese. Both European men and women in the current study showed preferences towards heavier bodies than Chinese participants. This is consistent with findings of previous studies that the BMI of the most attractive female body was lower in Asian populations (BMI=17, Stephen & Perera, 2014) than European populations (BMI=19, Crossley et al., 2012). One may argue that this difference in preference for body size reflects the avoidance of unhealthy mates, as WHO suggested that the cut-off point of being overweight should be lower for Asian populations than White populations (BMI 23 VS 25) (WHO, 2004). Hence, thinner partners should be preferred by Chinese compared to Europeans because Chinese face a higher risk of being overweight than Europeans given the same BMI (e.g. BMI 23 is overweight for Asians but not White). Nonetheless, the health risk should affect the perception of health more than attractiveness, thus the bodies perceived as healthiest should be also be lighter for Chinese than Europeans. In follows that no discrepancy between preference and perceived health should be observed in either ethnicity, which is not the case in the present study. Instead, we found that although Europeans did not differ in their preferred and perceived healthiest bodies of the opposite-sex, Chinese did choose a lower BMI for attractiveness than health in both sexes. Therefore, the health risk associated with heavier bodies is not the reason for Chinese preferring thinner partners than Europeans. As mentioned before, media plays an important role in shaping body ideals. Although a thin female ideal is prevalent in most developed areas, the degree of thinness promoted may vary between cultures. If women and men portrayed in Chinese media are thinner than those portrayed in Western media, it could result in Chinese preferring thinner partners than Europeans. Future study should explore the differences of the male and female models portrayed in Western and Chinese cultures to provide better understanding of the different preferences across cultures.

6.5.4 Body dissatisfaction

It should be noted that the discrepancy of body size does not only exist in the healthiest and the most preferred body but is also observed between the participants' ideal body and their perception of the healthiest body. Specifically, the body desired by European and Chinese women is thinner and lower in body fat than what they think is most healthy. For men, although the body desired by both ethnicities was more muscular than what they thought was healthiest, the two ethnicities diverged on the ideal body size. The ideal body for European men is heavier than what they think is the healthiest and the reverse is true for Chinese men. As discussed earlier, this difference might result from different male ideals portrayed in Western and Chinese media. It is plausible that Chinese media advocates lean muscularity in men while Western media advocates bulky and muscular bodies in men. Nevertheless, it is salient then that men and women are aware that their ideal body does not reflect the healthiest state. These findings suggest that young adults place greater importance on being attractive than being healthy. Therefore, interventions for eating disorders or body dissatisfaction are unlikely to be effective if they focus on emphasising the importance of possessing healthy bodies.

It has been revealed that women's misperceptions of men's preferences for thinness are positively associated with eating disorders and negative body attitudes (Bergstrom et al., 2004). Similarly, the current study shows that men's and women's body dissatisfaction is associated with what they perceive the opposite-sex prefer. Therefore, correcting misperceptions of opposite-sex preferences might help to prevent and treat eating disorders or body dissatisfaction among young men and women. Moreover, the sample in the present study was mainly young adults at an age where they may be looking for partners. In other words, the perception of attractiveness in the opposite-sex might play an important role in shaping attitudes of body image and eating behaviour for this group. In the past few decades, media exposure has been the focus of body image studies. Our findings provide evidence to support further research on the impact that misperceptions of opposite-sex preferences have on body dissatisfaction.

6.5.5 Media influence on preference for opposite-sex

As predicted, endorsement of media ideals was observed. Furthermore, participants' body ideal for themselves and their partners were influenced by own-culture's media more than other-culture's media. Contrary to our predictions (and to Study 2), media internalisation was not correlated with preference for opposite-sex body shape. The majority findings of the media effects on body ideals are centralized around own ideal body (Grabe et al., 2008; Swami et al., 2010). Few studies have tested whether media ideal internalisation is generalized to preference for opposite-sex (e.g. Study 2). Hence, the results suggest that the internalisation of media ideals might have greater impact own body ideal, whereas it is less influential on the preference for opposite-sex. Also noteworthy is that the questionnaire tests the internalisation of own body ideal but not opposite-sex body ideal. Future study employing questionnaire testing the endorsement of media ideal of opposite-sex might provide better understandings.

6.5.6 Caveats

It is worth noting that although the BMI and Fat% of the own ideal and preferred partner bodies are within the healthy range, the values may not truly represent realistic human figures. The body models used in the current study were generated through a mobile app. The extent to which the models accurately reflect the body weight and muscularity of real human bodies remains unclear. Compared with previous findings, the ideal female body figure found in the current study is heavier in terms of BMI. For example, the associated BMI of the attractive female bodies or faces found in previous studies was as low as 17 (Stephen & Perera, 2014), and the highest was around 20 (Tovée, Reinhardt, Emery, & Cornelissen, 1998). The BMI of women's ideal body figure in the present study is around 21 and this figure is even higher for men's preference, which is around 22. Clearly, the ideal female body size is higher in the current study than in previous studies. By the same token, the ideal male body size might also be higher compared to previous work. Previously, studies examining preferences of body size mainly used line drawings or photographs of different individuals; few used controlled interactive photographs or model images. Even though some studies used real individual body images, body composition was not taken into consideration. Future studies exploring the body weight and shape that are attractive in men and women should use realistic photographs of human bodies and control for other body parameters that influence physical attractiveness like waist to hip ratio. Nonetheless, even though the absolute values of BMI and Fat% of the preferred male and female bodies may not truly represent the most attractive figures of men and women in real life, the aim of the present study was to compare preferences between the two sexes. Thus, the accuracy of the representations of human body models should not affect the misperceptions of opposite-sex preferences found here.

