Physical Features of the Human Body that predict Attractiveness and Health Judgements

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For Mish

Missed Always, Loved Forever…

Abstract

This thesis focuses on examining which visual cues are used by observers to judge the health and attractiveness of the human body. To determine which cues are used, and their relative importance, a series of psychophysical studies were conducted using image processing software and eye-tracking. The first study addressed the problem of co-variation in body features using image processing software to produce a balanced set of torso shapes independently varying in bust, waist and hip size to determine the relative importance of these features (Chapter 2). Following on from this, an interactive 3D software programme was used to allow male and female participants to create a 3D model of their ideal body (Chapter 3). The programme allowed different body features to be independently manipulated, and indicated which features are the most important for this assessment. Next, the relative length of the leg and torso in male and females bodies were varied both in sets of artificial and real bodies and these stimuli were rated by male and female observers (Chapter 4). Subsequently, because there are reported behavioural differences in how women assess other women as compared to themselves, the pattern of eye-movements made by women when judging their own body was compared to the pattern of eye movements made when judging other women's bodies (Chapter 5). In the last study, the pattern of eye-movements made when judging male bodies were determined (Chapter 6).

The results suggest that the multiple shape configurations for the body are judged to be equally attractive or healthy, and it is possible to trade off low quality in one feature against higher quality in another feature. Finally, the results of these studies are discussed in the context of evolutionary and social psychology theory.

Chapter 1: Introduction

"There is certainly no absolute standard of beauty. That precisely is what makes the pursuit so interesting"

- John Kenneth Galbraith, author and economist (1908-2006)

When we see someone for the first time, whether it be passing them in the street or meeting them for a potential job or blind date, their physical appearance is the first thing we judge. Based on these immediate apparent features, we then form our first impressions of this person (McArthur and Baron, 1983; Baron, 2006; Lorenzo *et al.*, 2010). By purely judging someone on their physical appearance therefore, we can argue that attractiveness is a significant aspect of our social world.

Work such as that carried out by Dion, Berscheid and Walster (1972) provides evidence that physical attractiveness is a hugely influential part of our lives. Their 'what is beautiful is good' paper, is one of the most widely cited conclusions into the research on physical attractiveness, summarising that attractive people, compared to unattractive people, are perceived to be more successful, happier and sociable (Dion *et al.*, 1972).

From a young age, attractiveness judgements can be seen to influence our lives as it is shown that children who are seen as more attractive than their fellow classmates, are judged more highly on academic tasks (Maruyama and Miller, 1980), and are treated more generously when grades are assigned (Felson, 1980). This is further supported by a more recent study by Dunkake *et al*. (2012), who found that physical attractiveness significantly influenced school grades, based on a sample of three secondary high school classes in Germany. Furthermore, in the academic world, studies have shown that students are more likely to give their professors a higher evaluation if they are perceived as attractive, compared to unattractive professors (Riniolo *et al.*, 2006). Even later in life, attractiveness judgements persist in influencing our lives as Watkins and Johnston (2000) found that the attractiveness of an individual was an advantage when their résumé was mediocre, when applying for a job. It can therefore be said that discrimination, based on physical appearance, is present for the key milestones in our life, and that despite qualities such as personality and equivalent qualifications, individuals may experience different opportunities in life, as a result of their physical attractiveness.

In our everyday lives, physical attractiveness is shown to influence our decisions and judgements. For example, in the mass media and more specifically in the advertising world, attractive models and celebrities can be seen endorsing copious products from jewellery to beauty treatments, to phone services and home products. Kahle and Homer (1985) for example, observed that attractive celebrities produced more favourable attitudes toward as simple a product as a razor than did unattractive celebrities. It therefore seems that attitudes towards a target product will be affected in a positive light by consumers instinctively associating a product or message with a physically attractive model: The attractiveness that the model expresses, will be generalized to consumers' evaluations of the product. As a consequence, the attractive model is likely to enhance product evaluations (Trampe *et al.*, 2010).

Yet with all this information inferring attractiveness as an important aspect of our lives, the question, 'What makes a person attractive?' has continued to plague psychological research for many years.

The Ancient Greeks first began the investigation into physical attractiveness, and theorised that beauty involved having the right proportions, with the idea that there are mathematical proportions of the human body that define beauty (Armstrong, 2004; Swami, 2007). This view of beauty remains much debated today, with theoretical and empirical work having extensively studied the human body to determine what features are regarded as "attractive", and the reasons behind this.

1.1 The Evolutionary Explanation of Attractiveness

Most evolutionary psychologists agree on the main proposals of Darwin's theory of evolution by natural selection, which states that individuals of a particular species vary in their physiological, behavioural and morphological traits; also known as their 'phenotype'. Furthermore, part of this variation is heritable, and some individuals will produce more offspring than others because of particular traits they possess that give them an advantage over those lacking in such traits. The offspring will therefore inherit these successful traits, and when such predispositions are maintained over many generations, it has been known to lead to the formation of a new species (Darwin, 1887/1959).

However, Darwin (1887/1959) recognised that many of these traits/attributes were costly to maintain and detrimental to survival, and so should not have been retained. He further noted that males and females of the same species seemed to differ in size and shape, for example, on average amongst humans, males are 12% taller than females (Buss, 2007). Since both of these sexes have experienced the same survival pressures, how is it that they differ in such ways?

This led to the theory of sexual selection which explained evolution of traits in terms of mating advantages rather than simple survival. Consequently, sexual selection stems from sexual competition amongst individuals for access to mates, and has therefore created the evolution of certain flamboyant traits, for example the peacock's tail in the animal kingdom (Andersson, 1994). These traits cannot be explained via natural selection as they do not enhance survival of these individuals due to their maintenance being very costly (Grammer *et al.*, 2003). Instead, they often diminish survival prospects and can only be continued by sexual selection.

Darwin (1887/1959) proposed two main mechanisms through which sexual selection could take place. The first mechanism known as "Intra-sexual Competition" is said to occur between individuals of the same sex. This is predominantly seen in males who compete for access to females which has resulted in the evolution of traits such as dominance and size, providing that individual with an advantage over others to gain access to females. Therefore, the traits that led to the success in these same-sex contests are passed down to the next generation.

"Inter-sexual Selection" is the second mechanism which involves the preferences of members of one sex, for members of the opposite sex who possess particular traits. For example, if all men preferred to mate with women with blonde hair, blonde hair would have a mating advantage, and over time there would be an increase in blonde hair within the population. This mechanism is typically noted in females, and has resulted in the evolution of the flamboyant traits previously mentioned (Andersson, 1994).

Whilst the sexual selection theory gives rise to the explanation of such costly traits evolving within a species, there is still a predominant sex difference between these two mechanisms proposed by Darwin. Trivers (1972) therefore, offered an explanation in the form of the theory of parental investment, which states that the sex that invests the greatest in their offspring would consequently be choosier about their mates. For example, a nine month gestation period is the minimum necessary investment needed to produce a child for a woman, whereas one act of sex is the minimum investment required for a man to produce a child. Therefore women, who engage in careful mate selection, preferring a man who would stay, invest in her and protect their offspring, would enjoy reproductive benefits. The sex that invests less in offspring should, according to Trivers, be more competitive with members of the same sex for access to the high-investing sex. Subsequently, the relative investment of the two sexes drives the operative components of sexual selection.

Studies in humans have supported such theories by showing that across a wide range of cultures, men place a higher importance on female beauty than women, who traditionally rank male resources higher (Buss, 1995). Male resources signal male competitive ability, health and the ability to provide for potential offspring. Female beauty on the other hand, signals youth, health and fertility. In support of this, Baize and Schroeder (1995) found that women who mentioned physical attractiveness and youth as part of their description in personal ads, received significantly higher numbers of responses than older women, or women who failed to reference their physical attractiveness. Equally, men received higher response rates when they mentioned excellent financial resources in their personal ads, compared to men who failed to mention this attribute. These findings have been further replicated giving credibility to this theory (Ramasubramanian and Jain, 2009; Russock, 2011). However, they have also been criticised for their limited time frames and use of largely North American samples, which did not allow for sophisticated tests of whether these preferences were universal across all cultures and time periods, like evolutionary psychology predicted (Feingold, 1992; Eagly & Wood, 2013).

Furthermore, recent studies have highlighted the prominent changes that have occurred in mate preferences over the last half century, particularly in industrialised societies, where vast amounts of women have entered the work force. In support of the assumption that individuals value attributes in a partner that they believe will enable them to reproduce and asper, Buss *et al.*, (2001) for example, found that men, in more recent years, increasingly prefer women with good financial backgrounds, education and intelligence. A decrease in men’s preference for cooking skills and housekeeping was also found. Women on the other hand, were found to increasingly desire men with good looks, and decreasingly desire good financial prospects and ambitiousness (Buss *et al*., 2001; Boxer, Noonan & Whelan, in press).

However, in-keeping with the evolutionary sexual selection theory, males have developed certain 'flamboyant traits' to be able to successfully compete for women and resources. Therefore, certain physical characteristics that males have evolved, must be seen as appealing to females (Zahavi, 1975). For example, a study by Gangestad *et al*., (2005) has suggested that women prefer men who are symmetrical and present masculine facial features when they are ovulating. Such a finding has proven hard to replicate however (Harris, 2011; Harris *et al*., 2013) and this lack of effect has broadly been established in both published and unpublished findings on women's preferences for masculinity, dominance, symmetry and health (Wood *et al*., in press). Harris *et al*., (2013) suggest such a discrepancy, is due to the inconsistent methods used to estimate cycle phase in this research literature.

Nevertheless, one evolutionary hypothesis is that selections of such 'flamboyant traits' arose in environments where women could access resources essential for parental care, without the aid of males (Low, 1990b). Therefore when women are able to gain access to resources, they ought to care more about mate characteristics predictive of fitness (e.g. physical attractiveness), and place less emphasis on characteristics relevant to exclusive investment. To test the hypothesis that women's access to resources influenced their mate preference, Gangestad (1993) re-analysed Buss' (1989) data and found that women's mean preference for physical attractiveness in a mate, was positively correlated with the proportion of women who were involved in the economy (therefore had access to their own resources, independent of a potential partner). However, women's preference for qualities related to parental care (resources), did not negatively correlate with their economic participation (Gangestad, 1993). This could be explained by the fact that although working women have access to resources, they also have less time for many tasks and may therefore be less willing to trade off time-relevant investment qualities for heritable fitness. They may however, be willing to trade off other forms of investment (Gowaty, 1992). To explain this in evolutionary terms, in a species where males invest in offspring such as in humans, good genes sexual selection (GGSS) may introduce population subtleties resulting in trade-offs between investment and genetic quality. Therefore in a population where females value male investment and males differ in their investment potential as well as in their genetic fitness, a female strategy that requires the same amount of investment from any male, regardless of his genetic fitness, would not be an evolutionary stable strategy. It would follow that females who mated with males possessing 'good genes' and less "return" in investment, could do better than those who did not select their investment criteria as a result of male genetic fitness (Gangestad, 1993).

This is further supported due to women becoming increasingly more financially independent in the modern world. The Data Monitor research (2007) reveals that women's wealth is increasing by almost 11% every year. Therefore the assumption now, is that women are becoming less concerned with what resources potential mates can provide, and are more focussed with the quality of genes they can pass on to their offspring, which are displayed through a male's physical features.

An additional point here would be to focus on populations of young males who lack resources. In many cultures, young males do not have access to resources equal to those of older males, and therefore their success in gaining sexual partners may depend upon their relative indicators of heritable fitness. In support of this, Perusse (1993) found that in a Canadian sample, indicators of men's wealth did not co-vary with the number of sexual partners as strongly during their twenties as it did during their thirties. Gangestad (1992) further found men's physical attractiveness predicted the number of sexual partners in college samples, indicating trade-offs may vary as a function of age-dependant factors.

Of course, an alternative explanation of the self-reported preferences Buss (1989) originally collected is to look at the sociocultural variation in the sex differences. Eagly and Wood (1999) re-analysed this data to evaluate the extent to which mate preferences varied with the roles of men and women, particularly in nations which had a gender-unequal division of labour. They found that in less gender-equal societies where women were the homemakers and men were the providers, women were more likely to seek an older mate with resources, and men were more likely to prefer a younger female with homemaking skills. In addition to this influence of gender equality on the size of sex differences, Eagly and Wood (1999) found in all 37 countries, men placed higher importance on homemaker skills and women on economic resources. The authors attribute this finding to the lower status and power of women than men that existed in all nations, despite variability in the amount of this inequality.

Buss *et al*., (2006) subsequently argued that evolved dispositions could explain the variation in sex differences across cultures. They reported that parasites in each culture, predicted the size of several sex differences such as men's preference for women's attractiveness and women's emphasis on men's intelligence. Furthermore, after statistically controlling for parasite prevalence, nation's gender equality was found to have little impact. Such a finding was therefore explained by men and women having specialised mating adaptations that are activated in response to environmental cues, associated with environmental fitness in evolutionary history.

In addition, the sexual selection theory suggests that women have evolved the same criteria for female attractiveness as men (Buss, 1992). This is because of selection for those women who can judge their own level of attractiveness against other women and match it to the value of a potential mate. Consequently, the female avoids wasting valuable energy on unsuccessful courtship when females of higher quality will be expectedly chosen over her. In support of this, studies by Singh (1993a) and Tovée and Cornelissen (2001) have shown that men and women rank female images in a very similar way. Therefore, evolutionary theories predict that the judgement of female attractiveness is as important for women, as it is for men.

Evolutionary psychology can therefore be argued to take a some-what 'nature' approach, emphasising evolved, inherited dispositions in men and women (Daly & Wilson, 1983; Buss, 1989; Tooby & Cosmides, 1989, 1992). Yet, one immediate problem with this approach is that comparatively little is known about the lifestyle of our ancestors which leaves few facts that can make hypotheses (Foley, 1996; Richardson, 2007). Foley (1996) for example, emphasises that our ancestors did not simply have one lifestyle in one particular geographical location, nor were their livelihoods unchanging over time. Tooby and Cosmides (2005) defend the evolutionary approach however, by arguing that sufficient information is known about our ancestors' lives, but the crucial problems remain, in that no single hominin model for re-constructing human selection pressures exists, and therefore critics argue that the current knowledge it too vague to specify adaptive problems with precision.

Moreover, due to the evolutionary approach pervading the literature as a Pleistocene-African-savannah stereotype, critics have argued that some human psychological attributes will have a time depth that long precedes that appearance of Homo-sapiens in East Africa (Laland and Brown, 2002; Boyd and Silk, 2009). This adds to the challenge facing evolutionary psychologists if they are to use the past to develop hypotheses about the future as, how far back do they look, due to the reasonable assumption that the lifestyle of Homo-erectus 1.7 million years ago (at the beginning of the Pleistocene) was very different from that of the Homo-sapiens 50,000 years ago (towards the end of the Pleistocene)?

Furthermore, is the argument that human beings cannot be exclusively adapted to a past world and not at all adapted to modern life; otherwise, we would not survive (Laland and Brown, 2002, 2006). Therefore at best, the evolutionary argument is only partly true. This is shown through the explosion in human numbers in the Holocene period which followed the Pleistocene (Swami & Furnham, 2007). Population growth corresponds to high absolute fitness, which implies that a significant proportion of human characteristics remain adaptive, even in modern environments. Therefore, modern environments either share the truly critical features of past environments, or have been rendered more benign than those of the past.

1.2 The Sociocultural Explanation of Attractiveness

With such limitations questioning the steadfastness of the evolutionary approach, social psychological theories have sought to offer alternative explanations for attractiveness judgements. This approach emphasises the *process* of attraction, theorising that mate choice and attractiveness ideals are likely to depend on a combination of factors including, what we are looking for in a potential mate, what we are able to offer and our particular circumstances (both environmental and biological) (Swami & Furnham, 2007).

For instance, Buss and Schmitt (1993) argued that an important factor in evaluating a potential partner's attractiveness is the mating strategy of the observer, typically described as either short-term or long-term. Individuals following a long-term strategy tend to pursue a single, high-investment relationship whilst those following a short-term strategy, tend to pursue low-commitment, transient sexual relationships (Buss & Schmitt, 1993). Using the point of view of either short-term or long-term mating strategies, people are able to evaluate potential partner's traits, with the finding that their responses change with each view. Regan (1998) for example, found that both men and women were unwilling to compromise on physical attractiveness when considering short-term partners, and were unwilling to compromise on interpersonal responsiveness when considering long-term partners.

It is further thought that what we are able to offer in a relationship also has a profound effect on what we consider attractive. Individuals are more likely to be attracted to others who are similar to them in terms of physical, social and psychological traits (Klohnen & Mendelsohn, 1998; Watson *et al*., 2004; Luo & Klohnen, 2005). Such "assortative" mating strategies have been found in numerous studies, with spouses tending to be similar in traits including, physical traits such as overall attractiveness (Berscheid *et al*., 1973), height (Pawlowski, 2003) and facial attractiveness (Penton-Voak *et al*., 1999a, 1999b). However, whilst assortative mating can be interpreted as evidence of active mate choice, Barrett *et al*., (2002) have argued it could also be the best-of-a-bad-job strategy, in that individuals have failed to entice better mates and have consequently lowered their standards, which widens the range of potential mates leading to relationships with similar people to themselves. Waynforth and Dunbar (1995) for example, found that men were more willing to accept a woman's children from a previous relationship when they lacked resources, compared to men who did offer resources in their personal advertisements. Therefore, the results suggest that men recognise when they have little to offer in terms of resources, and attempt to seem more attractive by seeking alternatives.

Social psychologists have further emphasised that for attraction to be of evolutionary significance, it must ultimately be a two-way process; it is useless (in an evolutionary sense) if it does not lead to the formation of romantic relationships.

The 'social exchange' theory is a general social psychological theory of interpersonal relationships that highlights the interaction between two people. The key question in this theory is: what will it cost to get a positive reward from a potential partner? And the answer is dependent on both participants in the attraction process through the joint social interactions that take place between them. Hogg and Vaughan (2005) have likened this theory to a business exchange whereby the attraction process is a give and take relationship between people which can encompass a whole host of things from goods to affection, money to status. Any of these resources can be exchanged in a relationship, and the manner in which they are exchanged not only depends on the individuals concerned, but on structural constraints such as gender roles, stereotypes and cultural beliefs (Swami & Furnham, 2008).

Walster *et al*,. (1978) proposed that people from Western societies in general, believe that social exchanges should be fair and just, which is reinforced by societal norms. Therefore, the more inequitably we are treated by our partners, the more we come to view them as unattractive. Even deciding what is fair and unfair, may be governed by societal norms and therefore social exchange theorists emphasise that to understand the nature of attraction, it is first necessary to understand the structure of the relationship between two people, as this structure determines the resources people can offer.

Another important consideration is local socioeconomic and demographic conditions which have been found to affect attractiveness judgements. Swami and Tovée (2005b, 2007b) and Tovée *et al*., (2006) for example, found that body weight ideals change with socioeconomic status (SES). Low SES observers preferred a significantly heavier body than high SES observers however, until recently, this pattern linking resource availability and body weight, lacked a psychological mechanism. Nelson and Morrison (2005) proposed that collective resource scarcity has consequences for individual resources, as individual members of a society in which resources are scarce, are likely to lack resources themselves. Furthermore, affective and physiological states associated with individual-level resource availability, provide implicit information about collective resource availability. Therefore, it is believed that affective states can have a powerful influence on the thoughts and beliefs associated with psychological behaviours.

For example, in a series of studies, Nelson and Morrison (2005) repeatedly found that participants, who were more satisfied with their personal resources, preferred a lighter female partner than men who felt financially poor. Moreover, Swami and Tovée (2006a) replicated this work using hunger as a proxy for personal resources and found the same result: hungry men found a slightly heavier female body weight more attractive than satiated men.

An alternative explanation for these findings however, is that feelings of financial satisfaction or hunger were associated with different psychological variables such as self-esteem. However, Nelson *et al*., (2007) replicated the central conclusions of Nelson and Morrison (2005), but showed that there were no changes in self-esteem.

Such studies provide evidence that feelings, states and psychological experiences can influence behaviour, and therefore lead to individual variation in physical attractiveness preferences (Nelson & Morrison, 2005; Swami & Tovée, 2006a). Furthermore, social psychological research suggests that our attitudes and behaviours are, in part at least, formed through our interactions with those around us (Moscovici, 1981), and a central theme to social psychological theories is that physical attractiveness ideals involve a great deal of learning as part of the socialisation process. One important source of our attitudes and preferences is established upon the actions and behaviours of people around us, especially our parents when we are young. For example, studies have shown that parents influence the attitudes that their children have about overweight peers (Field *et al*. 2001, 2010; Irving *et al*. 2002; Stice *et al*., 2003), and parents have also been implicated in children's development of ideas concerning what constitutes the 'ideal' female image (Stice 1998; Gordon 2000; Markey, 2010; Helfert, 2011).

Research has also suggested that the mass media, which reflects and promotes cultural beliefs and values, also plays a significant role in influencing judgements of physical attraction (Heinberg and Thompson 1995; Becker and Hamburg 1996; Harrison 1997; Bryant and Zhilman 2002). Much of this research has focussed on the propagation of a thin ideal in contemporary Western cultures. Guillen and Barr (1994) have suggested that the content of magazines targeted at adolescent girls, supports the perception that female happiness and success are tied to physical attractiveness with ultra-slim being the preferred state of health and beauty. Such magazines promote thinness and associate attractiveness with a low body weight, by presenting models who are below average in weight, and by promoting products and articles that tell readers how to become thin (Franzoi 1995; Shaw 1995; Boyd and Fouts 1999).

Studies have further found that women who purchased entertainment, health and fashion magazines were more likely to have internalised the thin ideal, and to exhibit disordered eating (Stice, 1994; van Den Berg *et al*., 2007). In their survey of 1,374 young adult women and 1,106 young adult men, van Den Berg *et al*., (2007) found women compare their own bodies to that of movie/TV/fashion models more frequently than men. Media body comparison was a significant predictor of how dissatisfied women were with their own body, but not how dissatisfied men were with their own body, indicating that women internalize the media message more than men (van Den Berg *et al*., 2007).

The ideal image of males portrayed by the mass media, is muscular and of normal or heavier weight in comparison to the underweight female ideal (Margo, 2002; Murphy, 2002; Littleton, 2008; Coetzee and Perrett, 2011). However conflicting evidence has been reported as to the media's influence on male body dissatisfaction. Although studies by Jones (2001) and van Den Berg *et al*., (2007) found a simple significant correlation between body comparison and body dissatisfaction in adolescent boys, this association was not significant in multivariate models. Previous research has suggested that the media plays a less important role in transmitting sociocultural messages regarding the ideal body to boys than girls (Vincent & McCabe, 2000).

Nevertheless, although compared to women, male's body satisfaction is high, studies have shown men do diet, are aware of cultural norms of male attractiveness, are concerned with upper body strength and physical condition and report a preferred size different to their perceived shape (Rozin and Fallon, 1988; Brodie *et al*., 1991; Crossley *et al*., 2012). Therefore, the media influences on male body image should not be bypassed, as studies show an increasing rise in male body dissatisfaction and eating disordered behaviours also (Pope, 1999; 2000a,b; Rysst, 2010).

The fact that the propagation of Western forms of media is associated with increasing socioeconomic status (SES), further pinpoints the mass media as a source of learning of what constitutes the ideal body size across cultures. Consequently, as previously isolated cultures experience the effects of globalisation and the import of Western media, the concept of thinness as being symbolic of feminine attractiveness, becomes embedded within popular culture (Becker 2004; Swami *et al*. 2007g). Indeed, Becker *et al.* (2005) conducted a striking study on the influence of the media by introducing television to a rural village in Fiji. Although traditionally, the Fijians express preference for robust figures, eating disordered-related behaviours rapidly emerged amongst adolescent girls after the television was introduced, as Fijina girls' desire to become thinner, increased.

However, the findings of Anderson-Fye's (2004) longitudinal ethnographic work in Belize, report evidence for a "Coca-Cola" body shape being more important than attaining thinness. This developing nation where Westernisation has been marked therefore rejects the Western body ideals. Furthermore, it is possible that some values native to non-Western cultures engender a thin ideal irrespective of Western influence. For example, it has been suggested that the Confucian belief that "real" women attend to, and work on, the body and self-restrict food intake, may engender a thin ideal in some East Asian nations (Jackson, Keel & Lee, 2006).

In parallel with the invasion of westernisation however, is the modernisation, urbanisation and industrialisation of societies, which makes explaining attractiveness ideals due to westernisation itself, problematic. For instance, the rapid economic liberalisation in the 1980s-1990s in Malaysia encouraged deregulation of mass media, which led to an influx of Westernised media images of the ideal body. In tandem with this however, rapid socioeconomic development, industrialisation and urbanisation, damaged a sense of national identity allowing for easier assimilation of Western cultural values. It is these changes in their totality, that have led to the idealisation of thinness, and the coupling of thinness with perceived femininity, success and happiness in urban Malaysia (Swami & Tovée, 2005a; Swami, 2006). Such a theory is further supported by studies showing that urbanisation is associated with greater risk of negative body image, than rurality (Swami, Kannan & Furnham, 2012).

Improving prosperity further brings changes in a developing nation's nutritional transition, with increasing consumption of foods high in fats. Such poor quality diets have been implicated in rising rates of obesity in the developing world (Swami, 2013). Additionally, it has been proposed that with increasing rates of obesity, comes a legitimization of fear of fatness, obesity stigma and cultural sterotyping of obese individuals, which focus any preference for thinness that pre-exists (Becker, 2004; Swami, 2006).

Rapid development and modernisation also brings important changes in the roles of women, although these changes are often unevenly distributed. Consequently, among urban women in the developing world, economic prosperity brings competing demands in terms of pressure for career accomplishment and work on the body (Malson, 1998). In urban areas therefore, thinness itself may come to symbolise modernity, personal development and upward social mobility (Anderson-Fye, 2011). Furthermore, for men too, changing gender roles may bring greater pressure to reassert masculinity through muscularity (Swami & Voracek, in press).

It should be noted however, that any impact of such modernisation may be moderated by local protective factors such as differences in body shape and mass and dietary patterns (Gordon, 2001). In context, in societies where there is an increasing prevalence of HIV/AIDS for instance, thinness may come to be a marker of infection as well as mal-nutrition, whereas heavier bodies may symbolise relative health (Puoane, Tsolekile & Steyn, 2010).

Broad concepts such as Westernisation and modernisation as explained above, may be argued to be insufficient to fully account for the forces shaping body size ideals

(Anderson-Fye, 2009; Levine & Smolak, 2010), but it seems clear that macro-level cultural factors, are the key to understanding the way beauty ideals are shaped within particular cultures. The sociocultural perspective therefore introduces the argument that ideas and constructs learned in social contexts have a substantial influence on the process of attraction.

1.3 Combining Perspectives

Neither the evolutionary nor social psychological approach in isolation is sufficient enough to understand the science behind physical attraction. For example, in human societies, psychological flexibility is constrained in both sexes by a female-male division of labour that varies in form across societies. The specific activities involved in this division of labour, derive in part from the male and female biology, particularly women's reproductive activities and men's size and strength. This can therefore allow some activities to be more efficiently conducted by one sex over the other, depending on the socioeconomic and ecological context. Human biology thus interacts with the environment to form a division of labour.

Within societies however, division of labour is created through social psychological processes involved in forming gender role beliefs which most adults conform to, and internalise as personal standards for individual's behaviour. These social psychological influences interact with biological processes involving hormones to support sociocultural factors, that guide masculine and feminine behaviours (Wood & Eagly, 2010,2012).

Various interactive models have been theorised which try to combine such nature-nurture accounts (Osborn, 2004; Wood & Eagly, 2002/2012) however, research that tests interactive theories is more difficult to design than research testing simple, independent theories (Eagly & Wood, 2013). Therefore, whilst a more comprehensive perspective that melds evolutionary and social psychological theories is still being developed, the following thesis attempts to use both, evolutionary and sociocultural perspectives, to explain its findings.

1.4 Visual Cues to Female Attractiveness

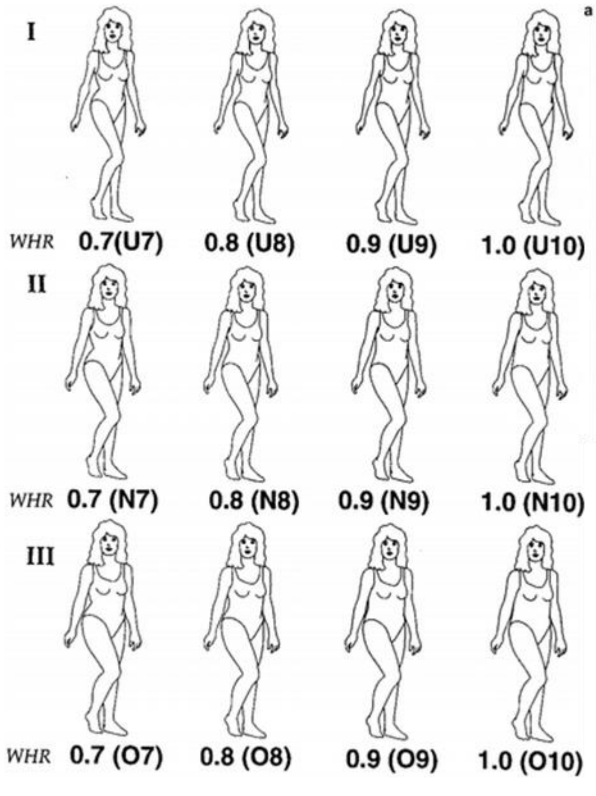
The most commonly researched features of the female body, in regards to physical attractiveness, are overall body fat (as indexed by the Body Mass Index (BMI)) and torso shape (usually indexed by the Waist to Hip Ratio (WHR)). Extensive research has been conducted to determine which is the best predictor of attractiveness judgements for female bodies (Singh, 1993b; Tassinary and Hansen, 1998; Tovée *et al*., 1999; Tovée *et al*., 2002; Dural *et al*., 2008).

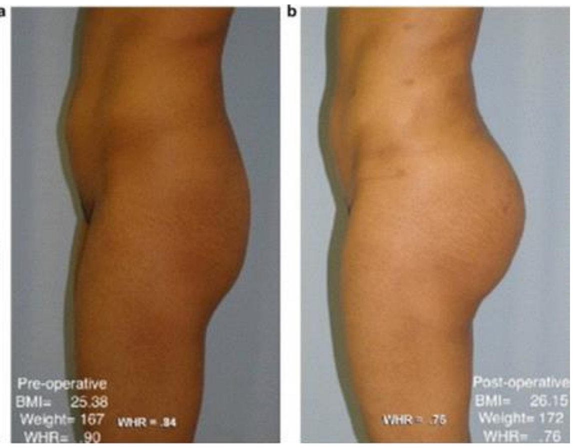
WHR is a measure of the relative distribution of fat between the upper and lower body, and is calculated by dividing waist circumference by hip circumference. Fat distribution is regulated by the sex hormones. Oestrogen inhibits fat deposition in the abdominal region and stimulates its deposition predominantly in the gluteofemoral region (hips, thighs and buttocks). In contrast, testosterone simulates fat deposition in the abdominal region and inhibits it in the gluteofemoral region. As a result, the torso shapes of men (android) and women (gynoid) are determined by fat distribution; influenced by these sex hormones (Björntorp, 1991). Before puberty, men and women have similar WHRs. However, females begin to deposit more fat on their hips during and after puberty and therefore, their WHRs become significantly lower than male's WHRs. The typical range of the WHR for healthy premenopausal women lies between 0.67 and 0.80, whereas healthy adult men have WHRs in the range of 0.85-0.95 (Marti *et al*., 1991; Cashdan, 2008).

Evidence that the risks for various diseases are more dependent upon anatomical distributions of fat deposits (measured by the WHR) is growing. For example, a high WHR is found to be an independent predictor for cardiovascular disorders (Spies *et al*., 2009), adult-onset diabetes, gall bladder disease and premature mortality (Björntorp, 1988, 1991; Kissebah, 1995). However, this finding is based on relatively affluent postmenopausal women, who were most commonly afflicted with chronic diseases. The current medical recommendation for good health however, is that the waist circumference of a woman, should be below 80cm and the WHR below 0.80 (Mutangadura, 2004). These two measures, independent of BMI, affect the risk for various diseases. It should also be noted, that the relationship between WHR and health risks depends on a range, and not a fixed value. For example, WHR measurements between 0.67-0.8 do not produce markedly different health outcomes (Singh, 2011).

Research has also suggested that the WHR is a reliable predictor of the reproductive capability of premenopausal women. Women with lower WHRs compared to women with high WHRs, have been found to have fewer irregular menstrual cycles (van Hooff *et al*., 2000), and have lower endocervical pH, which favours sperm penetration, (Jenkins *et al*., 1995). Furthermore, Wass *et al*., (1997) conducted a study regarding in-vitro fertilization (IVF) and embryo transfer, in 220 women. They found that women with a WHR > 0.80 have a significantly lower pregnancy rate. Compared to women with a WHR between 0.70-0.79 showing to have a pregnancy ratings of 29.9%, women with a WHR > 0.80 only had a pregnancy rating of 15.9%. Due to IVF being a laboratory and clinically controlled process, Wass *et al*., (1997) explain this decrease in pregnancy rate, as women with an android fat distribution having oocytes (immature female reproductive cells) of poor quality, or endometrial changes due to hormonal dysfunction for example. A similar study however, failed to find any relationship between a woman's WHR and her likelihood of conceiving with vaginal insemination (Eijkemans, Imani, Mulders *et al*, 2003).

Singh (1993a) argued that because of its association with healthy and fertility outcomes, the WHR is a direct assessment of women's underlying quality. To test this theory, Singh (1993a) created line drawings of female figures, (Figure 1a).





b) Singh & Randall (2007).

a) Singh; 1993a, b, 1994a, b

Figure 1. Images used in previous studies of female physical attractiveness.

These drawings were intended to differ solely in their WHR. The scale consisted of four different categories; two typical gynoid (i.e. female, pear-shape) WHR (0.7 and 0.8), and two android (i.e male, apple-shape) WHR (0.9 and 1). The drawings also fell into three weight categories, namely; underweight (I), normal (II) and over-weight (III). Singh (1993) asked participants to rate the drawings on how attractive they thought they were. The results indicated that the width of the waist in relation to the width of the hips (the WHR), was correlated with attractiveness, and line drawings with gynoid WHRs (0,7 and 0.80) were judged as the most attractive. Ratings decreased with increasing WHRs.

Using such drawings, the preference for low WHRs has been replicated (Singh, 1994c; Furnham *et al*., 1997; Henss, 1995) however such methods have been critiqued for not reflecting actual mate preferences as they occur in real life. Mikash and Bailey (1999) therefore, conducted field studies with real people and supported Singh's (1993) work, finding women with low WHRs have more sexual partners than women with high WHRs.

Singh further analysed the bodily features and WHR changes in Playboy centrefolds and Miss America contest winners, to identify changing criteria for female attractiveness. Garner *et al*., (1980) had previously inferred a trend towards idealization of thinness in their study examining Playboy centrefolds. By contrast, Mazur (1986) found that body shape of contestants retained an hour glass figure rather than becoming tubular, in spite of height and weight changes over the years. However, neither of these studies reported the WHR for their sample, and therefore it was not possible to determine whether WHR had stayed stable in the typical feminine range (below .80). Using published data for various bodily measurements for Playboy centrefolds available between 1955-1965 and 1976-1990, and data for Miss American winners obtained from Bivans (1991), Singh (1993a) reported that the WHR for Playboy centrefolds had increased slightly from .68 to .71, whereas the WHRs of the Miss America contest winners had decreased from .72 to .69. Therefore, despite the reduction in body weight over the years, the WHR of both samples seemed to have remained within the .68 to .72 range. Singh therefore concluded that in Western societies, a narrow waist set against full hips has been a consistent feature for female attractiveness, whereas other bodily features such as overall body weight and bust line fluctuate in their degree of importance over the years, giving rise to the argument that WHR is the primary cue in attractiveness judgements.

However, Freese and Meland (2002) reanalysed these two data sets, and found that the variation in WHR values were significantly higher than Singh reported. The centre of the WHR distribution was not 0.7, but actually significantly lower, and there had been a significant change in WHR over time. All of these findings are inconsistent with Singh's hypothesis.

Additionally, an alternative explanation from the health/fertility link with the WHR, that Singh (1993) so strongly drove to explain attractiveness judgements, is the more recent hypothesis that the WHR is a proxy for cognitive ability in women and their offspring. Indeed, Lassek and Gaulin (2008) suggest that gluteofemoral fat increases the supply of neurodevelopment resources such as fatty acids needed for brain development, whilst abdominal fat has the opposite effect, by inhibiting their availability. Therefore males' preference for lower WHRs would spread in a species undergoing rapid brain expansion, which would consequently increase the demand for brain-building resources (Lassek and Gaulin, 2008). Even though approximately three studies have actually explored the relationship between WHR and cognitive ability, all have shown that in older men and women, higher WHRs are associated with poorer cognitive performance and detrimental changes in the brain (Jagust, Harvey, Mungas & Haan, 2005; Waldstein & Katzel, 2006; Lassek & Gaulin, 2008), suggesting WHR indicates critical resources for brain development which may help explain its use as a cue for attractiveness.

A criticism of the WHR in attractiveness judgements however, is that Singh's original sets of line drawings used in many of the studies, lacked ecological validity, relying on a single original image from which modifications were made (Tassinary and Hansen, 1998; Furnham & Reeves, 2006). Careful measurements showed that figures which Singh (1993) claimed had the 0.7 WHR, for example, had actual ratios of 0.69, 0.70 and 0.75 (Furnham & Reeves, 2006).

Consequently, Tassinary and Hansen (1998) developed their own image set, comprising of 27 female images varying in waist and hip width (small, medium, large), and weight (light, moderate, heavy). They found that the weight of the images was more important than the WHR, and concluded the association between WHR and attractiveness was an artefact of a limited stimulus set (Tassinary & Hansen, 1998). In a more recent study, Streeter and McBurney (2003) failed to replicate the findings of Tassinary and Hansen (1998), finding a significant inverse relationship between WHR and attractiveness. However this was only when body weight was removed from the analysis, pointing out that arguments in favour of the WHR being an important factor in predicting attractiveness independent of weight are purely empirical.

An alternative method of looking at the relative importance of BMI and WHR was tried by Singh and Randall (2007), who used before and after photographs of the lower torsos (from the bottom of the ribcage to half way down the thigh) of 15 women who had undergone a cosmetic surgical procedure, which took adipose tissue from their stomach and added it to their thighs and buttocks, (Figure 1b). However, there were potential problems with these images also. The photographs were not standardized and varied in viewing angle (varying between a profile view and a view-point behind the body) and illumination in the before and after conditions, which complicates comparison of a body in the two conditions. Moreover, most importantly, both behavioural and eye-movement studies suggest that the degree of stomach depth (i.e. the degree to which the stomach protrudes) is used as a key cue to judge BMI (e.g. Tovée *et al*., 1999; Cornelissen *et al*., 2009b; Rilling *et al*., 2009). The cosmetic surgical intervention, which artificially alters this part of the body, may lead observers to perceive a difference in BMI in the before and after condition. This is important because the observers have only the visual image to go on, and if the image appears to vary in BMI (even if there is no significant change in the actual BMI of participants in the photographs), then the observers will react to the images as though they do alter in BMI (Holliday *et al*., 2012). Thus, the apparent BMI and WHR of the pictures may co-vary, and it is not clear whether the reported changes in the attractiveness judgements were due to changes in WHR, apparent BMI or some mixture of the two. The obvious control experiment for this image set is to ask a set of observers to estimate the BMI or body mass of the figures to see if their perception of the body's BMI changes before and after the surgical procedure.

This apparent co-variation of BMI and WHR is a further criticism of previous WHR literature, as it is argued that altering the width of the waist not only changes WHR, but also apparent BMI, making it impossible to say whether changes in attractiveness are due to WHR, BMI or both (Tovée *et al*., 1999; Tovée & Cornelissen, 2001). Further work by Cornelissen *et al*., (2009b) in real bodies, show that as bodies become wider (i.e. increasing BMI), the constant difference between the waist and hip circumferences becomes smaller relative to their total width, and thus bodies become less curvaceous (i.e. a higher WHR). Therefore on average, waist and hip circumferences are linearly related to BMI, and the difference between waist and hip circumference is approximately constant over a wide BMI range. This theory therefore implies, that both these body indices are dependent on one another, making the findings of studies looking into which one best predicts attractiveness, controversial.

An additional problem with some of these studies, is that some of the manipulations may result in the images being unrealistic, with the variations falling outside those seen in real people (e.g. Streeter & McBurney, 2003, see figure 2). As a result, the images may be rated on their realism, rather than their attractiveness (Bateson, 2007). To avoid such problems with un-naturalistic stimuli, a number of studies have used sets of unaltered photographs depicting the whole bodies of real women (Smith *et al.*, 2007a; George *et al.*, 2011). Analysis of the attractiveness ratings of such image sets shows, that although individually, both WHR and BMI are significant predictors of attractiveness, when both factors are entered into a multiple regression model, BMI explains the majority of the variance in attractiveness, with a BMI of around 20-21 kg/m² being optimally attractive for a UK population. The proportion of the variance explained by WHR, once BMI has been accounted for, is not statistically significant.

Figure 2. Examples of the Streeter and McBurney (2003) pictures. As can be seen there are a number of problems with their image manipulation. For example, the fact that the head remains a constant size gives a strong cue to the degree to which the body has been altered. The manipulation also impacts on features such as the hands which are elongated and distorted in some of the images. Finally, and most importantly, the manipulation of the body produces shapes that are just not credible as human bodies (Bateson *et al.*, 2007).

However, even these analyses are difficult to interpret due to the correlation between BMI and WHR. This has been repeatedly shown in large-scale health surveys. For example, the Health Survey for England (2003) which includes directly obtained measurements from 2,429 Caucasian women of reproductive age (16–45) ranging in BMI from around 15–50, shows a correlation between BMI and WHR of 0.46.

The use of large numbers of digital photographs of real bodies in which there is not an absolute correlation between BMI and WHR, has allowed an assessment of the relative importance of the two features, which suggests that BMI is a much stronger predictor of attractiveness and health judgments (e.g. Tovée *et al*., 1998, 1999, 2002; Fan *et al*, 2004; Rilling *et al*., 2009). This is true of silhouettes (e.g. Puhl & Boland, 2001), digital photographs (e.g. Tovée *et al*. 1999, 2000; Tovée & Cornelissen, 2001), video clips (Smith *et al*., 2007a; Rilling *et al*., 2009) and 3D laser scanned bodies (Fan *et al*., 2004, 2007). This also seems to be true cross-culturally, as supported by data from Bangladesh, Malaysia, Thailand, Indonesia, India, Japan, Samoa, Africa and a variety of European countries (e.g. Scott *et al*., 2007; Swami & Tovée, 2005, 2007a,b; Swami *et al*., 2006, 2007a, 2008). Additionally, the pattern of eye-movements used when judging WHR, are not incorporated into the eye-movement pattern used when judging attractiveness, although the eye-movement pattern used for judging body mass is (Cornelissen *et al*., 2009a).

Varying the relative ranges of BMI and WHR in the bodies used, also does not seem to significantly alter the relative importance of BMI and WHR (e.g. Tovée *et al*., 1999; 2002; Smith *et al*., 2007a). Of course, WHR itself is not a perfect measure of lower body shape as it is essentially trying to capture a complex, changing shape by sampling at only two points. This might be why it does not seem to be a strong predictor of attractiveness judgments. To better capture lower body shape change, waveform analysis has been used to quantify torso shape, but even using this analysis technique, BMI was still a stronger predictor of attractiveness judgments than the shape components of a principal component analysis (Tovée *et al*., 2002; Smith *et al*., 2007b).

Leading on to body size/weight, BMI is the most commonly used measure for body weight, calculated by dividing body weight (kg) by the square of the height (m). BMI is a good population measure of body fat (Romero-Corral *et al*., 2008), although it can produce errors with particular individuals (Yajnik &Yudkin, 2004; Flegal *et al*., 2008/9). This is because it assumes a common proportion of fat to lean muscle in all the population, and as muscle is 20% more dense than fat, this produces errors in individuals with significantly more muscle than the average or conversely significantly more fat. According to the World Health Organisation (2011), for Caucasians a BMI below 18.5 is considered underweight, a BMI ranging between 18.5 to 24.9 is considered normal weight, from a BMI of 25-29.9 is thought to be overweight and a BMI over 30 is classed as obese.

It has been shown that there are clear negative associations with excess body fat to health, longevity and fecundity (Brewer and Balen, 2010; Huffman and Barzilai, 2010). Therefore it is not surprising that fat has come to inherit a negative social stigma (Swami *et al*., 2010), a finding supported by the increasing prevalence of cosmetic surgery and liposuction to remove excess fat. In 2010 for example, a report from the American Society of Plastic Surgeons detailed that liposuction, was a top five cosmetic procedure and remained so in all age categories, including 13-19 year olds (Surgeons, 2010a).

To highlight the negative bias and fear that body fat produces in the population, Goldfarb *et al*., (1985) developed a scale to measure this fear of fat and illustrate the impact on behavioural efforts. Schwartz *et al*., (2006) reported that 46% of respondents to the survey reported that they would willingly give up 1 year of their life, rather than be obese. Even respondents considered to be in the normal or underweight category, reported greater willingness to give up years of their life, with 22% admitting they would rather lose a limb then be obese. Reports such as this show the level of disgust and fear that body fat creates in people, and the extent to which they would avoid it.

Controversially, Singh (1993a,b) suggested that this apparent obsession with fat may not be because the fat is considered ugly, but rather that it is a sign of age. However, whilst this might be the case to some extent, the prevalence of and large concern for the appearance of subcutaneous fat (such as cellulite), are considered visually unacceptable, which has led to the increasing desire to understand its physiology and treatment (Rawlings, 2006).

However not all fat is ‘bad’ and specific fat storage has in fact been shown to be beneficial. For instance, fat storage in the gluteofemoral region has proven important in metabolic health and reproduction (Lassek and Gaulin, 2008; Manolopoulos *et al*., 2010; Perilloux, 2010). In further support of this, Frisch and McArthur (1974) and

Frisch (1990) have shown that it is necessary for women to have a critical amount of body fat in order to initiate and maintain the menstrual cycle.

It has therefore been argued, that body fat (and therefore BMI) has a strong association with attractiveness judgements. Furthermore, using three-dimensional images, studies have found consistent evidence that BMI is the main determinant of women's attractiveness (Smith *et al*., 2007a). In general, it has been noted that compared to mesomorph body types (high muscle, low fat) and ectomorph body types (low fat, low muscle), endomorph body types (high fat, low muscle) have been considered less attractive, more unhealthy, weaker, lazier and less popular (Butler *et al*., 1993; Puhl and Brownell, 2001; Puhl and Brownell, 2003; Swami *et al*., 2008). A number of studies have further suggested that a BMI of around 20 to 22 kg/m² also appears to be a strong predictor of attractiveness throughout Western countries (Thornhill & Grammer, 1999; Tovée *et al*., 1998, 1999, 2002; Puhl & Boland, 2001; Fan *et al*., 2004; Cornelissen *et al*., 2009). Evolutionary psychologists have further argued that there are advantages of using BMI as a basis for mate selection, as it appears to be a reliable cue to female health (Manson *et al*., 1995; Willet *et al*., 1995) and reproductive potential (Frisch, 1988; Lake *et al*., 1997; Reid & van Vugt, 1987; Wang *et al*., 2000).

1.5 Male attractiveness

Why males vary in their attractiveness and ability to gain mates is puzzling from an evolutionary perspective because of the theory that women place higher importance on recourse possession than physical attractiveness (Darwin, 1871; Fisher, 1930). Anderson (1994) however, theorised that 'attractive' traits are costly to produce and therefore signal high mate quality; which has been widely accepted by evolutionary psychologists. Such qualities advocate either direct (e.g. parental investment, territory) or indirect benefits (e.g. 'good' genes for disease resistance) for potential offspring (Evans & Magurran, 2000; Jennions & Petrie, 2000; Milinski, 2006). For example, Barber (1995) suggested that some aspects of the male body could be sexually selected. Studies such as that carried out by Ross and Ward (1982) and Björntorp (1982) highlighted that ratings of men's bodies were enhanced with increasing masculinity and body features that signal dominance. Such features are more developed in men than women due to the influence of testosterone (Björntorp, 1982).

Penton-Voak *et al*. (1999, 2000) used computerised photographs and found some women considered masculine faces to be more attractive in their week of highest fertility, yet judged more feminine faces to be more attractive during the rest of their cycle. These results were advocated as evidence for mixed-mating strategy, in which females engage in extra-pair matings (EPM) with masculine males for indirect benefits such as ‘good genes’, whilst females pair long-term with caring, more effeminate males.

Whilst such a finding was replicated in numerous studies (Danel & Pawlowski, 2006; Gangestad & Simpson, 2000; Haselton & Gangestad, 2006; Haselton & Miller, 2006), criticisms of this interpretation have been proposed. For example, Yu *et al*., (2007) argue that such a mixed-mating strategy is implausibly applied to Western societies, even though choice tests have been conducted with Westernised females. A theory of mate choice in humans must also restrict the choices that a female has available to her. For example, by Penton-Voak *et al*., (2000) and others interpreting within-individual variation in preferences as indicators of long-term versus short-term mate choice, they have covertly reflected a recent and Western conception of marriage that women are free to choose their long-term partners. However, in almost all traditional societies (and in many industrialised countries), parents have varying degrees of influence over their daughter’s choice of partner (Beckerman, 2000). Consequently, any study regarding female preferences for long-term versus short-term partners, must take into consideration marriage systems, inheritance rules, and other sociocultural factors that influence mate choice (McGraw, 2002).

Indeed, Yu *et al*., (2007) found that Matsigenka women, who come from a culture where parents ensure their son-in-law will become a reliable food-provider for the extended family as the parents’ age, preferred masculine faces for sons-in-law, contrasting with the standard result, in which a feminine face is preferred in long-term mates. The authors attribute this finding to the different sociocultural roles on offer: husband or son-in-law. On the most basic level: masculine men on average are perceived as better resource providers. However, this finding is based on a very small sample size and the simplicity of the interviews Yu *et al.*, (2007) carried out, meant the authors could not reliably conclude cultural rules were in fact trading off a marriage advantage in masculine males. The combination of the data and their model however, does mean this is plausible, and such studies should be conducted in as many independent cultures as possible.

Whilst there has been a restricted amount of work surrounding male attractiveness, studies such as this, have attempted to rectify this, and it is now widely acknowledged that women, at least in some cultures, hold strong beliefs regarding what constitutes the ideal male body (Swami & Furnham, 2007).

1.6 BMI and WHR as cues of Attractiveness in Men

Using Singh's line drawings of males (Figure 3), studies have consistently found that with regards to body mass, the overweight figures are rated least attractive (Singh, 1993a, 1993b, 1994a, 1994b; Furnham *et al*., 1997). However, whilst these studies have found that normal weight male figures are rated as most attractive, Henss (1995) found that under and normal weight male figures had no difference in ratings of attractiveness. Furthermore, in contrast to females, it has been shown that males who fall into the under-weight category of the BMI range, consider themselves least attractive (McCreary & Sadava, 2001). However, similar to females, males in the over-weight BMI range class themselves as less attractive, although males in higher BMI ranges rate themselves as more attractive than females do in higher BMI ranges (Cash & Hicks, 1990; McCreary & Sadava, 2001).