6.6 Conclusion

In conclusion, using models of human bodies with various levels of BMI and Fat%, the current study revealed that misperceptions of opposite-sex preferences exist in young men and women. In particular, women tend to overestimate the thinness of female bodies that men prefer, and men tend to overestimate the muscularity of male bodies that women prefer. Moreover, these misperceptions are more exaggerated for short-term relationships. Women mistakenly believe that men would like thinner women for short-term than for long-term relationships, while men misperceive that women would like more muscular men for short-term than for long-term relationships. Future research on body image should evaluate the influence that misperceptions of opposite-sex preference has on body dissatisfaction and other body image related psychological problems.

Chapter 7 Conclusions

7.1 Summary of results

Previous studies have revealed several anthropometric features of the body affecting physical attractiveness and social judgements (e.g. Body Mass Index, Waist to Hip Ratio) (Tovée, Maisey, Emery, & Cornelissen, 1999; Singh,1993), but the influence of body composition has been generally ignored. With special attention to body composition and its facial correlates, the present work explored preferences for body composition as well as the influences of body composition on the perception of some social traits in men's faces.

Study 1 & 2 presents evidence for the influence of facial correlates of body fat and muscle mass on male facial masculinity as well as women's preferences. Study 1 showed that facial correlates of fat and muscle have distinct impacts on the perception of masculinity in male faces. To be specific, perceived facial masculinity increased as the body fat increases, but only up to a certain point (around BMI 22), where further increases neither increased nor decreased perceived masculinity. In contrast, increasing muscle mass was found to enhance the perception of male facial masculinity in a linear way. Study 2 showed that women have stronger preferences for facial correlates of muscle in short-term relationships than long-term relationships. However, this difference in long- and short-term relationships was not observed in preferences for facial correlates of fat.

Study 3 aimed at answering the question left in Study 2, which is why women show different preferences for facial correlates of muscle but not fat between short- and long-term relationships since both of these enhance masculinity in men. We tackled this issue by examining the two well-known hypotheses that were proposed to be the underlying psychological mechanisms of women's mate choices: the good genes hypothesis (i.e. men displaying cues of good genes like strength, fitness are preferred by women) and the good parent hypothesis (i.e. men displaying cues of good parents like kindness are preferred by women). In what follows, we investigated the influence of facial correlates of fat and muscle on the perception of health (testing the good genes hypothesis) and kindness (testing the good parent hypothesis) in male faces. The results showed that facial correlates of fat and muscle have similar effects on perceived health. Both were found to follow a quadratic relationship: perceived health increased with increasing fat and muscle mass from underweight to middle normal weight (BMI 21) but dropped off when BMI was over 21. In contrast, facial correlates of fat and muscle showed different impacts on the perception of kindness. While facial correlates of muscle diminished perceived kindness considerably, facial correlates of fat showed only a slight detrimental impact on perceived kindness. Therefore, the findings from

Study 2 that women show a stronger preference for facial correlates of muscle but not fat in short-term relationships than long-term relationships might be because facial correlates of muscle diminish kindness perception, which is important for long-term relationships. Taken together, these findings lend more support to the good parent hypothesis.

Study 4 examined men and women's preferences and perceptions of opposite-sex preferences for body size (BMI) and muscularity (Fat%). We found that both men and women had misperceptions about the preferences of the opposite-sex. Men tend to exaggerate body heaviness and muscularity that women desire, while women mistakenly believe men prefer thinner women than men actually do. These misperceptions were larger for short-term relationships compared to long-term relationships. In reality, men and women did not show different preferences between short- and long-term relationships in BMI and muscularity.

Furthermore, using a proxy measure of body dissatisfaction, this study revealed that university-aged men and women are perceptually dissatisfied with their bodies. Men desire a heavier and more muscular body than their own and women desire a thinner and less fat body than their own. Moreover, participants are aware that their ideal bodies are not the healthiest. Most importantly, the perception of opposite-sex preference predicts their body dissatisfaction. Specifically, women perceive men preferring thinness would be dissatisfied with their BMI. Men perceive women preferring muscularity would be dissatisfied with their muscularity.

7.2 Challenges of evolutionary hypothesis

The finding that a lower BMI in female bodies is perceived as more attractive in Chinese than White populations is consistent with some prior findings. Previous studies in Western populations reported that a BMI around 18~20 is most attractive in women (Crossley et al., 2012; Swami, Neto et al., 2007) whereas the most attractive female body has a BMI around 18 amongst Japanese (Swami, Caprario et al., 2006) and 17 amongst Malaysian Chinese (Stephen & Perera, 2014).

The difference in BMI preference between the different ethnicities has been explained as adaptation to the local environments (Stephen & Perera, 2014; Swami, Caprario et al., 2006). As the optimal BMI for health is lower for Chinese compared to European White, a Chinese population should prefer a lower BMI in comparison to a Western population. In fact, the results from the study 4 suggest that the male and female bodies that are seen as most healthy do not differ between White and Chinese samples. These findings challenge the proposal that individuals adjust their BMI preferences to fit the local environment.

It has been widely accepted that the difference in preferences for BMI between cultures is due to the variation in health risks associated with increased BMI (Swami, Caprario et al., 2006; Stephen & Perera, 2014; Tovée & Cornelissen, 2001) yet, no study has directly tested whether the attractiveness differences are accompanied by differences in health judgements. We show, for the first time, that attractiveness judgement can vary, while health judgement does not. Our findings suggest that adaptation does not account for the different BMI preferences between populations.

Furthermore, we found that young Chinese men and women differentiate attractiveness and health perceptions: a low BMI is judged to be the most attractive but it is not perceived as the most healthy. A discrepancy between attractiveness and health judgement in females in terms of BMI has been reported before. Using face stimuli (Coetzee et al., 2011) and body stimuli (Brierley et al., 2016) in Western (Brierley et al., 2016) or Asian (Stephen & Perera, 2014) populations, there are multiple reports that the most attractive female figure is thinner than what is believed to be most healthy. Taken together, these findings point to the possibility that the specific BMI values that are preferred may not be because BMI is used as an indicator of health, at least in economically developed areas.