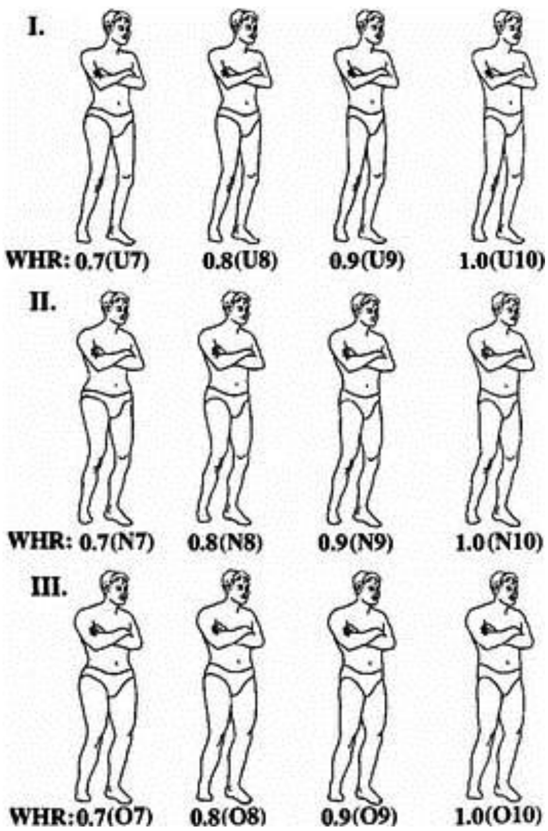


Figure 3. An example of the images used in male physical attractiveness studies.

The degree of adiposity, for example, is positively correlated with WHR in both males and females (Hartz *et al.*, 1984; Jones *et al.*, 1986; Shimokata *et al.*, 1989). Singh (1995) therefore, investigated the role of WHR in the male body attractiveness as viewed by females. In his study, 87 female volunteers ranked 12 line drawing stimuli of male figures representing four levels of WHR and three levels of body weight. The results showed that a WHR of 0.9 was ranked as the most attractive.

1.7 Male visual cues linked to Health issues

Unlike the research into female health-beauty links as proposed by the evolutionary theories, male health cues are less consistently linked with attractiveness judgements. In general, high BMIs are associated with overall all-cause mortality risk, as well as lower overall self-ratings of health in both men and women. However, as previously mentioned, BMI alone is shown to be an unsatisfactory measure of male attractiveness due to body shape (higher versus lower levels of muscularity in comparison to body fat) being more of a confounding factor. Frequent studies of cardiovascular disease in men, identify both increased mesomorph body types (high muscle, low fat), as well as increased endomorph body types (high fat, low muscle) as risk factors. This is in comparison to ectomorph body types (low fat, low muscle) which alone, is associated with better risk factors (Gertler, 1954; Spain, 1963; Carter, 1990; Williams *et al.*, 2000).

1.8 Summary

Attractiveness has therefore been shown to be, and is continuing to be, a significant aspect of our social world. In the past two decades, dissatisfaction with our bodies has almost become “the norm” with the extent to which both men and women will go to for the sake of beauty, becoming increasingly more severe (Smolak, 2006). Cosmetic surgery, the use of steroids, extreme dieting and fasting, all of which are dangerous for both men’s and women’s health, are just a few of the practices we indulge in, in the strive for “beauty” (Jeffreys, 2005**;** Norris, 2006).

And whilst the current body of research has described the role of the BMI and WHR in judgements of attractiveness, additional features of the body are becoming more thoroughly investigated to add to the complexity of ‘attractiveness’. With regards to female attractiveness for example, breasts are perceived as an evolutionary novelty in primates (Montagna, 1983) and in some cultures at least, they are perceived as an important component of sexual attractiveness in humans (Ford & Beach, 1952). Clear inconsistencies exist as to the exact function and preference for breasts in women however (Mazur, 1986; Barber, 1995; Swami & Tovée, 2006; Furnham *et al*., 2006), therefore making breasts an important feature to explore in relation to attractiveness judgements, (see Chapter 2).

Furthermore, a recent concept in human studies suggests that some men have a preference for longer legs in women (Morris, 1987). Fashion and run-way models are 11cm taller than normal women (Tovée *et al*., 1997), with much of this difference being related to leg length. Surprisingly however, few studies have been conducted on the effect of leg length on physical attractiveness and therefore Chapter 4 explores this feature in more depth.

In relation to male attractiveness, recent studies have advocated that the Waist-to-Chest ratio (WCR) and therefore male upper body shape, is the primary determinant, and accounts for the greatest amount of variance in attractiveness ratings (Maisey *et al*., 1999; Swami & Tovée 2005a; Fan, 2007). Women are thought to prefer men whose torsos have an 'inverted triangle' shape (narrow waist with broad shoulders) and such a shape is consistent with physical strength and muscle development (Thornhill & Gangestad, 1999; Bamman *et al*., 2007; Frederick & Haselton, 2007). The relatively less importance of BMI in male attractiveness is in sharp contrast to the significance of BMI in determining female attractiveness (Tovée *et al*., 1998, Tovée and Cornelissen, 2001; Fan *et al*., 2004), and is more extensively investigated in Chapters 3 and 6.

As with studies on female attractiveness, leg length and subsequently, the leg-to-body ratio (LBR) has also been associated with male attractiveness also. However, research has focussed primarily on independent female preferences for male height and not the relation of height to physical attractiveness. Therefore, Chapter 4 also investigates the role of this physical feature in judgements of male attractiveness.

With such conflicting theories presented as to what physical features best predict attractiveness judgements in men and women, coupled with the constant developments of social/cultural pressures and practices to look a certain way, it comes as no surprise that the question 'what makes a person attractive' still plagues psychological research today. This therefore gives ammunition for the following programme of research.

1.9 Aim of the thesis

The overall aims of the current thesis are therefore as follows:

1. To firstly explore the relative importance of different torso shape components in attractiveness judgements: the bust, waist and hips (see Chapter 2).
2. To then determine which of these features people would change to produce their ideal body using an interactive morphing program (see Chapter 3).
3. To investigate the relative importance of LBR in attractiveness judgements in both computerised and real bodies (see Chapter 4).
4. To use eye-tracking to identify the areas that observers actually use to judge attractiveness and link these with known morphological variables (see Chapters 5 and 6).

Chapter 2: The Importance of Women's Body Shape in Attractiveness Judgements.

2.1 Introduction

When trying to assess the relative importance of body features in determining their attractiveness, problems arise for two reasons. Firstly, features tend to co-vary. This is most obvious with WHR and BMI (Cornelissen, Tovée & Bateson, 2009) but also applies to other body features including the bust, waist and hips (Wells, 2009). Secondly, because body size is such a strong predictor of attractiveness, it tends to overwhelm other factors and mask their potential role in body judgements. Thus, developing a set of test stimuli whereby the individual body features vary independently, as far as possible, is needed to assess their relative importance.

Early studies into attractiveness judgements originally proposed that a low WHR was the main predictor of attractiveness because of its association with good health, and reproductive prospects (Singh, 2002; Lassek & Gauling, 2008). Yet, due to the confounded stimuli used in such studies (Tovée *et al*., 2002), more naturalistic and 3D perspective stimuli were created. This led authors to find, and consistently conclude, that BMI is the primary predictor of attractiveness (Tovée *et al*., 1999, 2002; Fan *et al*., 2004).

More recently however, alternative anthropometric variables have started to be considered in attractiveness judgements, with findings questioning the role of BMI as the primary determinant of attractiveness. In their univariate analyses for example, Rilling *et al*., (2009) found that abdominal depth and waist circumference explained more variance in attractiveness judgements then BMI. Furthermore, BMI was not a significant predictor in their multivariate analysis after controlling for other variables, suggesting that the relationship between BMI and attractiveness can be explained by BMI's association with other anthropometric variables in their model that were correlated with attractiveness (Rilling *et al*., 2009). Such a finding therefore questions the reliability of BMI's independent association with attractiveness that earlier studies have established, leaving scope for alternative anthropometric variables to be explored in association with attractiveness.

For example, with regards to sexually selected signals in humans, the female breast is a primary candidate. Permanently large breasts are an evolutionary novelty in primates

(Montagna, 1983) and in some cultures, human breasts are perceived as an important component of sexual attractiveness (Ford and Beach, 1952). This is further supported by data collected from cosmetic surgeries on breast augmentation, with the United States alone totalling 300,000 breast augmentations each year (American Association of Plastic Surgeons, 2005). Some of this data may of course, be for different reasons other than attractiveness purposes, but the comparable frequencies of both augmentations and reductions suggest that, with regards to breasts, smallness and largeness may be perceived as unattractive and undesirable.

The significance of female breasts has proven hard to explain from an evolutionary perspective, with functional theories such as they provide comfort to infants, they are a function of heat-stress avoidance and that they are storage for milk for breast-feeding infants; all emerging but lacking reliable evidence (Smith, 1986; Low, 1987; Fisher, 1992; Einon, 2007).

One favourable evolutionary explanation however, is the suggestion that men find breasts attractive because they are signals of fat reserves, which reflect a woman's ability to survive in lean environments, give birth and provide for offspring (Cant, 1981; Gallup, 1982). Brown and Konner (1987) suggested that the most reproductively successful females were the ones who were able to store surplus energy as fat. In support of this, cross-cultural studies have shown that men from insecure resource environments generally show a stronger preference for larger breasts than those from a relatively secure resource environment (Dixson *et al*., 2011).

In addition, Swami and Tovée (2013) found that participants from rural villages rated a significantly larger breast size as more attractive than participants from Kota Kinabalu employed in various tertiary industries, and participants from Ranau, who were predominantly farmers. Furthermore, the participants from Ranau, rated a significantly larger breast size as more attractive than participants from Kota Kinabalu. Financial security was also tested, and it was found that lower financial security was associated with a preference for larger breast size. The results therefore indicate that there are significant differences in judgements of female attractiveness based on breast size as a function of men's socioeconomic status. Therefore breast size can be said to signal calorific storage, and men from insecure resource environments perceive larger breasts as more attractive.

To further support this, Swami and Tovée (2013) examined the impact of hunger on men's judgements of female attractiveness within-culture. They found breast size judgements indicated a greater skew toward larger breast size in the hungry group than the satiated group. It may therefore be argued that temporary affective states result in individual variation in breast size judgements.

However, if men viewed breasts purely as fat stores, than they should find breasts no more erotic than fat anywhere else on the body; which is clearly not the case. Therefore, psychologists have theorised that there have been unique demands on female morphology, which resulted from certain biomechanical constraints due to sexually dimorphic fat deposition (Smith, 1984). Consequently, sexual selection for larger breasts has arisen (Pawlowski, 1999). Once enlarged, sexual selection may have heightened the manifestation of permanently enlarged breasts (Morris, 1967; Cant, 1981). This theory is supported by the findings that breasts act as a sign of age, sexual maturity and fertility in females (Gallup, 1982; Barber, 1995; Jasienska *et al*., 2004).

For example, Marlowe's (1998) 'nubility hypothesis' suggests that the primary role of breast size was to honestly signal age, and thus, residual reproductive value; which is the expected future reproductive output of an individual (Fisher, 1958). For example, if breasts are not protruding at all, the girl is prepubescent, if protruding and firm, the woman is mature but young; if sagging, she is old, as breasts sag with age due to the supporting fibrous tissue stretching and slackening (The Diagram Group, 1983). Marlowe (1998) proposed that the larger breasts are, the faster gravity should make them sag, and therefore males can judge the age of a female with large breasts better than they can a female with small breasts. Subsequently, men should prefer larger breasts. The nubility hypothesis is ultimately a 'good genes' argument, with females with greater vigour being more capable of allocating energy to signals of youth. A female would benefit later in life by having smaller breasts since her age would be difficult to judge, however Marlowe (1998) argued that men prefer large breasts precisely because they are *honest* signals.

Based on this perspective, it is hypothesised that men should find larger breasts more physically attractive which appears consistent with the objectification and fetishisation of large breasts in post-industrial societies (Tantleff-Dunn, 2001). Swami and Tovée (2013) assessed men's sexist attitudes and their tendency to objectify women in relation to their preference for female breast size. They found that benevolent sexism was the strongest predictor of men's breast size ideals, and suggested that this is because large breasts were associated with perceived femininity. In turn, this perceived femininity could indicate females who are more submissive and less threatening to power relationships and gendered inequalities (Sanchez *et al*., 2006).

Contrariwise, Swami and Tovée (2013) further found that most of the men in their sample selected medium sized breasts (32.7%) as the most attractive, compared to large breasts (24.4%), and to very large breasts (19.1%). Although the latter two were selected more frequently than small breasts (15.5%) and very small breasts (8.3%), this finding questions the hypothesis that men find larger breasts more attractive. Other studies have further reported mixed findings, with some finding preferences for small breasts (Furnham & Swami, 2007), medium (Tantleff-Dunn, 2002) and large breasts, (Singh & Young, 1995; Furnham *et al*., 1998). Such inconsistencies have been explained due to the poor ecological validity of the line drawn figures used in such studies (Tovée & Cornelissen, 2001), and the presentation format of the images (Zelazniewicz & Pawlowski, 2011). When computer-generated and photographic images are used instead, men from post-industrial societies are shown to prefer medium-to-large breasts (Dixson *et al*., 2011; Zelazniewicz & Pawlowski, 2011; Swami & Tovée, 2013).

It could be argued however, that breasts are reacted to in relation to other body features and overall body shape. Breast size and shape changes caused by old age or pregnancy, are not effective sexual signals. Similarly, Low (1979) theorised that large breasts on obese women are not judged as attractive, and the sexual appeal of breast size depends on overall body fat, waist and slenderness of the arms and legs (Low *et al*., 1987). Low (1990) further predicted that only thin young women with large breasts would be perceived as attractive.

Singh *et al*., (2007) examined British literature between the sixteenth and the eighteenth centuries and found that the breasts, waist and thighs, were more often referred to as beautiful, and moreover, waist size was always described as narrow or small. This finding was further found cross-culturally in Indian and Chinese descriptions of the female body, indicating that a small waist is a predominant hallmark of feminine beauty (Singh *et al*., 2007; reviewed in Singh & Singh, 2011).

Consequently, psychologists have argued that the waist and hip size and subsequently the WHR, plays a more critical role in female attractiveness, as it is a more accurate predictor of health and sex hormone aberration (Björntorp, 1988; Zaastra, 1993; Misra & Vikram, 2003). However, it has been theorised that the waist and hips carry different signals. For instance, a new-born baby's head is relatively large and therefore a large pelvis facilitates its delivery, which is thought to be signalled by wide hips (Rosenberg, 1992). In support of this, previous studies have suggested that males use wider hips as a cue for fertility and a healthy child baring age. On the other hand, waist size is thought to convey information such as current reproductive status to signify the female is not already pregnant (Gitter *et al*., 1983; Furnham *et al*., 1990; Wass *et al*., 1997; Singh, 2002), and female health status/ the risk of morbidity in the future (Björntorp, 1988; Misra & Vikram, 2003). Yet which anthropometric feature is more important in the assessment of female attractiveness?

In different ecological and demographic environments, it is thought that men may pay more attention to different features. For example, in traditional societies, fat reserves in the hip and thigh region may be more important and therefore preference for wider hips would be expected (Tassinary and Hansen, 1998; Singh & Luis, 1995). In contrast, since there is no risk of seasonal food shortage in more Westernised societies, the waist may carry more important information. For example, since waist size increases during pregnancy and post-reproductive period, it indicates the fecundity status of women (Rozmus-Wrzesinska & Pawlowski, 2005). Furthermore, the waist can better indicate a woman's health, as visceral fat in the waist region can be a signal of higher morbidity risk (Björntorp, 1988; Lin *et al*., 2002; Misra & Vikram, 2003).

With improved living conditions therefore, one should expect that smaller hip size and higher WHR to be preferred. Such a trend was found using Playboy centrefold models from the last 50 years by Voracek and Fisher (2002). More recently, Rozmus-Wrzesinka and Pawlowski (2005) independently altered the waist and hip size of a female photograph and found that males were more sensitive to changes in the WHR based on waist changes, rather than hip changes. The authors therefore concluded that males are more influenced by waist size, then hip size.

Such a study only investigated men's preferences in relation to women's body shape and therefore could not attribute their findings to the development of eating disorders, which might be related to self-body fat perception. However, the fact that females have been found to overestimate first of all their waist width, and secondly their hips and thighs (Bergstrom *et al*., 2000), confirms results portrayed by Rozmus-Wrzesinka and

Pawlowski (2005). It is therefore attributed that female's perceptual bias reflects male's criteria in judging women's body attractiveness.

Whilst such studies have attempted to pin-point which anthropometric feature best predicts female attractiveness, attempts to produce image sets which vary features independently have been patchy. The schematic silhouette drawings developed by Singh (1993a) and Tassinary and Hansen (1998) have been criticized for their lack of ecological validity and therefore unreliable results (Tovée *et al.*, 1999; Rilling *et al.*, 2009). Furthermore, studies that have previously used digital manipulation of the WHR to solely alter the waist or hip width also caused the simultaneous change of the figure's BMI. This then meant determining the individual role of the BMI and WHR was no longer possible, and the conclusions of the study may misattribute the response to the changing of one feature, when it is actually caused by changing another (Tovée *et al.*, 1999; Rilling *et al.*, 2009). Studies into BMI manipulation have also failed to keep breast size constant (Fallon and Rozin, 1985; Glauert *et al.*, 2009), and therefore in these studies, it is inconclusive as to whether the thinnest women were not preferred due to their low BMI or because of their breast size.

The present study therefore aims to overcome such methodological issues by asking participants to independently alter three features thought to be important in attractiveness judgements (bust, waist and hips) in a set of artificial bodies. This will allow the effect of changing just a single feature to be determined; changing the bust size will also alter the BMI of the body, but so will altering the waist or hips. By recording the BMI change however, the relative importance of the bust, waist and hip size can be explored. Furthermore, by asking participants to rate an image set consisting of varying bust, waist and hip sizes, some will have the same BMI but with different shapes. Therefore, for bodies in the same BMI range, this study can investigate which shapes are the most attractive.

The hypothesis for the following study therefore, will be that the three anthropometric features measured will have more of an influence on attractiveness judgements, rather than overall BMI. More specifically, breast size will predominantly influence male attractiveness judgements, however, due to waist size/stomach depth being linked to BMI (Cornelissen *et al*., 2009; Rilling *et al*,. 2009) and BMI being consistently reported as the primary determinant of female attractiveness judgements (Fan *et al*., 2004; Tovée *et al*., 1999, 2002), waist size will predominantly influence female attractiveness judgements.

2.2 Experiment 1: Rating pre-set images

2.2.1 *Participants*

The study was advertised via flyers around the Newcastle and Northumbria University campus' (Appendix A). A total of 35 female Caucasian participants (mean age = 20.43, SD = 2.06) and 20 male Caucasian participants (mean age = 21.2, SD = 1.57) were opportunistically recruited; all were undergraduate students with some students gaining course credit for their participation. All participants gave informed consent (Appendix B) and the aims and procedure of the study were explained beforehand.

2.2.2 *Protocol*

All participants were tested on the same PC in the Body Image Lab in the Institute of Neuroscience, however the study was split into two tasks. Firstly, Daz Studio 3.1 (www.daz3D.com) was used to create a stimulus image set of 125 bodies based on the Victoria 4.2 model which had independently varying bust, waist and hip sizes over 5 levels on the Body ++ morph dimensions (-100, -50, 0, 50 and 100), (see Figures 1,2, & 3). Using SuperLab (www.superlab.com) these images were then run on a rating script asking participants to rate how attractive they thought each image was on a scale of 0-9 where: 0 was unattractive and 9 was very attractive. A start screen was presented reiterating what was required of the participant and allowed the participant to begin when they were ready. The stimulus images were presented for an unlimited time until a keyboard response was entered. The order of image presentation was randomised.

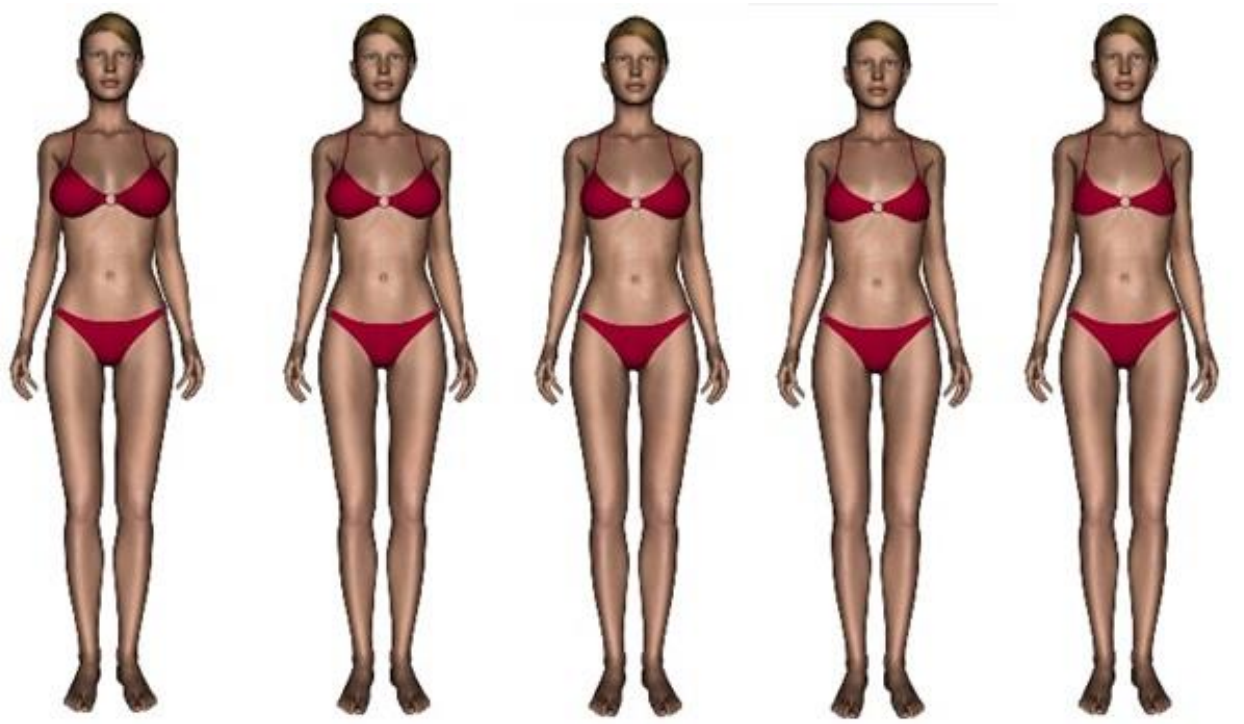


Figure 1. An example of the changes in bust size starting at bust size 100, 50, 0, -50 and -100. Waist and hip size remains at 0.

Figure 2. An example of the changes in waist size starting at waist size 100, 50, 0, -50, -100. Bust and hip size remains at 0.

Figure 3. An example of the changes in hip size starting at hip size 100, 50, 0, -50, -100. Bust and waist size remain at 0.

2.3 Experiment 2: Participant's own Bust, Waist and Hip preference

2.3.1 *Protocol*

Once participants had rated the 125 pre-set images they were then shown a 3D modelling software package (Daz Studio 3.1 from Daz3D.com). This software package allows the manipulation of photo-realistic male and female 3D models on a flat panel screen in order to modify different aspects of the body's features (see Crossley *et al*., 2012).

Participants were shown the 3D body model Victoria 4.2 and were directed to the three body sliders; "Breast size", "Waist width" and "Hip size", being informed they would only be altering these three body indices. Female participants were asked to alter the body to how they would like their body to look. Male participants were asked to alter the three areas to what they would like their ideal partner's body to look like. The shape change was determined by Victoria ++ body morphs which model how the individual parts of the body change. Each participant was required to do this twice. Once altering a thin, less curvy body in which the bust, waist and hips had been set to -100%, and once altering a bigger, more curvy body in which these three features had been set to +100%, (see Figure 4). The size of these areas could be altered by moving a slider on a scale which gave immediate visual feedback to the participant and the areas could be adjusted multiple times until the participant was happy with the image that had been created.

Figure 4. An example of the two base images used; 100, 100, 100 (left) and -100,-100,-100 (right).

After completion, a set of anthropometric measures were taken from the participants (Appendix C). Using a standard tape measure, the chest, waist and hip circumferences were measured. Height was measured using the Marsden/Invicta Free Standing Height Measure and weight was measured using the Weight Watchers 8944U Heavy Duty Body Fat Analyser Scale. Participants were then given a debrief form, outlining the aims of the study and thanking them for their participation (Appendix D). Experimenter contact details were also given for participants to withdraw their response, should they so wish at a later date.

2.3.2 *3D Body Analysis*

The 3D bodies were then saved as a Daz scene file. The two settings for each of the judgements were averaged to produce a single body for each participant. These bodies were then saved as Wavefront object files and imported into Autodesk 3ds max (http://usa.autodesk.com). The volume of the 3D body models was then calculated, assuming the bodies had a height of 1.64 m (the national average for women in the UK). Following this, it is then possible to calculate an estimate of body weight, assuming that the bodies have an average density of 1.04g/cm^3 (Pollock *et al*., 1975), and to then calculate a BMI value for each body (kg/m^2). Measurements of the bust, waist and hip circumferences were then taken by measuring the cross sections through the bodies at the relevant points in the software package, 3ds Max. Figure 5 shows an illustrative example of the three cross sections measured.

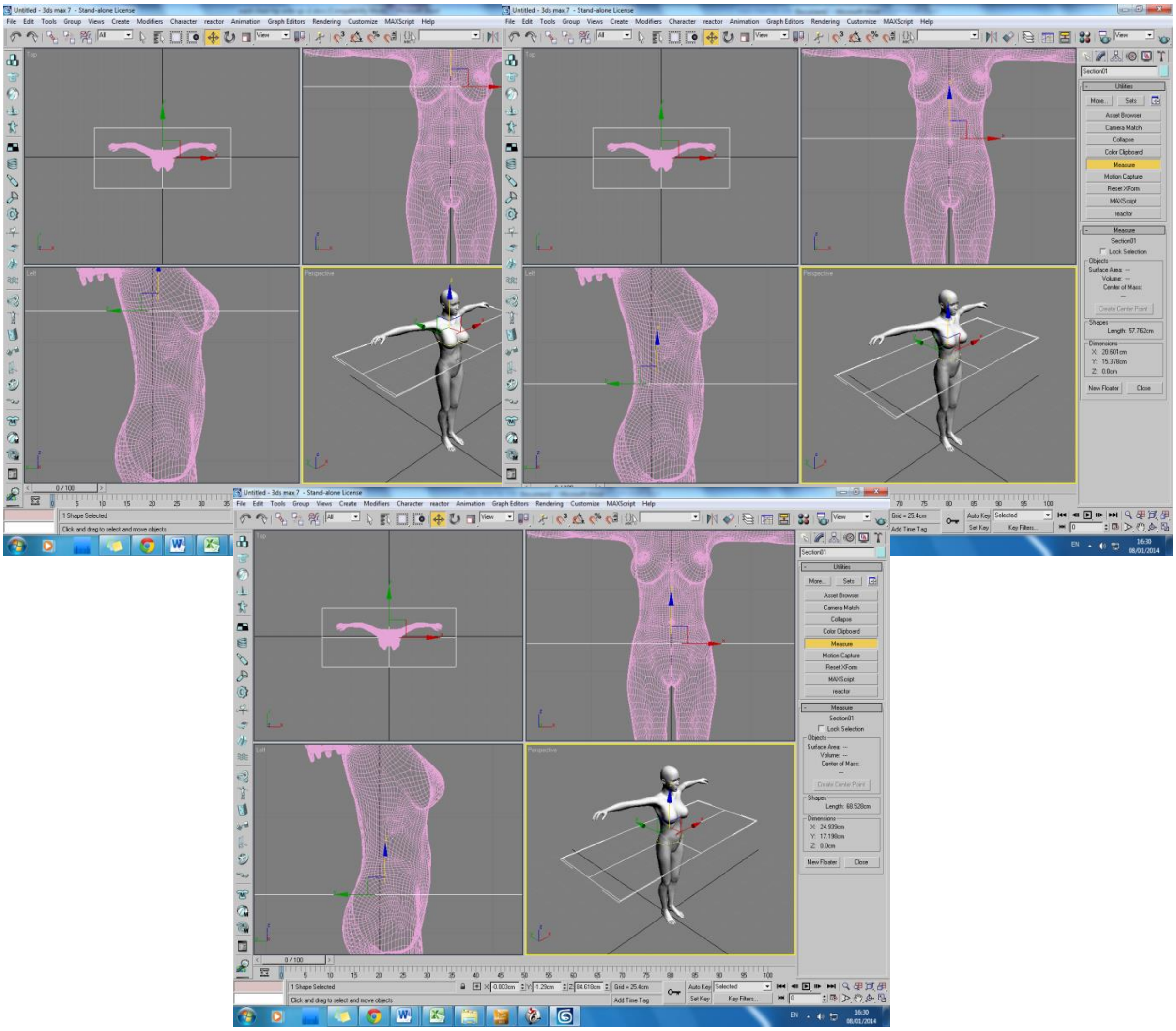


Figure 5. An example of the slices made through the bodies at the bust (top left), waist (top right) and hips (middle bottom).

2.4 Results; Experiment 1.

2.4.1 *Analysis of the 5 manipulations for each condition; Bust, Waist and Hips*

Table 1. A summary of the circumference measurements (in cm) and ratios of the bodies manipulated five times (100, 50, 0, -50, -100) for each of the three variables; Bust, Waist and Hips.

		Bust	Waist	Hips	BMI	WHR
Bust	Average	87.53	62.27	88.02	19.02	0.71
	SD	4.76	0.00	0.00	0.17	0.00
	Min	82.04	62.27	88.02	18.82	0.71
	Max	94.02	62.27	88.02	19.25	0.71
Waist	Average	87.03	62.30	88.02	19.00	0.71
	SD	0.00	3.75	0.00	0.30	0.04
	Min	87.03	57.59	88.02	18.62	0.65
	Max	87.03	67.07	88.02	19.39	0.76
Hips	Average	87.03	62.27	88.06	19.01	0.71
	SD	0.00	0.00	3.95	0.59	0.03
	Min	87.03	62.27	83.11	18.27	0.67
	Max	87.03	62.27	93.10	19.77	0.75

Table 1 gives a summary of the body index measurements of the images that were manipulated for each variable. For example, the ‘Bust’ summary is when the images were manipulated for bust size only, whilst the waist and hip size was held constant. The ‘Waist’ summary gives the information regarding the images when only the waist size was manipulated whilst bust and hip size was held constant. Similarly, the ‘Hip’ summary displays the information about the images when only hip size was manipulated at the five different levels.

A Pearson’s correlation was then carried out to examine the relationship each of these variables had on attractiveness judgements. As shape changes can also cause BMI change, the correlations were also calculated with BMI.

Table 2. Pearson's correlations between the three body circumferences and the image's BMI against male and female attractiveness ratings.

	BMI	Male attractiveness ratings	Female attractiveness ratings
Bust Circumference	0.25	**0.75****	0.36
Sig.(2-tailed)	0.36	0.001	0.19
Waist Circumference	0.44	0.00	0.06
Sig.(2-tailed)	0.10	1.00	0.84
Hip Circumference	**0.86****	-0.06	0.40
Sig.(2-tailed)	0.001	0.84	0.14
BMI		0.13	0.46
Sig.(2-tailed)		0.63	0.09

**Correlation is significant at the 0.01 level

As shown from Table 2, only bust circumference significantly correlated with male attractiveness ratings but not BMI, suggesting that bust circumference independently predicted attractiveness judgements for male observers. Furthermore, hip circumference and BMI significantly correlated, indicating that changes in hip size led to changes in BMI but not in attractiveness.

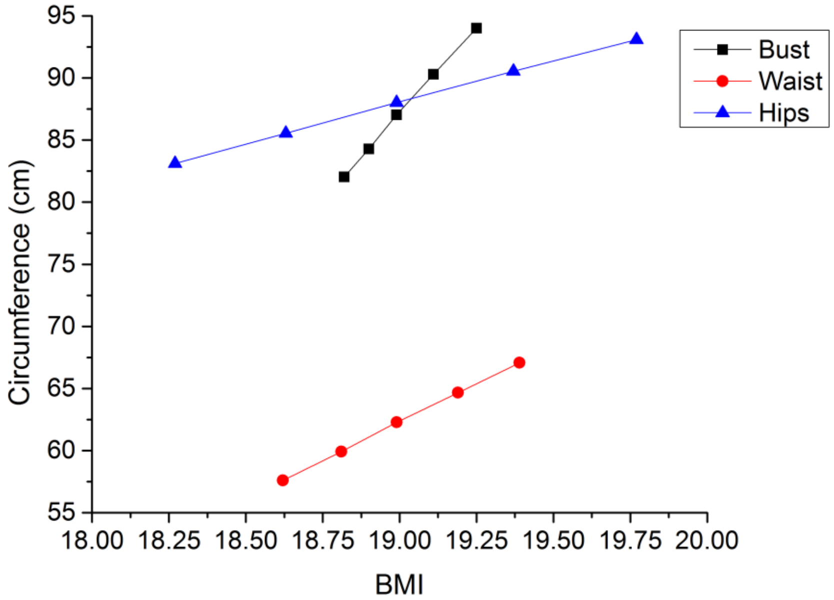


Figure 6. The relationship between the Bust, Waist and Hip circumferences and the bodies' BMIs at each manipulated point whilst the remaining two circumferences were held constant.

Figure 6 demonstrates the correlations found in Table 2 between the five manipulations of the bust, waist and hip circumferences and the bodies' BMIs. It can be seen that for all the manipulations, increasing the circumferences increased the bodies' BMIs, however only changing hip circumference produced a statistical significant change in BMI in this study.

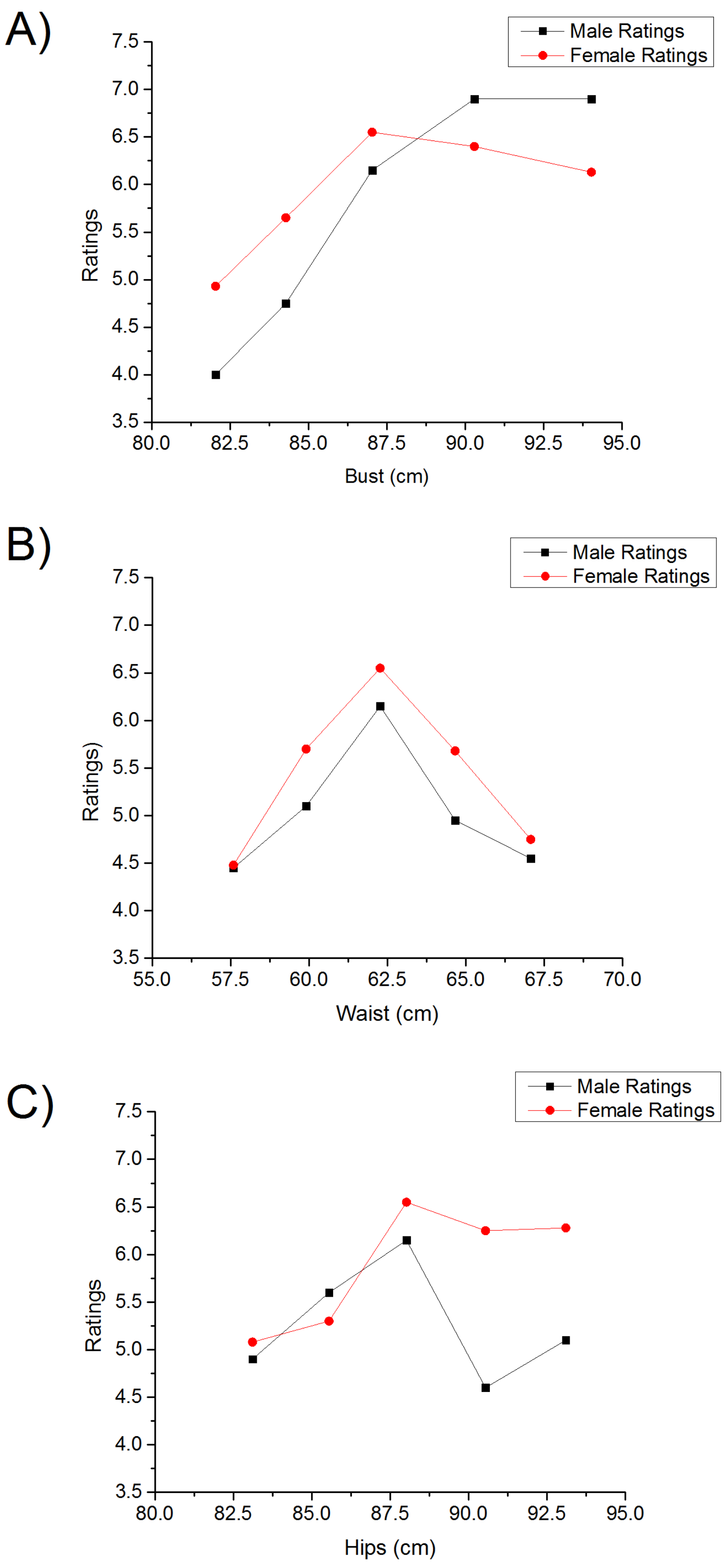


Figure 7. A) The relationship between Bust circumference and the attractiveness ratings of participants. B) The relationship between the Waist circumference and the attractiveness ratings of participants. C) The relationship between the Hip circumference and the attractiveness ratings of participants.

Figure 7A) shows that initially increasing the bust size whilst waist and hip size was held constant, males and females followed the same trend increasing their attractiveness ratings. However, the male participants increased or maintained their attractiveness ratings as the bust continued to increase, whereas the female participants decreased their attractiveness ratings.

Figure 7B) shows that both male and female participants followed the same preference trend for the waist circumference manipulations. A peak preference for a waist circumference is shown to be at approximately 62cm for both male and female participants before waist circumferences larger than this were seen as unattractive.

Figure 7C) shows that again, male and female participants followed the same preference trend for hip circumference manipulations. Whilst males are shown to steadily increase their ratings for the first 3 hip levels, there is a steep decrease as the hip circumference is increased beyond this point. Females are shown to slightly increase their preference between the first two levels before a steep preference is shown for the third level with only a slight decrease for the next two levels. Therefore males and females agreed on the third level being the most attractive hip circumference, but differed in their rating of hip circumferences over 90cm.

Figures 7A, B and C suggest that males and females generally showed a preference for the same female body shape with the exception of a slight difference between bust and hip size preferences. Males preferred a slightly bigger bust size and narrower hips than females.

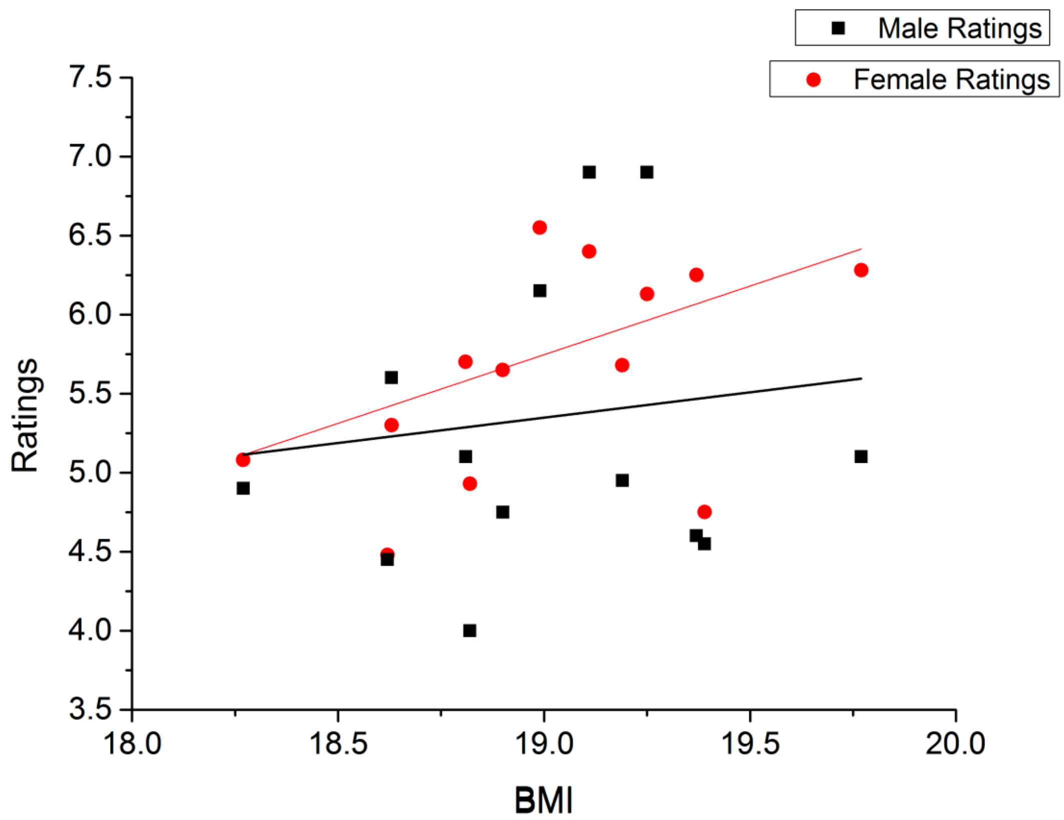


Figure 8. Male and female attractiveness ratings plotted against the BMI of the 15 manipulated images.

Figure 8 suggests a noisy, but linear trend between ratings and BMI. The BMI range of only two points is a comparatively small change, and previous studies have suggested that changes in this part of the BMI range will have the smallest effect on attractiveness judgements (see Tovée *et al*., 1999; Swami & Tovée 2005).

2.4.2 ***What is the best predictor of female attractiveness for male observers?***

To determine which factors best predicted the attractiveness ratings by the male observers in all 125 images, initially descriptive statistics and a correlation matrix were generated to illustrate the relationships between individual body features.

Table 3. Descriptive statistics for male participant's ratings and the 125 image's circumferences.

	Mean	SD
Attractiveness	4.72	0.92
BMI	19.03	0.62
Bust	87.53	4.28
Waist	62.30	3.37
Hips	88.06	3.55

Table 4. Pearson's correlation between male attractiveness judgements and the body circumferences, and between the body circumferences themselves.

	BMI	Bust	Waist	Hips
Male Attractiveness	**0.24****	**0.73****	0.17	-0.01
Sig. (2-tailed)	0.01	0.001	0.07	0.88
BMI	1.00	**0.25****	**0.44****	**0.86****
Sig. (2-tailed)		0.01	0.001	0.001
Bust		1.00	0.00	0.00
Sig. (2-tailed)			1.00	1.00
Waist				0.00
Sig. (2-tailed)				1.00

**Correlation is significant at the 0.01 level

BMI and bust size were found to significantly correlate with male attractiveness judgements with bust size having a stronger association (Table 4). However, BMI was shown to significantly correlate with all three circumferences measured, and therefore bust size cannot be solely attributed to explaining the male attractiveness judgements.

To more clearly define and statistically analyse these relationships, multiple linear regression analysis was performed whereby mean attractiveness was defined as the outcome variable whilst predictor variables were defined as the measured body indices. Because of the vast amount of previous research surrounding the BMI and WHR as predominant predictors for attractiveness, both these variables were entered into the first regression model. Bust, waist and hips were then entered separately into the regression, in a hierarchical manner, to determine their contribution to the male attractiveness ratings.

Table 5. Results of the linear regression determining the significant predictors of male attractiveness judgements.

Model		B	SE	β	*t*	*p*	VIF
1	Constant	-5.38	2.94		-1.83	0.070	
	BMI	0.40	0.13	0.27	3.06	0.003	1.03
	WHR	3.47	1.69	0.18	2.05	0.042	1.03
2	Constant	-13.11	2.17		-6.03	0.000	
	BMI	0.13	0.10	0.09	1.34	0.183	1.10
	WHR	2.90	1.19	0.15	2.44	0.016	1.03
	Bust	0.15	0.01	0.71	11.28	0.000	1.07
3	Constant	39.38	15.64		2.52	0.013	
	BMI	-4.72	1.44	-3.15	-3.29	0.001	271.14
	WHR	-87.28	26.65	-4.52	-3.28	0.001	563.01
	Bust	0.33	0.05	1.52	6.13	0.000	18.22
	Waist	1.42	0.42	5.17	3.39	0.001	689.40
4	Constant	-185.20	27.38		-6.77	0.000	
	BMI	-59.95	6.15	-40.00	-9.75	0.000	8392.67
	WHR	47.17	25.25	2.44	1.87	0.064	852.80
	Bust	2.33	0.22	10.81	10.45	0.000	534.01
	Waist	4.33	0.45	15.79	9.55	0.000	1363.94
	Hip	9.35	1.02	35.93	9.34	0.000	7720.05

The regression analysis found that whist BMI and WHR significantly predicted male attractiveness judgements together (Table 5; Model 1), and the overall model was significant, ($F_{(2,122)} = 5.92$, p =.004, r =.30), they only accounted for 8.9% of the overall variance. When bust size was added to the regression (Table 5; Model 2) however, 55.6% of the variance was accounted for and the model was highly significant, ($F_{(3,121)} =$ 50.41, p<.0001, r =.75). Furthermore, the variance inflation factor (VIF) values, which indicate whether a predictor has a strong linear relationship with the other predictors, suggested little concern for collinearity between these three variables (Myers, 1990) and they could therefore be attributed to the attractiveness judgements independently. The addition of bust size however, found that BMI became non-significant in this model giving premise to the hypothesis that BMI is not as strong a predictor of female attractiveness (for males at least) than other more specific anthropometric features (such as bust size).

When waist circumference was added (Table 5; Model 3), the variance accounted for 58.1% and was significant, ($F_{(4,120)} = 43.95$, p<.0001, r =.77). The addition of hip circumference (Table 5; Model 4) meant overall, 76.2% of the variance was accounted for and the model was again significant, ($F_{(5,119)} = 76.00$, p<.0001, r =.87). However, the addition of these two variables meant the VIF values were found to be substantially larger than 10 indicating cause for concern of collinearity (Myers, 1990).

To attempt to reduce the collinearity of these variables, the 125 images were sorted by ascending BMI, grouping the images into four categories of BMI ranges; a BMI of 17, 18, 19 and 20. The differences between each BMI within each of these four categories was found to be so small that the images that fell into each BMI category could be argued to have approximately the same BMI, (Table 6).

Table 6. A summary of the range of image measurements that fell into each BMI category.

	Min (cm)	Max (cm)	range	total number of images
Chest	82.04	87.03	4.99	
Waist	57.59	59.91	2.32	
Hips	83.11	83.11	0.00	
BMI Category 17	17.73	17.99	0.26	5
Chest	82.04	94.02	11.98	
Waist	57.59	67.07	9.48	
Hips	83.11	90.54	7.43	
BMI Category 18	18.02	18.99	0.97	54
Chest	82.04	94.02	11.98	
Waist	57.59	67.07	9.48	
Hips	85.55	93.10	7.55	
BMI Category 19	19.00	19.99	0.98	56
Chest	84.28	94.02	9.74	
Waist	62.27	67.07	4.80	
Hips	90.54	93.10	2.56	
BMI Category 20	20.03	20.42	0.39	8

Therefore, as an additional analysis, a further multiple linear regression was carried out using the measurements of the images that fell within the BMI category 19 as this gave a substantial amount of images (56 images), all with approximately the same BMI.

BMI was entered into the first regression model to ensure it was not a significant predictor and was found to account for 0% of the variance and the model was not significant, ($F_{(1,55)}$ = .003, p =.955, r =.01). However, when all the variables were entered individually into the model in a hierarchical manner, bust size accounted for 62.4% of the variance and was significant, ($F_{(2,54)}$ = 44.813, p<.0001, r =.79). Waist size increased the variance accounted for, to 66.5% and was significant, ($F_{(3,53)}$ = 35.126, p<.0001, r =.82). Hip size was then shown to increase the variance to 77.9% and was also significant, ($F_{(4,43)}$ = 45.738, p<.0001, r =.88).

Table 7. Results of the linear regression determining the significant predictors of male attractiveness judgements in the limited BMI image set.

Model		B	SE	β	*t*	*p*	VIF
1	Constant	5.36	8.98		0.60	0.553	
	BMI	-0.03	0.46	-0.01	-0.06	0.955	1.00
2	Constant	-5.91	5.69		-1.04	0.304	
	BMI	-0.24	0.29	-0.07	-0.82	0.414	1.01
	Bust	0.18	0.02	0.79	9.47	0.001	1.01
3	Constant	-7.07	5.43		-1.30	0.199	
	BMI	-0.40	0.28	-0.12	-1.43	0.160	1.06
	Bust	0.18	0.02	0.82	10.19	0.001	1.02
	Waist	0.06	0.02	0.21	2.56	0.013	1.07
4	Constant	-149.99	28.05		-5.35	0.001	
	BMI	-56.86	10.95	-16.59	-5.20	0.001	2395.77
	Bust	2.23	0.40	10.11	5.61	0.001	763.23
	Waist	4.61	0.88	15.86	5.23	0.001	2161.66
	Hips	8.57	1.66	20.87	5.16	0.001	3841.69

Whilst exclusively, BMI was not a significant predictor (Table 7; Model 1), bust and waist size were shown to significantly contribute to the attractiveness ratings (Table 7; Model 2 and 3) and furthermore, can be attributed independently, due to the low VIF scores (Myers, 1990). However, the *t* values indicate that bust size had a greater impact on attractiveness judgements overall.

Such results therefore support the hypothesis of the current study attributing bust size as the predominant predictor of male attractiveness judgements, lending further support to previous literature (Ward & Merriwether, 2006; Zelazniewicz & Pawlowski, 2011; Swami & Tovée, 2013).

2.4.3 *What is the best predictor of female attractiveness for female observers?*

To determine which features best predicted the attractiveness ratings made by the female observers for all 125 images, initially descriptive statistics and a correlation matrix were generated to illustrate the relationships between individual body features.

Table 8. Descriptive statistics for female judgements of attractiveness for the 125 image's circumference measures.

	Mean	SD
Female Attractiveness ratings	4.99	0.90
BMI	19.03	0.62
Bust	87.53	4.28
Waist	62.30	3.37
Hips	88.06	3.55

Table 9. Pearson's correlation between the female attractiveness judgements and the body circumferences, and between the body circumferences themselves.

	BMI	Bust	Waist	Hips
Female Attractiveness	**0.57****	**0.48****	0.00	**0.52****
Sig. (2-tailed)	0.001	0.001	0.97	0.001
BMI	1.00	**0.25****	**0.44****	**0.86****
Sig. (2-tailed)		0.01	0.001	0.001
Bust			0.00	0.00
Sig. (2-tailed)			1.00	1.00
Waist				0.00
Sig. (2-tailed)				1.00

** Correlation is significant at the 0.01 level

Pearson's correlation found BMI and bust size significantly correlated with female attractiveness judgements, the same as for males, although BMI is shown to have a stronger influence for females (Table 9). Bust size was stronger for males (Table 4). In addition, hip size was also found to significantly correlate with female attractiveness judgements (Table 9). However, BMI was found to significantly correlate with all three circumference measures and therefore the results cannot be independently attributed to the female attractiveness judgements.

Similar to the male judgements, a multiple linear regression was then performed. Again, BMI and WHR were entered into the first model as known predictors, and the remaining three variables were entered individually into the model, in a hierarchical manner.

Table 10. Results of the linear regression determining the significant predictors of female attractiveness judgements.

Model		B	SE	β	*t*	*p*	VIF
1	Constant	-6.60	2.37		-2.78	0.006	
	BMI	0.77	0.11	0.53	7.27	0.001	1.03
	WHR	-4.33	1.37	-0.23	-3.17	0.002	1.03
2	Constant	-10.57	2.24		-4.73	0.001	
	BMI	0.63	0.10	0.43	6.43	0.001	1.10
	WHR	-4.62	1.22	-0.25	-3.79	0.001	1.03
	Bust	0.08	0.01	0.37	5.63	0.001	1.07
3	Constant	19.03	16.61		1.15	0.254	
	BMI	-2.11	1.52	-1.45	-1.38	0.170	271.14
	WHR	-55.47	28.30	-2.95	-1.96	0.052	563.01
	Bust	0.18	0.06	0.85	3.12	0.002	18.22
	Waist	0.80	0.45	0.30	1.80	0.075	689.40
4	Constant	-248.49	26.32		-9.44	0.001	
	BMI	-67.89	5.91	-46.60	-11.49	0.001	8392.67
	WHR	104.69	24.27	5.58	4.31	0.001	852.80
	Bust	2.57	0.22	12.23	11.95	0.001	534.01
	Waist	4.27	0.44	16.01	9.79	0.001	1363.94
	Hips	11.14	0.98	44.03	11.32	0.001	7720.05

Interestingly, BMI and WHR were found to account for 37.2% of the attractiveness variance alone, which is a greater percentage than was found for male attractiveness judgements, previous. Furthermore, the model was found to be highly significant, ($F_{(2,122)}$ = 36.16, p<.0001, r =.61). When bust size was added (Table 10; Model 2), 50.3% of the variance was accounted for and the model was significant, ($F_{(3,121)}$ = 40.76, p<.0001, r =.71). Furthermore, the VIF scores in these first two models indicated little cause for concern regarding collinearity, and therefore BMI, WHR and bust size can be independently attributed to female attractiveness judgements, with BMI having the most impact (indicated by the *t* values).

Waist size increased the variance accounted for to 51.6% and was significant, ($F_{(4,120)}$ = 31.943, p<.0001, r =.72). When hip size was added (Table 10; Model 4), 76.7% of the variance was accounted for and the model was significant, ($F_{(5,119)}$ = 78.243, p<.0001, r =.88). However, collinearity was found to be cause for concern when both these variables were added (Myers, 1990).

As with the male ratings previously analysed, a multiple linear regression was further performed, using the female ratings for the images that fell in the BMI category of 19.

BMI accounted for 3% of the variance and the model was not significant, ($F_{(1,55)}$ = 1.70, *p* = 0.20, *r* =.17). When bust size was added to the model, 32.1% of the variance was accounted for and the model became significant, ($F_{(2,54)}$ = 12.76, *p*<.0001, *r* =.57). Waist size was added (Table 12; Model 3) and increased the amount of variance accounted for to 43.6%, ($F_{(3,53)}$ = 13.70, *p*<.0001, *r* =.66). Finally, 77.1% of the variance was accounted for when hip size was added and the model was found to be significant, ($F_{(4,52)}$ = 43.73, *p*<.0001, *r* =.88).

Table 11. The results of the linear regression determining the significant predictors of female attractiveness judgements in the limited BMI image set.

Model		B	SE	β	*t*	*p*	VIF
1	Constant	-4.57	7.65		-0.60	0.553	
	BMI	0.51	0.39	0.17	1.30	0.198	1.00
2	Constant	-11.21	6.60		-1.70	0.095	
	BMI	0.39	0.33	0.13	1.17	0.249	1.01
	Bust	0.10	0.02	0.54	4.81	0.001	1.01
3	Constant	-9.53	6.10		-1.56	0.124	
	BMI	0.62	0.32	0.21	1.98	0.053	1.06
	Bust	0.10	0.02	0.50	4.76	0.001	1.02
	Waist	-0.09	0.03	-0.35	-3.29	0.002	1.07
4	Constant	-221.80	24.67		-8.99	0.001	
	BMI	-83.24	9.62	-28.11	-8.65	0.001	2395.77
	Bust	3.14	0.35	16.47	8.98	0.001	763.23
	Waist	6.67	0.78	26.55	8.60	0.001	2161.66
	Hips	12.72	1.46	35.87	8.72	0.001	3841.69

Just as for male attractiveness judgements when BMI was restricted, exclusively, BMI was confirmed to not be a significant predictor in the analysis (Table 11; Model 1) and bust and waist size were shown to significantly contribute to the attractiveness ratings (Table 11; Model 2 and 3). Furthermore, they could be attributed independently due to the low VIF scores (Myers, 1990). Again, bust size was shown to have a stronger impact on attractiveness ratings than the other variables (indicated by the *t* values), although the differences between these values was not as big as it was for male attractiveness judgements (Table 7), suggesting that females used these features more equally in their judgements of attractiveness in contrast to males.

For female attractiveness judgements therefore, BMI is shown to be the strongest predictor (Table 9) complying with vast amounts of literature (Tovée *et al*., 2002; Pawlowski & Dunbar, 2005; Bateson *et al*., 2014; Grillot *et al*., 2014). However, when

BMI was restricted, bust and waist size were both found to be independent predictors, with bust size shown to have a slightly stronger association than waist size (Table 11). This disputes the study's hypothesis that waist size would be a stronger predictor of female attractiveness judgements as waist size is thought to be a good indicator of body fat and therefore BMI (Rilling *et al.*, 2009; George *et al.*, 2011). Instead, this finding would indicate that females are more attuned to the attractiveness criteria of males and use the same features (i.e. bust size) that they know males find attractive, to judge attractiveness for themselves. Such a concept can be explained by the 'mate selection theory' (Buss, 2003).

2.5 Experiment 2

2.5.1 *Men and Women's Ideal female body*

The mate selection theory suggests that individuals are not only able to judge attractiveness of the opposite sex but will also know their own attractiveness relative to other members of the same sex to avoid unsuccessful courtship of a more attractive partner (Buss, 2003). It is therefore hypothesised that each of us should know what the opposite sex finds attractive and be able to judge our attractiveness relative to our same sex peers. To investigate this hypothesis, female participants were asked to set their ideal body using the morph sliders for the three body circumferences mentioned above and male participants were asked to set their ideal partner's body shape using the same three sliders to compare the settings of the two genders.

Table 12. A summary of the collated body measurements set by female and male participants.

		Chest	Waist	Hips	BMI	WHR
Female ideal	Average	90.84	61.33	89.02	19.09	0.69
	SD	7.12	1.75	3.53	0.56	0.03
	Min	85.33	57.06	82.52	18.05	0.62
	Max	130.23	64.13	97.10	20.36	0.74
Male ideal partner	Average	88.66	61.95	90.18	18.98	0.69
	SD	2.54	2.75	3.48	0.48	0.02
	Min	84.49	58.23	83.24	18.14	0.65
	Max	93.65	68.13	96.05	19.86	0.73

Table 12 shows that for the three features participants were solely allowed to manipulate, the values are similar across both sexes. A slightly larger bust size is however shown to be preferred for female participants.

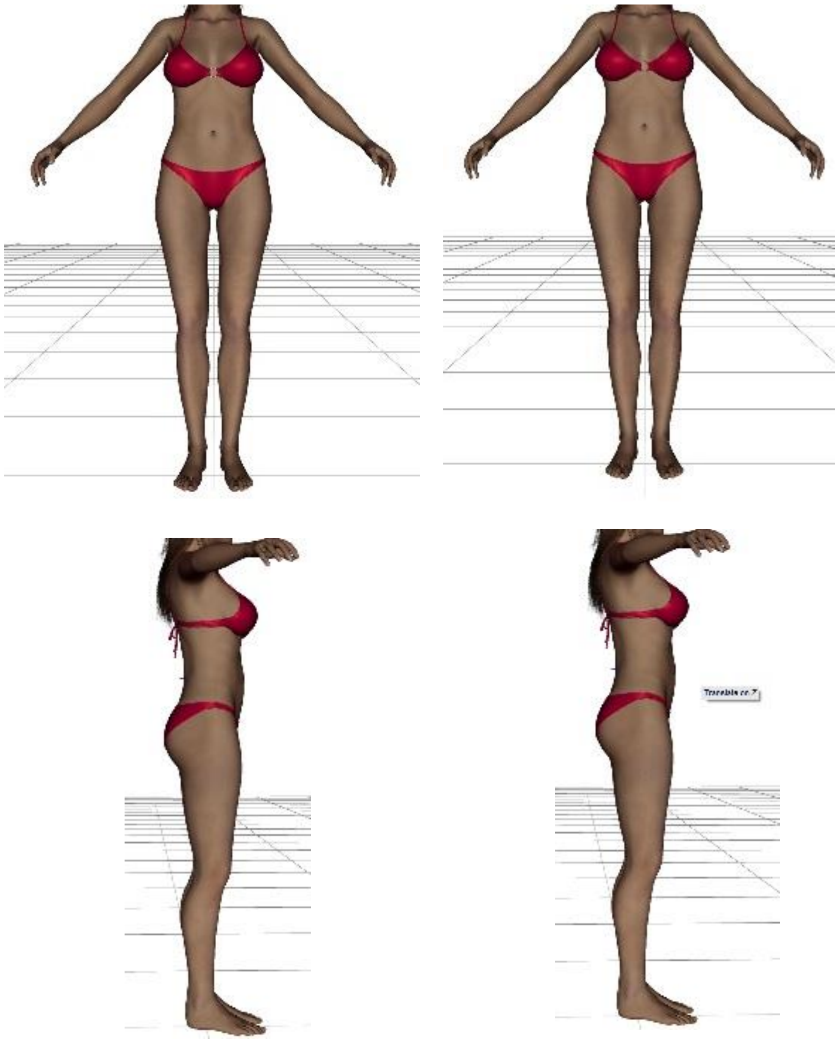


Figure 9. Examples of the ideal female body set by female participants (left) and the ideal partner set by male participants (right); only manipulating the Bust, Waist and Hip size.

Figure 9 shows the ideal female body created from the average measurements across male and female participants. It is clear from Figure 9 that the body shape created by both male and female participants was relatively similar, with very subtle differences.

An independent samples *t*-test was then conducted on the images' BMIs. On average, the female's ideal body preference was shown to have a slightly higher BMI (M=19.18, SE = .094) than the male's ideal partner, (M=18.98, SE = .106). No significant difference was found between the two however, ($t_{(53)}$ = 0.72, p = 0.47, r =.01).

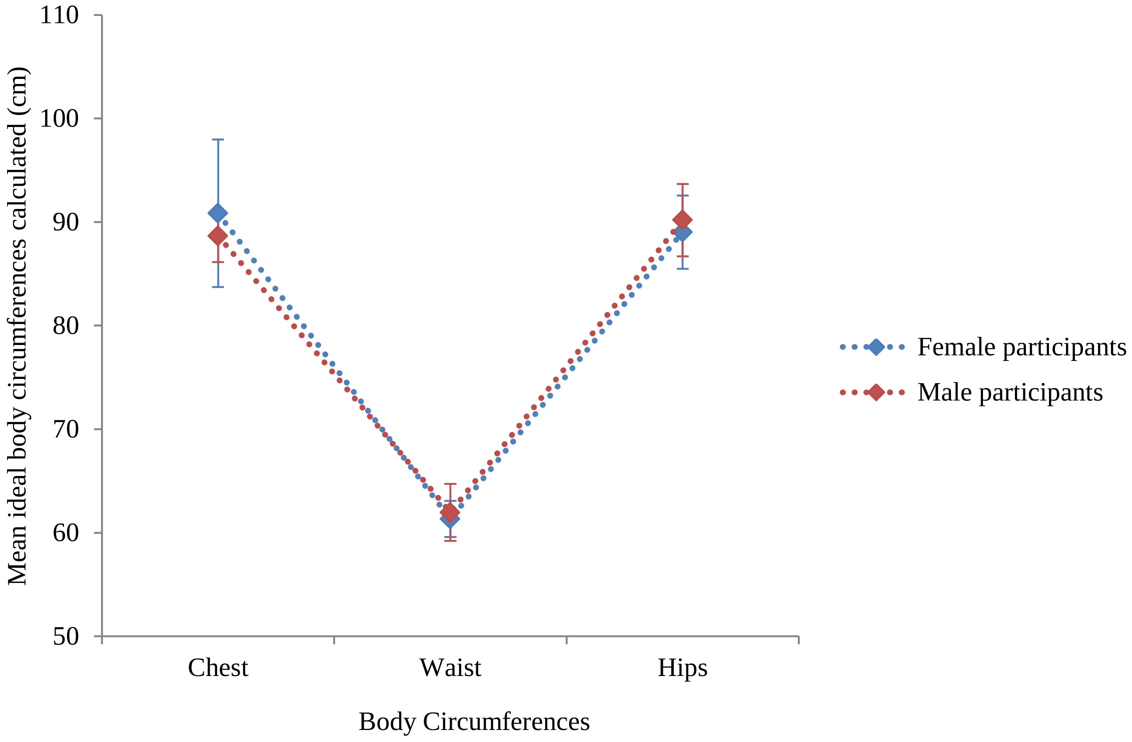


Figure 10. A comparison plot between the ideal circumferences set by participants (cm), with standard deviation bars included.

To determine whether the shape of the images set by males and females was different, a mixed ANOVA on the body circumferences was conducted. Gender was coded; males = 1, females = 2. Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of body circumference, $\chi^2(2)$ = 36.28, p<.0001. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε = .67).

A between-subjects analysis showed that gender was not significant ($F_{(1,53)}$ =0.03, p = 0.86, r = .02). A significant effect was found in the body circumference condition ($F_{(2,70.56)}$ = 847.86, p<.0001, r = .96) and there was no main interaction effect between the body circumferences and gender ($F_{(2,70.56)}$ = 2.59, p = 0.10, r = .19).

Therefore, both genders were found to idealise a similar body size and shape; results that are consistent with a common female physical ideal and that support the mate selection theory previously mentioned.

2.5.2 *Body Image Dissatisfaction: Actual vs. Ideal for the female participants*

As anthropometric measures were taken from the female participants, it was possible to compare the differences between the actual body shape of the women and their ideal (a measure of body image dissatisfaction (Cash & Deagle, 1997)).

Table 13. A comparison of the mean actual and ideal body indices taken from the female participants. The "a" prefix indicates an actual body measure and the "i" prefix indicates the ideal.

Measure	Mean	SD
aBMI	22.54	4.39
iBMI	19.09	0.56
aWHR	0.76	0.09
iWHR	0.69	0.03
aBust	89.05	10.37
iBust	90.84	7.12
aWaist	76.14	11.26
iWaist	61.33	1.75
aHips	100.71	11.24
iHips	89.02	3.53

A MANOVA found that overall, there was a significant effect of body perception on the body indices ($F_{(5,64)} = 29.91$, $p < .001$, $r = .55$). Moreover, a significant difference was found between actual and ideal BMI ($F_{(1,68)} = 21.28$, $p < .001$, $r = .49$); WHR ($F_{(1,68)} = 20.32$, $p < .001$, $r = .48$); Waist circumference ($F_{(1,68)} = 59.17$, $p < .001$, $r = .68$) and Hip circumference ($F_{(1,68)} = 34.48$, $p < .001$, $r = .58$). No significant difference was found between actual and ideal bust circumference however ($F_{(1,68)} = .704$, $p = .404$, $r = .10$). Statistical analysis was conducted using G*Power software to determine the sample size needed for a significant difference to be found and estimated 147 participants was needed (where effect size = 0.30, $\alpha = 0.05$ and power = 0.95).

Using a Pearson's correlation, the corresponding actual and ideal body indices were then correlated to explore any trends in the data which might suggest the ideal value was influenced by the observers own size and shape rather than an abstract ideal.

Table 14. A Pearson's correlation between the female participants' actual body indices (a) and their ideal body indices (i).

	aBMI	aWHR	aBust	aWaist	aHips
iBMI	**0.39***	-0.03	**0.36***	0.17	0.28
Sig. (2-tailed)	0.02	0.86	0.03	0.34	0.10
iWHR	-0.16	0.13	-0.21	-0.12	-0.29
Sig. (2-tailed)	0.37	0.47	0.23	0.50	0.10
iBust	0.01	0.32	-0.14	0.31	0.09
Sig. (2-tailed)	0.95	0.06	0.42	0.07	0.62
iWaist	0.19	0.16	0.12	0.06	-0.04
Sig. (2-tailed)	0.29	0.36	0.50	0.72	0.84
iHips	0.30	-0.01	0.31	0.17	0.27
Sig. (2-tailed)	0.08	0.95	0.07	0.33	0.11

**Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

As the aim of the correlations shown in Table 14 was to show the overall shape of the data and was not the main analysis, Bonferroni correction was not applied for the multiple comparisons made. A significant correlation between female participants' actual and ideal BMI was found.

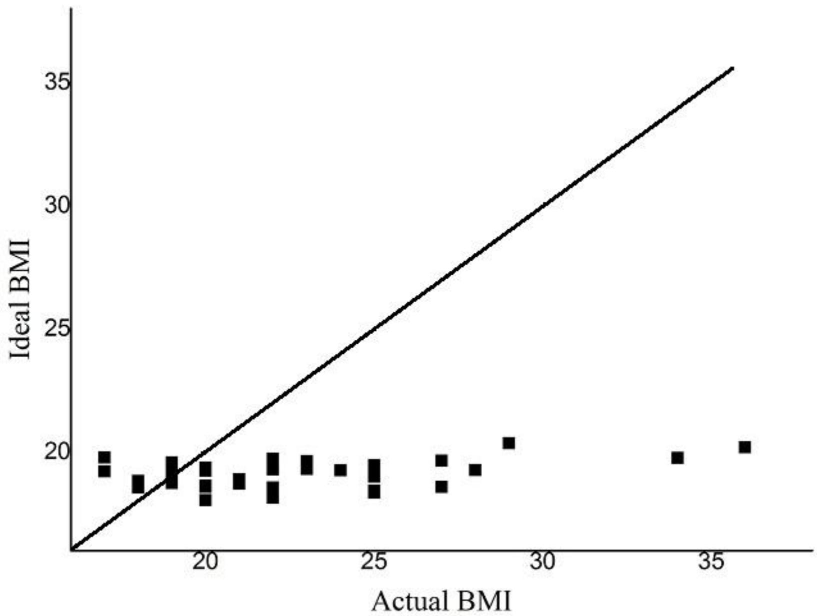


Figure 11. The comparison between participants' actual BMI and their ideal BMI, including a line of equality.

The overall BMI of the ideal bodies female participants created was shown to be predominantly lower than their own, (Figure 11). As can be seen, there is no relationship between actual BMI and ideal BMI. They chose a low ideal BMI no matter what their own BMI.

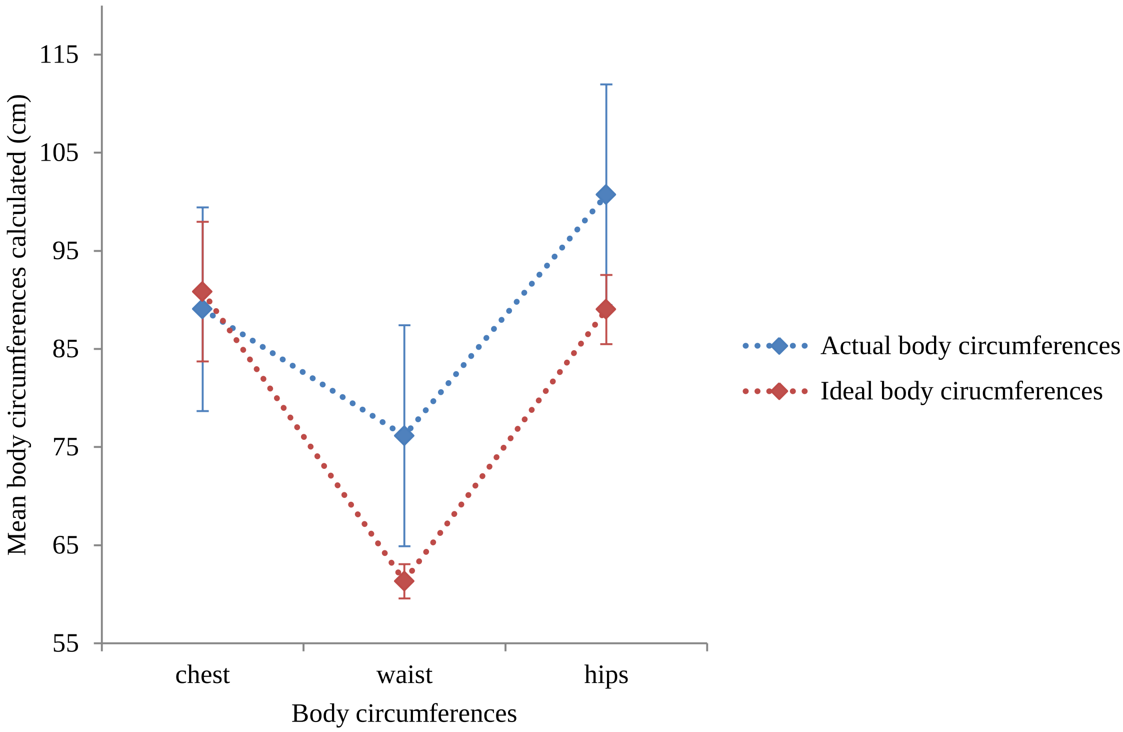


Figure 12. A comparison plot of the actual body circumferences of participants and the ideal body circumferences they set with standard deviation bars included.

To test whether the circumferences of the ideal bodies set by female participants was significantly different from their actual circumference measurements, a mixed ANOVA was conducted. Factor 1 was the condition (actual versus ideal) and Factor 2 was the body circumferences. Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of "condition*circumference", $\chi^2(2) = 12.22$, $p<.001$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .76$).

The "condition" of the experiment (actual versus ideal) was found to be significant ($F_{(1,34)} = 26.09$, $p<.0001$, $r = .66$) as was the body circumferences ($F_{(2,68)} = 628.13$, $p<.0001$, $r = .95$). A significant interaction effect was also found between these two factors ($F_{(1.53,51.93)} = 36.18$, $p<.0001$, $r = .64$).

2.5.3 *Summary*

The results from Experiment 2 suggest that males and females have a very similar ideal for the female body shape consistent with mate selection theory. To further extend on this, the results from section 2.5.2 found that there was a difference between what female participants actually looked like and what they would prefer to look like. Female participants would prefer to have larger breasts coupled with smaller waist and hip sizes relative to their own.

2.6 Discussion

2.6.1 *When Bust, Waist and Hip size are independently manipulated, which best predicts female attractiveness?*

This study was designed to establish the effect the three important anthropometric features (Bust, Waist and Hip size) had on attractiveness judgements. When the three variables were each independently manipulated on five different levels, bust circumference significantly predicted female attractiveness of male observers. This is consistent with the work of Dixon *et al*., (2011), Zelazniewicz and Pawlowski (2011) and Swami and Tovée (2013a,b), and it specifically supports the findings of Furnham (1990) who also found men's preferences for a larger breast size is independent of waist and hip size, thus validating the hypothesis that men selectively attend to this body site.

Whilst evolutionary theories would suggest such a finding is a result of our ancestral environment ascribing defining men's preference for large breasts as they signal better access to resources (Swami and Tovée, 2013), this would not fit as an explanation for the current study due to the male participants being recruited from a Westernised society where resources are predominantly secure. An alternative explanation would be to look therefore, at sociocultural influences (Carter, 1996; Tantleff-Dunn, 2001). Visual examples of the sexual objectification of women are prominent in the world of advertising, with findings showing that the role of 'sexual object' is a central way in which women are featured (Lindner, 2004; Reichert, 2004). Therefore, the popularity of media images depicting unrealistic breast sizes coupled with high rates of cosmetic surgery indicative of increasingly larger upper torso ideals, offers an explanation for the current findings of men's preference for breast size (Tantleff-Dunn, 2001). To more defiantly distinguish between an evolutionary and sociocultural explanation, future work should acquire more demographic information from participants such as socio-economic status, total household income and current hunger satiety for example, to be used as explanatory factors.

For female judgements on attractiveness, BMI was shown to account for the largest amount of the variance in attractiveness judgements when the relationship between each physical feature and the attractiveness judgements were tested hierarchically. This is consistent with the majority of the studies regarding female attractiveness (Tovée *et al*., 1998, 1999, 2000a, 2002; Thornhill & Grammer, 1999; Fan *et al*., 2005; Smith *et al*., 2007; Faries *et al*., 2012). However, it is hypothesised that the relationship between BMI and attractiveness can be explained by BMI's association with other anthropometric variables that are correlated with attractiveness (Rilling *et al*., 2009), and indeed, BMI was shown to correlate with all three features in this study (Table 10).

To try and overcome this element, BMI was restricted in an attempt to show the apparent role of the remaining features in attractiveness judgements, and bust size was found to best predict male and female judgements of attractiveness. Although this did not comply with the study's original hypothesis that waist size would be the best predictor of female attractiveness judgements, a possible explanation for this finding can be attributed to intra-sexual female competition focusing on the traits men deem to be most physically attractive, (the mate selection theory, (Buss 2003)), and such a theory has been repeatedly supported. For example, a recent study by Fink *et al*., (2014) investigated the hypothesis that more attractive women displaying feminine faces, larger breasts and lower WHRs (traits known to be desirable to men (Singh, 1993a, 1994b, 2010; Swami & Tovée, 2013)) were regarded as a threat by female observers. 15 images were shown to 35 heterosexual women; 5 varying in facial femininity, 5 in breast size and 5 rear view images of varying WHRs. Participants were asked to imagine they were single and were interested in a man they were talking to when another woman interrupts and starts to flirt with the man they are attracted to. The stimuli images were presented and participants were asked to rank them according to perceived competition, attractiveness and femininity if the face/breast/body belonged to the imaginary rival. Fink *et al*., (2014) found that women with more feminine facial features, larger breasts and a lower WHR were perceived as the biggest threat and received the highest attractiveness and femininity ratings. This would suggest intra-sexual competition is higher among women with regard to the traits that men find most desirable, and the results from the current study indicating bust size as the best predictor of female attractiveness judgements, are consistent with this hypothesis.

2.6.2 *Are Women's body size and shape ideals for female bodies the same as Men's?*

For both genders, the preference for the ideal female body was shown to be very similar. Both males and females were shown to prefer a large bust and hip circumference and a narrow waist circumference. This finding is consistent with the results from Crossley *et al*., (2012) and Fink *et al*., (2014), lending support to the mate selection theory which proposes that individuals must be able to assess bodies of their own gender using the same criteria as the opposite sex to avoid unsuccessful courtship (Buss, 1992, 2003). The general agreement between genders is also consistent with attractiveness rating studies, which show a strong correlation between male and female attractiveness judgements on female bodies (Tovée *et al*., 1999, 2002).

In a counter argument to the mate selection theory however, a recent study by Prantl and Grundl (2012) recruited a staggering 34,015 participants and allowed participants to manipulate the appearance of women's figures by adjusting weight, hip, waist and bust size and leg length. The results found a striking gender difference over breast size with 40% of men preferring a large bust size in comparison to 25% of women. The authors theorise that women believe a smaller breast size is more attractive due to the sociocultural stigma surrounding large breasts; namely that women with larger breasts are less intelligent and competent and women are therefore keen to avoid this label. This is particularly relevant in more Westernised societies where women are becoming more economically independent and career driven. The age group of the participants recruited for Prantl and Grundl's (2012) study however, was between 15-95 years old in comparison to 18-24 years old for the present study. This age group is therefore more arguably focussed on attracting a potential mate, and therefore the results for the present study can be more reliably explained through the mate selection theory.

2.6.3 *Are Women's Ideal bodies different to their Actual bodies?*

The female participants set the BMI of their ideal body towards the lower end of the 'normal' BMI range, a result consistent with previous studies of rating photographs and videos of real bodies (e.g. Tovée *et al*., 1999; Fan *et al*., 2004; Smith *et al*., 2007a; Rilling *et al*., 2009; Mo *et al*., 2014). They also preferred a narrower waist and a larger bust and hip size (e.g. Singh & Randall, 2007; Courtiol *et al*., 2010; Prantl & Gruendl, 2011).

Media influences offer an explanation for such differences between participant's actual and ideal body size/shape; portraying extremely thin bodies as the 'ideal' leading to body dissatisfaction as such a body is unattainable for most women (Homan, 2010; Lopez-Guimera, 2010). This is particularly common for Western cultures from which this participant sample is drawn (Homan, 2010; McCabe *et al*., 2010). More recently, research has focussed on weight teasing and the effects of negative comments from parents and peers on body dissatisfaction (Markey, 2010; Helfert & Warschburger, 2011). A meta-analysis reported a positive association between appearance-related comments and body dissatisfaction (Menzel *et al*., 2010). Indeed, studies using morphing software to compare the accuracy of body size estimation in eating disordered (ED) versus control participants have reported that control groups accurately estimated their overall body size whereas the ED groups significantly overestimated their body size (e.g. Tovée *et al*., 2003; Cornelissen *et al*., 2013). However, both the control and ED groups tended to overestimate their hips and thighs and show a preference for ideal bodies with these features significantly reduced in size, consistent with the results reported here.

Notably, whilst the social beauty ideal has become increasingly thinner over the years (Cash, 2003; Markey, 2004; Esnaola, 2010) reaching an unattainable level for the average population (Andrist, 2003; Slater, 2006; Lopez-Guimera *et al*., 2010), the average weight of girls/women has increased significantly, not only in the developed world (Health Survey for England, 2008; Ogden *et al*., 2012; Tsiros *et al*., 2011; Zhao, 2014), but also in developing countries (El-Bayoumy *et al*.,2009; Low, 2010). Additionally, the size and shape of women in beauty contests and in magazines has continued to reduce (e.g. Freese & Meland, 2002; Voracek & Fisher, 2006; Lopez-Guimera *et al*., 2010). Therefore the discrepancy between people's ideal and actual body size and shape will continue to increase, underlying the relevance of the topic at hand.

Interestingly however, the results attained from Section 2.4.3 indicated that bust size was the best predictor of female attractiveness judgements and the morphing analysis found that females idealised a bigger bust size then what they had, however, the MANOVA in Section 2.5.2, found this difference between females actual and ideal bust size was not statistically significant. This finding does not entirely fit therefore, with the theory that females use breast size as an important cue for attractiveness judgements due to intra-sexual competition, as a significant increase in breast size would be more affable.

One explanation of such a result is the hypothesis that women are not that reliable in knowing the actual size of their bust, due to fluctuating weight and hormone cycles theoretically rendering bust size malleable from month to month, particularly in pre-menopausal women (Willet *et al*., 1995). Consequently, the internal representation they have of their bust size to use as a "starting point" for creating their ideal bust size is therefore unreliable, so an accurate comparison between the two conditions (actual and ideal) is problematic. This explanation is of course, only viable if the female participants were creating an ideal bust size that was specifically bigger then what they thought they themselves had, and therefore, additional information would need to be collected from participants in future work describing the reasons behind each manipulation, i.e. were they using their own bodies as a basis for creating their ideal body or were they just creating an ideal body by comparing how the overall body looked once the features were manipulated.

Indeed, bust size has been shown to be affected by changes in body size and shape, suggesting that the effect of breast size on judgements of attractiveness may depend on both overall body fat and size of the WHR (Low, 1979, 1987, 1990).

To address this issue, Singh (1995) used line drawings of female figures representing two categories of body weight (slender and heavy), breast size (small and large) and WHR representing typically feminine (0.7) or typically masculine (1.0) ratios. They found that body, breast and WHR sizes interactively influenced judgements of attractiveness, healthiness and feminine looks. Past research reported that breast size preferences did not vary either body size or WHR of their female figures (Gitter, 1983; Thompson, 1992), however the findings from (Singh, 1995) show that both these features must be taken into account when trying to understand the influence of breast size in the perception of female attractiveness. The results in the present study can therefore be attributed to such findings, as females were found to significantly alter their ideal body's waist and hip size in comparison to their own, which could therefore have indirectly changed the perception of the body's breast size and therefore they did not need to physically manipulate the bust size feature to acquire the breast size they idealised. This could suggest that females actually place more importance on their waist and hip size and judge breast size in comparison to these features rather than independently. In support of this, the regression analysis on the female attractiveness judgements (Table 12) presented a more even distribution of significance to the predictor variables in comparison to the male judgements (Table 7) which found a stronger influence attributed to bust size; indicating females may use the anthropometric features more equally to make their judgements of attractiveness. Again, more subjective information as to the reasons for participant's choices in such studies would be beneficial.

2.6.4 *Limitations*

A limitation to the current study is due to the Daz 3D manipulation software used. When male and female participants manipulated the three body features; Bust, Waist and Hips to represent their ideal female body, the changes they made are a representation of the artistic impression of what the morph ++ software thinks the body should look like. Therefore they may not represent a change that is realistic in real bodies. Studies using real bodies overcome such limitations however they also introduce further confounding variables that are harder to control for.

In section 2.5.2 it should be noted that the circumference measures generated by 3ds Max for bust and hips in female bodies tend to be larger than the same measurements taken from real bodies. This is because 3ds max calculates the path length around each slice which includes, for example, the cleft in the bust or buttocks. In comparison, a tape measure looped around the bust or hips will straddle these gaps, and so will produce a shorter distance. To gain more accurate measurements therefore, future studies will need to import the bodies into a program with tools that will mirror the path of a tape measure.

Furthermore, the use of opportunistic sampling in the current study means that it may not be possible to widely generalise the present results. Future work should seek to replicate and extend the present results using larger and more representative samples. For example, it has been suggested perceptions of attractiveness vary not only with the observer's culture, but also with the perceived ethno-cultural affiliation of the person/stimuli being observed (Swami *et al*., 2008). Whilst the participants recruited for the present study were Caucasian and were asked to rate Caucasian stimuli, such findings limit the understanding of attractiveness judgements cross-culturally, and therefore future work should attempt to use a broader range of participants and stimuli from different ethnic backgrounds to determine cultural influences on attractiveness judgements and the implications of such findings to the universality of attractiveness ideals.

2.6.5 *Conclusion*

The findings of the current study therefore suggest that women use BMI as their main cue for judging attractiveness in other women and are shown to use alternative cues that they perceive to be most attractive to males, such as bust size, when BMI is restricted. Men predominantly use breast size in their judgements of attractiveness. Both genders are shown to prefer a female body of low BMI with a relatively curvaceous body shape. Overall, this study provides evidence of cross gender agreement in preferences for overall female body shape attractiveness but shows subtle differences in the way they prioritise the cues they use to make their preference.

Chapter 3: What is an Attractive Body? Using an Interactive 3D Program to Create the Ideal Body for You and Your Partner

3.1 Introduction

What makes a human body attractive to the opposite sex? In evolutionary psychology terms it is a judgment of a potential partner's health and reproductive potential (Buss, 1989; Thornhill & Gangestad, 1999). In this context it is important that to be able to detect and accurately assess the physical cues that indicate that one individual is more attractive (i.e., fitter and with a better reproductive potential) than another, and then use these cues to choose the partner who is most likely to enhance our chances of successful reproduction, (Buss, 1989, 2003; Thornhill & Gangestad, 1999). As a result, there should be a strong selective pressure to detect and accurately evaluate reliable cues to health and fertility in potential partners. However, there remains considerable debate over which cues are used to judge human physical attractiveness, their relative importance and whether these cues differ between men and women.

Previous studies that have attempted to define the importance of these physical cues have had a significant limitation. These studies have used line-drawings, photographs and, more rarely, video clips and 3D laser scans as test stimuli, (Fan *et al.*, 2004, 2005; Henss, 1995, 2000; Maisey *et al.*, 1999; Puhl, 2001; Sell *et al.*, 2009; Singh, 1993; Smith *et al.*, 2007; Streeter & McBurney, 2003; Swami *et al.*, 2006; Thornhill & Grammer, 1999; Tovée *et al.*, 1998, 2002, 2012). Typically, observers are asked to rate a set of images that vary on a number of anthropometric dimensions. However, these studies all suffer from the same intrinsic methodological limitation that they require their participants to rate bodies from the limited set of alternatives presented to them. Unfortunately, the ideal combination of features may not be included in the set of images with which they are presented. Thus, their apparent preference may actually be for a suboptimal body size and shape. To try and overcome this problem some researchers have presented participants with silhouettes or photographs in interactive computer programmes which allows the simple alteration of certain body features, (Courtiol *et al.*, 2010; Prantl & Gruendl, 2011; Tovée *et al.*, 2003). However, these techniques are obviously limited in the range of shape changes that can be made and the realism of the bodies produced. Additionally, the 2D representation of the bodies limits what can be seen of the change in the physical dimensions produced by the programme.

It can be difficult to extrapolate from a 2D representation of a body to its 3D shape, (Tovée & Cornelissen, 2001).

To overcome these important methodological limitations, this chapter used an interactive 3D software programme to determine male and female participants' perceptions of their ideal body and their ideal partners' body size and shape. The participants could alter the virtual 3D image of the body in more than 90 independent dimensions allowing very subtle changes in body shape. The body could be rotated through 360^o to allow participants to examine the body from different viewpoints. The scaled volume of these 3D models could then be measured and, assuming they had a standard body density, their body weight could be estimated. Additionally, the scaled circumference of the chest, waist and hips of each body was measured to allow the waist-to-hip ratio (WHR) and the waist-to-chest ratio (WCR) to be calculated. By taking anthropometric measures from all participants, it was possible to determine whether the accuracy of their estimation and whether the participants' own physical dimensions (and their estimation of their body's dimensions) influence their choice of both their own ideal body and their ideal partner's body. This morphing technique enabled three key questions to be answered:

3.1.1 *How accurate are people in estimating their own body size and shape?*

Mate selection theory would suggest that humans should be very good at this. The hypothesis was that people should know their own attractiveness relative to their peer group, so they know their own market value which then determines their mate choices, (Buss, 1989, 2003; Thornhill & Gangestad, 1999). To correctly assess their own mate value, they need to be able to know their own physical attractiveness which will be based on their body's size and shape. However, set against this theory are a number of empirical studies which have suggested that they may not actually have a very good idea of their own body shape and size, (Jasienska *et al.*, 2004; Manson *et al.*, 1995; Tovée & Cornelissen, 2001). By recording participants actual size and shape and their estimate of their size and shape this question can be directly answered.

3.1.2 *What is the ideal body size and shape?*

For women, several studies have suggested that the ideal body is based on a curvaceous body, with a curvy lower torso (indexed by the WHR) but also a curvaceous upper body (WCR), (Jasienska *et al.*, 2004; Singh, 1993; Streeter & McBurney, 2003). Set against this is an alternative hypothesis which postulates that the primary predictor of female attractiveness is overall body fat (usually measured as the Body Mass Index or BMI), (Fan *et al.*, 2004; Smith *et al.*, 2007; Tovée *et al.*, 1998, 2002). Changes in BMI have a strong impact on both health (Manson *et al.*, 1995; Willet, 1995) and reproductive potential (Frisch, 1988; Lake *et al.*, 1997; Reid & Vanvugt, 1987), and a low WHR and WCR (i.e., a curvaceous body) is believed to correspond to the optimal fat distribution for high fertility, (Frisch, 1988; Jasienska *et al.*, 2004; Lake *et al.*, 1997; Manson, 1995; Reid & Vanvugt, 1987; Willet, 1995; Zaadstra *et al.*, 1993). So there are clear reasons why both these features might impact on attractiveness judgements.

A similar difference of opinion exists for what is the main determinant of male attractiveness. Some studies assert that upper body shape (a broad upper body and a narrow waist; the classic V-shape) is the primary predictor of attractiveness, whereas others point to BMI as the key feature, (Fan *et al.*, 2005; Honekopp *et al.*, 2007; Maisey *et al.*, 1999; Sell *et al.*, 2009). It has been suggested that this v-shaped torso represents a muscular, strong body type that would be an advantage in our ancestral environment and therefore be sexually selected, (Frederick *et al.*, 2005; Sell *et al.*, 2009). BMI is an important predictor of male health and mortality (Collaboration, 2011a,b), and a narrow waist circumference is also important in long-term health and so should also be associated with a low WHR, (Lean *et al.*, 1995; Zhu *et al.*, 2002).

By asking both men and women to set their ideal bodies, it is possible to determine which features they change and how their ideal body differs from their actual bodies; whether they change shape, size or both.

3.1.3 *Do men and women share body ideals?*

A number of studies have suggested a difference between the genders for the ideal body size and shape of a particular gender (for example, men may prefer a more curvaceous, heavier female body than women think they do), (Fallon & Rozin, 1985; Oakes *et al.*, 2003; Rozin & Fallon, 1988) and eye-tracking studies have suggested significantly different patterns of eye-movements between the genders when assessing female attractiveness, (Cornelissen *et al.*, 2009a). However, mate selection theory predicts that an individual will have a very precise and accurate idea of what the opposite sex find attractive, (Buss, 2003). This allows them to judge their own relative value, with respect to their peer group, and match this value with the value of a prospective mate. So mate selection theory predicts that there will not be any difference between men and women in their ideals for both genders. There is some evidence to support this hypothesis in rating studies which have suggested the same ideals are held by both genders, (Maisey *et al.*, 1999; Tovée *et al*., 1999, 2006). The technique used in the following study can accurately determine whether there are gender differences in body preferences, even if they are comparatively subtle and would not be detected in the choice between bodies within an image set. However large the image set, it cannot provide a continuous smooth change along all feature dimensions and so can only provide a comparatively coarse grained assessment of attractiveness ideals.

3.2 Materials and Methods

3.2.1 *Participants*

A total of 80 heterosexual Caucasian undergraduate students aged 18-21 (40 females average age 19.10 years, SD = 1.01; 40 males average age 19.84, SD = 1.66) were recruited from Newcastle and Northumbria Universities. Participation was voluntary. All participants gave informed consent (Appendix B) and the aims and procedure of the study were explained beforehand. The study was reviewed and approved by the School of Psychology Ethics Committee of Newcastle University.

3.2.2 *Protocol*

The participants used a 3D modelling software package (Daz Studio 3.1 from Daz3d.com) which allows the adjustment of photo-realistic male and female 3D models on a flat panel screen in order to modify different aspects of the body's features (Figure 1). The female 3D model used was Victoria 4.2 and the male model was Michael 4.0. The program allows the body to be rotated to allow a 360^{o} view of the model. Along one side of the model is a set of 94 graphic sliders with which different aspects of individual body parts can be altered (using the 'Body morphs' and 'Body morphs++' add-on packages from Daz3D). When the slider is adjusted, the model simultaneously changes, providing immediate visual feedback. Sliders could be adjusted as many times as necessary and no time limit was set, so the participants could take as much time as they wished to satisfy themselves that the model was as accurate a representation as possible. The model was positioned so that the head was not visible and did not play a role in the judgements.

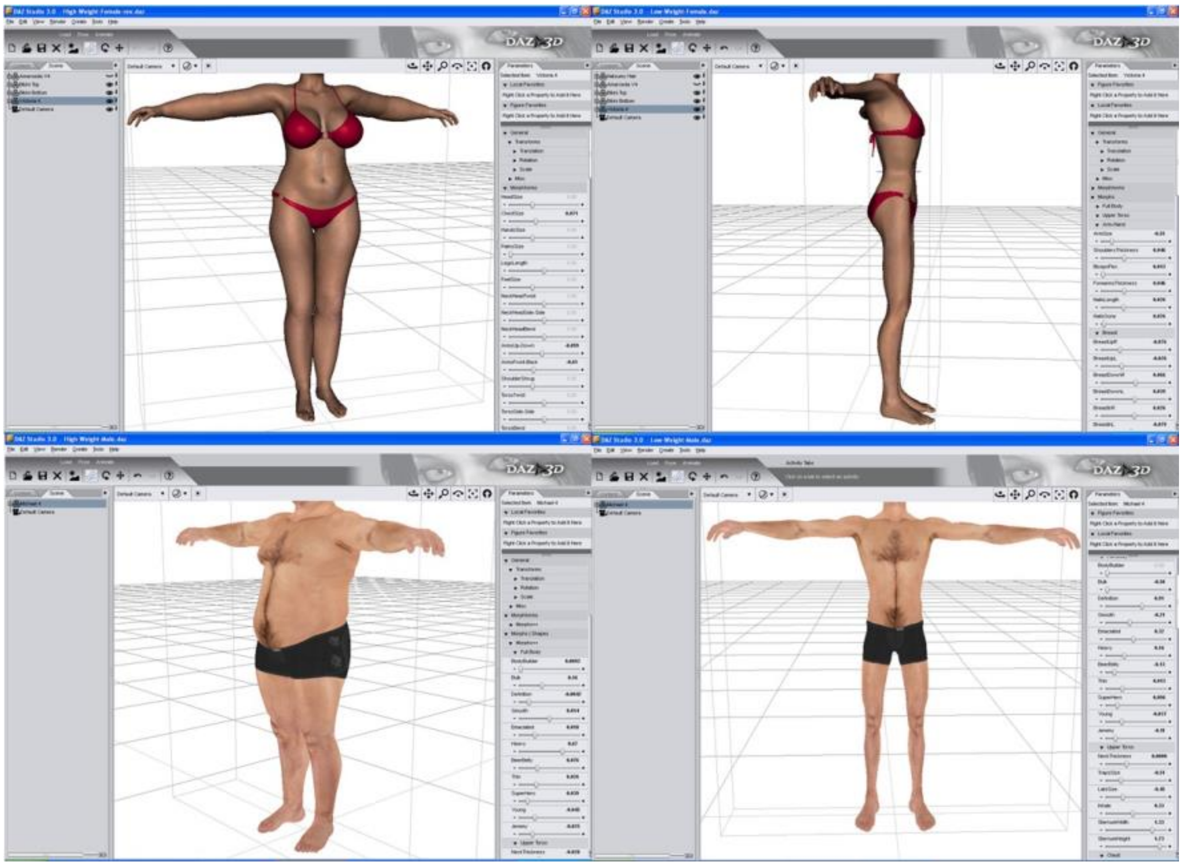


Figure 1. An example of the Daz3D interface, with examples of male and female bodies created in the software package. The bodies are displayed in slightly different viewing angles, and each body could be rotated though the whole 360°. Along the right of the picture are some of the 94 sliders which allowed different parts of the body to be independently altered.

Each participant created a total of six 3D bodies; two that represented an estimate of their actual body, two that represented their ideal body and two that represented their ideal partner's body. In each of the three conditions, the participants began with a 'heavy' body and then a 'thin' body, or vice versa. The order was counterbalanced between participants. The two estimates were averaged to render a final model. The use of fat/thin bodies as a starting point was to reduce potential anchor effects which might have occurred if participants had just begun by adjusting a normal weight body. The female "thin" body had a BMI of 14.9 and the "large" body had a BMI of 26.6. The male "thin" body had a BMI of 16.5 and the "large" body had a BMI of 37.7.

All the participants were tested on the same PC in the Body Image Lab at the Institute of Neuroscience. Participants were asked to adjust the sliders until they were satisfied that the model looked like themselves, their ideal body and then their ideal partner's body. No time limit was placed upon them. Although there were 94 sliders, many of them are used for comparatively subtle adjustments to features such as the length of the ring finger on the left hand, and so were not used. These minor features in the “heavy” and “thin” bodies were left at the default setting. Instead, most participants used a core set of sliders (Mean 36.2 sliders, SD = 7.8) which changed features, such as stomach depth and hip width.

After completion, a set of anthropometric measures were taken from the participants. Height was measured using the Marsden/Invicta Free Standing Height Measure and weight was measured using the Weight Watchers 8944U Heavy Duty Body Fat Analyser Scale. Using a standard tape measure, the waist and hip circumferences were measured, along with bust and under-bust circumferences if female, and chest circumference if male, following the protocols outlined in the Health Survey for England, (England, 2008) (Appendix C).

3.2.3 *The 3D Body Analysis*

The final 3D models were exported from Daz Studio, once clothing had been removed, and reopened in 3ds Max (autodesk.com), where they were set either to the height of the participant (for their ‘actual’ and their own ‘ideal’) or to the height of the average British man (1.78m) or woman (1.64m) (for ‘ideal partner’). First, the volumes of the 3D models were calculated by the software, scaling the body volume relative to the body height entered by the experimenter. Once the volumes were known, the weights of the models were estimated by multiplying their volumes by the density of either the average young adult female body (1.04 g/cm^3) or the average young adult male body (1.06 g/cm^3), (Krzywicki & Chinn, 1967; Pollock *et al.*, 1975). Finally, the BMI of each model was calculated as its weight (kg) divided by its height (m) squared.

Next, 3ds Max was used to slice through each model at predetermined points along its length to measure the circumference of the bodies at the chest, waist and hips in male models, and the bust, under-bust, waist and hips in female models. The software scaled the circumferences (measured in cm) to the dimensions that the bodies would have if they were real. However, the circumference measures generated by 3ds Max for the hips in male bodies and bust and hips in female bodies tend to be larger than the same measurements taken from real bodies. This is because 3ds max calculates the path length around each slice which includes, for example, the cleft in the bust or buttocks. In comparison, a tape measure looped around the bust or hips will straddle these gaps, and so will produce a shorter distance. To compensate for these effects, a screen grab of the cross-sectional slices of the bust or hips in 3ds Max was taken and imported into

ImageJ (http://rsbweb.nih.gov/ij/). There, the lasso drawing tools was used to replicate the path that a tape measure would take when placed around the bust or buttocks, and the measurement tools were used to calculate the path length which better reflected a real world measurement with a tape measure.

3.3 Results

The following results show that there are significant differences in size and shape between the actual bodies of the participants, their estimations of themselves and their ideals. These ideal bodies differ from the expected shape of real bodies of the same BMI, implying an explicit choice for specific sizes *and* shapes in their ideal bodies. Finally, the ideal size and shape for both a male and a female body is shared by both our male and female participants (i.e. there is no gender based difference on what constitutes an attractive male or female body).

3.3.1 *Comparisons of Participants' Actual BMI versus Estimated BMI versus Ideal BMI*

A summary of the anthropometric data from the participants' actual, estimate and ideal bodies are shown in Table 1 and examples of the bodies created are shown in Figure 2.

Table 1. A summary of the anthropometric measures taken from the male and female bodies in this study.