In areas where thinness might be more detrimental to health, plumpness is often desired in partners (Tovée et al., 2006; Swami et al., 2012). Here it does appear that a preference for high BMI reflects the drive for choosing healthy mates. Nonetheless, it is also possible that, when choosing a partner, individuals look for signs of a good capacity to provide resources, since resource availability is one of the major survival challenges in these areas. For example, men with good hunting reputations or those who show signs of hunting ability like strong arms are preferred by women in hunter-gather societies and resource-scarce areas (Apicella, 2014; Koster, 2011). Although women's mate value does not depend on their hunting ability, reproduction itself requires a large amount of energy and a certain level of fat storage (Frisch, 2004). Some researchers claim that women's physical attractiveness is partly explained by their reproductive value (Andrews et al., 2017; Lassek & Gaulin, 2019). Hence, plump women may be highly valued in areas with low food availability because plumpness signals high reproductive value. Note that we are not claiming that health plays no role in attractiveness judgements; we suggest that the difference in BMI preference found between different areas might not be solely due to adaptations to local environments.

7.3 Cultural difference and media influence

Since the different health risks associated with a given BMI could not account for the differences in BMI preferences between Chinese and White populations, this raises the question of why Chinese prefer thinner partners than White participants. It is more likely that sociocultural factors like media play an increasingly important role in the perception of physical attractiveness in economically developed areas. There is a pervasive effect of media exposure on body ideals (Grabe et al., 2008; Slater & Tiggemann, 2014, 2015). In a large cross-cultural study, researchers found that a general Western media exposure (including television, movies, magazines and music videos) predicts preference for thin female bodies in men and thin ideal body size in women (Swami et al., 2010).

Although a thin female ideal is prevalent in most developed areas, the degree of thinness promoted may vary between cultures. It is not surprising that Chinese people are influenced by Asian media more than by Western media (Jackson et al., 2016, and data presented here). If women and men portrayed in Chinese media are thinner than those portrayed in Western media, it could result in Chinese people preferring thinner partners than their European counterparts. By the same token, though a male body ideal is characterized by high muscularity (Boyd & Murnen, 2017; Pope, Phillips, & Olivardia, 2000), whether muscularity is portrayed as bulky (high BMI and low fat) or lean (low BMI and low fat) could well differ between cultures. Future studies should explore the differences of the male and female models portrayed in Western and Chinese media to provide better understanding of the different preferences across cultures.

In fact, there are several reasons to speculate that bodies portrayed in the media may be thinner in China than in the West. By analysing the weight of Miss Hong Kong between 1975 and 2000, researchers found that Miss Hong Kong Pageant winners have always been thinner than the average of women in Hong Kong (Leung et al., 2001). The authors argued that thinness has long been held as a beauty standard in women. Evidence for the thin female ideal can be traced back to as early as the Chun Qiu period (722–481 B. C.), in which fasting to attain slim bodies was documented. In addition, depictions of beautiful women in ancient literature and paintings also suggest that thinness was culturally expected in women in China for a long time (Leung et al., 2001).

Although it is possible that the thin ideal is admired most by the higher socio-economic status individuals, a recent study in rural China suggests that the preference for thinness is not limited to the rich and educated but also extends to labouring people (Mo et al., 2014). Researchers found that rural Chinese do not prefer heavier women compared to Hong Kong Chinese and British people, as would be predicted by the adaptation account. On the contrary, the peak BMI value for attractiveness is lower in rural Chinese compared to the other groups, although differences did not reach significance. The trend for a group difference was explained in terms of a 'visual diet'. Since the rural Chinese are thinner than Hong Kong Chinese and British on average, the constant exposure to thin female figures in rural China might cause the rural population to perceive lower body weight as normal, thus also attractive. In essence, this argument might also account for the attractiveness difference that we found. As Chinese (both men and women) have smaller body figures in general compared to Westerners (WHO, 2016), Chinese are more likely to be surrounded by thin figures in life compared to people in Britain who are likely to see heavy figures more often. Moreover, the difference in average size between these two ethnicities might underly the different representations in the media (i.e. portrayals are thinner in Chinese media than Western media) since people in the media are generally more attractive than average in appearance.

In the past 20 years, considerable attention has been given to the effect of media on body image, especially in women (Grabe et al., 2008; Thompson et al., 1999). A large literature has accumulated that long-term exposure to media can lead to acceptance of media ideals, which in turn cause body dissatisfaction as the media ideals are unattainable for most women (Grabe et al., 2008; Stice et al., 2001; Thompson et al., 1999). Yet, few studies tested whether media has an influence on the preference for opposite-sex body shape. In the current study, we did some preliminary investigations of media impact on preferred opposite-sex. The results were not consistent though. In study 2, we found that young women who have higher internalisations of media ideals show greater preference for facial correlates of muscle mass than women who are less influenced by media. Results from Study 4, however, did not show the media effect on preference for opposite-sex body size and muscularity.

The inconsistent results might be partly due to the difference in stimuli. In Study 2, faces were manipulated on the muscle mass vector, while bodies in Study 4 were manipulated on BMI and Fat%. Although a low Fat% implies more muscle in relative to fat, low Fat% alone does not indicate high muscularity. For instance, very thin people may also have low body fat percentage, but they do not look muscular. Only people who have relatively high BMI and low Fat% appear muscular. Hence, stimuli in Study 2 might better depict muscularity changes than stimuli in Study 4, and thus caused the different findings.

Overall, there is a neglect of studies of media effects on preference for opposite-sex. Although people may pay more attention to same-sex information on media, it is unavoidable to that observers see opposite-sex bodies. Consequently, the repeated exposure to the portraits of opposite-sex bodies in media might result in a preference towards these body shape (Boothroyd et al., 2012; Winkler & Rhodes, 2005). The current thesis and previous studies found misperception of opposite-sex preferences for body size and that these could result in body dissatisfaction (Bergstrom et al., 2004). In future studies it is important to investigate whether and to what extent media influences people's preference for opposite-sex bodies and how it is implicated in body dissatisfaction.

7.4 Contributions and future directions

The findings from the current thesis suggest that body composition should be taken into consideration in future studies when investigating the influences of BMI on perceptions of social traits and preferences for partners. Many previous studies have focused on the role BMI plays on physical attractiveness (Furnham, Petrides, & Constantinides, 2005; Tovée, Maisey, Emery, & Cornelissen, 1999; Tovée, Maisey, Vale, & Cornelissen, 1999). Although BMI has advantages in evaluating individuals' body size and is easy to measure, one cannot ignore the weakness that BMI does not distinguish between the effects of different aspects of body composition (fat and muscle). Through a series of studies, we showed that body fat and muscle have different impacts on perceptions of masculinity, kindness, and attractiveness. The distinct impacts highlight the importance of dissociating fat and muscle in future studies where body weight is of interest. For instance, Holzleitner et al. (2014) reported that facial cues to weight contribute to perceived masculinity in male faces. By dissecting facial cues to weight into fat and muscle, we revealed the distinct effects that facial correlates of fat and muscle have on perceptions of masculinity in male faces. Given the influences of BMI on perceptions of strength (Holzleitner & Perrett, 2016), competitiveness (Re & Perrett, 2014), leadership (Windhager et al., 2011) and so on, it may be beneficial to explore the impact that body fat and muscle have on social judgments separately.

One technical contribution that stems from the present studies is that we directly manipulated one set of features related to a specific aspect of body composition while keeping all other anthropometric features constant. This allowed us to isolate the contribution of a specific aspect of body composition on preferences and other social judgments. Thus, the direct manipulation of cues of interest defined the influences of body composition independently.

Yet, it remains unknown why fat and muscle have different impacts on some social judgements. It should be noted that although fat and muscle both contribute to an individual's weight, their contributions to perceived masculinity are different. We have shown in the thesis (Chapter 4 study 1) that facial cues to muscle enhance perceived masculinity dramatically while the effect of fat on perceived masculinity is less influential. There is robust evidence on the link between masculinity and men's mating effort, aggressiveness, trustworthiness, and dominance (Mascaro et al., 2013; Perrett et al., 1998; Puts, 2010). Hence, it is likely that the deleterious effect of facial correlates of muscle on perceived kindness and women's aversion of men displaying high muscle cues as long-term partners is due to the strong relationship between muscle and masculinity. Investigation of the mediating role that perceived masculinity may have on the effects of muscle on social judgements is warranted in future studies.

A further contribution stemming from the thesis is that we provided evidence that the good parent hypothesis may be a better account of women's stronger preference for masculinity for short- than long-term partners. In the past decades, the pursuit for good genes for health and immunity has been argued to be the major underlying psychological mechanisms of women's preference for masculine men, especially for short-term relationships (Fink & Penton-Voak, 2002; Gangestad & Simpson, 2000). Consequently, a great deal of attention has been put into investigations of the relationships between men's masculinity and gene quality or reproductive success (Apicella, 2014; Foo et al., 2017; Foo et al., 2017; Phalane et al., 2017). Unfortunately, the relationship between these two is far from clear-cut. Our findings from Study 3 suggest that the preference shift should rather be interpreted as women's strong aversion or avoidance of masculine men as long-term partners because masculinity decreases perceived kindness but not increases perceived health, therefore, providing support for the good parent hypothesis (Roney et al., 2006; Perrett et al., 1998). Future research should shift focus from finding the relationship between men's reproductive value and masculinity to the investigation of the extent to which pro-social traits influence women's mate choices. Note that we are not suggesting that there is no utility of the good genes hypothesis, rather we argue that good gene hypothesis may not serve as an explanation of women's context shift preference whereas good parent hypothesis may be the underlying mechanism and warrant more attention.

Another key contribution is that we provided clear evidence that men and women have misperceptions of opposite-sex preferences for body size and body muscularity. Findings from previous studies regarding attractiveness judgements between sexes are inconsistent, probably due to the variation in stimuli used. In the current thesis, we used more realistic body images and directly manipulated BMI and Fat% while keeping all other relevant parameters constant. In comparison, previous studies either used line-drawn figures or photos of different bodies for different levels of muscle/BMI but not controlled confounders (Bergstrom et al., 2004; Grossbard et al., 2011). Thus, the present work provided promising support for the existence of misperceptions of opposite-sex preferences for bodies. Additionally, to our knowledge, this is the first study revealing that the misperceptions are stronger for short-term relationships than long-term relationships. These findings may be beneficial to studies attempting to find ways of combatting body dissatisfaction or other body image related psychological problems. For example, some studies have provided preliminary evidence for the impact of correcting perceptions of others' attitudes and behaviour (social norms) on binge drinking (LaBrie et al., 2013; Neighbors et al., 2010). By the same token, interventions targeting at changing misperceptions of opposite-sex preferences for bodies might be useful for reducing body image related problems.

Attention has been put into the exposure effect (no matter short-term exposure in laboratory environments or long-term exposure like media exposure) on an individual's perceptions of normal and attractive bodies. And it is well-established that exposure does have a substantial effect on perceptions of normality and attractiveness (Boothroyd et al., 2016; Stephen & Perera, 2014; Suchert, Hanewinkel, & Isensee, 2016). However, it is usually not within one's control of what he or she is exposed to. Hence, it is not realistic to help people with body image concerns by changing the environments they are exposed to. Our findings suggest a new approach that modifying an individual's perceptions of opposite-sex preferences might be useful for decreasing body dissatisfaction. Future research should examine to what extent perceptions of opposite-sex judgements of body attractiveness affect an individual's body image especially in populations that have body image concerns such as anorexia nervosa and muscle dysmorphia. If it proves to be influential, further investigation is warranted to explore the methods of correcting misperceptions of opposite-sex preferences.