	BMI	Bust/ Chest	Under-Bust	Bust Size	Waist	Hips	WCR	WHR	CHR
Female Actual Body									
Average	21.7	87.4	75.93	11.47	72.91	99.4	0.86	0.76	0.88
SD	2.07	5.17	5.6	3.95	5.48	5.36	0.2	0.19	0.05
Female Estimated body									
Average	22.11	92.33	71.28	21.04	67.87	96.92	0.74	0.7	0.96
SD	1.99	9.45	3.18	9.79	4.3	6.81	0.07	0.04	0.11
Female Ideal Body									
Average	18.85	93.97	68.33	25.65	61.12	87.89	0.67	0.7	1.08
SD	1.75	18.24	4.06	17.55	3.38	6.52	0.09	0.04	0.23
Male's Ideal Female Partner									
Average	18.82	90.02	69.2	20.82	61.95	84.82	0.69	0.73	1.06
SD	1.56	4.73	5.79	5.86	5.79	4.92	0.05	0.04	0.07
Male Actual Body									
Average	24.54	97.74	-	-	86.12	98.76	0.88	0.87	0.99
SD	3.38	9.21	-	-	9.47	7.93	0.04	0.06	0.06
Male Estimated Body									
Average	27	107.57	-	-	88.42	98.48	0.82	0.87	1.12
SD	5.97	11.42	-	-	13.46	13.56	0.08	0.04	0.11
Male Ideal Body									
Average	25.86	111.26	-	-	82	91.17	0.74	0.87	1.25
SD	3.95	9.44	-	-	9.17	9.59	0.05	0.04	0.09
Female's Ideal Male Partner									
Average	24.46	104.16	-	-	80.57	90.81	0.77	0.86	1.17
SD	2.9	7.43	-	-	7.22	7.15	0.05	0.03	0.08

The BMI of the estimated bodies of the female participants are correlated with their actual BMI (Pearson correlation, $r = 0.46$, $p = 0.04$), but the degree of error in their estimation (i.e. how accurate people are in judging their body size) is not uniform. Everyone does not over-estimate by the same amount. Instead, the degree of over-estimation is negatively correlated with the BMI of the participant ($r = -0.55$, $p<.0001$), i.e. the lower the participants' actual BMI, the more they over-estimate their BMI. The actual BMI of the female participants is not correlated with the BMI of their ideal body or the BMI of their ideal male body, but the BMI of their estimated body is correlated with their ideal body ($r = 0.44$, $p <.001$) and their ideal male body ($r = 0.56$, $p<.0001$). The WHR and WCR of the female estimated bodies are not correlated the actual WCR and WHR. However, their estimated WHR is correlated with their ideal WHR (r = 0.52, *p*<.001) and their estimated WCR is correlated with their ideal WCR (r = 0.51, *p*<.001).

The BMI of the male participants' estimated bodies are very strongly correlated with their actual BMI (Pearson correlation, r = 0.786, *p* = 0.0001), but the degree of error is not significantly correlated. Additionally, their actual BMI is not significantly correlated with their ideal male body or their ideal female body, but the BMI of their estimated body is significantly correlated with their ideal body (r = 0.684, *p*<0.0001) although not their ideal female body. The WHR and WCR of the male estimated bodies are not correlated the actual WCR and WHR. The estimated WHR is also not correlated with the ideal WHR, but the estimated WCR is correlated with their ideal WCR (r = 0.631, *p*<0.001).

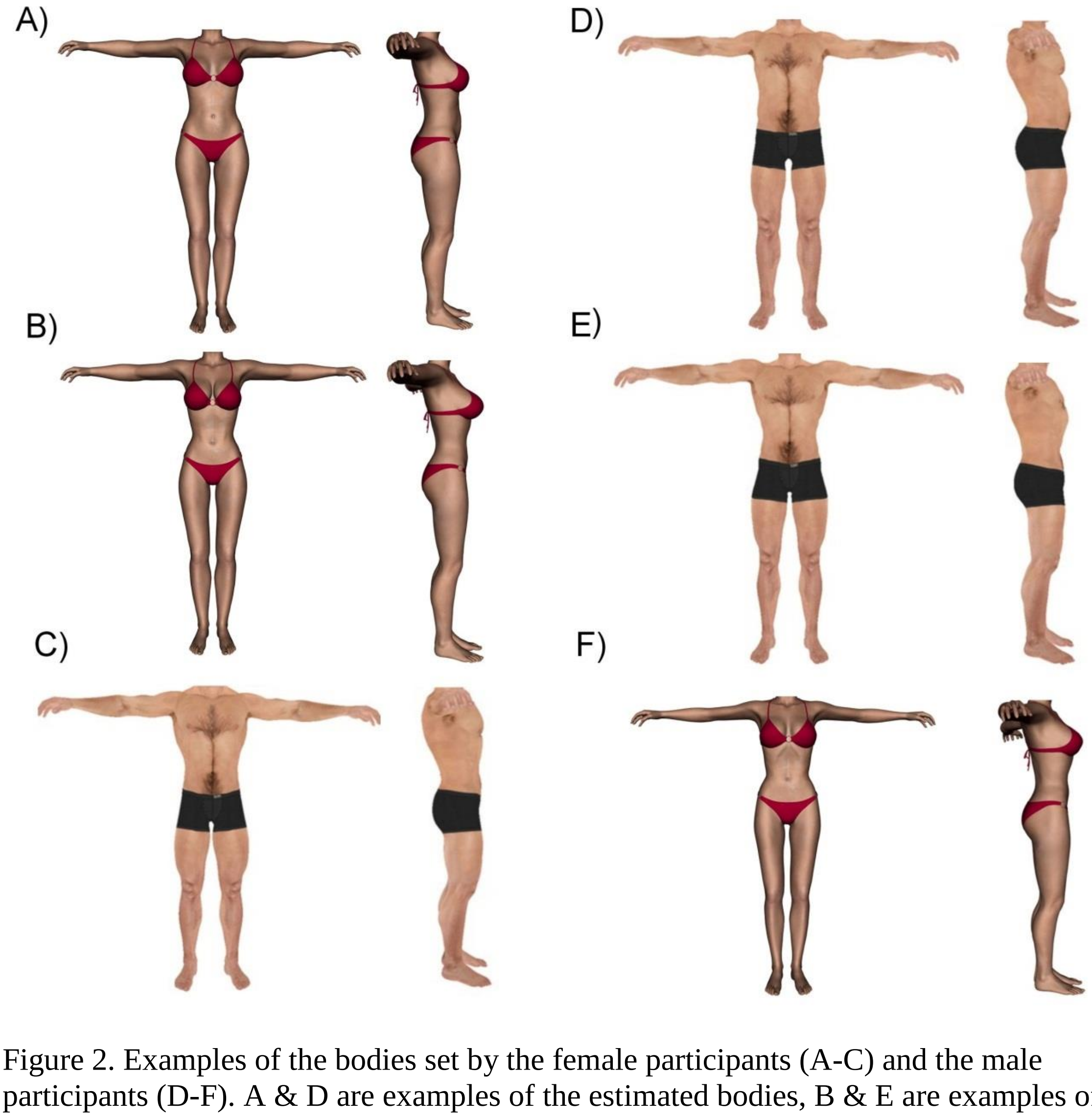


Figure 2. Examples of the bodies set by the female participants (A-C) and the male participants (D-F). A & D are examples of the estimated bodies, B & E are examples of the ideal bodies and C & F are examples of their ideal partners' bodies.

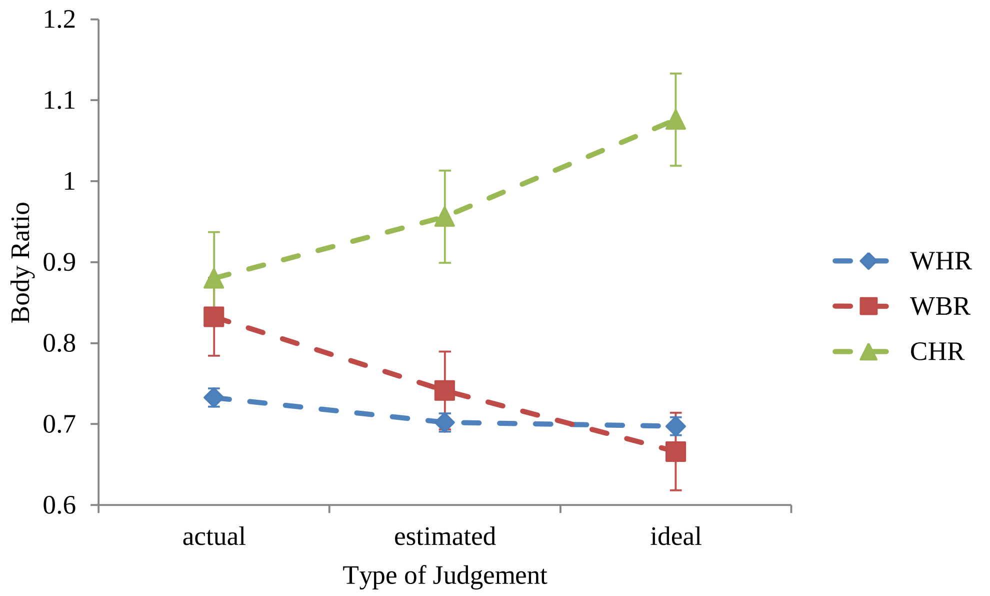
To test the main effect of condition (i.e. actual, estimated and ideal body) on BMI a one way repeated measures ANOVA was conducted. For female participants a significant effect was found, ($F_{(2,78)}$ = 52.82, p<.0001). Post-hoc differences of least square means using the Tukey-Kramer correction to compensate for multiple statistical tests showed that the BMI of the estimated bodies of the female participants were not significantly different from the actual body weight of the participants, ($t_{(78)}$= -1.21, p = 0.45). However, the ideal BMI of their ideal body is significantly lower than both their actual BMI, ($t_{(78)}$ = 8.24, p<.0001) and their estimated BMI, ($t_{(78)}$ = 9.44, p<.0001).

A significant main effect of condition for male participants was also found, ($F_{(2,78)}$ = 7.60, p<.001). Post-hoc differences of least square means using the Tukey-Kramer correction showed that the BMI of the estimated bodies of the male participant was significantly higher than the actual body weight of the participants, ($t_{(78)}$ = -3.90, p<.0001). However, the ideal BMI of their ideal body is not significantly different from both their actual BMI, ($t_{(78)}$ = -2.10, p = 0.10) or their estimated BMI($t_{(78)}$ = 1.80, p = 0.18).

3.3.2 *General patterns of shape change comparing male and female actual versus estimated versus ideal bodies*

Figure 3A shows a plot of the actual, estimated and ideal body shapes of female observers whilst Figure. 3B shows a plot for the male observers. Comparing between the two, the plots show that WHRs are generally larger for male bodies than for female bodies. Moreover, males appear to prefer a more tubular shape in their lower torso, indexed by a higher WHR, as their ideal. In comparison, females appear to desire a curvier lower torso shape, as indexed by lower WHR values for their ideal. Both genders appear to desire larger circumference chests than waists by about the same proportion in their ideal figures.

A.



B.

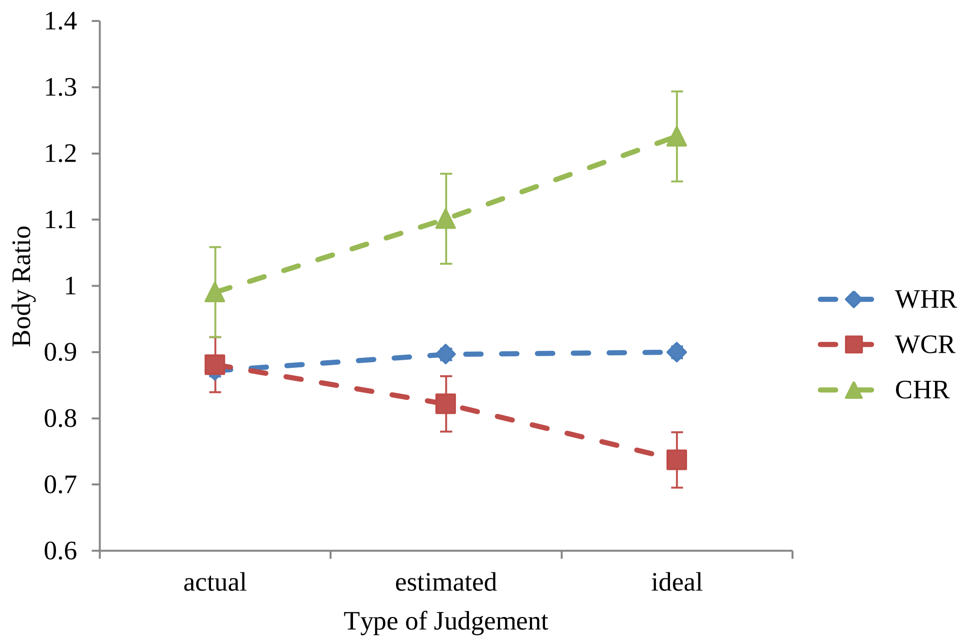


Figure 3. Fig. 3A shows a plot of the average actual, estimated and ideal body shapes for female observers. Fig. 3B shows the equivalent plot for male observers. Both with standard error bars included.

To test whether the settings of the female body shape (WHR, WCR and CHR) by the female participants were significantly different between the actual, estimated and ideal bodies and whether there are interactions between the setting of the body shape a 2 factor repeated measures ANOVA was used, where Factor 1 was the condition and Factor 2 was the shape measures. The results showed that both condition ($F_{(2, 312)} = 5.70$, $p<.0001$) and shape ($F_{(3, 156)} = 157.34$, $p<.0001$) were significant factors and that there was a significant interaction between the two factors ($F_{(6, 312)} = 36.81$, $p<.0001$). To determine differences between individual shape measures in the different conditions post-hoc differences of least square means were calculated using the Tukey-Kramer correction to compensate for multiple statistical tests (detailed in Table 2). The results show significant changes between the actual body and the estimated body in the WCR and CHR, but not the WHR. By comparison, the estimated body differs from the ideal body in the lower part of the torso (the waist and hips) but not the upper part.

Table 2. The post-hoc differences of least square means (using the Tukey-Kramer correction to compensate for multiple statistical tests) to test for differences between the body shape ratios (WCR, WHR and WCR) in the different conditions (i.e. the actual, estimated and ideal bodies) for the female participants' setting of the female bodies (significant results are in bold).

Ratio Analysis	Estimate	St.Estimate	DF	*t*Value	Pr> l t l
Act. WCR vs Est. WCR	0.09	0.02	312	4.94	**<.0001**
Act. WHR vs Est. WHR	0.03	0.02	312	1.67	0.88
Act. CHR vs Est. CHR	-0.08	0.02	312	-4.13	**<.0.001**
Act. WCR vs Ideal WCR	0.17	0.02	312	9.03	**<.0001**
Act. WHR vs Ideal WHR	0.04	0.02	312	1.93	0.744
Act. CHR vs Ideal CHR	-0.20	0.02	312	-10.64	**<.0001**
Est. WCR vs Ideal WCR	0.08	0.02	312	4.09	**<.0001**
Est. WHR vs Ideal WHR	0.00	0.02	312	0.25	1.00
Est. CHR vs Ideal CHR	-0.12	0.02	312	-6.51	**<.0001**

To test whether the settings of the male body shape (WHR, WCR and CHR) were significantly different between the conditions (actual, estimated and ideal body) and whether there were interactions between the setting of the ratios, a 2-factor repeated measures ANOVA was again used, where Factor 1 was the condition and Factor 2 was the shape measures. The results showed that that condition just failed to reach significance ($F_{(2, 97.6)} = 2.76$, $p = 0.07$), but shape was a significant factor ($F_{(3,148)} = 344.16$, $p<.0001$) and that there was a significant interaction between the two factors ($F_{(6, 223)} = 97.77$, $p<.0001$). Post-hoc differences of least square means using the Tukey-Kramer correction showed significant changes between the actual body and the estimated body in the WCR and CHR, but not WHR and AI (i.e. there are differences in the upper body, but not the shape ratios) (Table 3).

Table 3. The post-hoc differences of least square means (using the Tukey-Kramer correction) to test for differences between the body shape ratios (WCR, WHR and WCR) in the different conditions (i.e. the actual, estimated and ideal bodies) for the male participants' setting of the male bodies.

Ratio Analysis	Estimate	St.Estimate	DF	*t*Value	Pr> l t l
Act. WCR vs Est. WCR	0.06	0.01	317	4.80	**<.0001**
Act. WHR vs Est. WHR	-0.02	0.01	317	-2.00	0.69
Act. CHR vs Est. CHR	-0.11	0.01	317	-8.98	**<.0001**
Act. WCR vs Ideal WCR	0.14	0.01	317	11.65	**<.0001**
Act. WHR vs Ideal WHR	-0.03	0.01	317	-2.25	0.52
Act. CHR vs Ideal CHR	-0.24	0.01	317	-19.07	**<.0001**
Est. WCR vs Ideal WCR	0.08	0.01	317	6.85	**<.0001**
Est. WHR vs Ideal WHR	-0.00	0.01	317	-0.25	1.00
Est. CHR vs Ideal CHR	-0.12	0.01	317	-10.09	**<.0001**

3.3.3 *The Non-Linear Co-Variation of Body Mass and Shape*

The analysis suggests that the ideal body size and shape of both the male's and female's ideals differs from the corresponding actual bodies. However, a possible confound is that in real life, body shape and body size tend to co-vary in a non-linear way (i.e. a body with a particular BMI will have a particular shape), with different parts of the body changing size at different rates with changing BMI. This this relationship has previously been illustrated in women's bodies in several studies (Tovée *et al.*, 1999, 2002; Cornelissen *et al.*, 2009b) and this co-variation in male and female bodies can be further illustrated here, by plotting the torso width of a set of 122 young Caucasian men (average age 27.4, SD = 11.9) and 60 young Caucasian women (average age 26.1 years, SD = 6.7) who agreed to be photographed to provide stimuli for a number of studies of physical attractiveness (see Maisey *et al.*, 1999; Tovée *et al.*, 1999; Swami & Tovée, 2005). The widths of 31 slices taken through the torso of 2D frontal images of the participants were obtained, along with their respective BMIs (Figure 4). The location for each slice was standardized across participants by equally dividing the distance between fixed anatomical landmarks (the acromio-clavicular joint and the perineum) into 30 equal partitions. This is illustrated in Figure 4, which shows a plot of the width of the right side of the torso, starting from the midline, for the average male and female body at five different BMI levels.

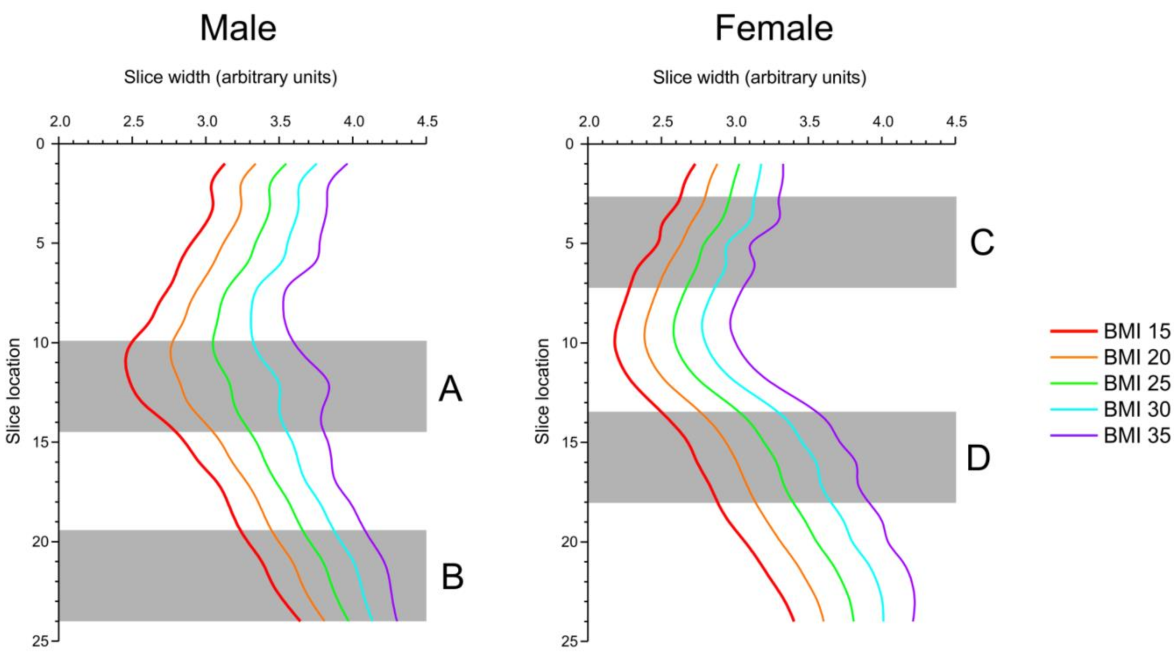


Figure 4. Plots of the width of the right side of the torso, starting from the midline, for the average male and female bodies at five different BMI levels. The plots illustrate that increasing BMI is associated not only with a generalized increase in torso width, reflected by the systematic separation of one profile from the next, but also with a non-linear component to the change in body shape. This non-linear component is illustrated by the male torso outline in sub-regions A (near the waist) and B (the lower hip). In region A, as BMI increases from 15 to 35, the contour of the waist changes from convex to concave and in region B, the slope of the line from lower to higher hip slices becomes less and less steep. There are similar non-linear shape changes in the female torso in sub-regions C (the upper chest) and D (upper hip).

A simple regression can then be used to estimate the relationship between each slice width and BMI. The key feature to appreciate about Figure 4 is that increasing BMI is associated not only with a generalized increase in torso width, reflected by the systematic separation of one profile from the next, but also with a non-linear component to the change in body shape. This non-linear component is illustrated by considering, for example, the male torso outline in sub-regions A (near the waist) and B (the lower hip) in Figure 4. In region A, as BMI increases from 15 to 35, the contour of the waist changes from convex to concave. Over the same BMI range, the slope of the line from lower to higher hip slices becomes less and less steep. Therefore, it is clear that by selecting an ideal body with a different BMI, participants are implicitly selecting a complex change in the shape of the ideal body. There are similar non-linear shape changes in the female torso that can be seen in sub-regions C (the upper chest) and D (upper hip) of Figure 4.

In the current study the question of how different are people’s own ideal body shapes compared to the shape they currently have, as well as the ideal body they would seek in a partner is sought. The complex shape changes illustrated in Figure 4 that occur as a result of changing BMI demonstrate that this question needs to be carefully refined. It could be that when people pick an ideal body shape, what they are really doing is picking a body which for them represents a body with an ideal BMI. Not only is this choice necessarily associated with a change in the width of the body, but also there are additional shape changes caused by the fact that fat is not deposited equally around the body. Therefore, in addition to any width changes represented in the ideal body, there are also non-linear shape changes associated with a change in BMI as illustrated in Figure 4. An alternative possibility, when people are asked to pick an ideal body shape, is that they may choose a shape which goes beyond any changes attributable to a change in BMI alone, including the linear and non-linear components. Therefore, in the analysis that follows, this confounding problem is directly addressed.

Since the BMI of both genders' ideals is different from their actual BMI, what proportion of the change in torso shape of their ideal body is attributable just to the change in BMI alone can be calculated. In other words we can predict the component of shape change in the ideal which is predicted by the BMI of the ideal body shape selected. The difference between the bust/chest, under-bust, waist and hip circumferences of the ideal image and the equivalent circumferences computed can be calculated on the basis of the BMI of the ideal and then demonstrate whether, on average, these are significantly different from zero. If this population of differences is not significantly different from zero, this suggests that the shape of the body that participants choose as their ideal is no different from merely choosing a higher or lower BMI. However, if the population of differences in circumferences *is* significantly different from zero, this means that the shape of the bodies that participants choose as their ideal is different from what they would achieve by merely selecting a higher or lower BMI.

The regression analyses to estimate the BMI shape change effect are based on circumference measures taken from 120 male and 120 female volunteers. The females were measured at bust, under-bust, waist and hips and the males at chest, waist and hips. The average age of the female volunteers was 20.3 years, SD = 3.5 and the average age of the male volunteers was 20.7 years, SD = 2.1. For each gender, the regression between BMI and chest/bust, under bust waist and hip respectively were computed separately, and these regression equations were then used to estimate the expected circumferences in the ideal bodies chosen, based purely on their BMI.

3.3.4 *Are the Circumferences of Ideal Male Bodies different from those Expected from their BMIs?*

Table 4 shows the descriptive statistics for the difference between the circumferences of the 3D model settings for the ideal male body shapes set by both male and female participants and those predicted from the BMI of the ideal models. Both male and female participants set ideal body shapes which have chest circumferences substantially larger than the chest circumference attributable to the lighter BMI ideal set in the section above. Moreover, the commensurate waist and hip circumferences are both substantially smaller than the values predicted on the basis of the ideal BMI that was selected in each case.

Table 4. Summary of the comparison between the ideal male body set by the participants and the body predicted by the BMI. The difference in the slice circumferences from the two bodies are shown along with the standard error in brackets. The DF for the t-test was 39.

Group	Body Slice	Average Difference in Circumference (cm)	*t*-test value	*p* value	r value	Power
Male's ideal male body	Chest	11.04 (0.86)	12.76	**<.0001**	0.90	>.99
	Waist	-12.92 (0.69)	-18.67	**<.0001**	0.95	>.99
	Hips	-9.64 (0.59)	-16.46	**<.0001**	0.93	>.99
Female's ideal male body	Chest	6.93 (0.92)	7.52	**<.0001**	0.77	>.99
	Waist	-10.99 (0.52)	-21.08	**<.0001**	0.96	>.99
	Hips	-7.60 (0.46)	-16.55	**<.0001**	0.94	>.99

To further explore this result, t-tests for each set of circumferences (i.e. chest, waist, hips) for the populations of differences were carried out (Table 4), where the null hypothesis was a mean of zero. All are statistically significant at $p < .05$, even after applying a Bonferroni correction for multiple comparisons.

3.3.5 *Are there Differences in the Circumferences of the Ideal Male Bodies set by the Male and Female Participants?*

The results from the t-tests show that the average shape of the ideal female bodies set by male and female participants differs significantly from the shape that would be predicted based solely on the BMI of the ideals. Next, whether the shapes of these ideals differed when comparing the settings made by male versus female participants was tested. To address this question, a 2 factor repeated-measures GLMM, was conducted where Factor 1 was the gender of the participant (male, female) and Factor 2 was the circumference (chest, waist and hip). There was no main effect of gender ($F_{(1, 234)}$ = 0.01, p = .94). The main effect of circumference was significant ($F_{(2, 234)}$ = 523.42, p <.0001) as was the interaction between gender and circumference ($F_{(2, 234)}$ = 12.78, p <.0001). To determine which individual ideal shape measures differed between male and female participants, post-hoc differences of least square means were calculated using the Tukey-Kramer correction to compensate for multiple statistical comparisons. The difference between male and female settings of chest circumference was statistically significant (p < .0001), whereas the differences for waist and hip were not.

3.3.6 *Is the Ideal Male Body Different in Size and Shape for the Male and Female Participants?*

An independent *t*-test showed that the ideal male BMI set by the female participants was not significantly different from that set by the male participants ($t_{(78)}$ = 1.81, p = 0.07; effect size r = 0.20; power to detect at two-sided alpha of 0.05 = 0.44). The WHR of the two bodies were also not significantly different ($t_{(78)}$ = 1.43, p = 0.23; effect size r = 0.16; power to detect at two-sided alpha of 0.05 = 0.20), but WCR was significantly different ($t_{(78)}$ = -3.09, p<.001; effect size r = 0.33; power to detect at two-sided alpha of 0.05 = 0.67).

3.3.7 *Are the Circumferences of Ideal Female Bodies different from those Expected from their BMIs?*

Table 5 shows the descriptive statistics for the difference between the circumferences of the 3D model settings for the ideal female body shapes set by both male and female participants and those predicted from the BMI of the ideal models. Both male and female participants set ideal body shapes which had bust circumferences substantially larger than the bust circumference attributable to the lighter BMI ideal set above. Moreover, the commensurate under-bust, waist and hip circumferences were substantially smaller than the values predicted on the basis of the ideal BMI that was selected in each case.

Table 5. Summary of the comparison between the ideal female body set by the participants and the body predicted by the BMI. The difference in the slice circumferences from the two bodies are shown along with the standard error in brackets. The DF for the t-test was 39.

Group	Body Slice	Average Difference in Circumference (cm)	*t*-test value	*p* value	r value	Power
Female's ideal Female body	Bust	10.78 (2.97)	3.62	**<.0001**	0.50	>.94
	Under Bust	-3.73 (0.60)	-6.19	**<.0001**	0.70	>.99
	Waist	-6.43 (0.47)	-13.68	**<.0001**	0.91	>.99
	Hips	-0.63 (0.77)	-0.81	0.42	0.13	.12
Male's ideal Female body	Bust	6.88 (0.81)	8.46	**<.0001**	0.80	>.99
	Under Bust	-2.81 (0.81)	-3.48	**<.0001**	0.50	.92
	Waist	-5.53 (0.48)	-11.56	**<.0001**	0.88	>.99
	Hips	-3.64 (0.57)	-6.40	**<.0001**	0.72	>.92

T-tests of location for the populations of differences, where the null hypothesis was a mean of zero, are all statistically significant at $p < .05$, even after applying a Bonferroni correction for multiple comparisons, with the exception of female settings for the hip circumference.

3.3.8 *Are there Differences in the Circumferences of the Ideal Female bodies set by the Male and Female Participants?*

The results from the *t*-tests show that the average shape of the ideal female bodies set by male and female participants differs significantly from the shape that would be predicted based solely on the BMI of the ideals. Next, to test whether these ideal body shapes differ when comparing the settings made by male versus female participants, a 2-factor repeated measures GLMM was conducted, where Factor 1 was the gender of the participant (male, female) and Factor 2 was the circumference (bust, under-bust, waist and hip). There was no main effect of gender ($F_{1, 78} = 1.67$, $p = .201$). The main effect of circumference was significant ($F_{3, 234} = 63.68$, $p<.0001$), but there was no significant interaction between gender and circumference ($F_{3, 234} = 2.43$, $p=.066$).

3.3.9 *Is the Ideal Female Body Different in Size and Shape for the Male and Female Participants?*

An independent t-test showed that the ideal female BMI set by the female participants was not significantly different from the ideal female BMI set by the male participants ($t_{(78)}$= 0.09, p = 0.93; effect size r = 0.01; power to detect at two-sided alpha of 0.05 = 0.05). The WBR of the two bodies were also not significantly different ($t_{(78)}$ = -3.64, p < .001; effect size r = 0.38; power to detect at two-sided alpha of 0.05 = 0.91), but WHR was significantly different ($t_{(78)}$ = -3.64, p < .001; effect size r = 0.38; power to detect at two-sided alpha of 0.05 = 0.91).

3.4 Discussion

3.4.1 *How accurate are people in estimating their own body size and shape?*

The interactive body software used in the current chapter, overcomes the problem of the limited number of body sizes and shapes that can be shown to observers in attractiveness experiments. Instead, the observers can set the body size and shape they most prefer, without the restriction of a limited number of options. It also allows the measurement of the participant's "body image" (i.e. their own view of their body size and shape); by asking them to estimate their own body size and shape, which may be significantly different from their actual body. For female bodies, the results suggest that the female participants are reasonably accurate in judging their own body size (as measured by BMI) although on average they do tend to over-estimate their size by approximately one BMI point. This is consistent with a previous 2D morphing study, which using a simpler morphing technique, asked women to estimate their own body size and shape (Tovée *et al.*, 2003). A significant difference was found between the estimated and the actual female bodies in an over-estimation of bust size, but this is consistent with a number of studies which suggest that most women are actually quite poor at accurately judging their own bust size, as indexed by the fact that over 80% are wearing incorrectly sized bras (Wells, 2007, 2008). The rest of the estimated body circumferences are broadly consistent with their actual body circumferences, although there is a narrowing of the waist. The differences in the shape measures (WCR and CHR) are mainly linked to the difference in bust size, which increases the degree of upper body curvature.

The male participants over-estimate their chest size and to a lesser extent their waist size. This gives them a slightly curvier upper body (closer to the v-shape) and a higher BMI than their actual BMI. This suggests that the male participants are slightly worse at judging their body size and shape than the female participants. This may be linked to the potentially lower importance of their own physical attractiveness for men in mate selection. Traditionally, men's mate value has been linked to their wealth and social status, rather than beauty or youth (Fan *et al.*, 2005). Thus men may be less attuned to their own physical appearance than women.

3.4.2 *What is the Ideal Female Body size and shape?*

Both male and female participants created an ideal body that was significantly different in body size relative to their own. The female participants significantly reduced the body size and the male participants increased it. Although some studies have suggested BMI is the primary predictor of female attractiveness and that shape is of marginal importance (e.g. Fan *et al.*, 2004; Smith *et al.*, 2007; Tovée *et al.*, 1999, 2002), this study suggests that body shape is a significant factor, at least with respect to the perception and creation of ideals. Shape and body mass co-vary (e.g. Cornelissen *et al.*, 2009b; Tovée *et al.*, 2002; Wells, 2007, 2008), but by controlling for the expected changes which occur with changing BMI, both male and female participants are shown to nevertheless produce ideals with a specific shape which is independent of the ideal's BMI.

The female participants' ideal female body has a BMI which is significantly lower than their actual BMI. Consistent with this lowered BMI, there is a general narrowing of the torso, with the hips, waist and chest (excluding the bust) reducing in circumference (i.e. the volume of the body is reduced). The actual BMI values of the female participants all fall within the normal BMI range (18.5-24.9), with the majority around the middle part of this scale (Organisation, 1995, 2000). While their ideal female body is also just within the normal range, it is only just above the underweight category. However, this is consistent with previous studies in which photographs of women's bodies have been rated for attractiveness which have suggested an ideal BMI of as low as 18-20 for Western male and female observers, (Tovée *et al.*, 1998, 1999). Only 1 of the 40 female participants wanted an ideal BMI above their actual BMI. This low ideal BMI is similar to the BMI reported for female models appearing in the media (Tovée *et al.*, 1997; Voracek & Fisher, 2002), a result consistent with the hypothesis that low BMI women in the media influence body size preferences (Andersen & Didomenico, 1992; Field *et al.*, 2005; Grabe *et al.*, 2008; Spettigue & Henderson, 2004; Stice *et al.*, 2001) and contributes to the high proportion of women who show dieting and weight loss behaviours even though they have a normal BMI (Andersen & Didomenico, 1992; Gruber *et al.*, 2001; Malinauskas *et al.*, 2006). The participants in the current experiment are university students and are therefore a relatively young group who may be more sensitive to media influence on body ideals than older people (e.g. Stice & Shaw, 1994; Yamamiya *et al.*, 2005). However in previous attractiveness studies which have used participants with wide age ranges, differences in their ideal size and shape have not been found (Fisher & Voracek, 2006) suggesting the findings in the current study are representative of the general population.

In contrast to the narrowing of the rest of the female body, the "ideal" bust increases in size (as indexed by bust circumference). Previous studies have linked relative bust size to circulating estrogen levels, with the suggestion that a large bust and a narrow waist should indicate high levels of estrogen and therefore be regarded as attractive (Willet, 1995). A number of studies have suggested that female bodies with a larger bust are considered to be more attractive (Prantl & Gruendl, 2011; Surgeons, 2010) and breast augmentation is the most common cosmetic surgical procedure in the UK and US (Cafri *et al.*, 2005). The large bust and low BMI set by both the male and female participants also reflects the size and shape of glamour models in men's magazines which are often taken as a proxy for a cultural ideal of female beauty, (Tovée *et al*., 1997; Voracek & Fisher, 2002).

The increase in bust size and narrowing of the torso between the female participants' actual body and their ideal changes the upper body shape (as indexed by WCR and illustrated in figure 3). The female participants also narrow their hips as well as their waist, but because there is a relatively greater narrowing of the waist, the lower torso also increases in curvature (as indexed by WHR). There is less change in the WHR than in WCR, but this may be because the WHR of the participants' actual body is already quite close to a value of 0.7 which has been suggested to be optimal for health and fertility and thus also for attractiveness, (Singh, 1993; Streeter & McBurney, 2003).

3.4.3 *What is the Ideal Male Body size and shape?*

Unlike the female thin ideal body, the ideal male body is comparatively heavy, falling at the boundary of the normal to overweight categories of the BMI scale. However, these are not bodies that look over-weight, but instead are big and muscular. In fact, the current calculation of their BMI is probably an under estimation, because the study assumes that the bodies have the average density for young men (i.e. the average balance of fat to muscle). As muscle is approximately 20% denser than fat, this would under-estimate the mass of a more muscular body such as the male ideals set in this experiment. This result is consistent with previous studies, which have suggested that muscularity (and the associated perception of dominance and strength) is the primary determinant of male attractiveness, (Honekopp *et al.*, 2007; Maisey *et al.*, 1999; Sell *et al.*, 2009). Whereas there is a tendency for women to diet to achieve their ideal body, young men are more likely to be influenced by magazines to build up a bigger, more muscular body, (Cafri *et al.*, 2005; Frederick *et al.*, 2005). So although the male ideal body is heavier, the additional weight is muscle rather than fat. As discussed above, BMI is a measure of body weight scaled for height and not a direct measure of percentage body fat. Its use in epidemiological studies is due to its ease of administration. The ideal male body set by both male and female participants is lean with high muscle definition (which requires a percentage body fat below 9-12%). The current participants' male ideal is both muscular and low in body fat.

The male participant's ideal body shows an increase in chest circumference (relative to their actual body) and a reduction in the waist and hips to produce a V-shaped upper body. Previous studies have also suggested that men prefer a body that is more muscular than the one they actually possess, (Frederick *et al.*, 2005; Lynch & Zellner, 1999; Olivardia, 2004; Pope, 2000). It is suggested that a v-shaped upper body is a key predictor of male attractiveness judgements because this indicates upper body strength, (Frederick *et al.*, 2005; Frederick and Haselton, 2007; Honekopp *et al.*, 2007; Maisey *et al.*, 1999; Sell *et al.*, 2009). By contrast, the ideal lower body is narrowed relative to the actual body making it less curvy and more straight-up and down. This is the opposite of what is found for the ideal female bodies.

3.4.4 *Do Men and Women Share Body Ideals?*

The preferences for the ideal female body are broadly similar between the two genders. They both prefer the same low BMI and a relatively curvaceous body with WCR and WHR with values around 0.7. There is also general agreement between the genders on the ideal male body; this male ideal has a relatively large body with a V-shape upper torso and a narrow waist and hips. This is consistent with attractiveness rating studies which to show a strong correlation between male and female attractiveness ratings of male and female bodies (i.e. both genders seem to rate bodies of both genders the same way), (Maisey *et al.*, 1999; Tovée *et al.*, 1999, 2002; Swami & Tovée, 2005). This can be explained by mate selection theory which suggests that individuals will not only be able to judge the attractiveness of members of the opposite sex, but will also know their own attractiveness relative to other members of the same sex (i.e. their competitors), (Buss, 2003). This information allows an individual to concentrate on potential partners of the same attractiveness as themselves, thus avoiding both unsuccessful courtship of a more attractive partner (potentially wasteful in time and resources) and accepting a less attractive partner (with a potentially negative impact on future reproductive success). Thus an individual must be able to assess bodies of their own gender using the same attractiveness criteria as the opposite sex, and by extension, must therefore have a good idea of the opposite gender's ideal partner. So the female and male participants here should share the same ideals for both male and female bodies.

An alternative explanation would be that the ideals are influenced by a common media environment which pushes them towards the same concept of the ideal body. However, there are subtle gender-specific differences in the media images seen in the magazines targeted at men and women. For the male body, magazines aimed at a male audience contain male models which are more muscular than those aimed at a female audience, (Cafri *et al.*, 2005; Frederick *et al.*, 2005). For the female body, female models in women's magazines are slimmer and have a smaller bust than female models in men's magazines, (Tovée *et al*., 1997; Voracek & Fisher, 2002). This would suggest that there should be systematic differences between the ideals favoured by the two genders.

This is partially what is found here. The male body selected by the male participants is indeed more muscular than the ideal male body chosen by the female participants. However, in the case of the ideal female body both men and women prefer a female body with the same low BMI, but the female participants prefer a larger bust size than the male participants. This directly contradicts what would be expected from the size and shape of the female models in their respective gender-specific media; the men should prefer a heavier female body than the women and a larger bust.

Previous studies have focussed on body size in women's bodies. These suggest that although women overestimate the level of female thinness desired by men (e.g. Cohn, 1992; Fallon & Rozin, 1985; Jacobi and Cash, 1994; Rozin & Fallon, 1988), when asked to simply rate images without reference to what they think men would find most attractive, women and men have the same ideal BMI for female attractiveness, (Fan *et al.*, 2004; Smith *et al.*, 2007; Swami and Tovee, 2005; Tovée *et al.*, 1999; Tovee & Cornelissen, 2001). This study asked the female participants what they thought was the ideal body size and shape, and if it had asked them to choose what they thought a man would choose, it might have got a difference between this body and the male judgement of female ideal body size.

That still leaves the question of why the difference exists in male and female preferences for upper body shape; female participants prefer a larger bust in their ideal female body than men, and male participants prefer a larger chest in their ideal male body than women. This may be linked to within gender competition for status and prestige, (Cohn, 1992; Frederick *et al.*, 2005). Many forms of prestige and status competition are between members of the same gender. Such a competition could produce a runaway process in which a physical feature becomes increasingly exaggerated over time due to competition between same-gender individuals. As this is a within gender competition the possibility exists that these processes will lead to divergence between preferences of the two genders for a specific feature, such as muscularity in men or bust size in women, (Frederick *et al.*, 2005; Frederick and Haselton, 2007; Sell *et al.*, 2009).

An alternative socio-cultural explanation would emphasise how a culture-specific female ideal body size and shape potentially exerts a particularly strong influence on women's concept of what they should aspire to, (Cash, 2003; Markey, 2004). This ideal, which is impossible for most women to achieve, is suggested to lead to body dissatisfaction and potentially in some cases to eating disorders, (Cash, 2003; Thompson & Stice, 2001). Women who do not conform to this ideal are more likely to receive negative comments and discrimination (Puhl & Heuer, 2009; Swami *et al.*, 2010), which serves to condition the importance of physical appearance as part of their estimation of self-worth, (Grover *et al.*, 2003; Markey & Markey, 2006). In this context, the importance of physical appearance is potentially clearest to young women (such as our participants) who are more likely to be actively involved in the mate selection process. This reinforcement of the perfect female ideal could potentially lead to an exaggeration of the internal representation of some of the ideal physical features (Bergstrom *et al.*, 2004; Markey *et al.*, 2004; Markey & Markey, 2006), such as bust size in our female participants relative to the males. A similar process may also explain the exaggeration of the upper body musculature of the male ideals by the male participants. The propagation of the highly musculature male ideal through gender specific magazines (Cafri *et al.*, 2005; Frederick *et al.*, 2005) and its reinforcement in young men by experience of mate competition with other men (Buss, 1989), may promote an exaggerated idea of the ideal male body shape.

3.4.5 *Limitations*

As stated in Chapter 2, the changes participants made to the computerised bodies were a result of the artistic impression of what the morph ++ software thinks the body should look like. Therefore they may not represent a change that is realistic in real bodies, limiting the generalisability of the results.

Furthermore, the method of using fat/thin bodies to reduce anchoring effects may be argued to lack reliability. The study wanted to choose bodies from both ends of the BMI spectrum as it was important that they were sufficiently thin/heavy to make the participant want to change their size and shape. However, the size of the bodies was constrained by two factors. Firstly, the bodies that were produced had to look realistic. Thus, the body size was limited by the quality of the body fat simulation at the upper and lower BMI ranges. The Daz morphs for Victoria 4 were better at simulating a body with a convincing low weight than a higher weight. As a result, the size of the lower weight body was on the border of the underweight/emaciated BMI range whereas the size of the upper weight body was only in the overweight range. The Daz morphs for Michael 4 were better at simulating higher body weights, so the higher weight male body was in the obese range.

Secondly, as discussed in this chapter, previous studies had suggested that female ideal body size was likely to be low (on the border of the underweight/normal weight range), whereas the male ideal body size was likely to be larger (reflecting a preference for a greater muscle mass). Thus, it was important that the low BMI female body and the high BMI male body was sufficiently different from where the ideal BMI value might fall to require the participant to engage with the program to change its body size, and not simply regard it as close enough to their ideal to be accepted with minimal change.

It is of course possible, that the position of the high and low weight bodies may have influenced the position of the body size generated by the participants however, and future work should aim to address this possible artefact.

In addition, exposing participants to 94 sliders could be argued as overwhelming, making the task at hand more complex. Newer versions of the morphing software now allow certain sliders to be “frozen” allowing for more “minor” sliders (as previously mentioned) to be restricted which would help to simplify the task, producing more concise results.

3.4.6 *Conclusion*

The combination of the 3D morphing software and the regression analysis shows that the ideals for both genders have a specific body size (as indexed by BMI) and shape. For both sexes, the primary predictor of female beauty is a relatively low BMI combined with a relatively curvaceous body, whereas the features important for the male ideal are a slightly heavier, muscled body with a specific V-shaped upper body. Although, the results suggest a largely consistent preference for an ideal male and female body size and shape across both genders, but with subtle differences based on an own gender exaggeration of upper body shape.

Chapter 4: Investigating the effects of the Leg-Body Ratio (LBR) on Attractiveness and Health Judgements.

4.1 Introduction

Whilst BMI and WHR have been repeatedly mentioned as two of the most important predictors of attractiveness judgements, a growing body of research has begun to focus on what other traits are perceived to be attractive and their relative importance.

Recent research has chosen to focus on the human legs as a predictor of physical attractiveness, with a specific interest in the leg-to-body ratio (LBR) (Swami *et al.*, 2006, 2007; Sorokowski and Pawlowski, 2008). The LBR is often measured as the ratio of a person's leg length relative to their torso length, including their head (Swami *et al.*, 2006) and until recently, the LBR had primarily been used in the research of childhood nutrition and growth (Gunnell *et al.*, 2003; Schooling *et al.*, 2008). It has been acknowledged for some time that some environmental pressures, for example, nutritional deficiency during childhood and adolescence, can have a negative effect on adult leg length, with poor nutrition leading to the development of a relatively long torso and shorter legs (Leitch, 1951). This long torso compared with shorter legs has therefore been associated with outcomes such as lower fertility and reduced biomechanical efficiency (Swami *et al.*, 2006; Fielding *et al.*, 2008; Sorokowski and Pawlowski, 2008). Therefore the LBR is thought to play a role in attractiveness judgements due to the possibility that the trait is a cue of health status, as it has been suggested leg length may be a very sensitive cue to the ability to withstand environmental stress (Gunnell *et al.*, 1998).

In addition, in adolescent females, menarche marks the point when the epiphysis fuses with the metaphysic and this ends long bone growth (Sinclair & Dangerfield, 1998). This means that at the point of menarche, a female will display longer legs relative to her torso. When investigating physical attractiveness, researchers have found this relationship between legs and torso to be attractive in females (Swami *et al.*, 2006, 2007). Furthermore, they found no effect of participant gender on the ratings of attractiveness. With menarche also marking the point of sexual maturity, this poses links with youth and fertility.

Evolutionary psychology provides an explanation for the findings of longer legs acting as a reliable cue to health and fertility status in a potential mate. As mentioned above, they appear to indicate better childhood nutrition (Leitch, 1951). In addition, shorter legs have also been associated with many adverse health problems including a high risk of cardiovascular disease (Gunnell *et al.*, 2004), type II diabetes and insulin resistance (Lawlor *et al.*, 2002) and an increased risk of certain types of cancer (Gunnell *et al.*, 2003). With longer legs potentially providing a signal for better health and therefore indicating a good set of genes, the potential partner should find the individual with such a trait, as more attractive as a possible mate.

For males, overall height appears to play a key role in aesthetic judgements with many studies reporting that females prefer taller men (Kurzban and Weeden, 2005). Height also appears to be an important physical characteristic specified by women seeking males in lonely hearts advertisements (Jackson and Ervin, 1992; Pawlowski and Koziel, 2002). Others have found that taller men have more reproductive success than males of an average height (Mueller and Mazur, 2001; Nettle, 2002a). Evolutionary psychology explains these findings by accrediting taller men with having 'good genes' displayed by their elevated reproductive success. Male height has been found to be positively correlated with several attributes which provide evidence that male tallness is an indicator of 'good genes', for example, cognitive abilities (Case and Paxson, 2008), success and income (Judge and Cable, 2004), and physical health (Silventoinen *et al.*, 1999). Although male height appears to be important for females with respect to mate choice, Swami *et al.*, (2008) point out that the current research still does not clearly show the exact degree of importance that height plays in relation to other possible factors in the role of physical attractiveness.

Social psychologists however, offer an alternative explanation to these results suggesting that LBR preferences are a culture-bound phenomenon specific to Western influences. More specifically: exposure to media images, for example, of women with longer legs relative to their torsos, are instilled with positive qualities (Morris, 1987). Swam, Einon and Furnham (2007) support such a concept in their cross-cultural study that asked 54 rural Malaysians and 80 Britons to rate line drawings varying in five levels of LBR. They found that British participants rated higher LBRs as more attractive than Malaysian participants, attributing such findings to the British participants being more exposed to longer-legged women in the mass media that are characterised positively in such sources. This is further supported by Western fashion and runaway models that are, on average, 11cm taller than normal women (Tovée *et al*., 1997).

By contrast, female legs have not been depicted in a similarly erotic manner in more traditional cultures such as where the rural Malaysian participants were recruited from. Such cultures often associate positive qualities with modesty and self-effacement, supported by that fact that female costumes from such cultures often obscure the legs which therefore helps to explain why there does not appear to be a strong preference for female LRB (Swami *et al*., 2007). This is further supported by the finding that as exposure to Western media increased in the rural Malaysian sample, participants perceived female stimuli with higher LBRs as more attractive and those with lower LBRs as less attractive (Swami *et al*., 2007).

In addition, psychologists theorise that people have come to associate a higher LBR with femininity and a lower LBR with masculinity (Swami *et al.*, 2006). A widespread norm encourages males to express masculinity and dominance for example, and height communicates these features as taller males are perceived as being more powerful and assertive (Melamed, 1992). Consequently, this leads to why male preference for female mates generally leads to females being shorter. Boyson (1999) found that when a female was shown to be taller than a male, participants perceived her as being more dominant which violates the typical gender norm that men should be more dominant and suggesting why males predominantly choose mates shorter then themselves.

Furthermore, Nettle (2002b) found that in western cultures, taller females have less reproductive success than females below average height, but better then very short females. This suggests that shorter females have an advantage in reproductive success due to the taller-male norm in western relationships, leading to taller females having a limited pool of potential partners. Therefore, in contrast to the evolutionary benefits of height indicating reproductive success in males, it can be said that there is no advantage for females being taller (Nettle, 2002b). Height can therefore be said to be of less importance to the physical attractiveness judgements of males.