As a further contribution, our work is the first to show body dissatisfactions in BMI and Fat%. While a drive for thinness and muscularity has been largely reported in women and men respectively in the past decades (Kelley et al., 2010; Swami, 2015; Thompson & Cafri, 2007), the findings were mainly based on questionnaires or line-drawn figures.

Consequently, it is unclear to what extent and on what aspects people are dissatisfied with their bodies. Here, we directly quantified the discrepancy between an individual's own bodies and their ideal bodies in BMI and Fat%. These findings provided further evidence for the existence of body dissatisfactions within both European and Chinese young adults.

Additionally, findings from Study 4 revealed both cultural differences and similarities in physical attractiveness judgements. Although these findings suggest that a thin female ideal and a muscular male ideal is prevalent in both Western and Asian cultures, Western European and Asian Chinese men and women showed different preferences for their partner's ideal weight. Compared to Western Europeans, Asian Chinese were attracted to opposite-sex partners with lower weight both in men and women. Previous studies either did not compare preferences between Western and Asian populations directly or did not treat men and women's judgements for the opposite-sex separately.

It remains unclear whether preferences for thin female bodies and muscular male bodies is universal. For the first time, we showed that although the ideal own body figures are similar across Western and Asian cultures, it is noteworthy that Asian Chinese desire significantly lower body weight of their partners than Western Europeans. These findings hint that it should not be taken for granted that perceptions of physical attractiveness are similar across areas where it is economically developed and influenced by Western culture. It has long been held that the discrepancy of preferences for body size is due to the different degree of media exposure or resource scarcity (Swami, 2015). The Chinese population we studied indeed reside in economically developed areas and are highly likely to be exposed to Asian and Western mass media. Therefore, our findings suggest that there are other factors that shape and influence physical attractiveness judgements. Future studies should investigate what these factors are.

Furthermore, the current work has a methodological contribution. Previously, studies of faces used either 2D face images or 3D face images, thus making it difficult to compare results across studies. While 3D face images have advantages in retaining some information that 2D face images do not show like shadow and depth, it is unknown whether usage of 2D and 3D face images would lead to different results. In the present work, 2D and 3D images were used at the same time to make direct comparisons. Our findings suggest that 2D and 3D images have both similar and distinct impacts on social judgements. For example, in Study 1, statistical analysis showed that facial cues to muscle enhanced perceived masculinity equivalently for 2D or 3D images. However, findings from Study 2 revealed that male faces judged to be most desirable were associated with higher BMI for 3D face images than 2D face images. Likewise, the BMI of the healthiest and kindest faces is higher for 3D faces than 2D faces. A potential explanation is that the perceived weight is higher for 2D face images than 3D face images given the same BMI. Future studies should examine whether 2D and 3D face images influence perceived weight in a similar way. Although the work presented here appears to implicate that the unique information retained in 3D face images does not affect social judgements in a different way compared to 2D face images, we note that comparisons of the influences of 2D and 3D face images on more social judgments are warranted to conclude that the use of 2D or 3D face images produce similar results.

7.5 Limitations

Despite the contributions discussed above, the current work possesses several limitations require further investigation. First, our studies are exploratory, therefore, the focus was on the effects of limiting factors. Consequently, we cannot conclude how much variance is explained by the facial correlates of fat and muscle. This limitation is due to the nature of stimuli. While manipulating body composition with other confounders controlled allowed us to detect any independent effects of body composition, it also prevented us from making inferences about how influential the cues from body composition are compared to other factors. Since these findings revealed the effects of the body composition on some social judgements, future study should set out to test the contribution of body composition in natural images.

Second, the current work investigated preferences and social judgements at the population level by analysing the average preferences or perceptions for certain features. We acknowledge that there are individual differences in attractiveness judgements. For example, self-attractiveness was found to be positively correlated with women's preferences for masculinity in men (Little et al., 2001; Holzleitner & Perrett, 2017). Given the close link between body composition and masculinity, one might expect that women who perceive themselves as more attractive than others might prefer more muscular men than women who have low ratings of self-attractiveness. Similarly, pathogen disgust sensitivity, financial worries, and hormones, all of which have been found to influence women's preference for men's masculinity (Holzleitner & Perrett, 2017), thus are likely to have an impact on women's preference for body composition, thus warrant further investigation.

Third, the present work mainly focused on male faces but not studied female faces. This is due to the difficulty of generating valid fat and muscle prototypes to create corresponding transforms. Holzleitner and Perrett (2016) reported that facial correlates of fat and muscle are highly correlated in women, indicating that female face shape could not be well separated to fat and muscle vectors independently. Collection of data from more female participants might help solve the problem. If the problem is successfully solved, researchers should examine the effects of fat and muscle on perceived femininity and other social judgements in women's faces. If the problem persists, it is still worth to investigate possible influences of body composition on female bodies as we did here. Besides, more investigations in different populations are warranted for better understandings of the effects found in the present thesis.

7.6 Conclusion

This thesis investigates the impacts of body composition on preferences for the opposite-sex and some social judgments. The current thesis demonstrated that facial cues to fat and muscle have different impacts on preferences and perceptions. These findings highlight the importance of treating body fat and muscle separately in future studies whenever BMI is concerned. The present work is one step towards a better understanding of the roles that body composition play in social judgements. In the next step, more investigations of the influences of body composition on other social judgements are needed. Most importantly, future research should investigate how influential the misperceptions of opposite-sex are on body dissatisfaction and whether perception corrections can improve body image.

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Appendix 1 Stimuli information

Table S1. Differences of anthropometric data in high and low fat and muscle mass prototypes (3D face set and 2D version of 3D face set)

Dimension manipulated	Dimension	Low mean	High mean	Mean difference
Fat	Fat	4.2kg	15.3kg	11.1kg***
	Muscle	60.8kg	61.9kg	1.1kg(n.s.)
	Height	180.4cm	180.1cm	0.3cm(n.s.)
	Age	20.7	21.8	1.1(n.s.)
	Fat%	6%	19%	13%***
	BMI	20.9	24.8	3.9***
Muscle	Fat	8.1kg	8.8kg	0.7kg(n.s.)
	Muscle	57.3kg	65.5kg	8.2kg***
	Height	181.7cm	180.3cm	1.4cm(n.s.)
	Age	21.0	20.2	0.8(n.s.)
	Fat%	12%	11%	1%(n.s.)
	BMI	20.8	23.8	3.0***

Note. BMI = Body Mass Index, Fat% = Body Fat Percentage

*** $p<.001$

n.s. (non significant)

Table S2. Differences of anthropometric data in high and low fat and muscle mass prototypes (2D face set)

Dimension manipulated	Dimension measured	Low mean	High mean	Mean difference
Fat	Fat	3.8kg	18.9kg	15.1kg***
	Muscle	66.8kg	68.1kg	1.3 kg(n.s.)
	Height	184.1cm	183.6cm	0.5 cm(n.s.)
	Age	20.5	20.8	0.3(n.s.)
	Fat%	5%	21%	16%***
	BMI	21.9	26.8	4.9***
Muscle	Fat	7.3kg	7.9kg	0.6kg(n.s.)
	Muscle	57.4kg	67.7kg	10.3kg***
	Height	182.8cm	182.9cm	0.1cm(n.s.)
	Age	22.3	23.3	1.0(n.s.)
	Fat%	11%	10%	1%(n.s.)
	BMI	20.3	23.7	3.4***

Note. BMI = Body Mass Index, Fat% = Body Fat Percentage

*** $p<.001$

n.s. (non significant)

Table S3. Matrix of the female stimuli (BMI — Fat%)

BMI

28-22	28-23	28-24	28-25	28-26	28-27	28-28	28-29	28-30	28-31	28-32
27-22	27-23	27-24	27-25	27-26	27-27	27-28	27-29	27-30	27-31	27-32
26-22	26-23	26-24	26-25	26-26	26-27	26-28	26-29	26-30	26-31	26-32
25-22	25-23	25-24	25-25	25-26	25-27	25-28	25-29	25-30	25-31	25-32
24-22	24-23	24-24	24-25	24-26	24-27	24-28	24-29	24-30	24-31	24-32
23-22	23-23	23-24	23-25	23-26	23-27	23-28	23-29	23-30	23-30	23-30
22-22	22-23	22-24	22-25	22-26	22-27	22-28	22-28	22-28	22-28	22-28
21-22	21-23	21-24	21-25	21-26	21-27	21-27	21-27	21-27	21-27	21-27
20-22	20-23	20-24	20-25	20-25	20-25	20-25	20-25	20-25	20-25	20-25
19-22	19-23	19-23	19-23	19-23	19-23	19-23	19-23	19-23	19-23	19-23
18-22	18-22	18-22	18-22	18-22	18-22	18-22	18-22	18-22	18-22	18-22
17-21	17-21	17-21	17-21	17-21	17-21	17-21	17-21	17-21	17-21	17-21
16-20	16-20	16-20	16-20	16-20	16-20	16-20	16-20	16-20	16-20	16-20

FAT%

Table S4. Matrix of the male stimuli (BMI — Fat%)

BMI

30-12	30-13	30-14	30-15	30-16	30-17	30-18	30-19	30-20	30-21	30-22
29-12	29-13	29-14	29-15	29-16	29-17	29-18	29-19	29-20	29-21	29-22
28-12	28-13	28-14	28-15	28-16	28-17	28-18	28-19	28-20	28-21	28-22
27-12	27-13	27-14	27-15	27-16	27-17	27-18	27-19	27-20	27-21	27-22
26-12	26-13	26-14	26-15	26-16	26-17	26-18	26-19	26-20	26-21	26-22
25-12	25-13	25-14	25-15	25-16	25-17	25-18	25-19	25-20	25-21	25-22
24-12	24-13	24-14	24-15	24-16	24-17	24-18	24-19	24-20	24-21	24-22
23-12	23-13	23-14	23-15	23-16	23-17	23-18	23-19	23-20	23-21	23-22
22-12	22-13	22-14	22-15	22-16	22-17	22-18	22-19	22-20	22-20	22-20
21-12	21-13	21-14	21-15	21-16	21-17	21-18	21-18	21-18	21-18	21-18
20-12	20-13	20-14	20-15	20-16	20-16	20-16	20-16	20-16	20-16	20-16
19-12	19-13	19-14	19-14	19-14	19-14	19-14	19-14	19-14	19-14	19-14
18-12	18-12	18-12	18-12	18-12	18-12	18-12	18-12	18-12	18-12	18-12

FAT%

Note: the first number represents BMI and the second number represents Fat%. The shaded cells do not change on Fat%.

Appendix 2 Questionnaire

Questionnaire on media internalization (1–5) and source of media influence (6–8) on 5-point Likert Scale (1. Definitely disagree 2. Mostly disagree 3. Neither agree nor disagree 4. Mostly agree 5. Definitely agree).

1. I compare my body to the bodies of people who are on TV.
2. I have felt pressure from TV or magazines to have a perfect body.
3. I compare my body to that of people in good shape.
4. I have felt pressure from TV or magazines to exercise.
5. Famous people are an important source of information about fashion and being attractive.
6. I follow more Western celebrities (e.g. European, American) than Asian celebrities (e.g. Chinese, Japanese, Korean) on social media.
7. I would like my body to look more like the Western than Asian celebrities on social media.
8. I would like my partner's body to look more like the Western than Asian celebrities on social media.