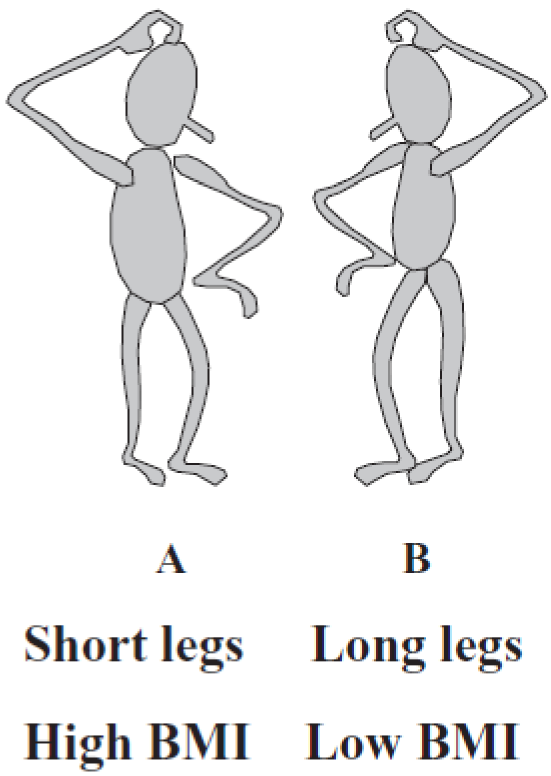


Figure 1. Schematic figure illustrating the effect of LBR on BMI values (from Deurenberg *et al*., 2002).

An alternative explanation for the LBR being correlated with attractiveness focusses not on relative leg length as a measure of childhood nutrition and health status, but on its correlation with BMI. BMI has been shown to be a strong predictor of attractiveness and health judgements, particularly for female bodies (e.g. Tovée *et al*., 1999, 2002, 2006; Swami *et al*., 2006, 2007) but also male bodies (e.g. Maisey *et al*., 1999; Swami & Tovée, 2005b). So it is possible that LBR has been linked to attractiveness because it is a cue to BMI rather than a cue to developmental stability. Additionally, LBR may be a cue to the age of the female body. Growth in the long bones ceases after the first menses, but the growth of the torso does not end until the late teens. Thus, a younger teenager will have a higher LBR than an older teenager or adult. As fertility is closely linked to age, people's estimate of age should therefore be a significant influence on attractiveness judgements.

4.1.1 ***Stimulus Validity***

Many of the previous studies investigating the role of the LBR have been criticised for their stimuli lacking ecological validity. For example, a key paper published from

Swami *et al.*, (2006) has been criticised for the stimuli not being based on anthropometric data and also for the lack of control over features such as arm length and the groin region (Sorokowski and Pawlowski, 2008). However, after modifying the stimuli used by Swami *et al.*, (2006), Sorokowski and Pawlowski (2008) have also been criticised for their findings lacking ecological validity. Recent research into the influence of LBR on judgements of physical attractiveness has attempted to improve on these methodological constraints by using computer-generated images (Frederick *et al.*, 2010). Their stimuli consisted of female images with eight varying levels of LBR. Consistent with previous findings, they found that lower LBR's were not preferred. Men tended to rate the females with mid-ranging LBR's as most attractive, whilst the female participants tended to perceive that males would find higher LBR's more attractive. The authors argue that their images have been significantly improved from the stimuli used for traditional silhouette studies. However, the research was conducted using only images of female bodies and only investigated the judgements of physical attractiveness.

The current body of research therefore sought to replicate and extend previous work into the influence of the LBR on judgements of attractiveness. Similar to Frederick *et al.*, (2010), life-like computer generated images were used to create the image set, however, both male and female images were used for the judgements to be based upon. Furthermore, along with attractiveness and health, judgements on age and body fat were also investigated.

In addition, to assess the question of whether the LBR would actually play a role in judgements of real bodies rather than artificial bodies where they have arguably been positioned to be maximally effective, the data taken from previous studies that have used photographs of real male and female bodies was reanalysed. By adding the LBR as an explanatory variable, it is possible to assess its relationship with attractiveness judgements and its relative strength as a predictor.

Swami *et al.*, (2006) highlight that current research has used various and inconsistent definitions of the LBR. For instance, they used the measure of leg length as distance from the floor to the hip whereas other authors such as Smith *et al.*, (2007) have measured leg length from the perineum to the ankle. Furthermore, others have argued that the torso length should not include the head and have instead the torso measurement to the collar bone region, eliminating the head (e.g. Smith *et al*., 2007).

Other researchers have used the leg length divided by the total body height (e.g. Frederick *et al*., 2009; Bogin *et al*., 2010). It should therefore be noted that the current study uses total leg length divided by torso length (Swami *et al.*, 2006, 2007).

4.2 Height Constant study (Control Study)

A control study was run with overall height held constant, to replicate the findings of Swami (2006; 2007) and Sorokowski and Pawlowski (2008). The hypothesis for the current study was therefore that the higher the LBR of the images, the more attractive they would be perceived to be due to the positive association high LBRs have with stable development.

4.2.1 *Participants*

Participants were primarily recruited via the Psychology school's participation scheme at Newcastle University. Here, advertisements for research studies are uploaded onto the school's database which students can access and respond to. The study was also advertised on social media sites such as Facebook.

Due to the experiment being run via an online survey, participants were at their own leisure to complete either or both surveys, (a separate web link was made for male and female images). This also meant participants were in an environment where no experimenter was present and so were under no obligation to fully complete the experiment. As a result, each of the four conditions in this experiment contained uneven participant numbers due to incomplete data sets having to be removed. Therefore for Attractiveness, Health and Age judgements 171 female participants rated female images (average age = 21.1, SD = 6.3) and 193 rated male images (average age = 21.2, SD = 5.9). For Weight judgements, 173 female participants rated female images (average age = 19.9, SD = 2.7) and 142 rated male images, (average age = 19.3, SD = 2.0). Again for Attractiveness, Health and Age judgements, 67 male participants rated female images, (average age = 23.9, SD = 13.8 and 55 rated male images, (average age = 25.6, SD 16.1). For Weight judgements, 38 male participants rated female images, (average age = 19.7, SD = 3.9) and 38 rated male images (average age = 20.2, SD = 4.1).

4.2.2 *Stimulus*

The image set used contained 10 images varying in leg length that increased in stages of 1 percent from a base image of “torso 0, leg 0" whilst the torso length decreased by the same number. 10 image’s torso length then increased by 1 percent from the base image each time whilst the leg length decreased by the same number. This created 21 male and 21 female images in total. An example of the female and male images used can be seen in Figures 1 and 2.

Figure 2. An example of the female figures used in the online questionnaire. The figure on the far left had a leg length +10% of the base image and a torso length -10%, the middle figure was the base image with a torso and leg length of 0 and the right figure had a leg length of -10% of the base image and a torso length +10%. Height remained constant at 28.68 cms.

Figure 3. An example of the male images used in the online questionnaire. The image on the left has a leg length +10% of the base image and a torso length -10%, the middle image is the base image with a leg and torso length of 0 and the right image has a leg length of -10% of the base image and a torso length +10%. The height was held constant at 28.05cms.

4.2.3 ***Protocol***

The experiment was run using the online system; Qualtrics.com. Two experiments were created to show the images varied in leg length and torso length but overall height was kept constant. The first experiment contained only female images; http://nclpsych.qualtrics.com/SE/?SID=SV_6QA2SoqMdrK7w7q and the second only male images; http://nclpsych.qualtrics.com/SE/?SID=SV_8ctQ95beFPdOPsw.

Participants were firstly shown an information screen describing the study and what was required of them before being asked to fill out their demographic information (see Appendix E). The computerised images were then presented on the screen individually with the four questions underneath: How attractive do you think this body is? How healthy do you think this body is? How heavy do you think this body is? How old do you think this body is? Each question had a slider scale whereby participants were required to move the slider from 0-100% to indicate their response, (0 = low, 100 = high), (see Figure 4). Participants had to respond to each of the four questions before the program allowed them to continue to the next image, however they could end the experiment prematurely by closing down the screen altogether leaving their data set incomplete.

Once participants had fully completed the experiment, a screen was shown thanking participants for their responses. 24 slides were therefore viewed in total.

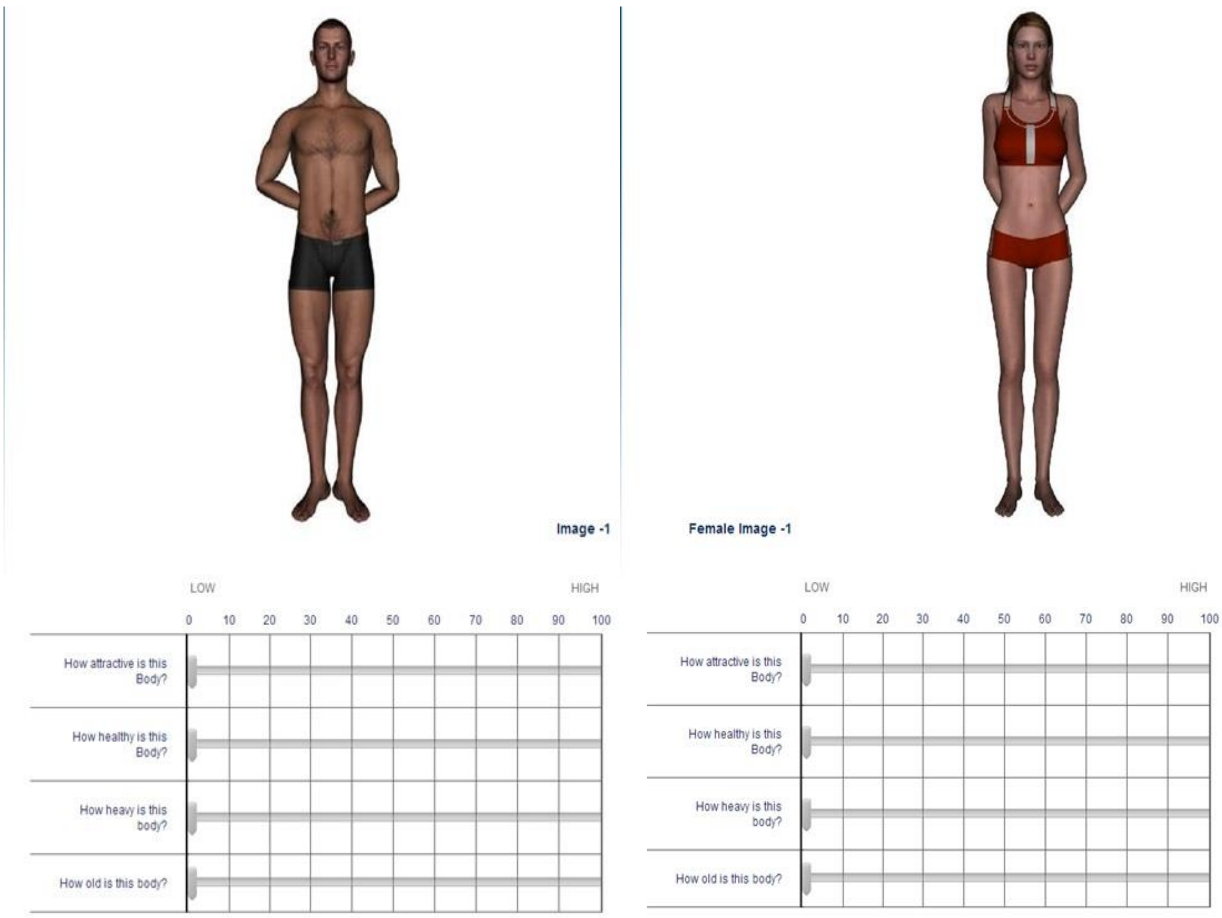


Figure 4. An example of the online questionnaire participants undertook.

4.2.4 *Data Analysis*

The absolute measurements of the bodies were measured in Photoshop in centimetres, recording the y-coordinate of the top of the head, shoulder, crotch and foot of every image. From this, the leg length and torso length were calculated and recorded. Due to the fact that, independently, only the leg length and the torso length without the head measurement was manipulated, the following analysis only included the torso length measured from the collar bone to the perineum (Figure 5). The LBR was calculated by dividing the leg length measurement by the torso. The LBR was also calculated using the head as well as torso, but as the results were not qualitatively different only the analysis with the first condition are reported here.

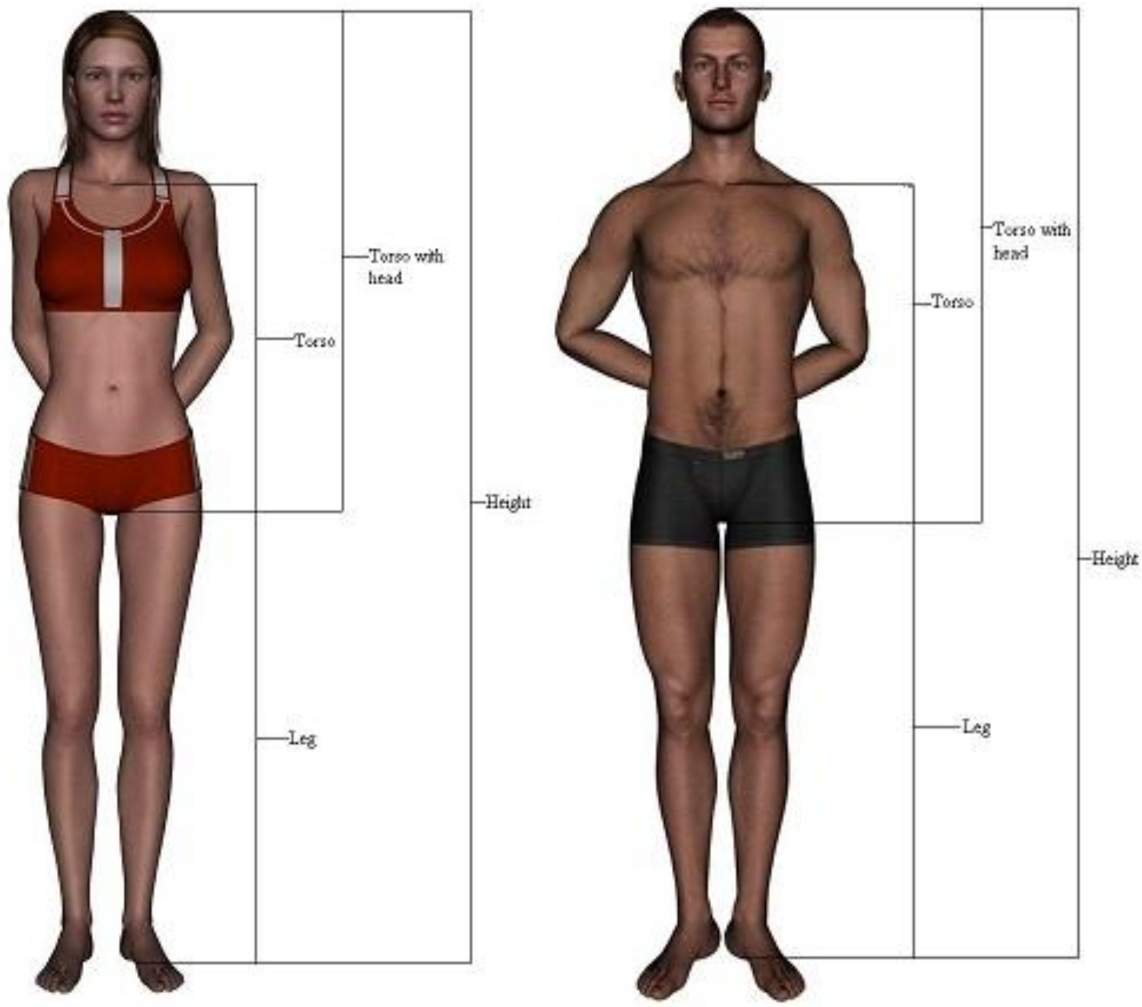


Figure 5. An example of the points each image was measured at.

4.2.5 *Results*

To test the inter-rater reliability of the data, a Cronbach's Alpha (α) was performed testing to what extent people within a particular group are rating in the same way, to ensure that combining male and female ratings into one group retained intra class homogeneity.

For Attractiveness judgments, an α value of .97 was found for female images for the combined male and female raters and an α value of .95 was found for male images suggesting uniformity in performance between male and female participants.

For Health judgements, an α value of .97 was found for female images for the combined male and female raters and an α value of .97 was found for male images suggesting uniformity in performance between male and female participants.

For Weight judgements, an α value of .99 was found for female images for the combined male and female raters and an α value of .97 was found for male images suggesting uniformity in performance between male and female participants.

For Age judgements, an α value of .97 was found for female images for the combined male and female raters and an α value of .97 was found for male images suggesting uniformity in performance between male and female participants.

Therefore, male and female participant data was combined for the remaining analysis to strengthen the reliability of the overall findings.

4.2.6 *Female Images*

To test the relative importance of the LBR in attractiveness judgements, a Pearson's correlation between the participant's ratings of the four judgements and the female image's LBR was conducted.

Table 1. A correlation between the four judgements and the female image's LBR.

	LBR
Attractiveness	**0.47***
Sig. (2-tailed)	0.03
Health	0.05
Sig. (2-tailed)	0.85
Weight	**0.90****
Sig. (2-tailed)	0.001
Age	**-0.89****
Sig. (2-tailed)	0.001

As shown from Table 1 all the body indices measured can be shown to significantly correlate with all the judgements made with the exception of health judgements.

Table 2. Pearson's correlation between the four behavioural judgements.

	Health	Weight	Age
Attractiveness	**0.84****	**0.51****	**-0.76****
Sig. (2-tailed)	0.001	0.001	0.001
Health		0.00	-0.39
Sig. (2-tailed)		0.99	0.08
Weight			**-0.86****
Sig. (2-tailed)			0.001

Table 2 shows that all the behavioural ratings significantly correlated with each other, with the exception of health with weight and age. The strongest correlations are between attractiveness and health, and an inverse correlation between weight and age.

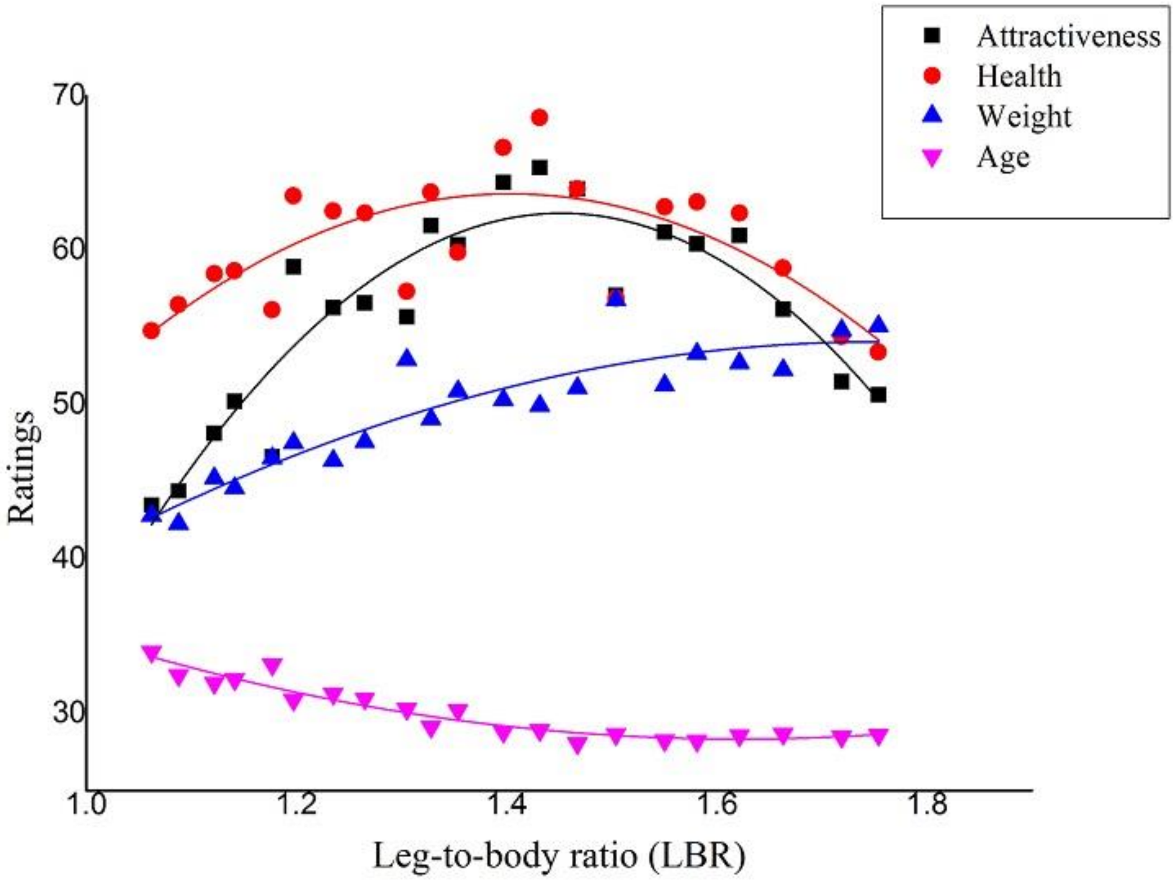


Figure 6. The comparison plots of female images LBRs and the four behavioural judgements made.

To determine the regression function used to illustrate the data in Figure 6, a hierarchical regression was performed. However, the pattern of the data shown in Figure 6 indicated a polynomial trend whereby a change in the direction of the line was shown; known as a quadratic trend. This was found particularly for the data representing attractiveness and health which would suggest that as the LBR of the images increased, so did participant's perception of attractiveness and health, however this pattern changed once an LBR of approximately 1.4 was reached and images with an LBR greater than this, caused a decrease in ratings (Figure 6).

To statistically determine the trend in the data, LBR was squared and cubed and inputted into the regression in a hierarchical manner, for each of the four variables. When the term of the LBR did not significantly contribute to the variance of the data (determined by the "Sig. F change" value), the last point of significance was interpreted to be the trend of the data. For attractiveness judgements therefore, the squared LBR term significantly increased the variance from 22.5% ($F_{(1,19)} = 5.51$, p=.030, r = .47) to 85.8% ($F_{(1,18)} = 80.27$, p<.0001, r = .94). For health, the squared term significantly increased the variance accounted for from 0.3% ($F_{(1,19)}$ = 0.05, p=.818, r =.05) to 55% ($F_{(1,18)}$ = 21.86, p<.0001, r =.74). Interestingly for weight, whilst the squared term for LBR accounted for an additional 4.6% the variance and was significant, ($F_{(1,18)}$ = 5.45, p=.031, r =.92), it wasn't as significant as the linear term which accounted for 80.2% of the variance alone, ($F_{(1,19)}$ = 76.88, p<.0001, r =.90). Finally for age, the squared term increased the variance from 79.8% ($F_{(1,19)}$ = 75.07, p<.0001, r =.80) to 90.7% ($F_{(1,18)}$ = 25.41, p<.0001, r =.96). Cubed terms added no significance to the data.

Table 3. Regression models for each of the four judgements for female images.

		B	SE	β	*t*	*p*
Attractiveness	Constant	-353.78	43.19		-8.19	0.001
	LBR	889.35	96.30	15.18	9.24	**0.001**
	LBR^2	-475.27	53.05	-14.73	-8.96	**0.001**
Health	Constant	-166.51	48.41		-3.44	0.003
	LBR	505.86	107.92	13.72	4.69	**0.001**
	LBR^2	-277.97	59.45	-13.69	-4.68	**0.001**
Weight	Constant	-42.98	27.44		-1.57	0.135
	LBR	174.82	61.17	4.86	2.86	**0.010**
	LBR^2	-78.68	33.69	-3.97	-2.34	**0.031**
Age	Constant	89.12	9.18		9.71	0.001
	LBR	-117.55	20.48	-7.25	-5.74	**0.001**
	LBR^2	56.85	11.28	6.36	5.04	**0.001**

4.2.7 *Male Images*

Table 4. Pearson's correlation between the four judgements and the male image's LBR.

	LBR
Attractiveness	0.31
Sig. (2-tailed)	0.18
Health	0.19
Sig. (2-tailed)	0.42
Weight	**0.80****
Sig. (2-tailed)	0.001
Age	**-0.79****
Sig. (2-tailed)	0.001

**Correlation is significant at the 0.01 level

For male images, the LBR significantly correlated with weight and age judgements but failed to reach significance for attractiveness and health judgements (Table 4). This would suggest participants were using alternative cues to make such judgements.

Table 5. Pearson's correlation between the four behavioural judgements.

	Health	Weight	Age
Attractiveness	**0.82****	0.15	-0.25
Sig. (2-tailed)	0.001	0.52	0.27
Health		0.17	-0.32
Sig. (2-tailed)		0.47	0.15
Weight			**-0.55****
Sig. (2-tailed)			0.01

**Correlation is significant at the 0.01 level

Furthermore, attractiveness and health ratings were found to strongly correlate and the weight and age ratings were correlated also (Table 5).

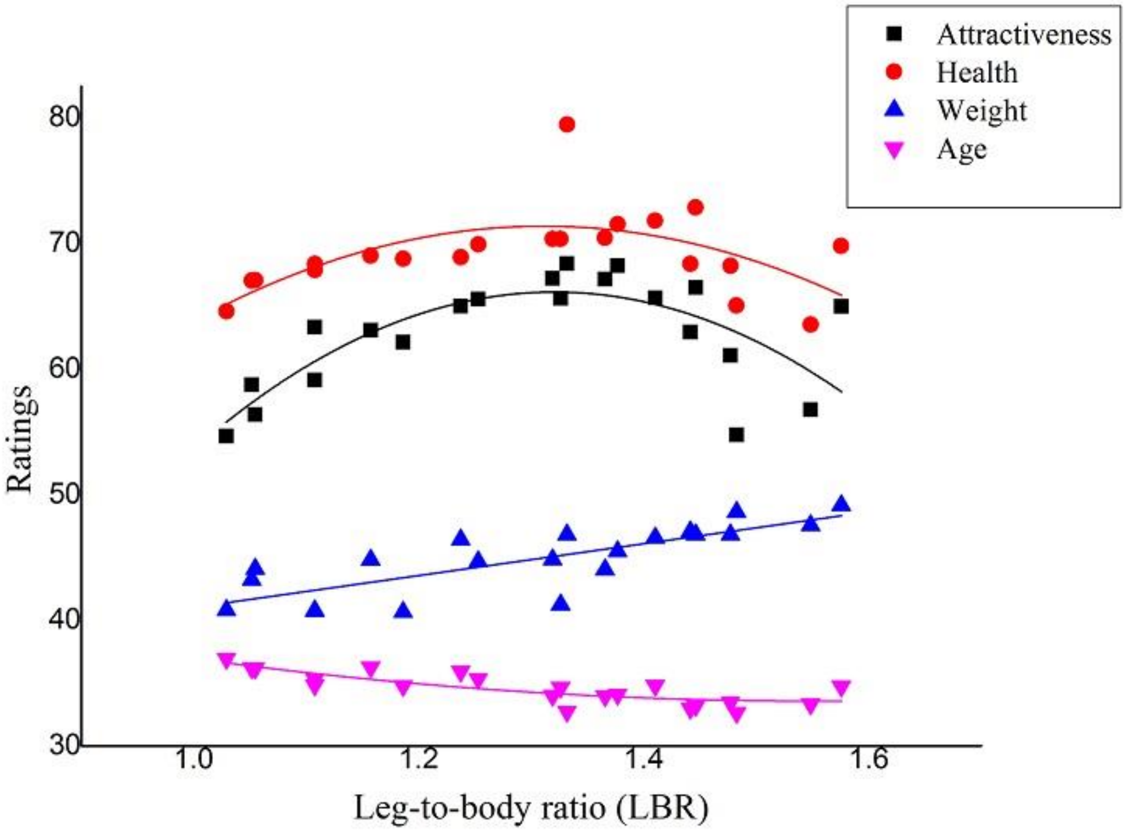


Figure 7. The comparison plots of male images' LBRs and the four behavioural judgements.

As with the female images, to statistically determine the trend of the data presented in Figure 7, the LBR was squared and cubed and added into the regression model with each of the four variables, in a hierarchical manner. The squared term of the LBR increased the attractiveness variance accounted for, from 9% ($F_{(1,19)}$ = 1.88, *p*=.186, *r* =.30) to 57.3% ($F_{(1,18)}$ = 20.35, *p*<.001, *r* =.76). For health judgements, the squared LBR term increased the variance from 3.4% ($F_{(1,19)}$ = .671, p=.423, r =.18) to 37.8% ($F_{(1,18)}$ = 9.96, p<.005, r =.61). Weight judgements found that the squared LBR term increased the variance from 63.4% ($F_{(1,19)}$ = 32.92, p<.001, r =.80) to 65.1% but the addition of the squared term was not signficant ($F_{(1,18)}$ = .897, p=.356, r =.81). For age judgements, the squared term of LBR increased the variance accounted for, from 62.1% ($F_{(1,19)}$ = 31.07, p<.001, r =.79) to 66.4% but again, was not found to be significant ($F_{(1,18)}$ = 2.32, p=.145, r =.81).

Table 6. Regression models for each of the four judgements for male images.

		B	SE	β	*t*	*p*
Attractiveness	Constant	-239.42	64.63		-3.71	0.002
	LBR	703.77	153.10	15.11	4.60	**0.001**
	LBR	-405.10	89.81	-14.83	-4.51	**0.001**
Health	Constant	-120.85	58.74		-2.06	0.054
	LBR	445.09	139.16	12.69	3.20	**0.005**
	LBR	-257.59	81.64	-12.52	-3.16	**0.005**
Weight	Constant	25.26	3.43		7.37	**0.001**
	LBR	22.80	3.40	0.80	5.74	**0.001**
Age	Constant	43.63	1.63		26.70	**0.001**
	LBR	-10.56	1.89	-0.79	-5.57	**0.001**

4.2.8 *Summary*

These results reproduce the pattern of judgments reported in previous studies where altering LBR changes attractiveness judgments in a non-linear pattern (Sorokowski & Pawlowski, 2008; Swami, 2006, 2007; Frederick *et al*., 2010). However, a potential flaw exists in the data described above, as the shape of the relationship between the attractiveness and health ratings and the change in LBR could be interpreted as either a genuine preference for a particular value or group of values, or it could be a response to an increasing level of unrealism in the bodies (i.e. it is an experimental artefact). Additionally, it might be asked whether LBR would actually play a role in judgements of real bodies rather than in artificial bodies where it has been positioned to be maximally effective. One approach to these questions is to use real bodies to determine whether they are rated in a similar manner. A number of previous studies have had sets of digital photographs of male and female bodies rated for attractiveness. By reanalysing this data and adding LBR as an explanatory variable, it should be possible to assess its relationship with attractiveness judgements and its relative strength as a predictor.

4.3 Real Female Bodies

4.3.1 *Protocol*

50 female bodies presented in front view were rated by 100 British Caucasians, equally divided between sexes. Details of the participants' age and demographic information, along with the specifics of the image set can be found in Tovée *et al*., (2006). Observers rated on a 9-point Likert scale how beautiful they thought the person in the photograph was with the head/face being obscured so facial attractiveness would not be a factor in the observer's ratings. Instead of "attractiveness" being used as an adjective however, the authors used the term 'beautiful' which is a potentially loaded phrase which invites a subjective rather than objective judgement, and a replication should use the more neutral phrase 'physically attractive'. However, with this caveat in mind, this study still provided a useful pointer to the role of LBR in attractiveness judgements.

Whilst Tovée *et al*., (2006) had originally calculated body indices such as the BMI and WHR of their image set, this study wanted to focus on the specific role the LBR plays in attractiveness judgements and the separate components of this body index. To acquire such measurements, the original bodies from Tovée *et al*., (2006) were individually uploaded into Corel Photo-Paint 9, and measurements (in pixels) were taken (see section 4.2.4, Figure 5 for an example). The data was then re-analysed with the new body indices included to investigate the effects of the LBR on attractiveness judgements.

4.3.2 *Results*

Tovée *et al*., (2006) found high correlations between male and female observers suggesting both genders were rating the images in the same way and therefore their data could be combined and analysed as one data set.

Table 7. A Pearson's correlation between the body indices of the 50 images.

	WHR	WCR	Torso	Leg	LBR	Height
BMI	**0.63****	**0.75****	**0.67****	**-0.37****	**-0.75****	0.02
Sig. (2-tailed)	0.001	0.001	0.001	0.01	0.001	0.87
WHR		**0.65****	**0.39****	-0.24	**-0.32***	-0.08
Sig. (2-tailed)		0.001	0.01	0.09	0.02	0.56
WCR			**0.70****	-0.11	**-0.47****	0.23
Sig. (2-tailed)			0.001	0.44	0.001	0.11
Torso				0.11	**-0.47****	**0.56****
Sig. (2-tailed)				0.43	0.001	0.001
Leg					**0.74****	**0.83****
Sig. (2-tailed)					0.001	0.001
LBR						0.23
Sig. (2-tailed)						0.10

As can be seen from Table 7, the body indices were found to highly correlate with each other. BMI is highly correlated with LBR and torso length, and significantly correlated with leg length.

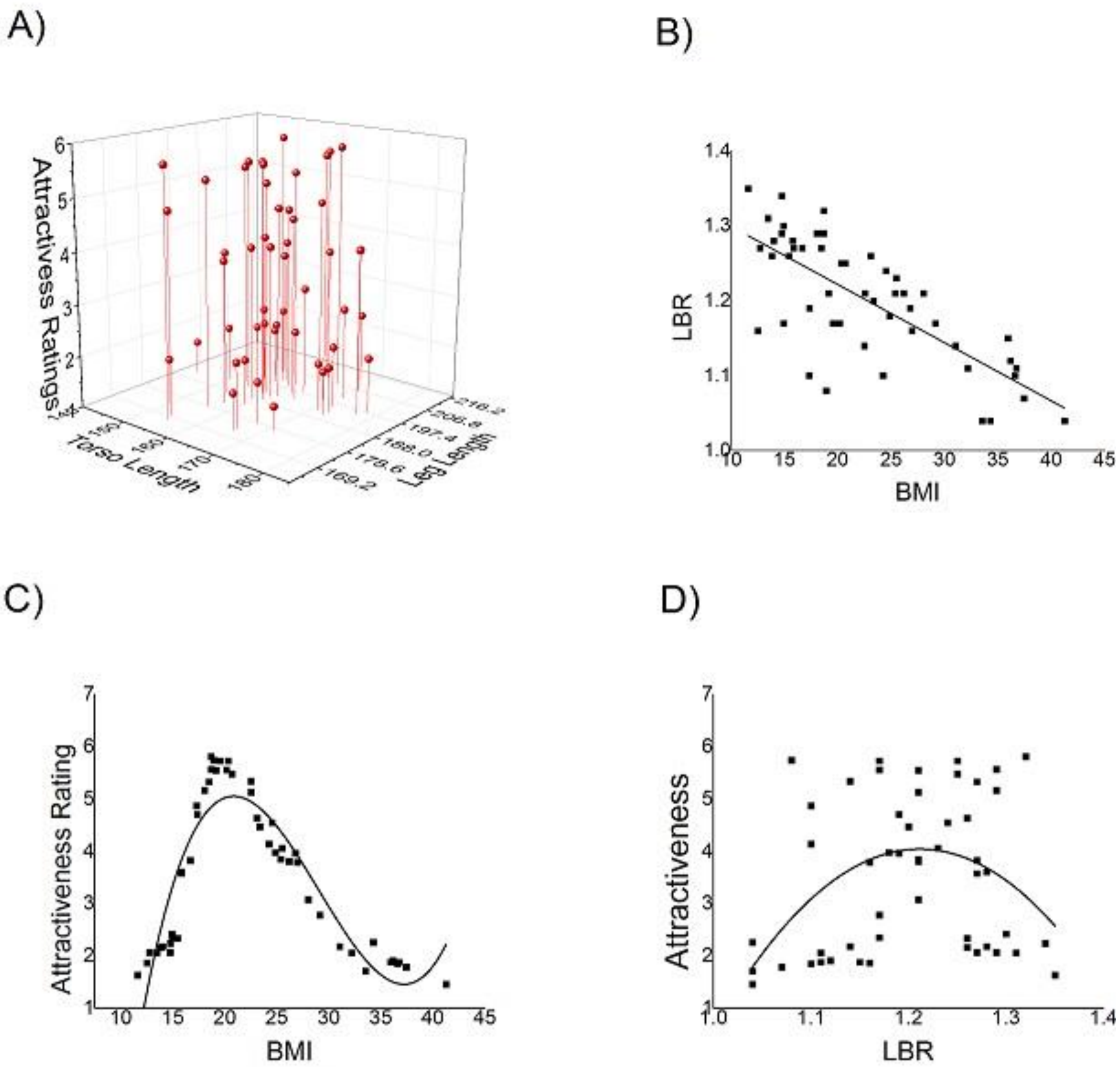


Figure 8A) A 3D plot of the attractiveness ratings against leg length and torso length. As can be seen, a shorter torso and a longer leg are rated as most attractive. B) A plot of LBR against BMI illustrating a strong correlation. C) A plot of attractiveness ratings against BMI shows a strong non-linear relationship. D) A plot of attractiveness ratings against LBR shows a weak non-linear relationship with LBR.

The relationship between the attractiveness ratings of the observers and the LBR is shown in Figure 13D. A hierarchical regression suggested that a squared term was the best descriptor of the relationship with LBR (LBR = 0.4%, $F_{(1,48)} = .20$, p=.66, r =.06; LBR^2 = 21.8%, $F_{(1,47)} = 12.84$, p<.001, r =.50). A multiple regression using a 3^{rd} order term for BMI, a second order term for LBR and a linear term for WHR, therefore produced a model which accounted for 85.4% of the variance ($F_{(6,43)} = 41.83$, p<.0001, r =.92), but only BMI was significant.

Table 8. The regression model for attractiveness judgements on real female bodies.

		B	SE	β	*t*	*p*
Model 1	Constant	-7.89	22.25		-0.35	0.73
	BMI	3.80	0.36	20.37	10.42	**0.001**
	BMI^2	-0.14	0.02	-28.61	-9.42	**0.001**
	BMI^3	0.00	0.00	18.21	8.23	**0.001**
	LBR	-29.85	37.15	-1.67	-0.80	0.43
	LBR^2	11.96	15.52	1.59	0.77	0.45
	WHR	-1.03	1.88	-0.04	-0.55	0.59

4.4 Real Female Bodies with a Limited BMI range

In the initial body set analysed above, BMI strongly correlated with LBR and the dominant role of BMI in determining attractiveness ratings may therefore overshadow any role for the LBR. Therefore to further investigate the effects of the LBR on attractiveness judgements; analysis was carried out on an image set with a limited BMI range. Using an image set with a more restricted BMI range may help to prevent BMI overwhelming the outstanding body indices and lend more insight into the potential role of the LBR.

4.4.1 *Protocol*

The original data used for the following analysis was taken from Tovée *et al*., (2002) who asked 46 undergraduate students (23 females and 23 males) to rate 60 front view colour female bodies for attractiveness.

Whilst Tovée *et al*., (2002) used 60 images in total, the following data analysis could only use 58 due to the fact that 2 of the original images were lost when a central server failed and the backup copy of the images proved to be incomplete. The original biometric data for the bodies in the images did not include LBR, and as the pictures for these two bodies were lost, it was not possible to measure their leg and body length. If one assumes that the attractiveness rating of each image in the set is influenced by the size and shape of the images in the test set (i.e. that you rate a body in the context of the other bodies in that specific stimulus set, and not in the context of all the bodies you have seen during your life) then the loss of these two data points may influence the outcome of the analysis. However, as there were only 2 missing bodies out of a total of 60 bodies, the effect, if it exists, is likely to be minimal. Additionally, an unpublished study by Tovée and Cornelissen suggests that there is not a significant effect of the range of parameters in a stimulus set on the results. They had 20 participants rate a set of 20 female images for attractiveness. They then had each image rated by 20 participants who saw only that image (with each of the 20 images being rated by 20 participants, a total of 400 participants took part in the second experiment). There was no significant difference in the ratings for the images in the two studies (Tovée & Cornelissen, in prep). This would suggest that when participants judge the images, they are rating them relative to the variation in physical features that they have seen in the wider population, and not just in the context of the specific image set used to test them.

4.4.2 ***Results***

Male and female observer data was pooled together for the analysis due to Tovée *et al*., (2002) finding high intra-class reliability suggesting no difference between the relative ranking of the female images.

Table 9. Pearson's correlation between the body indices.

	WHR	BWR	Torso	Leg	LBR	Height
BMI	0.13	-0.02	**0.27***	0.18	0.01	0.22
Sig. (2-tailed)	0.35	0.88	0.04	0.17	0.92	0.10
WHR		**0.76****	0.07	-0.14	-0.09	-0.12
Sig. (2-tailed)		0.001	0.60	0.28	0.50	0.37
BWR			-0.19	-0.22	0.02	**-0.30***
Sig. (2-tailed)			0.17	0.10	0.91	0.03
Torso				0.24	**-0.44****	**0.61****
Sig. (2-tailed)				0.07	0.001	0.001
Leg					**0.67****	**0.86****
Sig. (2-tailed)					0.001	0.001
LBR						0.20
Sig. (2-tailed)						0.13

As can be seen from Table 9, there was no significant correlation of LBR with BMI and so BMI should not overshadow it as an explanatory variable in a regression analysis.

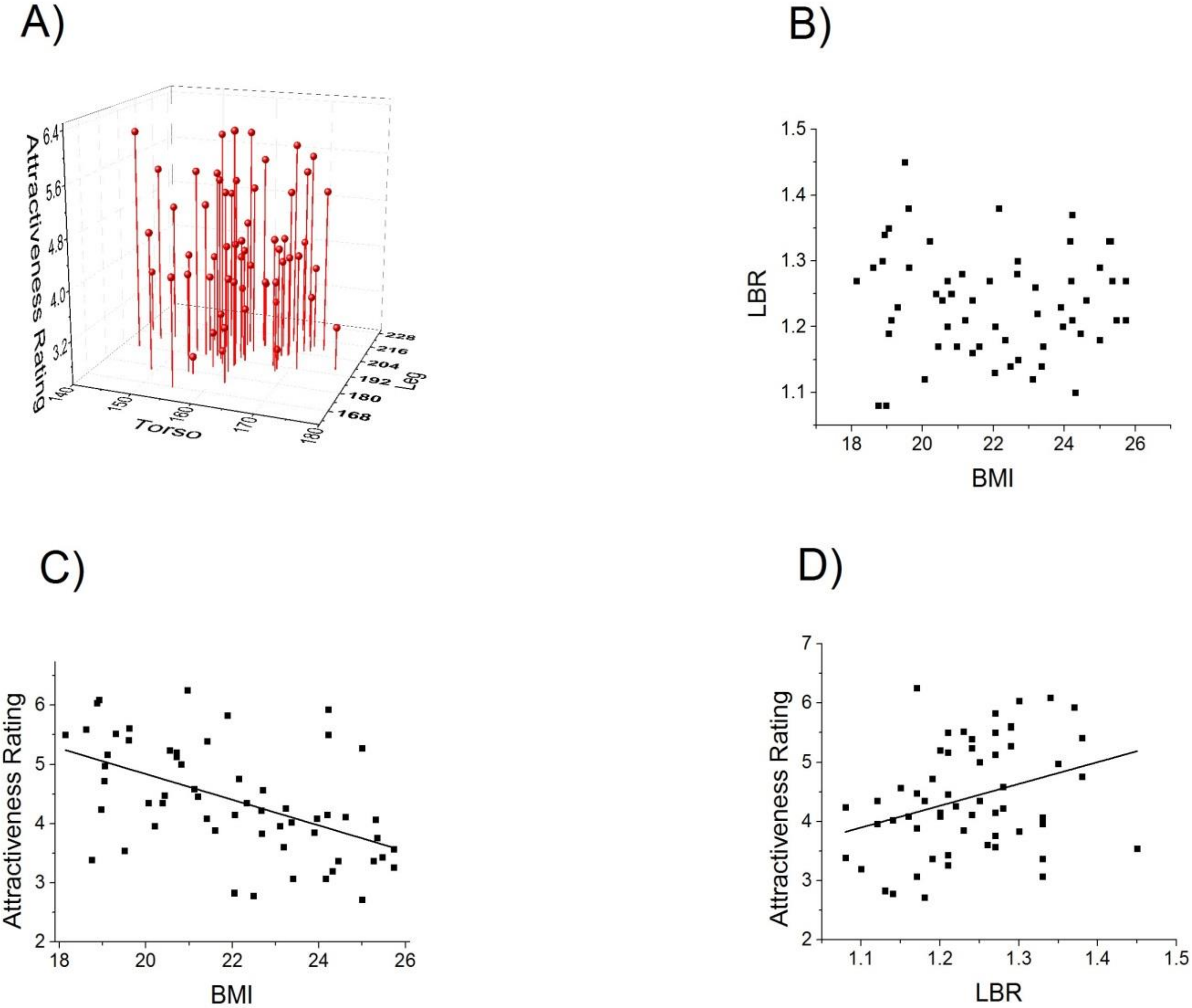


Figure 9A) A 3D plot of the attractiveness ratings against leg length and torso length. As can be seen, a shorter torso and a longer leg are rated as most attractive. B) A plot of LBR against BMI illustrating there is no correlation. C) A plot of attractiveness ratings against BMI shows a linear relationship. D) A plot of attractiveness ratings against LBR shows a linear relationship.

A hierarchical regression found a second order term to be the best description for LBR in this data set. Replicating the regression analysis used in Tovée *et al*., (2002), a stepwise non-linear regression was carried with the same explanatory terms as previously used, but with the addition of a second order term for LBR. This model accounted for 47.1% of the variance ($F_{(2,52)} = 7.87$, $p<.0001$, $r = .66$) and only BMI and LBR reached significance as predictors. LBR accounted for 19.7% of the variance.

Table 10. Regression model for attractiveness judgements on female images of a limited BMI range.

		B	SE	β	*t*	*p*
Model 1	Constant	-51.54	19.00		-2.71	0.01
	BMI	-0.24	0.04	-0.58	-5.42	**0.001**
	WHR	-0.92	3.80	-0.04	-0.24	0.81
	WCR	0.04	2.62	0.00	0.02	0.99
	LBR	96.46	30.10	8.31	3.21	**0.001**
	LBR^2	-37.38	12.05	-8.03	-3.10	**0.001**

4.5 Real Male Bodies

4.5.1 *Protocol*

In Maisey *et al*., (1999), 30 male and 30 female participants rated a series of 50 colour pictures of male images in front view for attractiveness. Detailed information regarding the observers and the images used can be found in Maisey *et al*., (1999) along with the full methodology. To calculate the LBR, the images were individually uploaded into Corel Photo-Paint 9 and measurements of the torso and leg length were made in pixels directly from the photographs.

4.5.2 *Results*

Height has previously been suggested to be a predictor of male attractiveness and in this image set was found to correlate with LBR. However, torso and leg length did not significantly correlate with BMI, (Table 11).

Table 11. A correlation matrix between the body indices of the images used in Maisey *et al's*., (1999) image set.

	WHR	WCR	Torso	Leg	LBR	Height
BMI	0.23	**0.48****	-0.07	0.14	**-0.29***	-0.22
Sig. (2-tailed)	0.11	0.001	0.63	0.33	0.04	0.13
WHR		**0.44****	**0.43****	**0.40****	0.19	0.01
Sig. (2-tailed)		0.001	0.001	0.001	0.19	0.96
WCR			0.14	0.08	0.16	-0.09
Sig. (2-tailed)			0.35	0.58	0.26	0.55
Torso				**0.97****	0.00	0.04
Sig. (2-tailed)				0.001	1.00	0.77
Leg					0.11	0.15
Sig. (2-tailed)					0.45	0.30
LBR						**0.29***
Sig. (2-tailed)						0.05

**Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

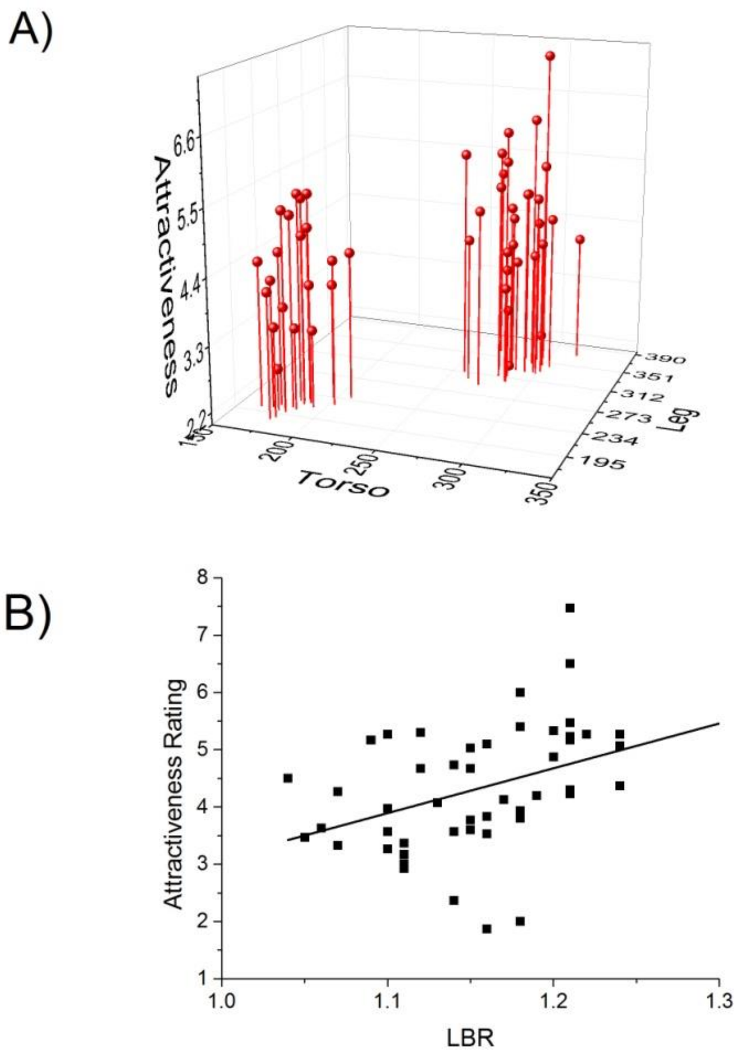


Figure 10 A) The attractiveness ratings plotted against the leg and torso length of the bodies in the photographs. B) The attractiveness ratings plotted against the LBR from the Maisey *et al's* (1999) study.

As in the ratings of the real female bodies, a clear trend was found for more attractive bodies to have longer legs and longer torsos (see Figure 10a), and this may represent a preference in male attractiveness judgements for taller men (e.g. Stulp, Buunk & Pollet, 2013). Despite this, Figure 10b shows there is a clear linear relationship with attractiveness and LBR. Higher LBRs are rated as more attractive. There is a surprising break in the torso and leg length range in this image set as can be seen in Figure 10a, however this probably arose by chance when the images were selected to show a balanced range of BMI and torso shape from a larger set of images.

The ratings of the male images significantly correlated with LBR (Pearson correlation, r = 0.44, p<0.01) and a hierarchical regression suggested that a linear term is all that was required as an explanatory variable. In the original Maisey study, the attractiveness judgement was explained by a multiple, non-linear regression in which WCR and BMI were significant predictors. Reanalysing the data using a hierarchical regression with non-linear terms for WCR, BMI, and WHR, but adding a linear term for LBR and height produced a model which accounted for 73.2% of the variance and only BMI, WHR and LBR were significant explanatory variables ($F_{(8,40)} = 12.09$, $p<.0001$, $r=.84$). LBR accounted for 9% of the total variance.

Table 12. The results of the regression model for attractiveness judgements on real male bodies.