Appendix 3 Ethics approval

University Teaching and Research Ethics Committee

04 September 2017

Dear Xue and Patrick

Thank you for submitting your ethical application which was considered at the School of Psychology & Neuroscience Ethics Committee meeting on 14th July 2017; the following documents have been reviewed:

1. Ethical Application Form
2. Advertisement
3. Participant Information Sheet
4. Participant Consent Form
5. Participant Debriefing Form
6. Questionnaire (Sections A and B)
7. Data Management Plan

The School of Psychology & Neuroscience Ethics Committee has been delegated to act on behalf of the University Teaching and Research Ethics Committee (UTREC) and has granted this application ethical approval. The particulars relating to the approved project are as follows -

Approval Code:	PS13092	**Approved on:**	30/08/2017	**Approval Expiry:**	30/08/2022
Project Title:	Exploring facial cues to attractiveness and health				
Researchers:	Xue Lei and Patrick Cairns				
Supervisor:	Professor David Perrett				

Approval is awarded for five years. Projects which have not commenced within two years of approval must be re-submitted for review by your School Ethics Committee. If you are unable to complete your research within the five year approval period, you are required to write to your School Ethics Committee Convener to request a discretionary extension of no greater than 6 months or to re-apply if directed to do so, and you should inform your School Ethics Committee when your project reaches completion.

If you make any changes to the project outlined in your approved ethical application form, you should inform your supervisor and seek advice on the ethical implications of those changes from the School Ethics Convener who may advise you to complete and submit an ethical amendment form for review.

Any adverse incident which occurs during the course of conducting your research must be reported immediately to the School Ethics Committee who will advise you on the appropriate action to be taken.

Approval is given on the understanding that you conduct your research as outlined in your application and in compliance with UTREC Guidelines and Policies (http://www.st-andrews.ac.uk/utrec/guidelinespolicies/). You are also advised to ensure that you procure and handle your research data within the provisions of the Data Provision Act 1998 and in accordance with any conditions of funding incumbent upon you.

Yours sincerely

Convener of the School Ethics Committee

cc Professor David Perrett (Supervisor)

School of Psychology & Neuroscience, St Mary's Quad, South Street, St Andrews, Fife KY16 9JP
Email: psyethics@st-andrews.ac.uk Tel: 01334 462071

University of St Andrews | FOUNDED 1413

University Teaching and Research Ethics Committee

11 September 2017

Dear Xue

Thank you for submitting your amendment application which comprised the following documents:

1. Ethical Amendment Application Form
2. Advertisement
3. Participant Information Sheet
4. Participant Consent
5. Participant Debriefing Form

The School of Psychology & Neuroscience Ethics Committee is delegated to act on behalf of the University Teaching and Research Ethics Committee (UTREC) and has approved this ethical amendment application. The particulars of this approval are as follows –

Original Approval Code:	PS13092	**Approved on:**	30/08/17
Amendment Approval Date:	08/09/17	**Approval Expiry Date:**	30/08/22
Project Title:	Exploring facial cues to attractiveness and health		
Researchers:	Xue Lei and Patrick Cairns		
Supervisor:	Professor David Perrett		

Ethical amendment approval does not extend the originally granted approval period of five years, rather it validates the changes you have made to the originally approved ethical application. If you are unable to complete your research within the original five year validation period, you are required to write to your School Ethics Committee Convener to request a discretionary extension of no greater than 6 months or to re-apply if directed to do so, and you should inform your School Ethics Committee when your project reaches completion.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that you adhere to the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf).

Yours sincerely

AP

Convener of the School Ethics Committee

cc Professor David Perrett (Supervisor)

School of Psychology & Neuroscience, St Mary's Quad, South Street, St Andrews, Fife KY16 9JP
Email: psyethics@st-andrews.ac.uk Tel: 01334 462071

University of St Andrews | FOUNDED 1413

University Teaching and Research Ethics Committee

14 November 2017

Dear Xue

Thank you for submitting your amendment application which comprised the following documents:

1. Ethical Amendment Application Form
2. Advertisement
3. Participant Information Sheet
4. Participant Consent Form: Coded Data
5. Participant Debriefing Form

The School of Psychology & Neuroscience Ethics Committee is delegated to act on behalf of the University Teaching and Research Ethics Committee (UTREC) and has approved this ethical amendment application. The particulars of this approval are as follows –

Original Approval Code:	PS13092	**Approved on:**	30/08/2017
Amendment Approval Date:	14/11/2017	**Approval Expiry Date:**	30/08/2022
Project Title:	Exploring facial cues to attractiveness and health		
Researchers:	Xue Lei, Patrick Cairns, Martha Lucia Borras Guevara and Jack MacLean		
Supervisor:	Professor David Perrett		

Ethical amendment approval does not extend the originally granted approval period of five years, rather it validates the changes you have made to the originally approved ethical application. If you are unable to complete your research within the original five year validation period, you are required to write to your School Ethics Committee Convener to request a discretionary extension of no greater than 6 months or to re-apply if directed to do so, and you should inform your School Ethics Committee when your project reaches completion.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that you adhere to the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf).

Yours sincerely

Convener of the School Ethics Committee

cc Professor David Perrett (Supervisor)

School of Psychology & Neuroscience, St Mary's Quad, South Street, St Andrews, Fife KY16 9JP
Email: psyethics@st-andrews.ac.uk Tel: 01334 462071

University of St Andrews | FOUNDED 1413

University Teaching and Research Ethics Committee

22 November 2017

Dear Xue

Thank you for submitting your ethical application which was considered at the School of Psychology & Neuroscience Ethics Committee meeting on 16th November 2017; the following documents have been reviewed:

1. Ethical Application Form
2. Advertisement
3. Participant Information Sheet
4. Participant Consent Form: Anonymous Data
5. Participant Debriefing Form
6. Questionnaires
7. Data Management Plan

The School of Psychology & Neuroscience Ethics Committee has been delegated to act on behalf of the University Teaching and Research Ethics Committee (UTREC) and has granted this application ethical approval. The particulars relating to the approved project are as follows -

Approval Code:	PS13176	**Approved on:**	16/11/2017	**Approval Expiry:**	16/11/2022
Project Title:	Exploring facial cues to attractiveness and health (online) – MTurk and Prolific				
Researchers:	Xue Lei, Patrick Cairns and Martha Lucia Borras Guevara				
Supervisor:	Professor David Perrett				

Approval is awarded for five years. Projects which have not commenced within two years of approval must be re-submitted for review by your School Ethics Committee. If you are unable to complete your research within the five year approval period, you are required to write to your School Ethics Committee Convener to request a discretionary extension of no greater than 6 months or to re-apply if directed to do so, and you should inform your School Ethics Committee when your project reaches completion.