		B	SE	β	*t*	*p*
Model 1	Constant	-195.72	72.60		-2.70	0.01
	BMI	3.55	0.73	8.49	4.88	**0.001**
	BMI²	-0.08	0.02	-8.70	-5.00	**0.001**
	WCR	45.88	53.10	2.07	0.86	0.39
	WCR²	-35.36	33.53	-2.53	-1.06	0.30
	WHR	306.43	149.36	7.97	2.05	**0.05**
	WHR²	-169.84	82.50	-8.00	-2.06	**0.05**
	LBR	3.68	1.79	0.20	2.06	**0.05**
	Height	1.91	1.53	0.12	1.25	0.22

4.6 Summary

The LBR range in the latter two studies using real bodies were similar to the ranges seen in the artificial bodies, and both show a linear increase in attractiveness with lengthening leg and shortening torso length in the bodies of both male and female bodies (i.e. increasing LBR). This result differs from the result reported earlier in the chapter which showed a non-linear relationship between behavioural judgements and LBR and it is not clear whether this reflects defects in the realism of these bodies or whether the pattern between the rating of the real bodies and their LBR is being influenced by changes in other physical parameters which are partially or wholly correlated with LBR.

4.7 Discussion

Previous studies have co-varied leg and torso length, whilst keeping height constant and this study supported such work, finding the pattern of responses to the manipulation of the computerised bodies is non-linear, with a decline as the degree of manipulation increases. However, this is potentially an artefact, based on the bodies appearing progressively less realistic. This is a criticism that can be made of all the images used in the LBR studies. To address this potential confound, data from several studies using digital photographs of real women and men were re-analysed to determine whether LBR had an effect where the range in LBR was based on natural variation in the population. In female bodies, BMI is a very strong predictor of attractiveness judgements and as BMI tends to co-vary with both torso length and LBR, the effect of LBR can be arguably overshadowed by BMI. However, in the image set with a narrower BMI range, LBR was a weak but significant cue to attractiveness judgements. Across both sets of female bodies, there was a trend to prefer bodies with longer legs and shorter torsos. A similar pattern is seen in the real male bodies; longer legs and shorter torsos were rated as most attractive.

Our original hypothesis was that BMI would co-vary with LBR and be the driving force for why attractiveness was correlated with LBR, rather than as a measure of developmental stability. This would place the emphasis on torso length rather than leg in the change in LBR. However, LBR seems to have an effect on judgements largely independent of the BMI of the real images. This suggests that the LBR may after all be based on leg length as a measure of childhood health and nutrition. The demonstration here of the effect of LBR on attractiveness judgments is the first time that it has been shown using real bodies that we are aware of.

Such findings therefore support previous work indicating the role of the LBR, particularly in female attractiveness (Fan *et al*., 2004; Swami *et al*., 2006, 2007; Sorokowski & Pawlowski, 2008; Frederick *et al*., 2010). Preference for longer legs in comparison to torso length is thought to be because they indicate stable childhood development and positive health outcomes such as decreased infant and maternal mortality during pregnancy (Swami *et al*., 2006; Bogin & Varela-Silva, 2010).

However, the pattern for male attractiveness is reported as more ambiguous with Fan (2007) reporting that longer legs had no significant effects of men’s bodily attractiveness whilst Swami *et al*., (2006) found an inverse relationship in that lower LBRs were judged as more attractive than higher LBRs; results that contrast with the findings reported in the current study. Again, contrasting stimuli can be used to explain such a discrepancy as Swami *et al*., (2006) noted in their discussion that their stimuli were not based on anthropometric data and therefore may not be representative of a real population.

The results from the current study with regards to male attractiveness however, can be said to support those of Sorokowski and Pawlowski (2008) in that a preference is shown for slightly higher than average or average LBRs. Such results lend support to the evolutionary theory that longer legs were selected for, due to them signalling beneficial traits such as running skills. Bramble and Lieberman (2004) argue that running speed was an important determinant of fitness in our ancestral environment allowing for better efficiency when hunting, escaping predators or during agonistic intra-sexual encounters, resulting in intersexual selection favouring longer legs.

There may also be a stronger effect of LBR in attractiveness and health judgements in more challenging, resource scarce environments. In the UK, starvation and serious illness is rare, and there is unlikely to be large variations in LBR due to these issues. As a result, observers may not be highly tuned to variation in this physical parameter. However, in less developed, resource scarce environments there may both be a greater variation in LBR and greater sensitivity to variation in this parameter.

In their cross-cultural study, Swami *et al*., (2006, 2007) found rural Malaysians tended to prefer women with LBRs in the middle range, although participants who reported more exposure to Western media preferred longer legs suggesting that preferences for LBR are malleable in response to different ecological and sociocultural conditions.

More recently, Sorokowski *et al*., (2011) investigated LBR preferences across 27 nations and found silhouettes with short and excessively long legs were perceived as less attractive across all nations whilst silhouettes with LBRs close to the average were perceived as most attractive. Furthermore, too long legs were generally perceived as more attractive than those too short. The LBR preferences were only slightly modified by the participant's origin, however the majority of participants came from urban areas within their respective countries so they might have had frequent contact with Western culture.

Sorokowski *et al*., (2012) therefore investigated the same preferences in a population isolated from Western culture (the nomadic-pastoral ethnic 'Himba' tribe in Africa). The study found that preference seemed to be for an LBR value lower than in previous research supporting the concept of media influences on LBR preferences in Western societies (e.g. Sorokowski *et al*., 2011).

Furthermore, their study found men's attractive LBR was higher than women's attractive LBR, the opposite of what previous studies have found (Bertamini & Bennett, 2009). Such a finding can be explained in evolutionary terms due to leg length in men indicating biomechanical efficacy i.e. running and jumping abilities, which might have been more important for men than women in past environments (i.e. for hunting).

Whilst such studies lend support to cross-cultural differences in the preference for an attractive LBR, they continue to use the line drawings that arguably lack ecological validity. Some studies on attractiveness have been undertaken using real bodies as stimuli (e.g. Swami & Tovée, 2005, 2007; Swami *et al*., 2006, 2007). However, they have all used the same 50 body set from Tovée *et al*., (2006). Whilst this means that the results are comparable across different populations, it also means that the high correlation of BMI and LBR in this image set obscures any independent effect of LBR on the judgements.

4.7.1 *Limitations*

The current study failed to obscure the faces of the computerised images and so facial features may have contributed to participant's ratings. Studies into facial attractiveness have found strong positive correlations between women's facial femininity and attractiveness (Rhodes *et al*., 2003; Koehler *et al*., 2004) and also men's facial 'masculinity' and attractiveness (Penton-Voak *et al*., 2001; Rhodes *et al*., 2003). As the faces were unchanged across all the images, this common feature may act to "flatten" the rating responses (i.e. cause similar ratings across all the images). Therefore it would be beneficial to blur faces out in future studies to eliminate the risk of facial attractiveness influencing judgements.

A further limitation is the restriction on the programming software used at the time the study was undertaken. The 3D morphing software Daz 3.0 did not allow for the separate manipulation of torso length, only leg length, and therefore the images had to be uploaded into Photoshop to allow for the torso length to be further manipulated. This had two drawbacks. Firstly, this may produce a less realistic manipulation of torso length. Secondly, this meant that there was no 3D body model of the different LBR versions and so no BMI measure could be calculated (as it was not possible to calculate their volumes). To counter this last point the participants were asked to rate the bodies' weight so we could include this in the subsequent analysis, but this may be less accurate than a direct measure of body weight from a calculation of volume. A newer version of the programming software Daz 4.5 and 3D model now allows for the independent manipulation of both the leg and torso length which will enable future studies to obtain these additional anthropometric measures from the images.

The use of within-subjects designs has also been criticised for leaving open the possibility of halo effects or response bias (Swami & Hull, 2009). For example, when participants are asked to make ratings of physical attractiveness, the concept of attractiveness may prime a "beautiful is good" belief set (Dion, Berscheid & Walster, 1972). This consequently influences other interpersonal ratings (Feingold, 1992; Tovée *et al*., 2007). Such a criticism could be applied to the current study as participants were asked to rate all four variables on the same screen consecutively for each image, and so a cognitive bias may have occurred whereby if the image was perceived as having one attribute, it may have been assumed to have the other attributes also (Nisbett & Wilson, 1977). Future work may consider including a second within-subjects condition in which the order of ratings is counterbalanced to allow a more detailed examination of whether the differences are due to a halo effect.

4.7.2 *Conclusion*

The LBR is therefore shown to play a role in attractiveness judgements in both artificial and real bodies. A non-linear relationship was found in judgements on computerised bodies, with attractiveness ratings declining at the extremes of the manipulations; thought to be an artefact of the bodies being perceived as unrealistic. Advancements in the modelling software will allow future studies to create more realistic changes in the images. For real bodies the preference was for longer legs and a shorter torso which corresponds with the hypothesis that longer legs signal better health and biomechanical efficacy (Gunnell *et al*., 2003; Swami, 2006; Fielding *et al*., 2008; Schooling *et al*., 2008; Sorokowski & Pawlowski, 2008). BMI is thought to override the potential role of the LBR in real populations but when restricted, the LBR was shown to have a significant relationship with attractiveness judgements supporting its role as a morphological trait that influences a person's attractiveness.

Chapter 5. Investigating Eye Movements involved in our perception of our own body compared to our perception of other people's bodies.

5.1 Introduction

This chapter will combine behavioural and eye-tracking techniques to determine whether there are differences in the strategy used to assess female participants' own bodies versus other women's bodies. Eye-movements potentially provide a way into how women assess their bodies. The human eye can attend to a visual field of approximately 200°; however, high-resolution detail and colour can only be processed from a central region of around 2° (Levi *et al.*, 1985; Thibos *et al.*, 1987). This implies that the information given by an image can only be processed in tiny chunks corresponding to the particular place that the observer is fixating on at a particular time (Miller and Bockisch, 1997). Consequently, if an observer's fixation pattern is tracked, it is possible to record areas of a picture for example that are being attended to at any one time, and subsequently gain an understanding of which areas are contributing information to allow the judgements of the image being made by the observer. Subsequently, eye movement studies have been carried out in several studies assessing the key features used in judgements of female attractiveness (e.g. Cornelissen *et al*., 2009; Dixson *et al*., 2010, 2014; George *et al*., 2011; Hall *et al*., 2011).

Cornelissen *et al*., (2009) found that fixations during the judgements of body size focussed on the stomach depth, a region that has been suggested to be very sensitive to BMI change (Tovée *et al*., 1999; Wells *et al*., 2007; Rilling *et al*., 2009). They further found that these fixations were incorporated within the fixations made by participants judging attractiveness. A result consistent with previous behavioural studies (e.g. Tovée *et al*., 1999; Smith *et al*., 2007). However, other studies have suggested that the pattern of eye-movements when judging body size and particularly when judging attractiveness actually is more focused on the upper body (particularly the bust) and the fixations in the centre of the body are being made to judge the WHR (e.g. Dixon *et al*. 2010, 2014; Hall *et al*., 2011). In addition to disagreements on which features are fixated during a behavioural judgement, there is the potential modulating effect of cognitive factors in the observer.

Tovée *et al*., (2003) used a custom built caricaturing programme to alter digital photographs of the participants' own bodies based on biometric data to mimic the increase or decrease in BMI. Individual body parts could be altered independently. They asked 60 women with eating disorders and 144 controls to estimate the size and shape of their own body. They found that as the eating behaviour and body size concerns in the participants rise, they are significantly more likely to alter more body features than the low concern participants who primarily alter the stomach. This is consistent with subsequent eye-movement studies which have shown that when judging body size in other people's bodies, the pattern of fixations is more diffuse in people with higher body size concerns possibly reflecting more global concerns (George *et al*., 2011; Cornelissen et al., unpublished data).

Previous studies have suggested a potential difference in how women assess their own versus other women's bodies. For example, in a behavioural study Tovée *et al*., (2000) asked 204 eating disordered and control women to rate digital photographs of their own and a set of 25 control bodies for size. The faces were obscured. Their accuracy of estimation of their own body was linked to both their own BMI and their cognitive state (as assessed by a battery of questionnaires). Those participants with high body size concerns significantly over-estimated their body size relative to control bodies of the same size. Additionally, Tovée *et al*., (2000) added a second copy of the participant's own body into the set of control bodies without telling the participants. When the participants rated their own body without knowing it was their own body, their estimation of body size was the same as their estimation of the control bodies. This reinforces the hypothesis that there is a significant difference in how women rate their own bodies relative to other women's bodies.

Eye-movement studies suggest that these behavioural differences mirror differences in eye-movement patterns. Jansen *et al*., (2005) used eye-tracking to measure fixation patterns in 23 participants rating digital photographs of their own body and 2 control bodies for size. Participants who scored high on the eating disorder examination questionnaire (EDE-Q) looked less at the parts of their body that they considered attractive than participants who scored low on the scale. The reverse pattern was seen when the participants assessed the control bodies.

By contrast, Roefs *et al*., (2008) did not find differences in participants' fixation patterns when viewing their own versus other people's bodies. In their study, 51 normal BMI observers rated their own and a single control body for attractiveness. Their results show that as BMI increased, the attractiveness ratings reduced consistent with previous studies (e.g. Tovée *et al*., 1999; Smith *et al*., 2007). Where the bodies have a low rating of attractiveness, the participants show a "negative attentional bias" and viewed the body parts they had previously rated as unattractive for both their own and the control body.

This study will try to determine which physical and psychological parameters predict judgements of attractiveness and which parts of the body are fixated on when these judgements are being made. As previous work has suggested that stomach depth is related to perceptions of BMI change (Cornelissen *et al*., 2009) and BMI is a strong predictor of female attractiveness judgements (Tovée *et al*., 1998, 1999, 2002; Fan *et al*., 2004), the study hypothesises that BMI will be the best predictor of female attractiveness judgements and furthermore, participants will specifically fixate on the stomach region when making both their judgements. It will also look at whether differences exist in the physical and psychological features that predict the rating of a participant's own body versus a control body. Additionally, it will use the same subterfuge as Tovée *et al*., (2000) and add a second copy of the participant's body to the set of control bodies without telling them so they rate their body when they know it is their body and when they do not.

5.2 Preliminary Work

5.2.1 *Stimulus set / Participants*

As this experiment required participants to make judgements on their own body as well as other women's, the study was split into two parts;

(i) Participants first consented to having a full frontal body photograph taken.

(ii) They then returned to complete the eye movements study when a sufficient stimulus set of women's bodies had been collected.

The study was advertised through the Psychology school's participation scheme at Newcastle University and through the Institute of Neuroscience's mailing group where students and staff members in the institute receive group email alerts.

From this opportunistic sampling, a total of 28 female participants were recruited. The age range of participants was 18-46 years old (Mean = 21.9; SD = 5.4). All participation was voluntary.

Out of the 28 participants that had their photograph taken, only 26 returned to complete the remainder of the experiment. Table 1 gives their averaged anthropometric measures.

Table 1. The collective anthropometric measurements averaged across the 26 female participants.

	BMI	WHR	WBR	BHR
Mean	21.02	0.83	0.84	0.99
SD	3.16	0.04	0.05	0.06
Min	15.10	0.73	0.72	0.83
Max	28.60	0.93	0.94	1.10

5.2.2 *Protocol*

Female participants were firstly briefed on the nature of the task they were about to take part in and were given an information sheet to reiterate this (Appendix F). They were then asked to sign a consent form allowing the experimenter to use their photographs in the follow-up part of the experiment (Appendix B). The fact that this experiment was in two parts was also explained to participants and that they were required to return at a later date to complete the experiment.

Participants were then shown the white briefs and elasticated sports bra (with no under wiring to allow the body to remain in its most natural shape as possible). Participants were asked to choose their correct size and to change into the clothing. Although previous studies into attractiveness judgements have used alternative clothing garments in their stimuli such as the ‘grey leotard’ clothing (Tovée *et al.*, 1999), this garment photographed in such a way as to obscure cues to the 3D structure of the torso. Moreover, Smith (PhD thesis, 2007) used stimuli that wore a top and briefs that proved to be partially transparent under the studio lighting and might prove to be too distracting for this experimental design. It was consequently decided that the current clothing used in this experiment allowed the body to be sufficiently concealed, without obscuring from the overall size and shape of the torso.

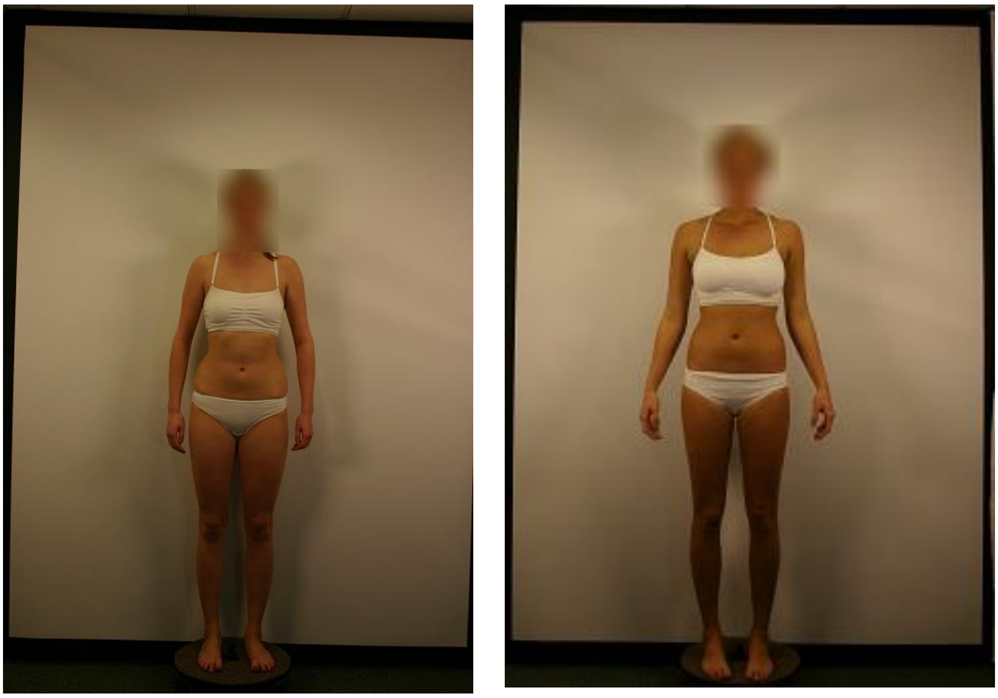


Figure 1. An example of the images used in the eye tracking study.

Once changed, participants were required to stand on a platform approximately 12cm off the ground. The platform was situated in-front of a 2m x 2m white projection screen. Extra lighting was also set up on either side of the room in the form of two Interfit Digilite 6 x 24W panels that contained fluorescent tubes of 288 total watts (120V AC). These were situated approximately 148cms away from the platform where participants stood. The Bilora MOD 3145 camera tripod was situated 245cm in-front of the platform and a Canon E0S camera with a Sigma autofocus lens of 24-70mm f/2.8 IF EX DG HSM, was used to take full frontal body photographs of the participants.

Participants were asked to stand in a natural pose with their arms hanging almost naturally, but slightly away from the sides of their body so the observer could distinctly see their body shape, (see Figure 1). Faces of the participants were blurred out using Photoshop before they were used. This preserved confidentiality and prevented facial cues playing a role in the judgements.

Although using 3D images (i.e. video clips in which bodies rotate through 360^{o}) would be a better representation of judgements of attractiveness and body size in real life as it allows all potential cues to be viewed, using moving images in the eye tracking paradigm renders data analysis extremely complicated: each frame would have to be analysed separately resulting in sparse eye movement data per frame. Furthermore, Smith (PhD, 2007) found that ratings of attractiveness between 2D and 3D images were highly correlated (r = 0.95, $p<0.0005$), therefore only 2D images were used in this Chapter and Chapter 6.

Once the photograph had been taken of the participant, anthropometric measures were taken using the form in Appendix C. Height was measured using the Marsden/Invicta Free Standing Height Measure and weight was measured using the Weight Watchers 8944U Heavy Duty Body Fat Analyser Scale. Using a standard measuring tape, the bust, under bust, waist and hip circumferences were measured following the protocols outlined in the Health Survey for England (England, 2008b). Participants were finally given a debrief sheet to help explain the study more (Appendix G).

5.2.3 *Recording eye movements*

The second part of the experiment then required participants to come back and judge the completed image set. A SensoMotoric Instruments (SMI) GmbH 2012 eye tracking system was used to record their eye movements while rating the images. This system has a remote, contact-free setup and allows for binocular gaze and pupil data recordings. The high-resolution sensor allows the subject free head movement across a wide range, (40cmx40cm at 70cm distance), whilst the software automatically locates the pupils' position and compensates for motion, (http://www.smivision.com/en/gaze-and-eye-tracking-systems/products/red-red250-red-500.html).

Figure 2. An example of the SMI iView X™ RED (Remote Eyetracking Device) model that was used to record eye movement and how it looks set up in the experiment.

The particular iView X™ system used in this experiment was a dark pupil eye tracking system that uses infrared illumination and computer based image processing. Images of the eye are analysed in real-time by detecting the pupil, calculating the centre and eliminating artefacts. Once a calibration is performed, the pupil location is translated into gaze data. One or several corneal reflexes are also tracked by the system in order to compensate for changes in position of the camera relative to the head.

This experiment further used a double PC setup with the iView X gaze tracking system running on one PC, (Figure 2). This PC is connected to the gaze tracking device (the RED (60, 120Hz) eye tracking interface) which is mounted underneath the visual stimulus monitor. The Experimenter Centre is run on a second PC with both components being interconnected using a UDP/IP socket connection.

Once the image set had been collected, each image was uploaded into the Experiment Centre 2.5™ used in this study to run the experiment. This experiment centre automatically connects to the iView X™ system and records the participant's eye movements whilst they are viewing the presented stimuli. Whilst recording, the Experimenter Centre automatically stores the eye and gaze tracking data and the corresponding stimuli files to an experiment results directory for later analysis.

5.3 Eye tracking experimental paradigm

When participants returned for the main experiment, they were briefed on the experimental protocol and given an information sheet (Appendix H). Participants were then required to sign a consent form (Appendix B). In addition to this, participants were also asked to complete a Body Shape Questionnaire (BSQ-16b) (Evans and Dolan, 1993) and the Eating Attitudes Test (EAT-26) (Garner *et al.*, 1982). The mechanisms of attention and eye movements are closely related; significant features of a scene will be fixated upon. Research on what determines the significance of particular regions has acknowledged two main aspects; the first involves 'bottom-up' processing whereby features of an image will be fixated upon (Reinagel and Zador, 1999). The second involves 'top-down' processing whereby cognitions of the observer such as memories, beliefs and preconceptions will effect movements of the eye around an image. Therefore these questionnaires were used to quantify body shape and eating disordered concerns to participant's eye gaze patterns as well as the physical attributes of the image.

Sitting at desk with the SMI eye tracker and a 22"computer screen directly in front of them at the recommended 70cm distance, participants were then shown a 9 point calibration screen. The purpose of the calibration is to allow the system to establish a relationship between the position of the eye in the camera view and a gaze point in space. The calibration also establishes the plane in space where eye movements are rendered. Since this relationship strongly depends on the overall system setup and also varies between test subjects, a reference measurement (calibration) must be performed before each experimental run.

Once calibrated, the experiment was started and participants were shown their own body and asked to rate it for attractiveness and then for body size, on a scale of 0-9 (0 being very unattractive/very thin, 9 being very attractive/very fat). The image was shown for 3000ms.

Participants were then shown the full image set and were again asked to rate them for attractiveness and body size using the same scale as before. The experiment comprised of 6 block trials with participants being required to alternatively rate the entire image set for attractiveness and body size in each block; each body was shown and rated three times. Each trial followed the same sequence: An information screen informing the participant of what they would be rating the following images for; an image would then appear for a period of 3000ms; a rating screen would appear until the participant had chosen their score and then the next image was shown. The trial would end when all 28 images had been shown and the next trial would automatically begin with an information screen informing the participant to now rate the images for the alternative behavioural judgement. The images were randomised for each trial to prevent order effects.

Once each image had been rated; three times for attractiveness and three times for body size, a screen was shown on the computer informing participants that the experiment had finished and thanking them for their participation. The experimenters contact details were also given if participants wanted any more information about the study or if they later decided to withdraw their data from the study (Appendix I).

An additional hypothesis this study wanted to investigate is whether participants could recognise their own body within an image set when they weren't aware their body would be shown. If participants viewed their own body in such a way, would they perceive their body any differently compared to when they were aware they were viewing their own body? Each participant's body image was therefore included in the main image set participants rated but this information was withheld from the participant. Therefore participants were aware they were rating themselves in the first half of the eye movements experiment but were unaware their body would be shown again in the remaining part of the experiment. At the end of the experiment the experimenter verbally asked the participant if they recognised any of the images shown in the main image set and each participant said they had recognised that their own body had been repeated.

5.4 Data Analysis

From the anthropometric measures obtained from the participants, body indices such as their BMI and WHR were calculated. The circumferential measures were also calculated into ratios, namely; the Waist Bust Ratio (WBR), (waist circumference divided by the bust circumference), and the Bust Hip Ratio (bust divided by the hip). These additional circumferential measures would allow further insight into potential predictors of Attractiveness and Body Size.

Participants were also required to complete two questionnaires which were scored and correlated with their ratings also. The Body Shape Questionnaire (Evans and Dolan, 1993) is a self-report scale used to assess body dissatisfaction caused by feelings of being fat (see Appendix J). To score the questionnaire the numbers are totalled up to question 14 as follows: ‘Always’ = 1 to ‘Never’ = 6. For question 15 the numbers are scored the opposite way round: ‘Always’ = 6 to ‘Never’ = 1. Evans and Dolan (1993) state that a score of 66 is the cut off for someone who has high body shape concern, therefore participants scoring 66 and above were classed as having high concerns for the current study.

The Eating Attitudes Test (EAT-26) (Garner *et al.*, 1982) is used to test “eating disorder risk” based on attitudes, feelings and behaviours relating to eating and eating disorder symptoms (see Appendix K). To score the questionnaire, for questions 1-25, ‘Always’ = 3, ‘Usually’ = 2, ‘Often’ = 1, ‘Sometimes’ = 0, ‘Rarely’ = 0 and ‘Never’ = 0. For question 26 the scores are the opposite way round. A score of 20 or above indicates a high level of concern about dieting, body weight or problematic eating behaviours and you should seek further advice from a qualified health professional. There are also 6 behavioural questions towards the end which Garner *et al*., (1982) suggests if any are checked by the respondent, further advice from a qualified mental health professional should be sought.

The analysis for the following data set was then separated into two main sections;

The participant's judgement of other people's bodies was analysed. This allowed the confirmation that they were rating the bodies in the same way as had been reported in previous studies.
The eye movements for participant's own versus other people's bodies and participant's rating female bodies were analysed.

In each section, the ratings participants gave were analysed to determine whether the calculated body indices had an influence on the two behavioural judgements. This was achieved through Pearson's *r* correlation coefficient; and multiple regression analysis was then used to determine how much of an influence these measures had. The gaze patterns of the participants were then analysed to determine where on the bodies participants looked when making the two behavioural judgments. This was illustrated by plotting fixation density heat maps and quantified by conducting 2 factor repeated measures ANOVAs to determine significant differences in participant's gaze patterns.

5.5 Results

5.5.1 *Rating Analysis: Women Rating Other Women's Bodies*

To test the inter-rater reliability of the data, a Cronbach's Alpha (α) was performed testing to what extent people within a particular group are rating in the same way.

For attractiveness judgements, an α value of .98 was found and for body size an α value of .99 was found. As an alpha value of .70 or above is considered satisfactory (Kline, 1999), these results would suggest high within-group consistency of female participants when rating female bodies for the two behavioural judgements in the current study.

The four body indices were firstly correlated with one another to determine whether any co-varied.

Table 2. Pearson's correlation between the four body indices.

	BMI	WHR	WBR	BHR
BMI	1.00	**0.52****	**0.42***	0.04
Sig. (2-tailed)		0.01	0.03	0.83
WHR	**0.52****	1.00	**0.39***	**0.49****
Sig. (2-tailed)	0.01		0.04	0.01
WBR	**0.42***	**0.39***	1.00	**-0.61****
Sig. (2-tailed)	0.03	0.04		0.001
BHR	0.04	**0.49****	**-0.61****	1.00
Sig. (2-tailed)	0.83	0.01	0.001	

**Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

As can be seen from Table 2, many of the body indices co-varied and therefore in the subsequent analysis it was hard to determine which singularly, was the best predictor for each of the two judgements.

The body indices taken from the women in the pictures were then correlated with the two behavioural measures (see Table 3).

Table 3. Pearson's correlation between all body indices and the two judgements made.

	Attractiveness	Body Size
Attractiveness	1.00	**-0.51****
Sig (2-tailed)		0.01
BMI	**-0.50****	**0.89****
Sig (2-tailed)	0.01	0.001
WHR	-0.14	**0.57****
Sig (2-tailed)	0.47	0.001
WBR	-0.20	**0.55****
Sig (2-tailed)	0.32	0.001
BHR	0.06	-0.03
Sig (2-tailed)	0.77	0.90

**Correlation is significant at the 0.01 level

Only BMI was found to significantly correlate with attractiveness judgements whilst all but BHR significantly correlated with body size judgements.

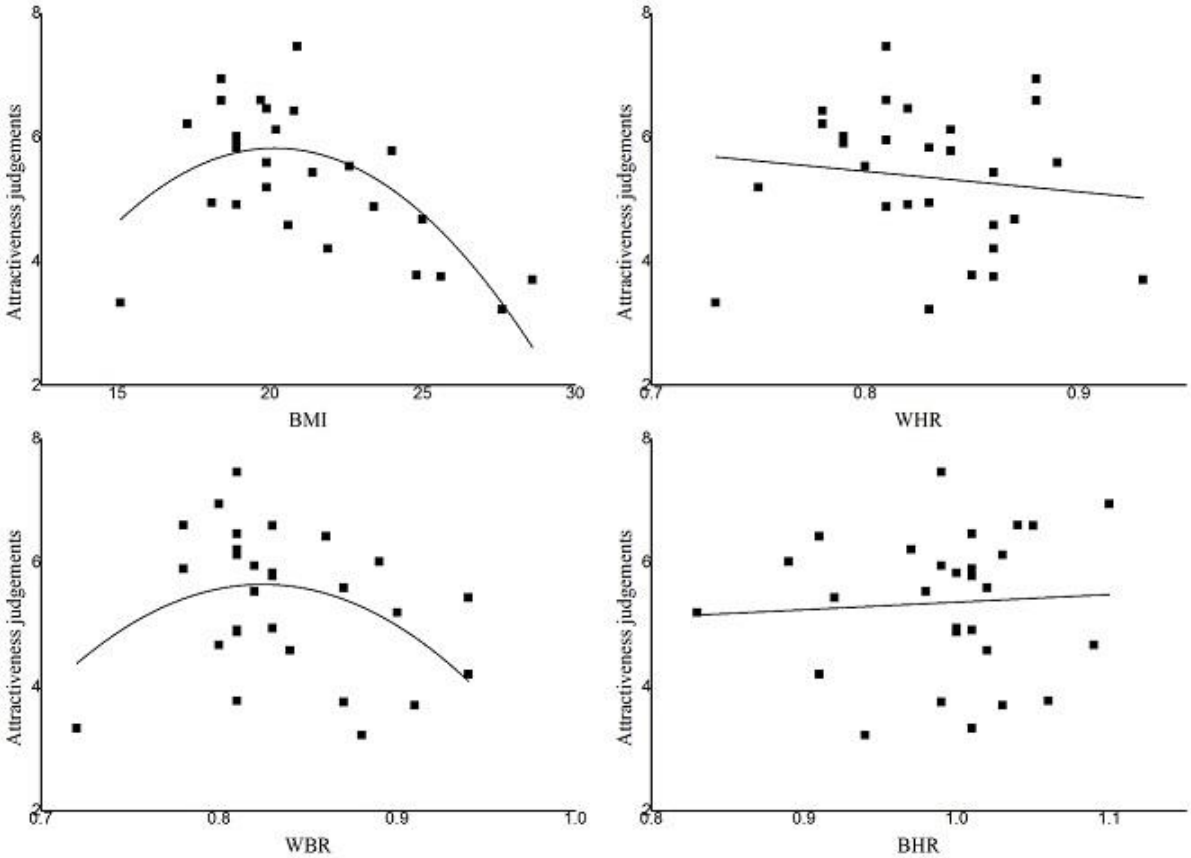


Figure 3. The relationship between the average female attractiveness score for each female image and the female images' body indices.

Due to Figure 3 suggesting polynomial trends in the data, particularly for BMI and WBR, a hierarchical regression was first performed to clarify what variable terms should be entered into the regression model.

The linear term for BMI accounted for 24.8% of the variance ($F_{(1,26)} = 8.58$, p =.007, r = .50) whilst the squared term accounted for 47.7% ($F_{(1,25)} = 10.97$, p =.003, r = .70). Similarly, the linear term for WBR accounted for 3.7% of the variance ($F_{(1,26)} = 1.00$, p =.328, r = .20) whilst the squared term accounted for 17.9% ($F_{(1,25)} = 4.34$, p =.048, r = .42). Therefore, due to the squared terms adding significance to the model, a 2^{nd} order polynomial regression was performed whereby mean attractiveness was defined as the outcome variable whilst predictor variables were the measured body indices (WHR and BHR were excluded as they were non-significant). 57.5% of the variance for attractiveness was accounted for and the overall model was significant ($F_{(4,23)} = 7.78$, p<.0001, r = .80).

Table 4. The results of the multiple regression model for attractiveness judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	-85.94	34.41		-2.50	0.02
	BMI	1.24	0.66	3.47	1.88	0.07
	WBR	190.60	88.03	8.25	2.17	**0.04**
	BMI²	-0.03	0.02	-4.03	-2.22	**0.04**
	WBR²	-113.37	51.68	-8.29	-2.19	**0.04**

For the current model (Table 4), the VIF value of 1.184 was found to be well below 10 (Myers, 1990) and the tolerance statistic of .845, well above 0.2 (Menard, 1995); therefore there is little cause for concern of collinearity suggesting that both BMI and WBR independently predicted female attractiveness judgements.

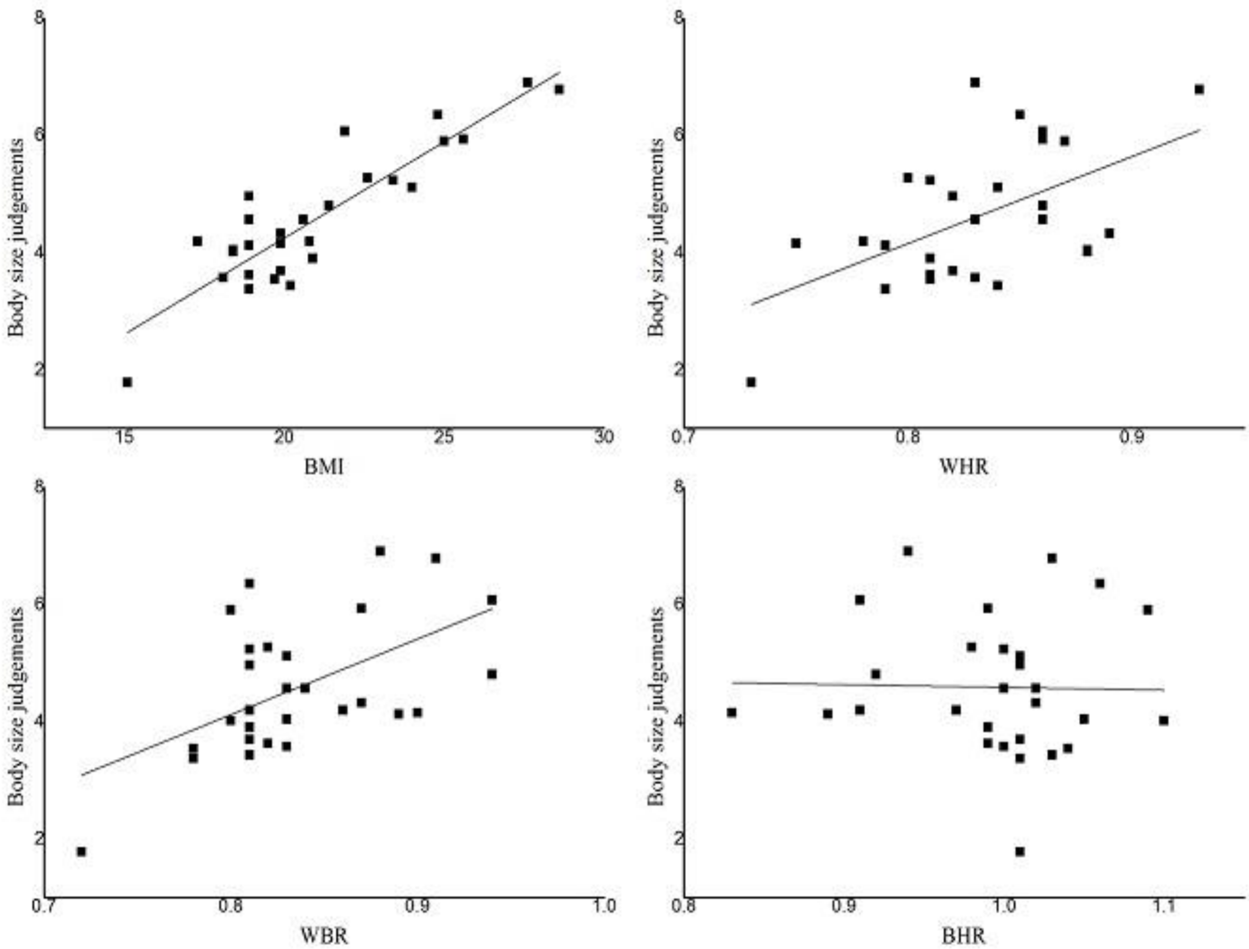


Figure 4. The relationship between the average female body size score for each female image and the female images' body indices.

Because adding the squared terms for each variable added no significance, a multiple linear regression was performed for body size judgements. 83.1% of the variance was accounted for and the model was highly significant ($F_{(3,24)}$ = 39.46, p<.0001, r = .91).

Table 5. The results of the multiple linear regression performed for body size judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	-7.11	2.20		-3.23	0.00
	BMI	0.28	0.04	0.76	7.48	**0.001**
	WHR	2.70	2.66	0.10	1.02	0.32
	WBR	4.23	2.26	0.18	1.88	0.07

Table 5 shows that when entered into the regression model, only BMI significantly predicted body size judgements. This is further supported by the collinearity diagnostics which were found to all be below 10 (1.48; 1.44; 1.28, respectively) (Myers, 1990). The tolerance scores were also found to be above 0.2; (.68; .70; .78, respectively) (Menard, 1992) and therefore BMI can reliably be concluded to account for the body size judgements, independent of the remaining body indices.

5.5.2 *Women Rating Their Own Bodies*

To investigate which body features are used when a person is judging their own body, each participant's body indices was correlated with the average rating they gave themselves for attractiveness and body size.

Table 6. Pearson's correlation between the two behavioural judgements and the participant's body indices.

	Attractiveness	Body Size
Attractiveness	1.00	-0.26
Sig. (2-tailed)		0.21
BMI	0.12	**0.66****
Sig. (2-tailed)	0.57	0.001
WHR	0.26	**0.49***
Sig. (2-tailed)	0.21	0.01
WBR	0.25	**0.46***
Sig. (2-tailed)	0.21	0.02
BHR	-0.01	-0.04
Sig. (2-tailed)	0.98	0.87

**Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

As with the previous analysis of females rating other women's bodies, none of the body ratios were found to correlate with attractiveness judgements and furthermore, even BMI failed to reach significance (Table 6). This would indicate other factors affecting attractiveness judgements. The body size judgements were primarily predicted by BMI (Table 6). WHR was also a significant predictor, consistent with the suggested role of stomach size as a visual cue to body weight (e.g. Tovée *et al*., 1999; Rilling *et al*., 2009).

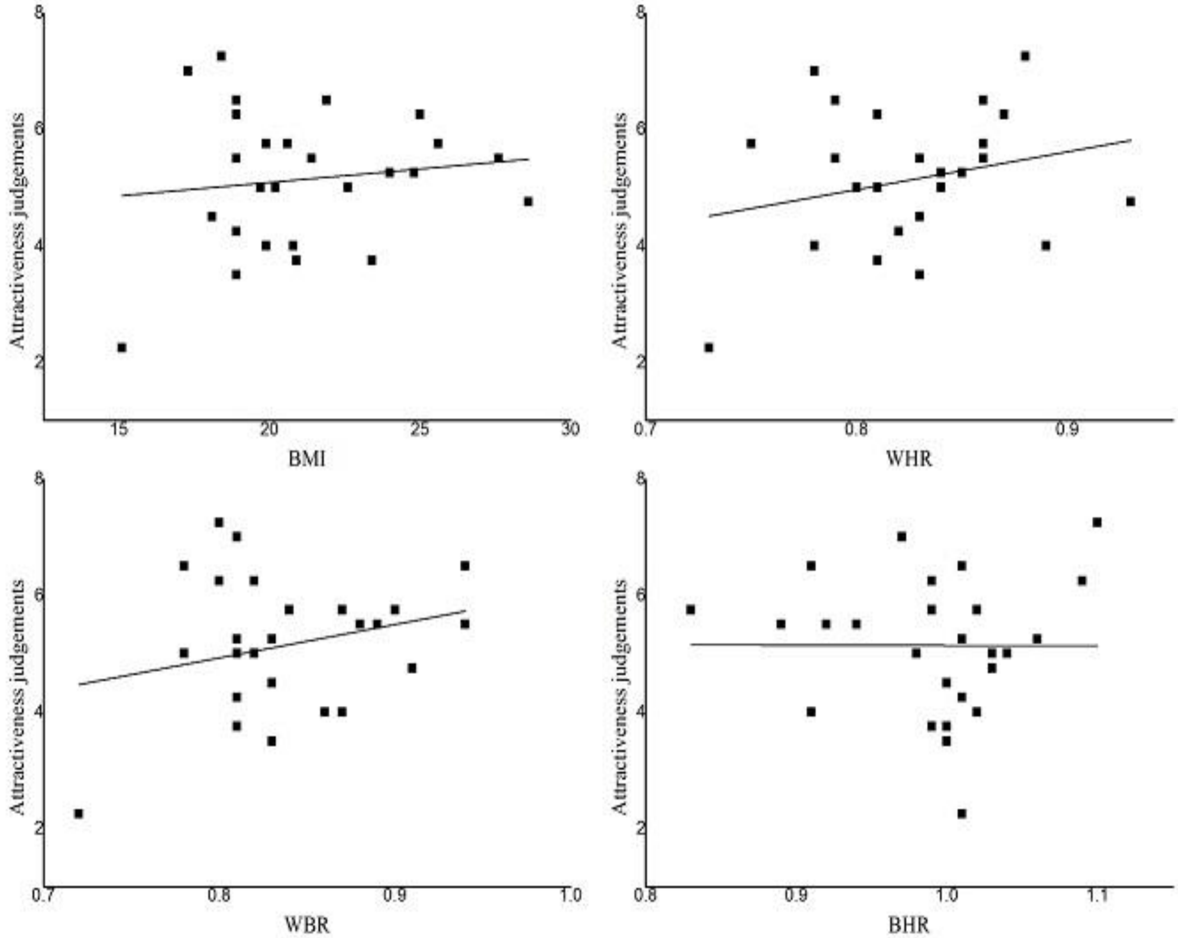


Figure 5. The relationship between the average female attractiveness score they gave themselves and their body indices.

Due to the findings of the hierarchical regression finding no significant improvement to the models when the squared terms were added, a multiple linear regression was performed. The variance for attractiveness was found to account for 20.5% and the model was not significant ($F_{(4,21)}$ = 1.36, *p* = 0.28, *r* = .50).

Table 7. The results of the multiple linear regression for attractiveness judgements.

		B	Std.Error	β	*t*	*p*
Model 1	Constant	-135.77	78.67		-1.73	0.10
	BMI	0.00	0.09	-0.01	-0.03	0.97
	WHR	-151.43	93.11	-5.79	-1.63	0.12
	WBR	158.53	91.07	6.84	1.74	0.10
	BHR	134.83	79.67	6.94	1.69	0.11

Using the statistical software package G*Power, version 3.1.7 (http://www.gpower.hhu.de/en.html), a priori calculation for linear multiple regression estimated a sample size of 43 participants would be required for the model to reach significance (effect $r = 0.50$, $\alpha = 0.05$, power = 0.95).

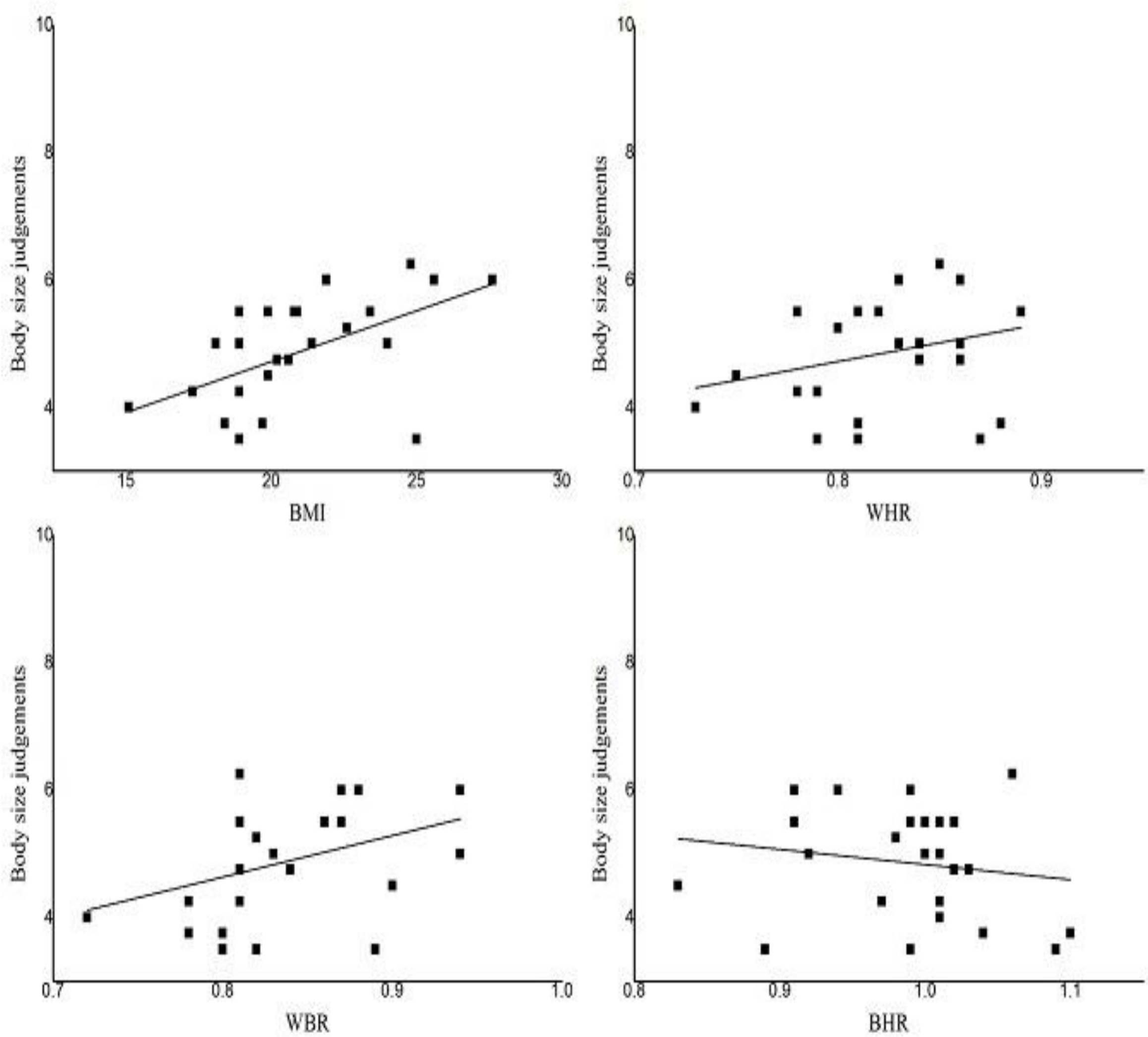


Figure 6. The relationship between the average female body size score they gave themselves and their body indices.

Again, due to none of the squared terms of each of the body indices adding significance to the models, a multiple linear regression was performed. 49.7% of the variance was found to be accounted for and the model was significant ($F_{(3,22)} = 7.26$, $p<.001$, $r = .71$).

Table 8. The results of the multiple linear regression model for body size judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	-5.47	3.94		-1.39	0.18
	BMI	0.19	0.07	0.51	2.70	**0.01**
	WHR	3.60	4.91	0.14	0.73	0.47
	WBR	4.27	3.94	0.19	1.08	0.29

For the model described in Table 8, the VIF values were found to be well below 10 (1.58; 1.55; 1.28, respectively) (Myers, 1990) and the tolerance statistics were all above 0.2 (.63; .64; .78, respectively) (Menard, 1995); therefore no collinearity occurred within the data and BMI can be reliably attributed as an independent predictor of the body size judgements.

5.5.3 *Are 2D cues a better predictor of own body judgements?*

In the analysis above, the cues used were the circumferential measures taken from the women's bodies. However, the observers were judging 2D photographs of themselves, and a measure of body size taken across the body might be a better way of capturing what they actually saw.

The images were therefore opened in Corel Photo Paint 9 and X coordinates were recorded (in pixels) across the width of the corresponding body parts. The left X coordinate was then subtracted from the right X coordinate to obtain the width of the body part.

Table 9. Pearson's correlation between the body indices measured across the bodies and the two behavioural judgements.

	Attractiveness	Body Size	BMI
Attractiveness		-0.24	
Sig. (2-tailed)		0.23	
BMI	0.13	**0.67****	
Sig. (2-tailed)	0.54	0.001	
WHR	0.26	0.01	0.01
Sig. (2-tailed)	0.20	0.96	0.97
WBR	0.29	-0.13	0.16
Sig. (2-tailed)	0.15	0.51	0.44
BHR	-0.12	0.15	-0.17
Sig. (2-tailed)	0.56	0.48	0.41

**Correlation is significant at the 0.01 level

Only BMI was still found to significantly correlate with body size judgements; the remaining body indices failed to reach significance. Again, none of the physical indices correlated with attractiveness.

5.5.4 *Do cognitive factors predict judgements of own body?*

As physical factors did not seem to predict attractiveness judgements, the scores on the BSQ and EAT-26 were correlated with the attractiveness and body size ratings.

Table 10. Pearson's correlation between the two behavioural judgements and participants' questionnaire scores.

	Attractiveness	Body Size
Body Size	-0.24	1.00
Sig. (2-tailed)	0.23	
BSQ	**-0.62****	0.15
Sig. (2-tailed)	0.01	0.46
EAT_26	**-0.60****	-0.07
Sig. (2-tailed)	0.01	0.74

**Correlation is significant at the 0.01 level

The results seemed to suggest a significant relationship between the BSQ and EAT_26 questionnaires and the judgements for own body attractiveness. Plots of the significant relationships found between the questionnaire scores and the judgement were derived from a hierarchical regression (Figure 7).