If you make any changes to the project outlined in your approved ethical application form, you should inform your supervisor and seek advice on the ethical implications of those changes from the School Ethics Convener who may advise you to complete and submit an ethical amendment form for review.

Any adverse incident which occurs during the course of conducting your research must be reported immediately to the School Ethics Committee who will advise you on the appropriate action to be taken.

Approval is given on the understanding that you conduct your research as outlined in your application and in compliance with UTREC Guidelines and Policies (http://www.st-andrews.ac.uk/utrec/guidelinespolicies/). You are also advised to ensure that you procure and handle your research data within the provisions of the Data Provision Act 1998 and in accordance with any conditions of funding incumbent upon you.

Yours sincerely

Convener of the School Ethics Committee

cc Professor David Perrett (Supervisor)

School of Psychology & Neuroscience, St Mary's Quad, South Street, St Andrews, Fife KY16 9JP
Email: psyethics@st-andrews.ac.uk Tel: 01334 462071

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University Teaching and Research Ethics Committee

02 April 2018

Dear Dave

Thank you for submitting your amendment application which comprised the following documents:

1. Ethical Amendment Application Form
2. Advertisement
3. Participant Information Sheet
4. Participant Consent Form: Anonymous Data
5. Participant Debriefing Form
6. Questionnaire: Sections A and B
7. Body Image Stimuli

The School of Psychology & Neuroscience Ethics Committee is delegated to act on behalf of the University Teaching and Research Ethics Committee (UTREC) and has approved this ethical amendment application. The particulars of this approval are as follows –

Original Approval Code:	PS13092	**Approved on:**	30/08/2017
Amendment Approval Date:	22/03/2018	**Approval Expiry Date:**	30/08/2022
Project Title:	Exploring facial cues to attractiveness and Health		
Researchers:	Xue Lei, Patrick Cairns, Martha Lucia Borras Guevara, Jack MacLean and Umanga De Silva		
Supervisor:	Professor David Perrett		

Ethical amendment approval does not extend the originally granted approval period of five years, rather it validates the changes you have made to the originally approved ethical application. If you are unable to complete your research within the original five year validation period, you are required to write to your School Ethics Committee Convener to request a discretionary extension of no greater than 6 months or to re-apply if directed to do so, and you should inform your School Ethics Committee when your project reaches completion.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that you adhere to the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf).

Yours sincerely

pp

Convener of the School Ethics Committee

School of Psychology & Neuroscience, St Mary's Quad, South Street, St Andrews, Fife KY16 9JP
Email: psyethics@st-andrews.ac.uk Tel: 01334 462071

University of St Andrews | FOUNDED 1413

University Teaching and Research Ethics Committee

09 April 2019

Dear Xue

Thank you for submitting your amendment application which comprised the following documents:

1. Ethical Amendment Application Form
2. Questionnaire (Sections A and B)

The School of Psychology & Neuroscience Ethics Committee is delegated to act on behalf of the University Teaching and Research Ethics Committee (UTREC) and has approved this ethical amendment application. The particulars of this approval are as follows –

Original Approval Code:	PS13092	**Approved on:**	30/08/2017
Amendment Approval Date:	05/04/2019	**Approval Expiry Date:**	30/08/2022
Project Title:	Exploring facial cues to attractiveness and health		
Researchers:	Xue Lei and Patrick Cairns		
Supervisor:	Professor David Perrett		

Ethical amendment approval does not extend the originally granted approval period of five years, rather it validates the changes you have made to the originally approved ethical application. If you are unable to complete your research within the original five-year validation period, you are required to write to your School Ethics Committee Convener to request a discretionary extension of no greater than 6 months or to re-apply if directed to do so, and you should inform your School Ethics Committee when your project reaches completion.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that you adhere to the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf).

Yours sincerely

pp

Convener of the School Ethics Committee

Cc Professor David Perrett (Supervisor)

School of Psychology & Neuroscience, St Mary's Quad, South Street, St Andrews, Fife KY16 9JP
Email: psyethics@st-andrews.ac.uk Tel: 01334 462071

University of St Andrews | FOUNDED 1413

University Teaching and Research Ethics Committee

09 April 2019

Dear Xue

Thank you for submitting your amendment application which comprised the following documents:

1. Ethical Amendment Application Form
2. Questionnaire (Sections A and B)

The School of Psychology & Neuroscience Ethics Committee is delegated to act on behalf of the University Teaching and Research Ethics Committee (UTREC) and has approved this ethical amendment application. The particulars of this approval are as follows –

Original Approval Code:	PS13176	**Approved on:**	16/11/2017
Amendment Approval Date:	05/04/2019	**Approval Expiry Date:**	16/11/2022
Project Title:	Exploring facial cues to attractiveness and health (online)_MTurk_Prolific		
Researchers:	Xue Lei, Patrick Cairns and Dongyu Zhang		
Supervisor:	Professor David Perrett		

Ethical amendment approval does not extend the originally granted approval period of five years, rather it validates the changes you have made to the originally approved ethical application. If you are unable to complete your research within the original five-year validation period, you are required to write to your School Ethics Committee Convener to request a discretionary extension of no greater than 6 months or to re-apply if directed to do so, and you should inform your School Ethics Committee when your project reaches completion.

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Approval is given on the understanding that you adhere to the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf).

Yours sincerely

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Convener of the School Ethics Committee

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