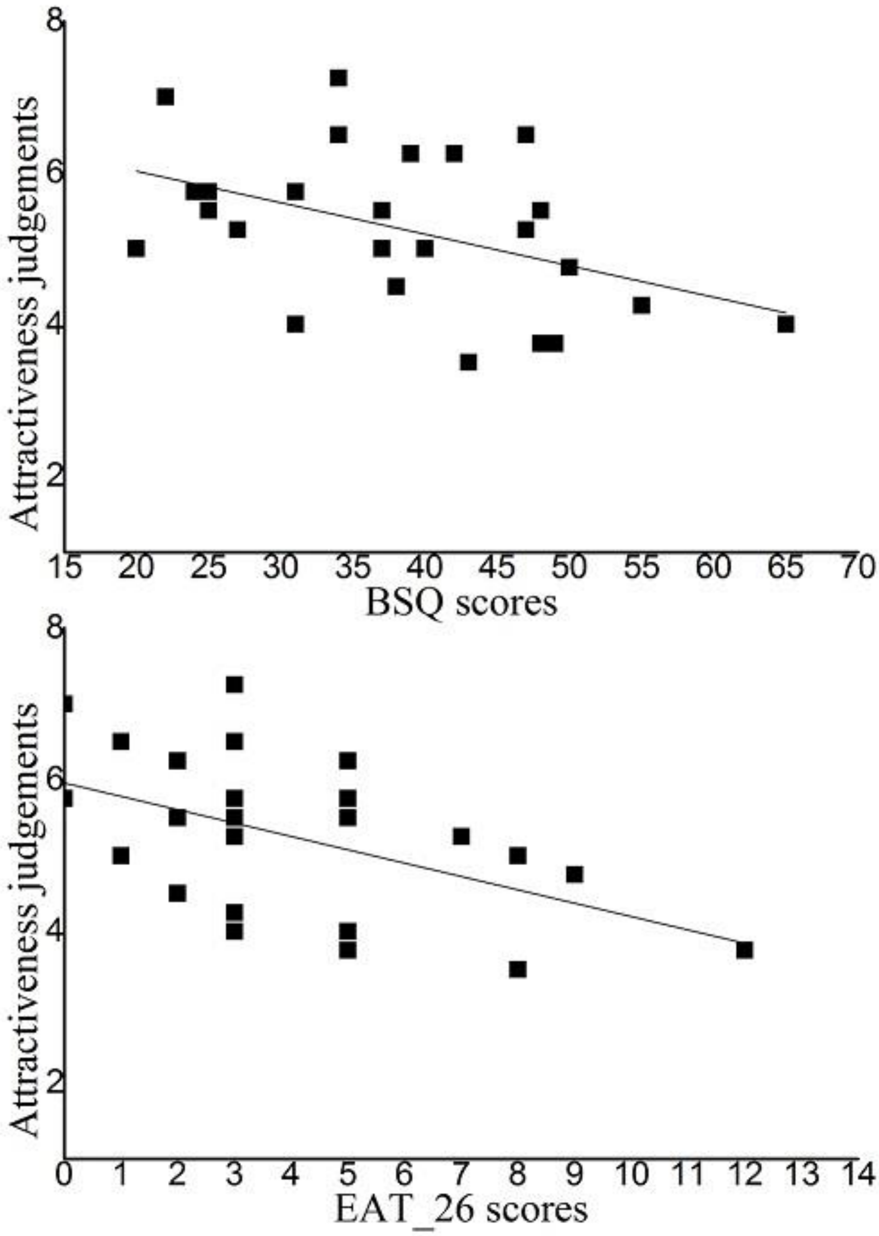


Figure 7. Plots of the significant relationship found between the BSQ and EAT_26 questionnaire scores for each participant against her rating of her own body's attractiveness.

The squared terms of the questionnaires did not significantly improve the attractiveness model and therefore a multiple linear regression was performed. The attractiveness model accounted for 44.3% of the variance and was significant ($F_{(2,23)} = 9.16$, $p<.001$, $r = .67$).

Table 11. The results of the multiple linear regression model for attractiveness judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	6.64	0.64		10.39	0.00
	BSQ	-0.03	0.02	-0.40	-1.81	0.08
	EAT_26	-0.04	0.02	-0.33	-1.50	0.15

The linear term for EAT_26 accounted for 0.5% of the body size variance ($F_{(1,24)}$ = .12, *p* =.737, *r* = .07), however the squared term for EAT_26 accounted for 16.1% of the variance and was shown to significantly improve the body size model ($F_{(1,23)}$ = 4.27, *p*<.05, *r* = .40). Therefore a 2^{nd} order polynomial regression was performed. The variance for body size was found to account for 21.7%, however the model was not significant ($F_{(3,22)}$ = 2.03, *p* = 0.14, *r* = .47).

Table 12. The results of the polynomial regression model for body size judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	3.55	0.80		4.42	0.00
	BSQ	0.03	0.02	0.34	1.26	0.22
	EAT_26	0.14	0.10	1.28	1.45	0.16
	EAT_26^2	0.00	0.00	-1.62	-1.93	0.07

Using G*Power, version 3.1.7, a priori calculation for linear multiple regression estimated a sample size of 43 participants would be required for the model to reach significance (effect *r* = 0.50, α = 0.05, power = 0.95)

5.5.5 R*atings between when participants knew it was their body and when they didn't know*

When asked if participants were aware their own body was shown in the main data set of images viewed, they all said they recognised their body had been repeated. Analysing the ratings they gave themselves compared with the part of the experiment where they weren't told their body would be shown, confirmed this, as significant correlations were found for attractiveness judgements, (M=5.2, SD=1.20) (participants knew), (M=5.23, SD=1.33) (participants didn't know),($r_{(26)}$ = 0.98, *p*<.0001). A paired t-test found no significant difference between the two conditions ($t_{(25)}$ = -1.20, *p* = 0.24, *r* = .23).

Similarly, a significant correlation was found for body size judgements between the two conditions, (M=5.01, SD=1.2) (participants knew), (M=4.9, SD=1.30) (participants didn't know), ($r_{(26)}$ = 0.98, p<.0001). A paired t-test further found no significant difference between the two conditions ($t_{(25)}$ = 0.88, p = 0.39, r = .17).

5.6 Eye Movement Analysis

The data files produced by the eye tracker interface were comprised of eye position coordinates for each field (120 per second) for each segment (image presentation). Analysis of the raw eye movement data involved removing the saccadic movements (involuntary, rapid, small movements of both eyes simultaneously) and leaving the fixation information which can be subsequently collapsed into a single fixation point using the BeGaze 3.2 analysis software package.

To illustrate the spatial structure of fixations, the gridded data for the whole period of image presentation was smoothed and converted into a matrix in order to create contour plots of fixation density. The colour scheme is non-linear; the most densely fixated area (over 50% of fixations) is coloured red thus allowing clear identification of the main Areas of Interest (AOIs).

In order to examine specific areas of the body that participants may fixate on when making certain judgements, twelve 14.5 x 14.5mm cells created a grid over each image containing the total number of fixations for each participant. This cell size represents a compromise between capturing as many fixations per cell as possible (usually requiring larger cells) whilst retaining good anatomical resolution (usually requiring small cells). Each cell can therefore be said to represent an AOI (see figure 8 for an example).

5.6.1 *Eye Movements When Rating Other Women's Attractiveness*

To examine the hypothesis that fixations will show a specific distribution on the body when making attractiveness judgements and are not evenly distributed, a one-way ANOVA was conducted to see whether the total number of fixations in each of the 12 AOIs was significantly different. The results showed a significant overall relationship ($F_{(11,324)}$ = 62.10, p<.0001, r = .83).

Post hoc comparisons using the Tukey HSD test indicated that there were significant differences between the AOIs, (see Table 13).

Table 13. The differences in gaze distribution between the AOIs indicated by the significance level found.

	AOI1	AOI2	AOI3	AOI4	AOI5	AOI6	AOI7	AOI8	AOI9	AOI10	AOI11	AOI12
AOI1			$p<.0001$		$p<.0001$		$p<.0001$				$p<.0001$	$p<.05$
AOI2			$p<.0001$	$p<.05$	$p<.0001$	$p<.0001$	$p<.0001$					
AOI3	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI4		$p<.05$	$p<.0001$		$p<.0001$		$p<.0001$			$p<.05$	$p<.0001$	$p<.0001$
AOI5	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI6		$p<.0001$	$p<.0001$		$p<.0001$		$p<.05$		$p<.05$	$p<.0001$	$p<.0001$	$p<.0001$
AOI7	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.05$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI8			$p<.0001$		$p<.0001$		$p<.0001$				$p<.05$	$p<.0001$
AOI9			$p<.0001$		$p<.0001$	$p<.05$	$p<.0001$					$p<.05$
AOI10			$p<.0001$	$p<.05$	$p<.0001$	$p<.0001$	$p<.0001$					
AOI11	$p<.05$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.05$				
AOI12	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.05$			

It can be seen by visual inspection of Table 13 that AOIs 3, 5, 7 and possibly 6, has the most significantly different gaze fixations with the remaining AOIs.

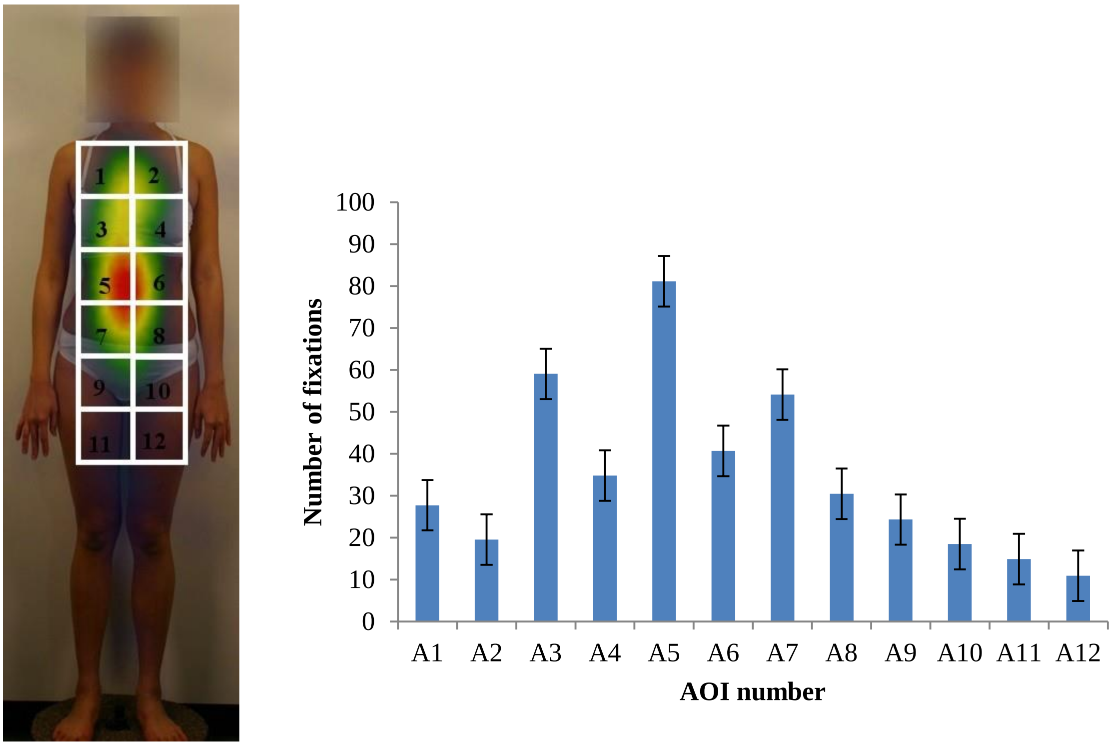


Figure 8. The number of fixations for Attractiveness judgements for each AOI averaged across all 28 images with standard error bars.

From Figure 8, it is evident that AOIs 3, 5 and 7 have a predominantly higher number of fixations compared to the remaining AOIs. However, only the fixation count in AOI 7 was significantly correlated with the mean attractiveness ratings (Pearson correlation, $r_{(28)}$ = -0.50, p<.001). The location of AOI 7 corresponds with the pattern of looking observed in women judging women’s bodies; that they look significantly more in the waist region when judging attractiveness (e.g. Cornelissen *et al*., 2009; George *et al*., 2011). A possible explanation could be that females are estimating stomach depth which has been suggested as a predictor of attractiveness judgements (e.g. Tovée *et al*., 1999; Rilling *et al*., 2009).

There was no significant correlation between attractiveness judgements and the remaining AOIs.

5.6.2 *Eye movement analysis between Attractive and Less Attractive bodies*

To then investigate whether there are differences in eye movement patterns when viewing perceived attractive images compared to perceived less attractive images, fixation density maps were plotted for the 5 most attractive images and the 5 least attractive images rated by participants.

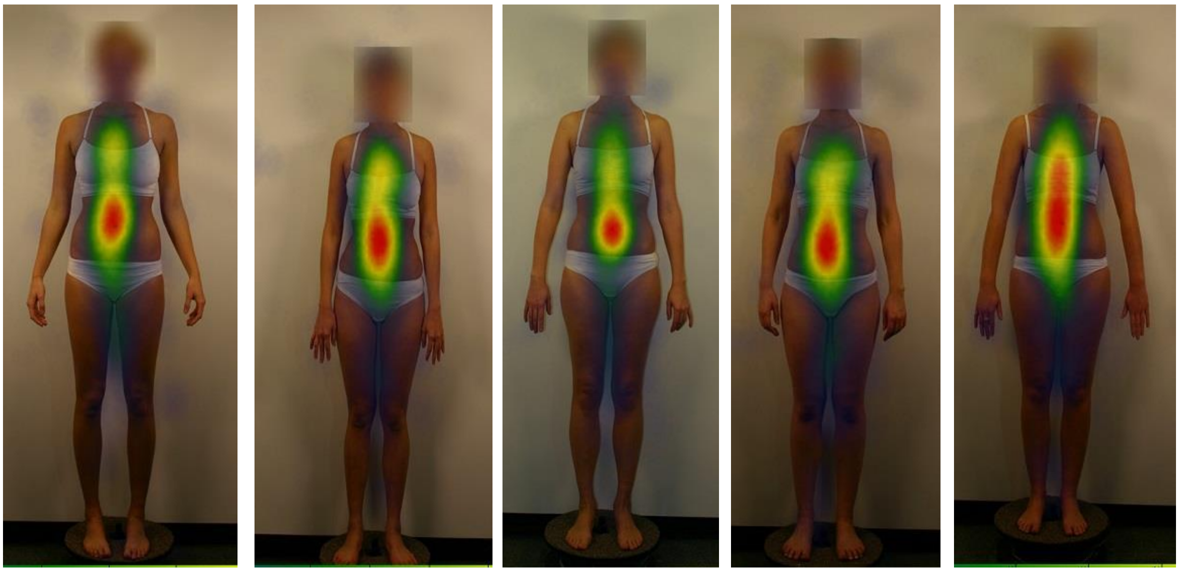


Figure 9. Fixation density heat maps for the 5 most attractive bodies rated by female participants.

Figure 10. Fixation density heat maps for the 5 least attractive bodies rated by female participants.

From preliminary inspection of Figures 9 and 10, no prominent difference in fixation pattern was evident between the fixation densities on the most attractive and least attractive images.

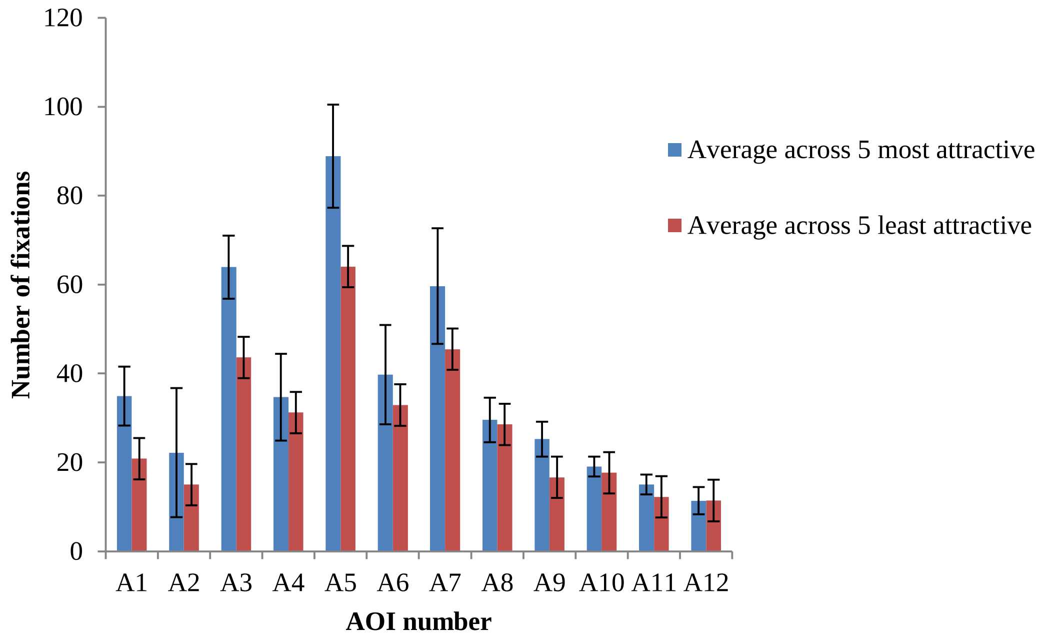


Figure 11. The number of fixations per AOI averaged across each image for the 5 most attractive and least attractive rated images with standard error bars.

When plotting the total number of fixations for each AOI for the 5 most attractive images against the total number of fixations for each AOI for the 5 least attractive images, the results suggest that when an image was perceived as more attractive, participants made more total fixations than when the images were perceived as less attractive (Figure 11). A paired samples t-test confirmed a significant difference between the 12 AOIs for the most attractive images (M=37.02, SD= 23.01) and the 12 AOIs for the least attractive images, (M= 28.3, SD=16.13), ($t_{(11)}$ = 3.76, p<.05, r = .75).

A 2 factor repeated measures ANOVA using Factor 1 as Attractive versus Less Attractive and Factor 2 as the AOIs, found no significant effect between the judgements ($F_{(1,4)}$ = 1.13, p = .349, r =.47), a significant effect was found between the AOIs ($F_{(1,11)}$ = 15.58, p<.0001, r = .77) however no interaction effect was found between the judgement and the AOIs ($F_{(1,11)}$ = 0.425, p = .936, r = .20).

A simple effects analysis was then performed to look at the effect of one independent variable at individual levels of the other independent variables. The analysis revealed two corresponding AOIs to have significant differences between the 5 most attractive and 5 least attractive rated bodies, namely; AOI 7; ($F_{(1,4)}$ = 78.29, p<.001, r =.98) and

AOI 11; ($F_{(1,4)}$ = 10.29, p<.05, r =.85). From Figure 11 it can be concluded therefore that observers spent more time gazing at AOI 7 and 11 on attractive bodies compared to the same areas on bodies perceived as less attractive.

No significant effects were found between the remaining AOIs across the 5 images rated most and least attractive.

5.6.3 *Eye Movements When Rating Other Women's Body Size*

To then examine whether the distribution of fixations were specific to certain body parts or evenly distributed across the body when making body size judgements, a one-way ANOVA was conducted on the number of fixations across the 12 AOIs for body size judgements. A significant relationship was revealed ($F_{(11,324)}$ = 53.26, p<.0001, r =.80) suggesting fixations were more specifically distributed when making such a judgement.

Post hoc comparisons using the Tukey HSD test indicated that there were significant differences between the AOIs (see Table 14).

Table 14. The differences in gaze distribution between the AOIs indicated by the significance level found.

	AOI1	AOI2	AOI3	AOI4	AOI5	AOI6	AOI7	AOI8	AOI9	AOI10	AOI11	AOI12
AOI1			$p<.0001$		$p<.0001$	$p<.05$	$p<.0001$					$p<.05$
AOI2			$p<.0001$	$p<.05$	$p<.0001$	$p<.0001$	$p<.0001$					
AOI3	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI4		$p<.05$	$p<.0001$		$p<.0001$		$p<.0001$			$p<.05$	$p<.05$	$p<.0001$
AOI5	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI6	$p<.05$	$p<.0001$	$p<.0001$		$p<.0001$				$p<.05$	$p<.0001$	$p<.0001$	$p<.0001$
AOI7	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.05$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI8			$p<.0001$		$p<.0001$	$p<.05$	$p<.0001$					$p<.0001$
AOI9			$p<.0001$		$p<.0001$	$p<.05$	$p<.0001$					$p<.05$
AOI10			$p<.0001$	$p<.05$	$p<.0001$	$p<.0001$	$p<.0001$					
AOI11			$p<.0001$	$p<.05$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.05$				
AOI12	$p<.05$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.05$			

Much like for attractiveness judgements, visual inspection of Table 14 indicated that AOIs 3, 5, 6 and 7 had the most significantly different gaze fixations with the remaining AOIs for body size judgements.

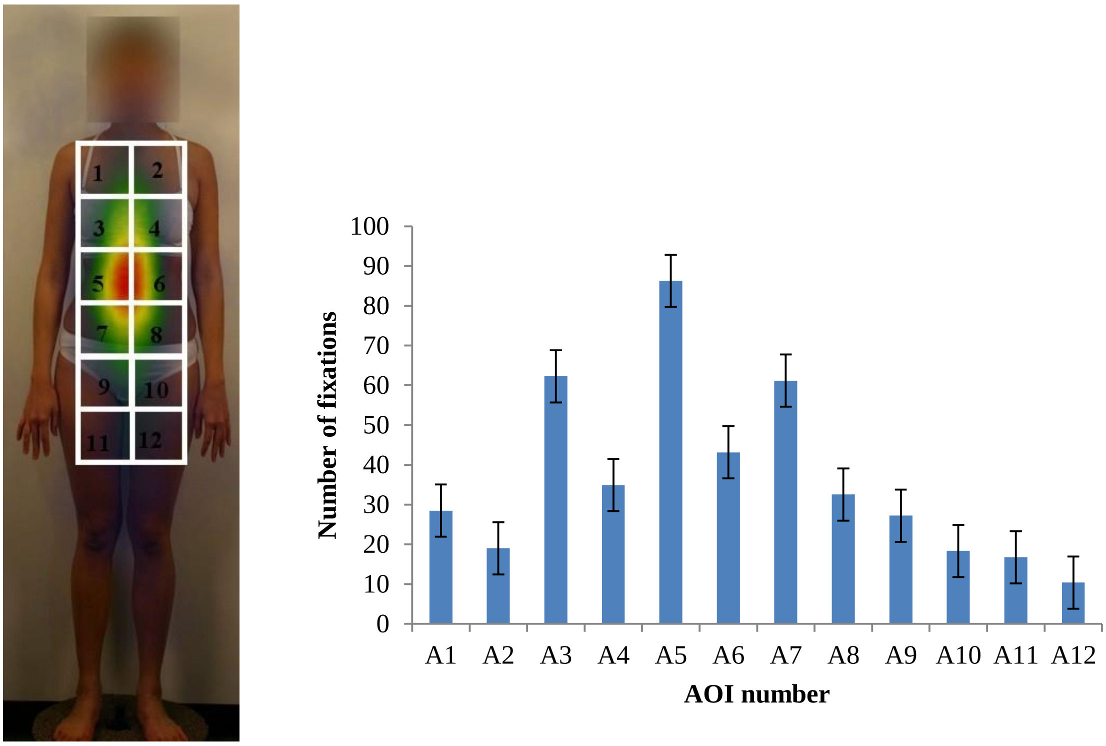


Figure 12. The number of fixations for Body Size judgements for each AOI averaged across all 28 images using standard error bars.

Just as for attractiveness judgements, AOI 3, 5 and 7 were found to have a higher number of fixations when judging body size. However, AOI 6 can also be seen to have a slightly greater number of fixations when participants judged body size. Further analysis of the data, using Pearson's *r* coefficient indicated that none of the fixation counts in these AOIs were significantly correlated with the mean body size ratings.

5.6.4 *Eye movement analysis between Heavy and Light bodies*

To further investigate whether there are differences in eye movement patterns when viewing perceived heavy bodies compared to perceived light bodies, fixation density heat maps were plotted for the 5 heaviest and the 5 least lightest images rated by participants.

Figure 13. Fixation density heat maps for the 5 heaviest images rated by female participants.

Figure 14. Fixation density heat maps for the 5 lightest rated images.

Visual inspection of the fixation density heat maps revealed no prominent difference between when participants rated the 5 images perceived as the heaviest and the 5 images perceived as the lightest (see Figures 13 and 14).

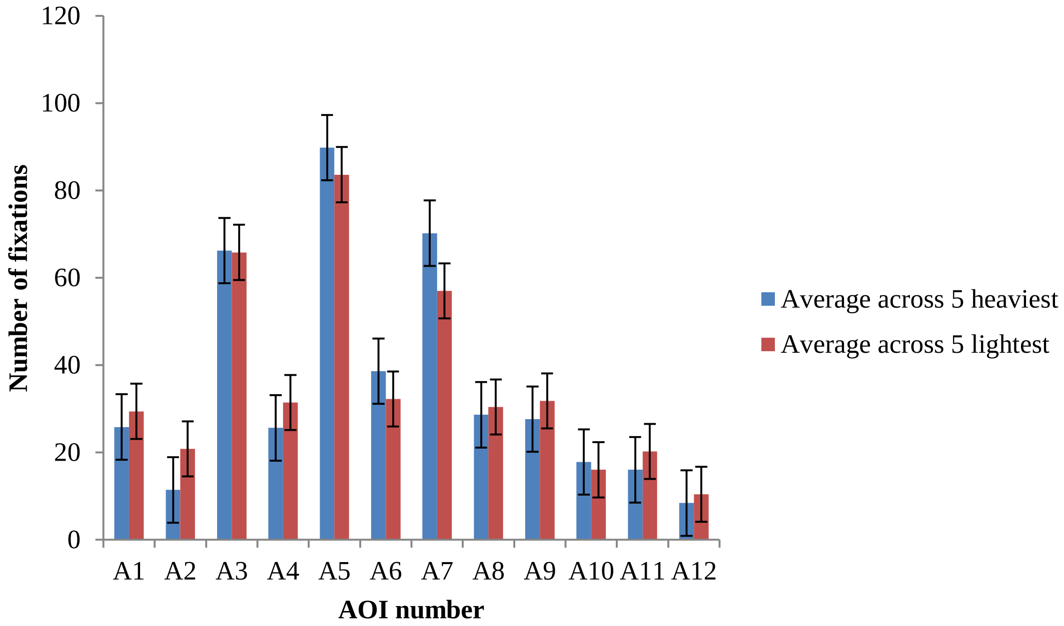


Figure 15. The number of fixations per AOI averaged across each image for the 5 heaviest and lightest rated images, including standard error bars.

Preliminary viewing of Figure 15 suggested no significant difference in the fixation distribution between the two conditions. A paired samples t-test confirmed this, as no significant difference was found between the 12 AOIs for the heaviest images (M=35.5, SD= 25.96) and the 12 AOIs for the lightest images (M= 35.8, SD=21.9), ($t_{(11)}$ = -0.14, p = 0.89, r = .04).

A 2 factor repeated measures ANOVA using Heavy versus Light judgements as Factor 1 and the AOIs as Factor 2 further confirmed this, revealing no significant effect between the judgements ($F_{(1,4)}$ = 0.04, p = 0.85, r =.10), a significant effect was found between the AOIs ($F_{(1,11)}$ = 11.81, p<.0001, r = .46) but no significant interaction effect was found between the judgements and the AOIs ($F_{(1,11)}$ = 0.34, p = 0.95, r = .09).

A simple effects analysis showed no significant effects between any of the AOIs across the 5 heaviest and 5 lightest bodies.

It can therefore be concluded that observers showed no significantly different gaze patterns when viewing perceived light weight and heavy weight bodies.

5.6.5 *Eye movements analysis when rating Attractiveness and Body Size*

To examine whether fixation distributions differ overall when making the two separate judgements a 2 factor repeated measures ANOVA was then conducted. Mauchly's test indicated that the assumption of sphericity had been violated for the interaction between attractiveness and body size perception, ($\chi^2_{(65)}$ = 223.79, p<.0001). Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (Ɛ=.266 for the main interaction effect).

A significant effect was found between the two judgements ($F_{(1,27)}$ = 5.26, p<.05, r =.40) and also between the AOIs ($F_{(2.041,55.107)}$ = 60.04, p<.0001, r =.72). No significant interaction effect was found between the judgements and the AOIs however ($F_{(2.927,79.040)}$ = 0.77, p = 0.51, r =.09).

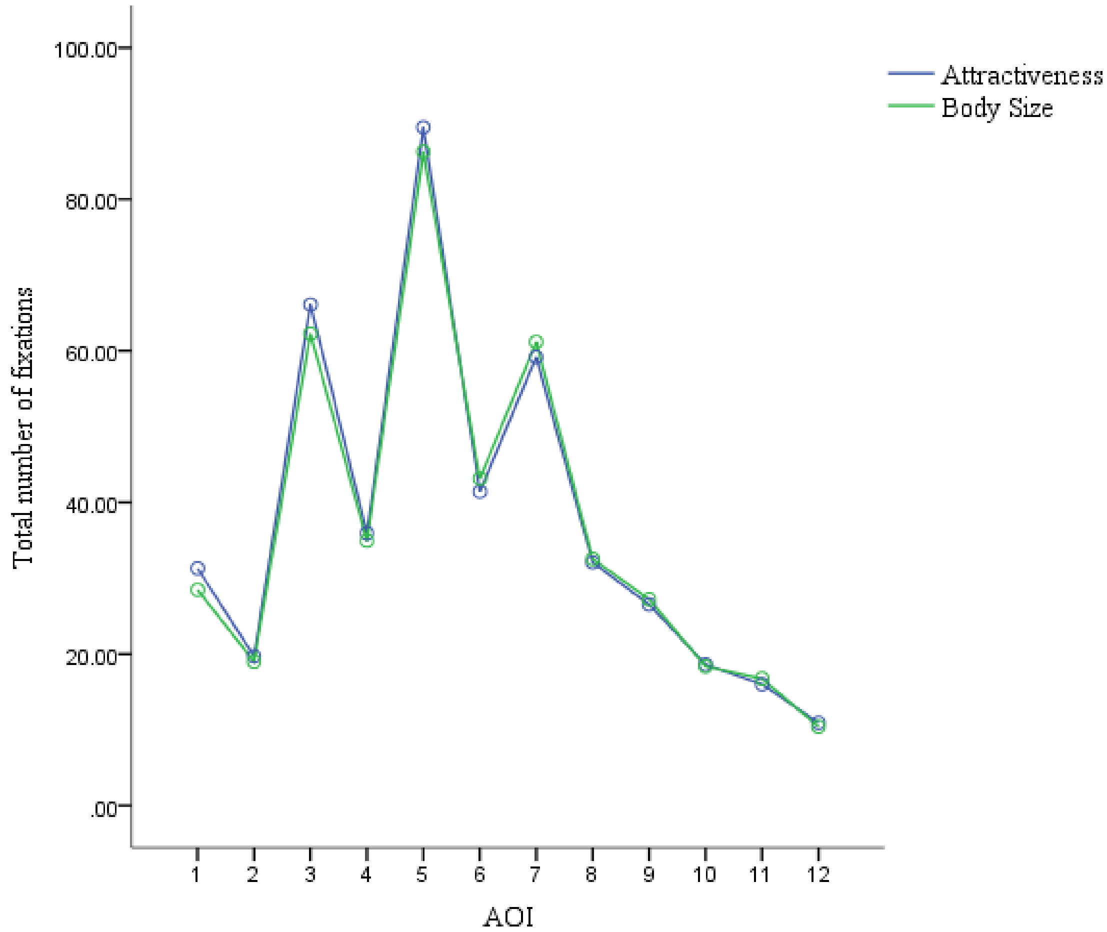


Figure 16. The interaction plot of the total number of fixations per AOI when participants rated bodies for Attractiveness compared to Body Size.

A simple effects analysis revealed no significantly different gaze fixations between any of the AOIs for both judgements.

It can be concluded therefore that participants similarly distributed their gaze when making attractiveness and body size judgements on other women. This corresponds with the ratings data, as only BMI significantly correlated with attractiveness judgements when females were rating other women's bodies and as BMI and body size judgements were found to highly correlate, it can be interpreted as females predominantly using BMI/perceived body size to make their judgements of attractiveness on other women.

5.6.6 *Are the Eye-movements made when Judging Own Attractiveness Different to when Judging Own Body Size?*

For each condition, the fixation counts were converted into percentage scores (see figure 17 for an illustration) and analysed using a 2 factor repeated measures ANOVA. Factor 1 was the condition (own attractiveness vs own body size) and factor 2 was the AOI cell. Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of AOI, ($\chi^2_{(65)} = 120.27$, $p<.0001$) and for the main interaction between the condition and the AOIs, ($\chi^2_{(65)} = 94.32$, $p<.01$). Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε=.56 for the main effect of AOI and ε=.67 for the main interaction effect).

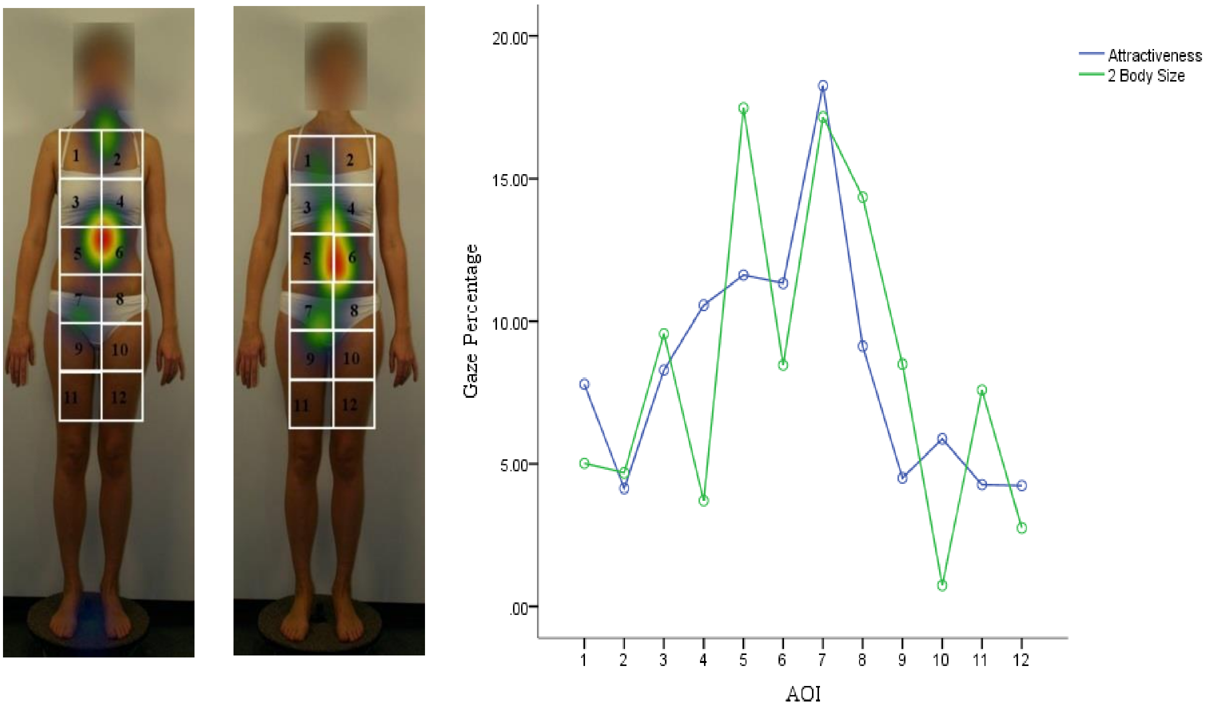


Figure 17. An example of the percentage gaze times for the 12 AOIs when participants looked at their own bodies for Attractiveness (left body image) and Body Size (right body image).

The analysis found no significant main effect between the two conditions ($F_{(1,26)} = 1.15$, $p = 0.39$, $r = .21$). However a significant effect was found between the AOIs ($F_{(5.19,132.37)} = 5.73$, $p < .0001$, $r = .20$). No significant effect was found between the interaction of the two conditions and the AOIs ($F_{(6.24,162.23)} = 1.56$, $p = 0.29$, $r = .09$).

To see whether there were differences between specific AOIs when participants were observing their own body for attractiveness and body size, a simple effects analysis was then performed.

The analysis showed that the only significant differences found were between AOIs 4 for attractiveness and body size ($F_{(1,26)} = 7.57$, $p < .01$, $r = .50$) and between AOIs 10 ($F_{(1,26)} = 5.84$, $p < .05$, $r = .43$).

No significant differences were found between the remaining corresponding AOIs.

Therefore overall, participants show no significantly different gaze patterns when judging their own body for attractiveness and body size apart from spending significantly less time gazing at AOI 4 and AOI 10 when judging body size, (Figure 17).

5.6.7 *Own Body Judgements versus Judgements of Other Women's bodies*

To compare across the two conditions (i.e. when participants rated their own body compared to when they rated other people's bodies), would produce an uneven data set with only one output per participant when they viewed their own body and 26 outputs for when they viewed the remaining image set. Therefore, the overall total percentage for each of the 12 AOIs, across all 26 images had to be calculated for when participants were judging other people's bodies. Therefore, for each participant, the total number of fixations was totalled across the 26 images for each corresponding AOI, i.e. all the AOI 1s across all the 26 images were totalled, all the AOI 2s were totalled, all the AOI 3s across the 26 images were totalled etc. These 12 totals were then added together and then individually divided by this overall total to gain a percentage for each of the 12 AOIs. The 12 AOIs for when participants were looking at their own body were also converted into percentages and therefore gave a data set with an even output; 12 AOI percentages for when participants viewed their own body and 12 AOI percentages for when they viewed other people's bodies.

5.6.8 *Own versus Other Women's bodies: Attractiveness judgements*

A 2 factor repeated measures ANOVA was used to test whether participants looked differently at their own body compared to other women's bodies. Factor 1 was the condition (own body vs other women's body) and Factor 2 was the AOI cell.

Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of AOI ($\chi^2_{(65)}$ = 156.19, p<.0001) and for the main interaction effect between participants looking at themselves verses other people when judging for attractiveness and the AOIs ($\chi^2_{(65)}$ =126.24, p<.01). Therefore degrees of freedom were corrected using Greenhouse-Geisser estimated of sphericity (Ɛ=.47 for the main effect of AOI and Ɛ=.53 for the main interaction effect).

Overall, no significant main effect was found between the two conditions ($F_{(1,26)}$ = 0.16, p = 0.82, r =.07). A significant main effect of AOI was found ($F_{(4.16,105.51)}$ = 8.97, p<.0001, r =.23). However no significant interaction effect was found between when participants viewed their own body compared to when they viewed other people's bodies and the AOIs ($F_{(5.89,150.77)}$ = 1.29, p = 0.31, r =.09). However when looking at the interaction graph (Figure 18), prominent differences can be seen between the percentage gaze times in the 12 AOIs between the two conditions.

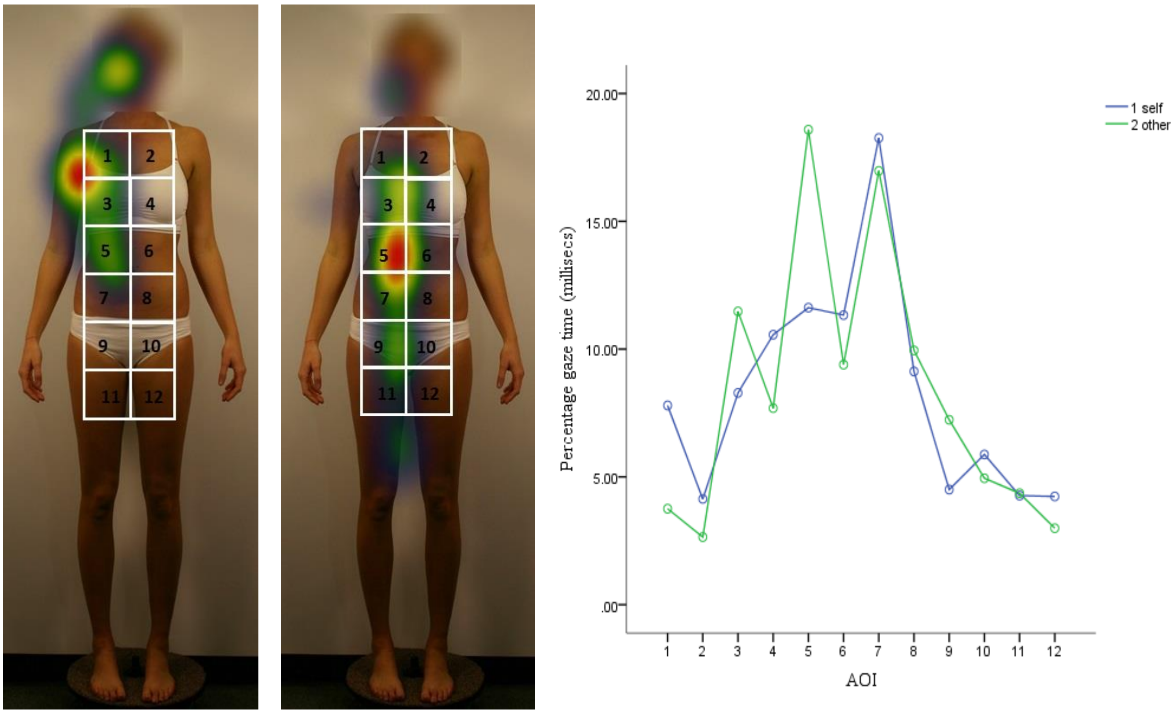


Figure 18. The percentage gaze times for the 12 AOIs when participants looked at their own body (example on the left side) compared to other people's bodies (example of the whole group looking at a body (right)).

It was noticeable that when participants viewed other people's bodies, they spent considerably longer looking at AOI 5 in particular, than they did when they viewed the same AOI on their own body, (Figure 18). Therefore a simple effects analysis was conducted to compare the differences between each paired AOI e.g. AOI 1 when looking at their own body compared to AOI 1 when looking at other people's bodies. The analysis showed that the only significant difference found between the paired AOIs was between AOI 5 ($F_{(1,26)} = 6.55$, $p<.05$, $r = .45$). It suggests that participants spent an increased amount of time looking at the upper abdominal area when making judgements of attractiveness on other people than they did when making the same judgments on their own body.

No significant differences were found between the remaining corresponding AOIs.

5.6.9 *Own versus Other Women's bodies: Body Size judgements*

Again, Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of AOI ($\chi^2_{(65)} = 135.48$, $p<.0001$) and for the interaction effect for when participants rated their own body and when they rated other people's bodies for body size and the AOIs ($\chi^2_{(65)} = 121.33$, $p<.01$). Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε=.50 for the main effect of AOI and ε=.52 for the main interaction effect).

No significant effect was found between the two conditions ($F_{(1,26)}$ = 2.60, p = 0.12, r =.30). A significant effect of AOI was found ($F_{(5.52,143.62)}$ = 12.56, p<.0001, r =.28). However, no significant interaction effect was found between the two conditions and the AOIs ($F_{(5.74,149.13)}$ = 1.96, p = 0.10, r =.11).

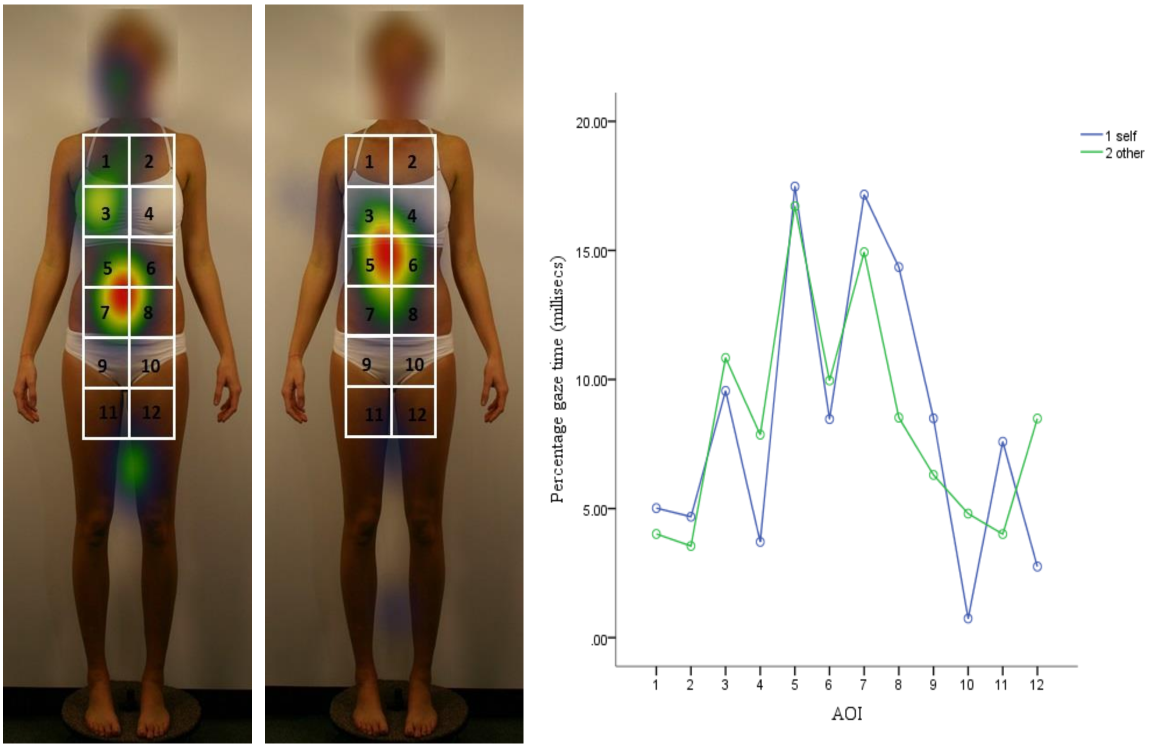


Figure 19. The percentage gaze times for the 12 AOIs when participants looked at their own body (example on the left) compared to other people's bodies (example of the whole group looking at a body (right)), when judging for Body Size.

Unlike Figure 18 which presented a smooth curve between AOIs with the only prominent fixation being on AOI 7 for when participants viewed their own body, Figure 19 shows a more staccato pattern indicating that participants are differing more in their fixations on specific AOIs when making body size judgements.

A simple effects size analysis was therefore conducted to test the statistical differences between the paired AOIs between the two conditions. The results showed a statistical difference between AOIs 4, ($F_{(1,26)}$ = 4.69, p<.05, r =.40), AOIs 8, ($F_{(1,26)}$ = 4.33, p<.05, r =.38), AOIs 10, ($F_{(1,26)}$ = 9.78, p<.01, r =.52) and finally AOIs 12, ($F_{(1,26)}$ = 23.23, p<.0001, r =.69). It can therefore be concluded that participants specifically look at AOIs 4, 10 and 12 for a significantly longer amount of time *on other people* compared to when they look at the same AOIs on their own body when judging for body size. In contrast, when making the same judgement, they look significantly longer at AOI 8 *on their own body* compared to when looking at the same AOI on other people's bodies.

No significant difference was found between the remaining corresponding AOIs.

5.7 Discussion

The aim of this study was to use eye tracking methodology to determine where women looked when judging their own and other women's bodies.

5.7.1 *When judging other women, what is the best predictor of attractiveness?*

When determining which physical features of female bodies contributed to attractiveness judgements, only BMI was shown to be a significant predictor. This is consistent with previous studies in this area (Tovée *et al.*, 2002). Taking the 'mate selection' theory into consideration, there are clear explanations as to why BMI is used by males as a cue for potential mates and therefore why females use the same cue when assessing potential rivals. In adult women for example, BMI is shown to closely correlate with health and fertility. Manson *et al*., (1992) conducted a cohort study following 115,195 women over a period of 16 years and found that high values of BMI increased the risk of mortality considerably. BMIs of 25-27 having a 33% increase in relative risk, BMIs of 27-29 having an increased risk of 60% and BMIs of 29-32 having 100% increased risk. High BMI also has a negative impact on fertility (Frisch, 1988; Manson *et al*., 1995; Lake *et al*., 1997). Furthermore, a relatively low BMI is associated with irregular menstrual cycles and problems with ovulation (Desouza & Metzger, 1991), therefore studies have shown that the balance between the optimal BMI for health and fertility is 18-20kg/m^2 (Cash & Hicks, 1990; Tovée *et al*., 2003). The results from this study can also be shown to support such findings.

5.7.2 *Do observer's gaze patterns change when making different judgements about other people's bodies?*

The overall gaze pattern for observer's judging other people's bodies for attractiveness and body size showed a very similar distribution. This is consistent with the eye movements necessary for judging body size being part of the eye movement pattern used to judge attractiveness and is therefore consistent with the behavioural data which suggested that attractiveness ratings were predicted by body size (indexed by BMI).

This therefore supports previous studies of this question (Tovée *et al*., 1998, 1999, 2002; Fan *et al*., 2004; Smith *et al*., 2007; Cornelissen *et al*., 2009).

In accordance with the eye movement analysis, the lower abdominal/hip region was specifically shown to have a significant correlation with the mean attractiveness ratings. This is consistent with fixations to estimate stomach depth which has been suggested to be the principle cue to BMI (Rilling *et al*., 2009; George *et al*., 2011).

5.7.3 *What is the best predictor of behavioural judgements when females judge themselves?*

Only responses to the EAT_26 questionnaire and BSQ significantly correlated with observer's attractiveness judgements of themselves indicating psychological/attitudinal processing influencing this judgement. Therefore it can be suggested that 'top-down' processing occurred (Gregory, 1970). This process incorporates people's prior knowledge and past experiences/memories into their perception. Gregory (1970) hypothesised that sensory receptors receive information from the environment which is then combined with previously stored information which we have built up as a result of experience. Such a finding is consistent with research carried out by Cash (1997) and Waldman (2013), who suggested that we have significant concerns and pre-concepts regarding our own bodies when it comes to making attractiveness judgements.

For body size judgements, observers (who were predominantly in the normal BMI range) were shown to accurately estimate their own body size supporting previous studies (e.g. Tovée *et al*., 2003; Cornelissen *et al*., 2013). Furthermore, the majority of the remaining body indices used in the analysis were shown to correlate with body size judgements, consistent with a perceptual/sensory process involved in making such a judgement; observers used the visual stimuli presented to them to make their judgements, therefore indicating predominantly 'bottom-up' processing (Reinagel & Zador, 1999).

The results from the current study therefore lend support to both perceptual and attitudinal processes being used when making judgements about one's own body with attractiveness judgements being more subjective depending on a person's pre-conception of them-self, whereas body size is more objective and based on sensory information. This further supports the hypothesis presented by Garner and Garfinkel

(1981), Cash and Green (1986) and Gardner and Brown (2010) that both of these processes are independent and should be measured separately.

In addition to such explanatory theories, it is known that in Western societies such as the sample used in the current study, a lower BMI is preferred due to cultural/medial pressures to look at certain way (Cash, 2003; Markey, 2004). This would potentially exert a strong influence on women's concept of what they should aspire to be. This ideal body size/shape which is notably impossible for many women to achieve is suggested to lead to body dissatisfaction (measured by such questionnaires as used in the current study) and in more severe cases, to an eating disorder (Thompson, 2001; Cash, 2003).

5.7.4 *Do observer's gaze patterns change when making different judgements about their own body?*

When judging their own bodies, observers were shown to fixate longer on their breast and thigh region when making attractiveness judgements compared to making body size judgements; although no overall significant interaction effect was found between the two judgements. These fixations could support either Jansen *et al*., (2005)'s findings that control observers fixated longer on the parts of their body they considered the most beautiful or could lend support to the contrasting findings of Roefs *et al*., (2008) who found that control observers spent longer fixating on 'problem areas' of their body. As no subjective information was collected from observers in this study as to their attitude to different body parts, it cannot be concluded which hypothesis is supported. Future work should collect such information from observers.

Although judgements of own body attractiveness are predicted by psychological measures and other women's attractiveness by BMI, there was no significant difference in the eye-movements in the two conditions. This suggests that the information gained from the visual fixations is over ruled by their pre-conceptions of the body's attractiveness.

5.7.5 *Do observer's gaze patterns change when judging their own body compared to other peoples?*

The results of the current study showed that female observers fixate longer on the abdominal region of other women than on the same region when judging their own body. This suggests that observers selectively attend to the abdominal region when judging other people's attractiveness and is consistent with the use of abdominal fat to judge whether that particular body is attractive or not (e.g. Tovée *et al*., 1999; Rilling *et al*., 2009; Crossley *et al*., 2012). This is consistent with previous work such as that by George *et al*., (2011) suggesting that the physical dimensions of the stomach are a good indication of overall body mass and so of attractiveness as also reported in this study (Tovée *et al*., 1999; Rilling *et al*., 2009).

5.7.6 *Limitations*

A main limitation to this experiment is that the AOIs on the body were assumed independent of one another when a more realistic view would be to assume that there is co-variation within cells of close proximity to one another, (see Figure 20).

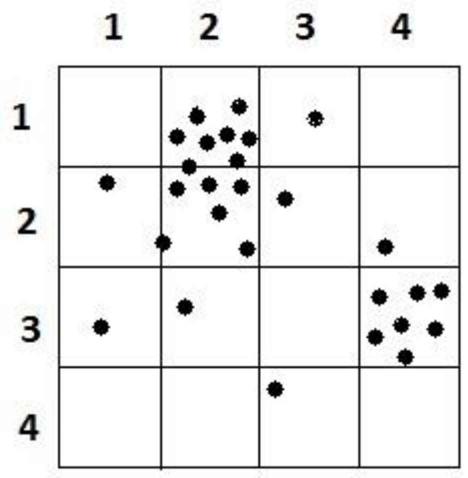


Figure 20. An example of spatial co-variation.

In the hypothetical example shown in Figure 20, cells (2,1), (2,2) and (4,3) could all be statistically significant compared to the remaining cells. However, whilst cell (4,3) is clustered on its own, it could be that cell (2,2) is statistically significant due to its close proximity with cell (2,1) where the fixation counts are more densely populated. Therefore when modelling the fixation data, this experiment did not control statistically for spatial co-variation. This limitation can be overcome with the use of the GLIMMIX procedure in SAS which allows specification of spatial co-variation structures by integrating the spatial variability into the statistical models. However, as the current experiment failed to show any significantly striking results, the need for a more complex analysis is unnecessary. However it should be considered for future studies.

It should also be noted that the range of body shapes and sizes used in the current study was quite limited and is not representative of a general population (Table 1). Furthermore, it is likely that the "type" of person who is willing to pose for the type of photographs in this study would be generally more "body confident", a hypothesis which is supported by the average BSQ score of 40.19 in this sample. Therefore recruitment of a sample of participants with a diverse range of shapes and sizes, and with a wider body image concern, may produce more interesting results.

Furthermore, using a stimulus set of real bodies produces confounding variables such as discrepancies in skin tone for example. Previous studies have found positive links between attractiveness judgements and skin tone (Smith *et al*., 2007; Fink, Grammer & Thornhill, 2001). Whilst the current study used a Caucasian stimulus set, skin colour varies due to factors such as the degree of sun exposure and therefore it can be argued that skin tone may have influenced judgements of attractiveness. Future studies should take this into consideration and try to quantify the variation in skin tone by calculating the mean red, green and blue colour channels within a standard size patch of skin on each volunteer and then factor analyse the patch to compress them to a single value related to skin tone (see Smith *et al*., 2007).

5.7.7 *Conclusion*

In conclusion, although there are subtle differences shown in gaze patterns specifically with observers looking at the abdominal region longer on other people when judging attractiveness and at the breast and thigh region on other people when judging body size, no significant overall main effect was found. Future studies could collect additional information from participants as to specific body regions they are particularly concerned or happy about to compare to their fixation patterns. The results also suggest that body size fixations are very similar to attractiveness fixations, which is consistent with body size (namely BMI) being one of the main features used in female attractiveness judgements. Furthermore this study has shown that attitudinal processes influence judgements of attractiveness about our own bodies but perceptual processes were more important when making body size judgements. These potential pre-conceptions of one's own attractiveness could lead to body image distortion and potentially to eating disorders. Developing ways to help better understand and manage them, can potentially lead to the preventions of an eating disorder.

Chapter 6. Investigating Eye Movements of Female Observers when judging Male Attractiveness, Body Size and V-Shape.

6.1 Introduction

Whilst the majority of past research has focussed on which visual cues of the female body are fixated on when making attractiveness judgements (Jansen *et al.*, 2005; Roefs *et al.*, 2008; George *et al.*, 2011), visual cues of male bodies have been less extensively examined. The following chapter will therefore aim to combine participant's judgements and eye-tracking techniques to determine whether there are differences in the strategies used to assess male bodies for; Attractiveness, Body Size and apparent V-Shape.

Focusing solely on the perception of male bodies, the measured features of body size (BMI) and shape (WHR) are the most extensively researched variables, similar to that of female bodies (for a review see Weeden & Sabini, 2005). In addition to these two features, the waist-to-chest ratio (WCR) has also been included in male attractiveness research along with related variables that measure the angle of the upper torso caused primarily by differential upper body muscle and bone structure in relation to body fat, such as the chest-to-hip ratio (CHR) and the shoulder-to-hip ratio (SHR) (Franzoi and Herzog, 1987; Salussodeonier *et al.*, 1993; Maisey *et al.*, 1999; Dixson *et al.*, 2014).

Maisey *et al*., (1999) considered the three variables; BMI, WHR and WCR, when studying male attractiveness. Thirty female undergraduates (average age: 20.6 years, SD = 1.4) rated colour pictures of 50 men in front view. Multiple-polynomial regression was used to identify the parameters that were the best predictors of male attractiveness. WCR was found to be the principal determinant of male attractiveness and accounted for 56% of the variance, whereas BMI accounted for only 12.7% of additional variance. WHR was not a significant predictor of attractiveness in the model. Their findings suggest that women prefer men whose torso has an 'inverted triangle' shape (i.e. a narrow waist and a broad chest and shoulders). This is a shape consistent with physical strength and muscle development in the upper body. This finding is comparable with findings of other studies in which researchers used line drawings that exposed women to prefer men with a V shape body (Lavrakas, 1975; Furnham and Radley, 1989).

In further support of this, Fan *et al*., (2005) used a body scanner to create 3D wire-frame male body images and short film clips. Each clip was standardised and the body image rotated 360° during the viewing. The results showed that for both female and male observers, WCR was the most important factor of male attractiveness accounting for 53.6% (female observers) and 49.6% (male observers) of the variance. BMI was the second significant factor for female observers' in comparison to the WHR which was chosen as the second significant factor for the male observers.

To offer an explanation for such findings, evolutionary psychologists such as Barber (1995) suggested that increased masculinity enhanced attractiveness with the theory that bodily features thought to signal masculinity or dominance were particularly important. In this explanation, men's shoulders, biceps and upper body musculature are all central characteristics that determine male attractiveness. This is due to these features being better developed in men than in women (Ross, 1982) due to biological influences such as the effect of testosterone (Bjomtorp, 1987). Mesomorphy (muscularity) in men, is further shown to predict strength and endurance (Lassek and Gaulin, 2009; Sell *et al.*, 2009) and therefore may augment men's attractiveness as an indirect signal of heritable immunocompetence (Rantala *et al.*, 2013) and a direct signal of protectiveness and potential resource acquisition (Puts, 2010).

Others have tested how attractiveness influences visual attention by measuring attentional allocation to morphological cues within a body (Cornelissen *et al.*, 2009a; Dixson *et al.*, 2011a; Dagnino *et al.*, 2012). Subtle differences in attentional allocation have been found in multiple versus singular presentations of female bodies. Suschinsky (2007) manipulated female body shapes to reflect low, medium and high WHR values and presented all three versions simultaneously to male participants. They found men allocated most of their attention to the images judged most attractive irrespective of the WHR size supporting the hypothesis that attractiveness captures attention. However, attention to specific body regions differed with attractiveness and WHR, with the head and bust attracting more attention than the waist region irrespective of WHR, yet the bust region attracted more attention when judging the more attractive images with low WHRs (Suschinsky, 2007). In contrast, Cornelissen *et al.*, (2009a) presented female bodies in singular formation and found eye movements predominantly clustered around the bust and stomach region, emphasising that morphological cues relating to female health and fertility compete for men's attention when assessing attractiveness. Such a finding has also been replicated in several other studies where female images have been presented singularly (Dixson *et al.*, 2010b; Dixson *et al.*, 2011a; Nummenmaa *et al.*, 2012).

Interestingly, few studies have measured female's gaze patterns when judging male attractiveness. However, in a recent study Dixson *et al*., (2014) supported evolutionary theories as previously mentioned (Barber, 1995; Sell *et al*., 2009; Puts, 2010) by reporting that muscular men received the highest attractiveness ratings over lean and heavy built men by female observers. For eye movements, attention was shown to be evenly distributed to the upper and lower back on both muscular and lean men. In contrast, for heavy built men, the lower back, including the waist, was fixated on more. Furthermore, these patterns in visual attention were recorded as early as in the first second of viewing, suggesting that body stature is identified early in viewing and influences attention to body regions that provide relevant biological information during judgements of men's bodily attractiveness.

Considering the association between muscularity, immunocompetence and competitive ability therefore (Puts, 2010; Rantala *et al.*, 2013), the hypothesis for the current study that women should attend greatest to male's upper body region; chest and shoulders when assessing attractiveness is therefore proposed. In this study female participants were presented with male images and their eye movements were recorded to try and differentiate participant's eye movement patterns between the three behavioural judgements; Attractiveness, Body Size and predominant V-shape. It was expected that corresponding regions of the body would draw and hold visual attention to a greater extent in accordance to the question asked and that this would be similar for all participants for each variable. However taking into consideration that previous research has shown strong correlations between Attractiveness and V-shape, the study hypothesised that participants eye movement patterns would follow a similar path when judging these two variables but would show a differential gaze pattern when judging Body Size.

6.2 Preliminary Work

6.2.1 *Stimulus set*

29 male volunteers were recruited to have their bodies photographed for the image presentations used in the eye movements study. The study was advertised through the

Psychology School's research participation scheme at Newcastle University whereby students gained course credit for taking part. The males were aged between 18-24 years old, (Mean = 20.72, SD = 1.66) and all participation was voluntary.

Table 1. The 29 male volunteers average body measurements.

	BMI	WHR	CHR	WCR
Mean	23.90	0.91	1.07	0.85
SD	1.88	0.04	0.07	0.04
Min	20.30	0.82	0.98	0.73
Max	28.00	0.98	1.25	0.94

6.2.2 *Protocol*

Males were required to sign a consent form giving permission to use their photographs for the main eye movements study (Appendix B) and were briefed on what was required of them verbally, and through an information sheet (Appendix F). The experimenter provided a set of plain white boxer shorts in a range of sizes that the male participants could choose from and were asked to change into, (see Figure 1 for an example).

Participants were then asked to stand on a platform approximately 12cm off the ground. The platform was 218cm from the first prong of the Bilora MOD 3145 camera tripod used; 245cm from the centre of the tripod. Two Interfit Digilite 6 x 24W panels and light stands were used for extra lighting that contained fluorescent tubes of 288 total watts (120V AC). These were situated either side of the platform participants stood on, with the first prong being at a 95cm distance away from the centre of the platform and the middle of the light stand was situated 148cm's away, approximately. Both lamps were of a 178cm height from the ground. A 2m x 2m projection screen was also directly behind where participants stood to create a plain background to further enhance the images.

Using a Canon E0S camera with a Sigma autofocus lens of 24-70mm f/2.8 IF EX DG HSM, frontal body photographs were taken of the male participants. Participants were asked to stand with their legs shoulder width apart and their arms hanging naturally by their sides so the viewer can distinctly see the shape of the body, (see Figure 1). The faces were blurred in Photoshop both to anonymise participants and to prevent facial features playing a role in the judgements being made.

Figure 1. An example of the image set used in the eye tracking experiment.

Once the photographs had been taken, anthropometric measures were taken from the participants and recorded on the standardised participant data sheet (Appendix C). Height was measured using the Marsden/Invicta Free Standing Height Measure and weight was measured using the Weight Watchers 8944U Heavy Duty Body Fat Analyser Scale. Using a standard measuring tape, the chest, waist and hip circumferences were measured following the protocols outlined in the Health Survey for England (England, 2008b).

6.3 Main Experiment

6.3.1 *Participants*

30 female participants were recruited for this experiment aged between 18-46 years old, (Mean = 21.83, SD = 5.21). Again, participants were recruited through responding to the study advertised by the Psychology School's participation scheme for undergraduate students at Newcastle University and also, via the Institute of Neuroscience's internal mailing list where the study was conducted at.

6.3.2 *Recording eye movements*

The eye tracking equipment and experimental set up for this experiment was the same as that used in Chapter 5. Once the stimulus set had been collected and modified, they were inserted into the SMI Experimenter Centre™ 2.5.

During the experiment design time, the Experiment Centre software was started and a 'storyboard' was created for the visual stimuli to be presented. During the experiment execution time, the SMI Experimenter Centre™ 2.5 was started which automatically connected to the iView X eye tracker. The Experiment Centre recorded the participant's eye movements whilst they viewed the presented stimuli. Whilst recording, the Experimenter Centre automatically stored the eye and gaze tracking data as well as the corresponding stimuli files to an experiment results directory for later analysis.

6.3.3 *Eye tracking experimental paradigm*

The female participants were required to sit at a desk with the computer monitor approximately 70cm away from them. Participants were then given an information sheet (Appendix H) and briefed on the nature of the experiment. They were told that they would be shown a series of male images on the screen in-front of them and would be asked to rate these images for three variables; Attractiveness, Body Size and prominent V-Shape. Prominent V-Shape was described to participants as any of the bodies that had broad shoulders and a narrow waist, representing a V-like shape. The ratings would be on a scale of 0 (unattractive, emaciated and no V-shape, (straight up/straight down)) to 9 (very attractive, obese and definite V-shape). Whilst they were rating these images, participants were further told that their eye movements would be tracked and recorded by the eye tracking device positioned below the computer screen, (see Figure 2 in Chapter 5). Once satisfied with the procedure, participants were then required to sign a consent form (Appendix B).

To begin the experiment, participants were firstly shown a 9 point calibration screen. Once the software was satisfied with the tracking of the participant's gaze, the experiment began. An instruction screen was presented reiterating that participants would view an image set and rate them according to the corresponding question asked.

Participants began the experiment by pressing 'spacebar' which then presented the first question screen to indicate which behavioural judgement the participants were rating the following images for. Each individual male image was presented on the screen for 3000ms before a rating screen was presented and remained until the participant had given their response. Once all the images had been rated, the next question screen appeared instructing the participants of the next judgement they would be rating the image set for. This whole process was repeated three times per question so an average rating for each image could be obtained for each question. The images were randomised for each trial to prevent order effects.

Once the experiment was completed, a completion screen was presented, indicating the end of the experiment and thanking participants for their time. The experimenters contact details were also provided for any further questions participants may have or if they later decided to withdraw their data from the study.

6.3.4 *Data Analysis*

From the anthropometric measures obtained from the male participants in the stimulus pictures, body indices such as their BMI and WHR were calculated. Additional indices were also calculated such as the Chest Hip Ratio (CHR), measured by dividing the chest circumference by the hip circumference and the Waist Chest Ratio (WCR), measured by dividing the waist circumference by the chest circumference. These additional circumferential measures permitted further insight into potential predictors of Attractiveness, Body Size and V-Shape.

The analysis for the following data set was separated into two sections;

The ratings participants gave were analysed to determine whether the calculated body indices had an influence on the three questions asked. This was achieved through Pearson's correlation coefficient and multiple regression analysis which was used to determine how much of an influence these measures had.
The gaze patterns of the participants were then analysed to determine where on the bodies participants attended when making the three judgements. This was achieved through fixation density heat maps and by conducting two factor repeated measures ANOVAs on the total number of fixations in each Area of Interest on the body to compare potential differences between specific regions of the body participants attended when making separate judgements.

6.4 Results

6.4.1 *Rating Analysis; Women Rating Male Bodies*

To test the inter-rater reliability of the data, a Cronbach's Alpha (α) was performed testing to what extent people within a particular group are rating in the same way.

For attractiveness judgements, an α value of .98 was found, for body size an α value of .98 was found and for V-Shape judgements an α value of .98 was found. As an alpha value of .70 or above is considered satisfactory (Kline, 1999), these results would suggest uniformity in the performance of female participants when rating male bodies for all three judgements in the current study.

The body indices of the male volunteers were then correlated with one another to determine whether any co-varied.

Table 2. Pearson's correlation between the five body indices measured on the male bodies

	WHR	CHR	WCR	Height
BMI	0.04	0.22	-0.22	0.12
Sig. (2-tailed)	0.85	0.27	0.26	0.56
WHR		**0.63****	0.16	-0.10
Sig. (2-tailed)		0.001	0.42	0.63
CHR			**-0.67****	0.01
Sig. (2-tailed)			0.001	0.94
WCR				-0.10
Sig. (2-tailed)				0.62

**Correlation significant at the 0.01 level

Very few of the body indices were found to co-vary with one another (Table 2) and can therefore be considered to be predominately independent in their potential role in the three judgements asked.

The body indices were then correlated with the female observers judgements (Table 3).

Table 3. Pearson's correlation between the three judgements and the body indices calculated.

	Attractiveness	Body Size	V-Shape
Attractiveness	1.00	0.32	**0.78****
Sig. (2-tailed)		0.10	0.001
BMI	0.25	**0.77****	0.12
Sig. (2-tailed)	0.20	0.001	0.55
WHR	0.31	**0.38***	0.21
Sig. (2-tailed)	0.11	0.05	0.28
CHR	0.25	0.36	0.31
Sig. (2-tailed)	0.20	0.06	0.11
WCR	-0.01	-0.08	-0.19
Sig. (2-tailed)	0.98	0.69	0.33
Height	0.00	-0.24	-0.20
Sig. (2-tailed)	0.99	0.23	0.30

**Correlation significant at the 0.01 level
*Correlation significant at the 0.05 level

Attractiveness and V-shape judgements were only found to correlate with each other and none of the other body indices (Table 3). Body size however was found to correlate with BMI and WHR suggesting that these particular anthropometric measures were predominantly used when making such a judgement.

A regression analysis was then performed with mean attractiveness as the outcome variable and the body indices as predictor variables. To determine the type of relationship found, a hierarchical regression was first performed.

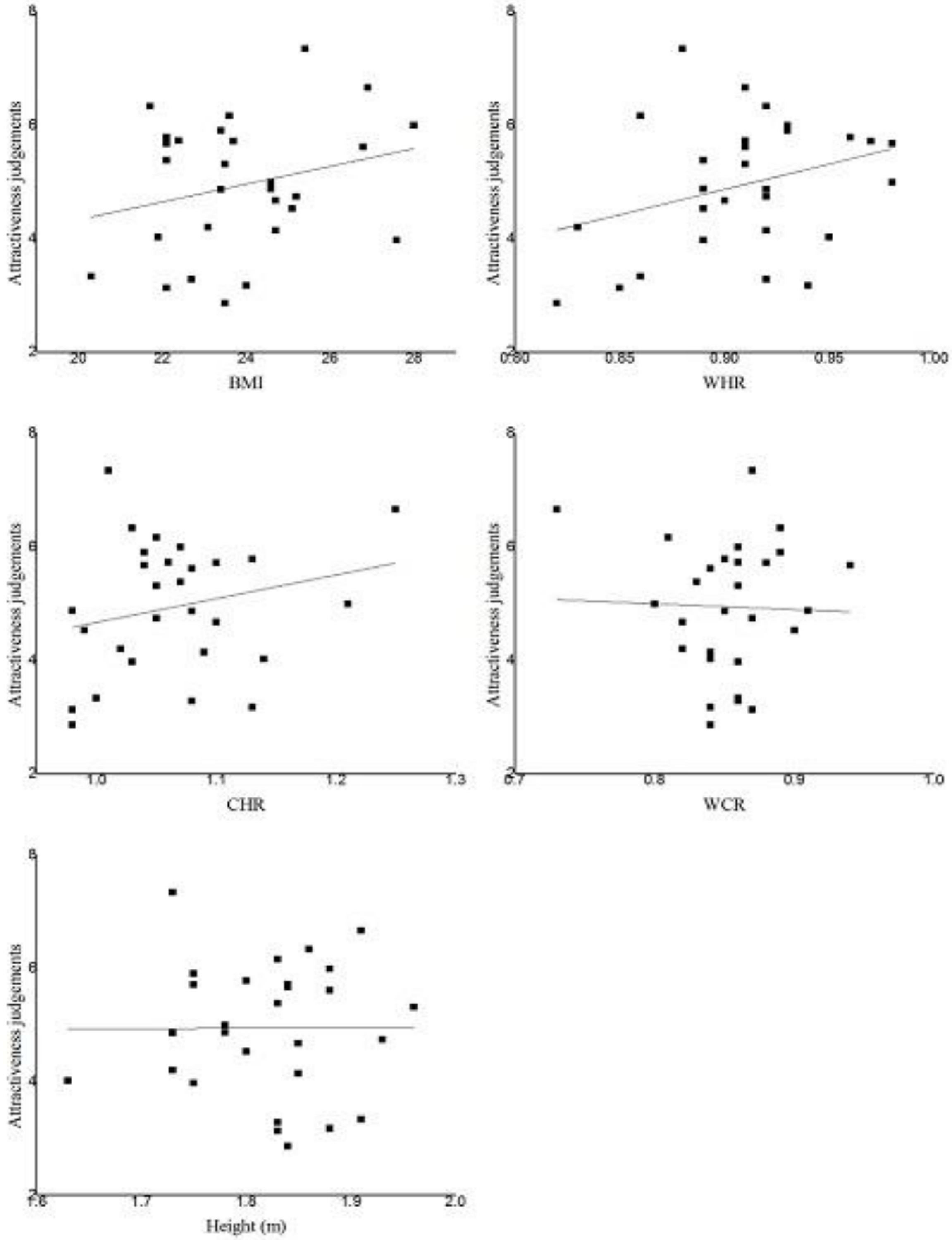


Figure 2. The relationship between the average female attractiveness score for each male image and the male images' body indices.

Because adding the squared terms to each hierarchical model added no significance, a multiple linear regression was performed. Using the predictors BMI, WHR, CHR, WCR and Height, only 19.2% of the variance for attractiveness was accounted for and the model was not significant ($F_{(5,22)}$ = 1.04, p = 0.42, r = .21).

Table 4. The results of the linear regression for attractiveness judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	-66.43	58.60		-1.13	0.27
	BMI	0.12	0.13	0.19	0.94	0.36
	WHR	-59.07	65.26	-2.06	-0.91	0.38
	CHR	56.15	54.01	3.13	1.04	0.31
	WCR	73.99	71.42	2.44	1.04	0.31
	Height	-0.46	3.15	-0.03	-0.15	0.89

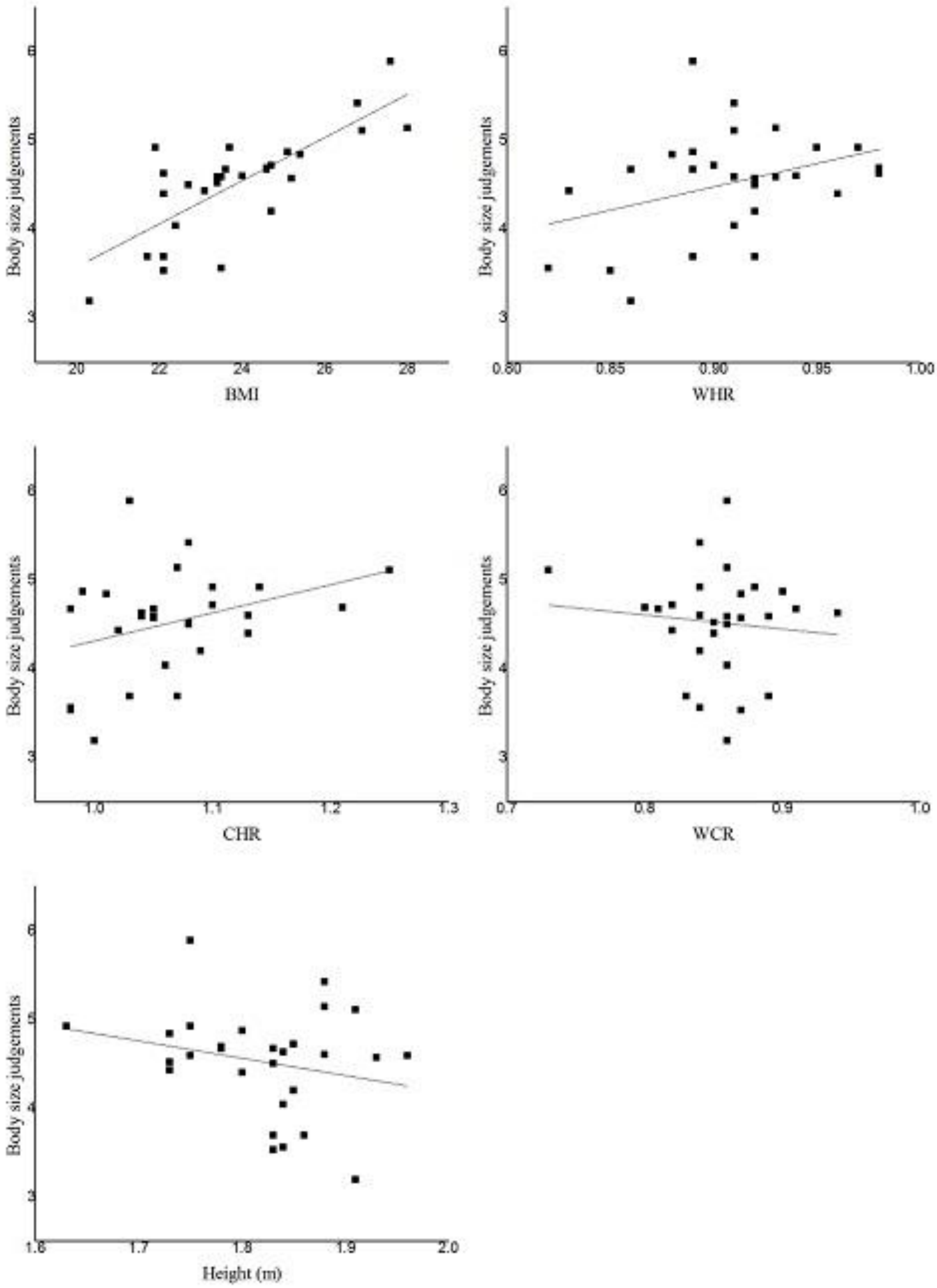


Figure 3. The relationship between the average female body size score for each male image and the male images’ body indices.

Much like for attractiveness judgements, the squared terms of the body indices added no significance to each of the models. Therefore a multiple linear regression was performed.

Using BMI and WHR as predictors, the model accounted for 71.5% of the variance and was significant ($F_{(2,25)} = 31.29$, $p<.0001$, $r = .66$).

Table 5. The results of the linear regression for body size judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	-5.83	1.61		-3.63	0.00
	BMI	0.24	0.03	0.76	7.07	**0.001**
	WHR	5.12	1.56	0.35	3.28	**0.001**

For the model described in Table 5, the VIF value was reported as 1.00, well below 10 (Myers, 1990) and the tolerance statistic of .999 is above 0.2 (Menard, 1995); therefore no collinearity occurred within the data. BMI and WHR can therefore be reliably attributed as independent predictors of the body size judgements.

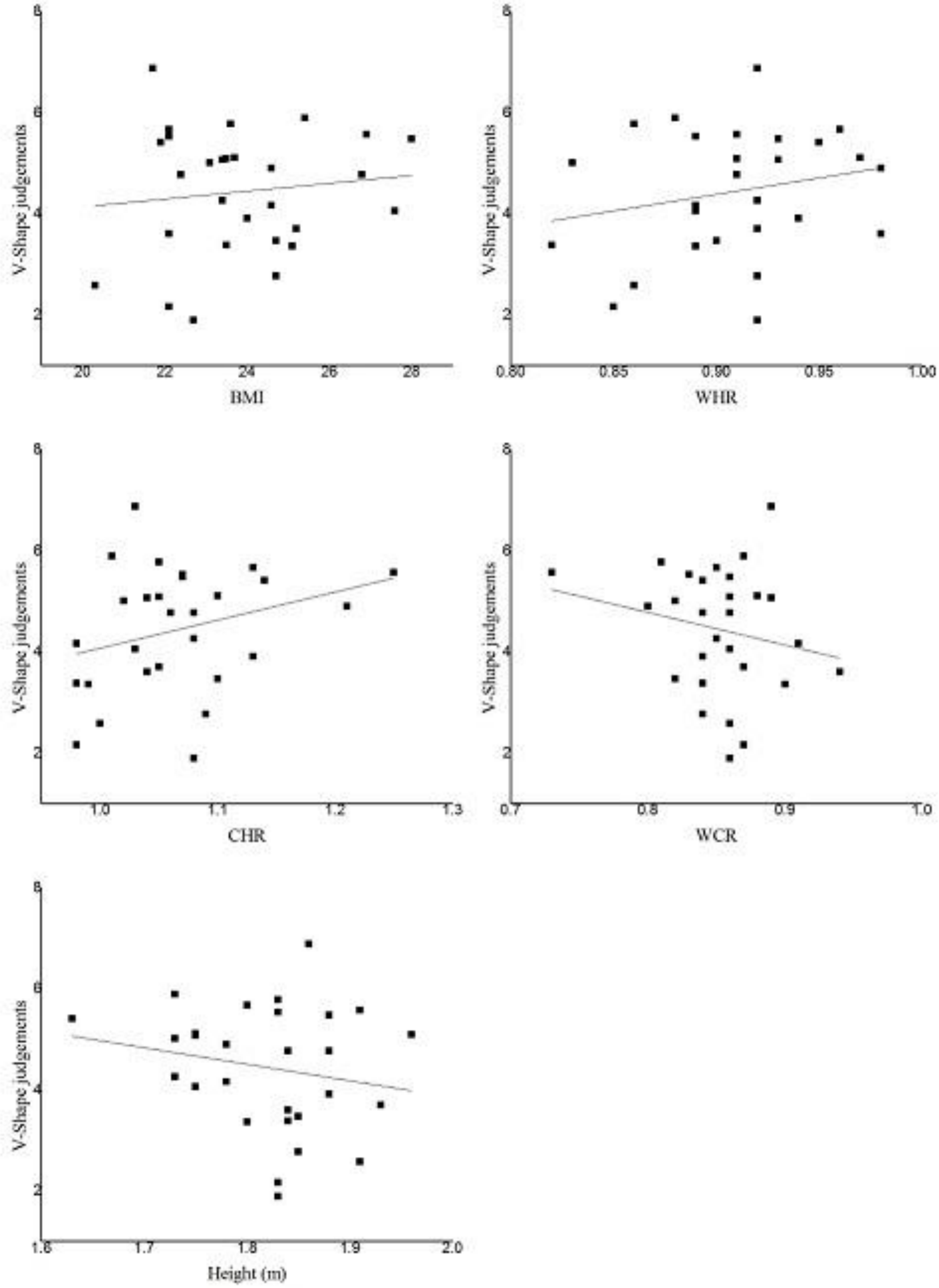


Figure 4. The relationship between the average female V-shape score for each male image and the male images' body indices.

The results from the hierarchical regressions indicated that a multiple linear regression was needed for the V-shape analysis. The model found only 14.7% of the variance to be accounted for and was not significant ($F_{(5,22)} = 0.76$, $p = 0.59$, $r = 98$).

Table 6. The results of the linear regression showing the relationship between the five body indices and V-shape judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	10.50	63.52		0.17	0.87
	BMI	0.06	0.14	0.08	0.40	0.69
	WHR	7.58	70.73	0.25	0.11	0.92
	CHR	-0.62	58.53	-0.03	-0.01	0.99
	WCR	-8.19	77.41	-0.26	-0.11	0.92
	Height	-3.64	3.42	-0.22	-1.07	0.30

6.4.2 *Are 2D cues a better predictor of the judgements made?*

In the analysis above, the circumferential measures of the male bodies were used despite the fact observers only viewed the images in 2D. Therefore a measure of the body indices taken from across the body might present a better way of capturing what observers actually saw.

The male images were therefore opened in Corel Photo-Paint 9 and were measured (as described in Chapter 5) across the body for shoulder width, chest width, waist width and hip width. Using these measurements, the ratios for each body were recalculated and correlated against the three behavioural judgements. The opportunity to take into account shoulder measurements was taken at this point as male shoulder width is known to contribute to overall body shape and therefore, potential attractiveness judgements, (Franzoi and Herzog, 1987; Salussodeonier *et al.*, 1993; Maisey *et al.*, 1999). The Shoulder Waist Ratio (SWR) was therefore calculated by dividing the shoulder width by the waist width and the Shoulder Hip Ratio (SHR) was calculated by dividing the shoulder width by the hip width. These additional body indices may further lend support for possible predictors in the behavioural judgements.

Table 7. Pearson's correlation between all body indices for the measurements across the male bodies.

	Attractiveness	Body Size	V-Shape
WHR	**0.41***	**0.52****	0.33
Sig. (2-tailed)	0.03	0.01	0.09
CHR	**0.54****	0.22	**0.75****
Sig. (2-tailed)	0.001	0.26	0.001
WCR	-0.23	0.18	**-0.53****
Sig. (2-tailed)	0.24	0.37	0.001
SWR	0.31	**-0.45***	**0.50****
Sig. (2-tailed)	0.11	0.02	0.01
SHR	**0.58****	-0.14	**0.73****
Sig. (2-tailed)	0.001	0.48	0.001

**Correlation at the 0.01 significance level
*Correlation at the 0.05 significance level

Table 8. Pearson's correlation between all of the body indices measured across the bodies.

	WHR	CHR	WCR	SWR	SHR
BMI	0.15	-0.03	0.14	-0.26	-0.17
Sig. (2-tailed)	0.44	0.90	0.48	0.18	0.38
WHR		**0.47***	0.31	-0.33	0.24
Sig. (2-tailed)		0.01	0.11	0.09	0.21
CHR			**-0.70****	0.22	**0.50****
Sig. (2-tailed)			0.001	0.24	0.01
WCR				**-0.49****	-0.33
Sig. (2-tailed)				0.01	0.08
SWR					**0.84****
Sig. (2-tailed)					0.001

**Correlation at the 0.01 significance level
*Correlation at the 0.05 significance level

By measuring across the bodies and therefore using a more direct representation of what the observers actually saw and used to rate the images, it can be seen that more body indices significantly correlated with the three judgements (Table 7). WHR, CHR and SHR were now correlated with attractiveness judgements however as Table 8 shows, WHR and CHR co-varied as do CHR and SHR, therefore it is hard to determine which one played more of a role in predicting attractiveness judgements. The same can be said for V-shape judgements as all the body indices with the exception of the WHR correlated with the judgement (Table 7) yet most correlated with each other as well (Table 8).

However, these additional results do lend support to the theory that because participants were not able to view the images in a 360° view, it was harder for them to make accurate judgements about the bodies' 3D shape.

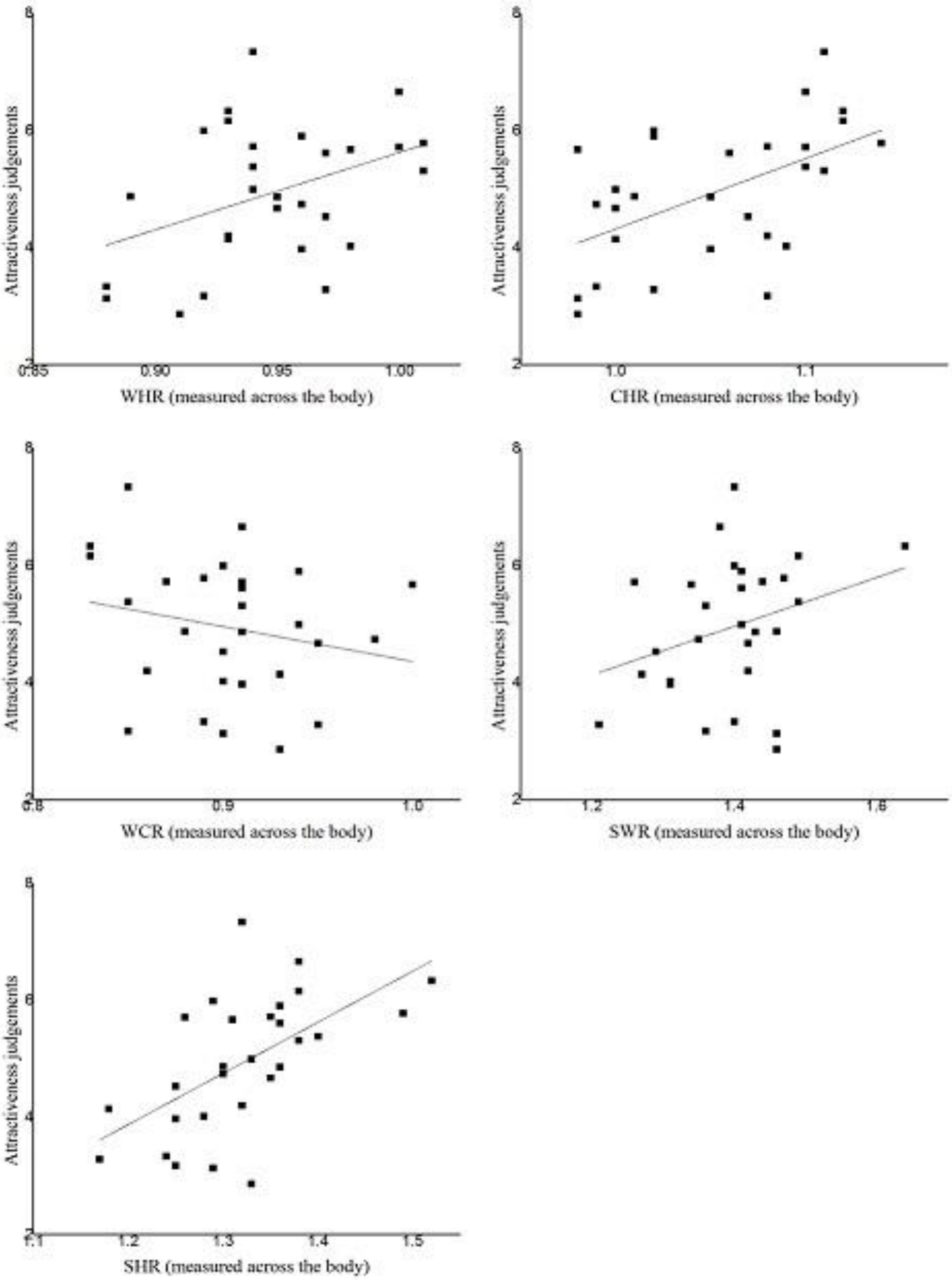


Figure 5. The relationship between the average female attractiveness score for each male image and the male images' body indices measured across the body.

Due to the high correlations found (Table 8), significant predictors were only used in the regression analysis that weren't found to correlate with another predictor. This would enable only independent predictors of the judgements to be found. A multiple linear regression using the predictors BMI, WHR and SHR therefore found the variance to now account for 51.3% and the model was significant ($F_{(3,24)} = 8.43$, $p<.001$, $r = .51$).

Table 9. The results of the linear regression for the body indices measured across the body and attractiveness judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	-18.27	5.15		-3.55	0.00
	BMI	0.20	0.09	0.32	2.16	**0.04**
	WHR	7.45	4.92	0.23	1.52	0.14
	SHR	8.66	2.23	0.58	3.89	**0.001**

The results from Table 9 show that individually, BMI and SHR significantly predicted judgements of male attractiveness. This is further supported by the VIF values (1.07; 1.10; 1.11 respectively) (Myers, 1990) and the tolerance statistics (.93; .91; .90, respectively) (Menard, 1995); therefore no collinearity occurred between the variables and BMI and SHR can be independently attributed to attractiveness judgements.

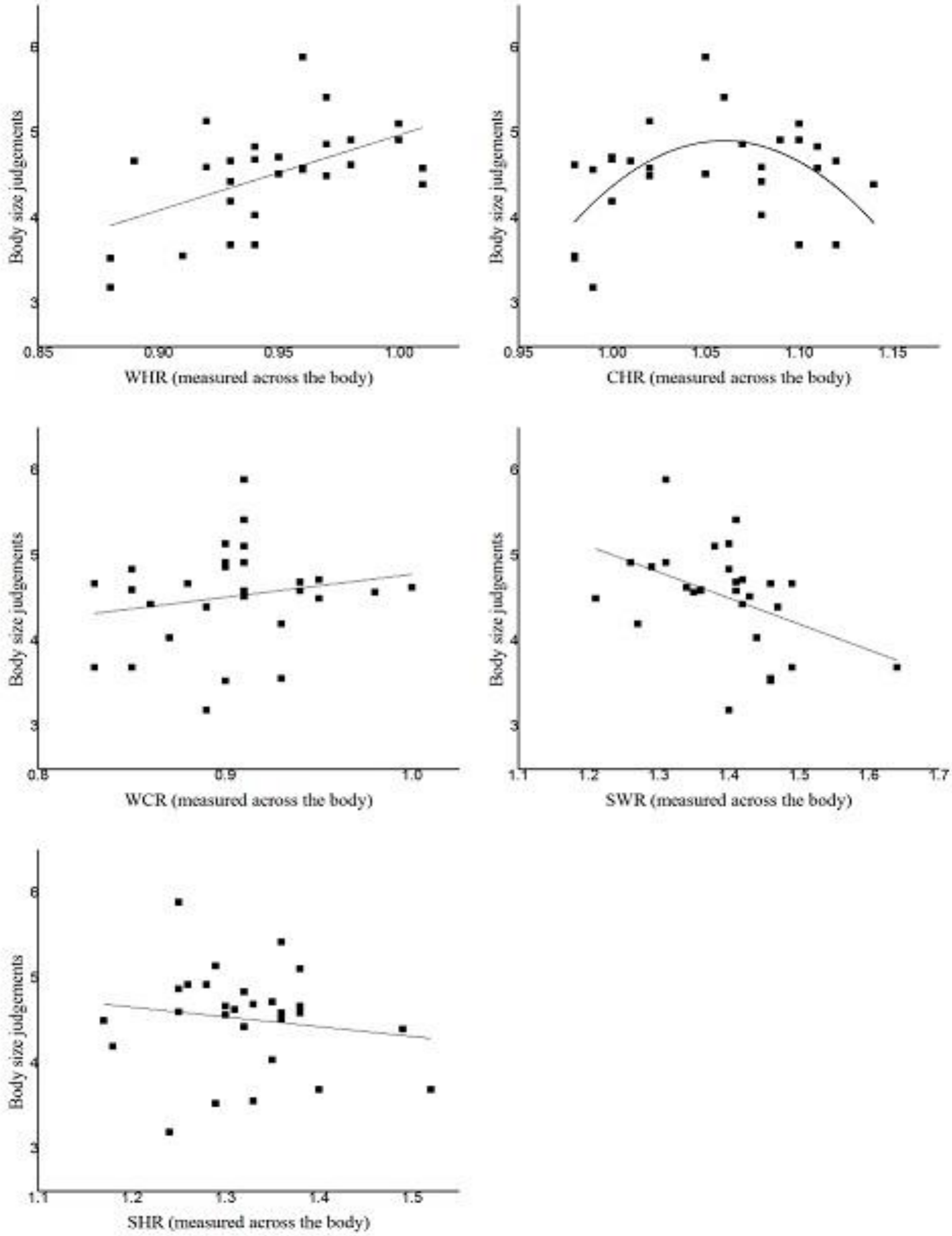


Figure 6. The relationship between the average female body size score for each male image and the male images' body indices measured across the body.

A multiple linear regression using the predictors BMI, WHR and SWR, found the body size model accounted for 77.2% of the variance and was significant ($F_{(3,24)} = 27.11$, $p<.0001$, $r = .73$).

Table 10. The results of the linear regression for the body indices measured across the body and body size judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	-5.18	2.42		-2.14	0.04
	BMI	0.22	0.03	0.68	6.73	**0.001**
	WHR	6.14	1.77	0.37	3.47	**0.001**
	SWR	-0.90	0.74	-0.13	-1.22	0.24

The results of the linear regression show that individually, BMI and WHR significantly predicted body size judgements, (Table 10). This is further supported by the VIF scores, found to be below 10 (1.08; 1.17; 1.23 respectively) (Myers, 1990) and the tolerance scores found to be above 0.2 (.930; .852; .814 respectively) (Menard, 1995).

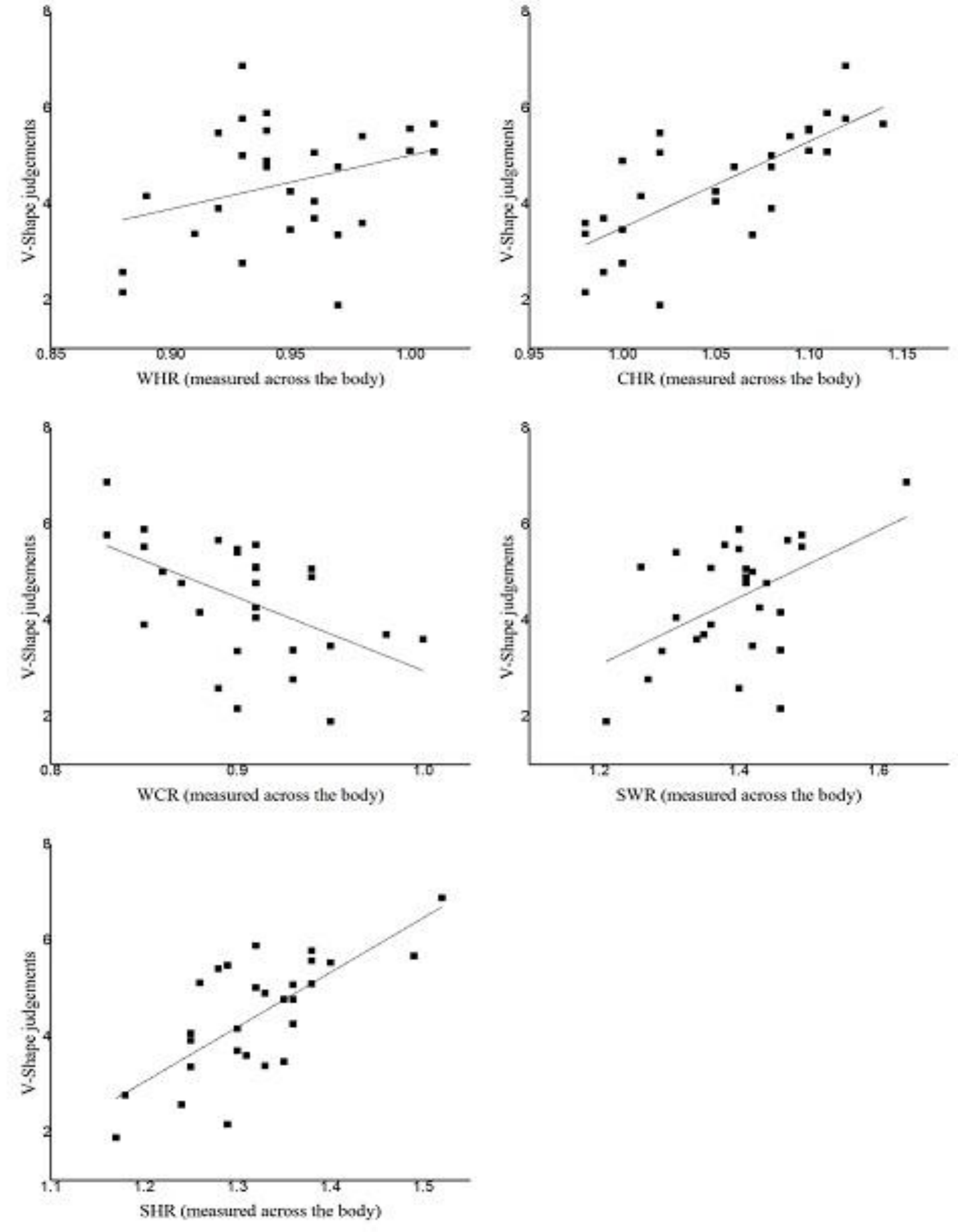


Figure 7. The relationship between the average female V-shape score for each male image and the male images' body indices measured across the body.

Based on the results of hierarchical regression, the best model for the data incorporated linear terms in the multiple regression model. Using the predictors BMI, CHR and SWR, this found 74.2% of the variance for V-shape judgements to be accounted for ($F_{(3,24)}$ = 23.02, p<.0001, r = .70).

Table 11. The results of the linear regression for the body indices measured across the body and V-shape judgements.

		B	SE	β	*t*	*p*
Model 1	Constant	-24.31	3.70		-6.57	0.00
	BMI	0.16	0.07	0.24	2.28	**0.03**
	CHR	15.84	2.50	0.67	6.34	**0.001**
	SWR	5.93	1.55	0.42	3.82	**0.001**

For the model described in Table 11, the VIF values were found to be well below 10 (1.07; 1.05; 1.12, respectively) (Myers, 1990) and the tolerance statistics were all above 0.2 (.932; .956; .892, respectively) (Menard, 1995); therefore no collinearity occurred within the data and all three variables can be reliably attributed as an independent predictors of the V-Shape judgements.

6.4.3 *Summary*

From the rating analysis, attractiveness and V-shape judgements highly correlated (Table 2) suggesting one predicts the other and complying with evolutionary theories that a V-shape figure signals traits such as dominance, strength and muscularity which females find appealing and therefore select for in a potential mate (Barber, 1995; Lassek and Gaulin, 2009; Puts, 2010; Rantala *et al.*, 2013). Furthermore, using the 2D measures that gave a more direct representation of what observers saw when making their judgements, body ratios that indicate a broad upper torso with a narrow waist such as the SHR and the CHR are shown to be the best predictors of attractiveness judgements and V-shape judgements.

6.5 Eye Movements Analysis

BeGaze 3.2 analysis software package was used to analyse the eye movement patterns for this experiment. In accordance with the eye movement analysis conducted in Chapter 5, fixation density heat maps were generated for each image separately for each behavioural judgement, (Figure 8).

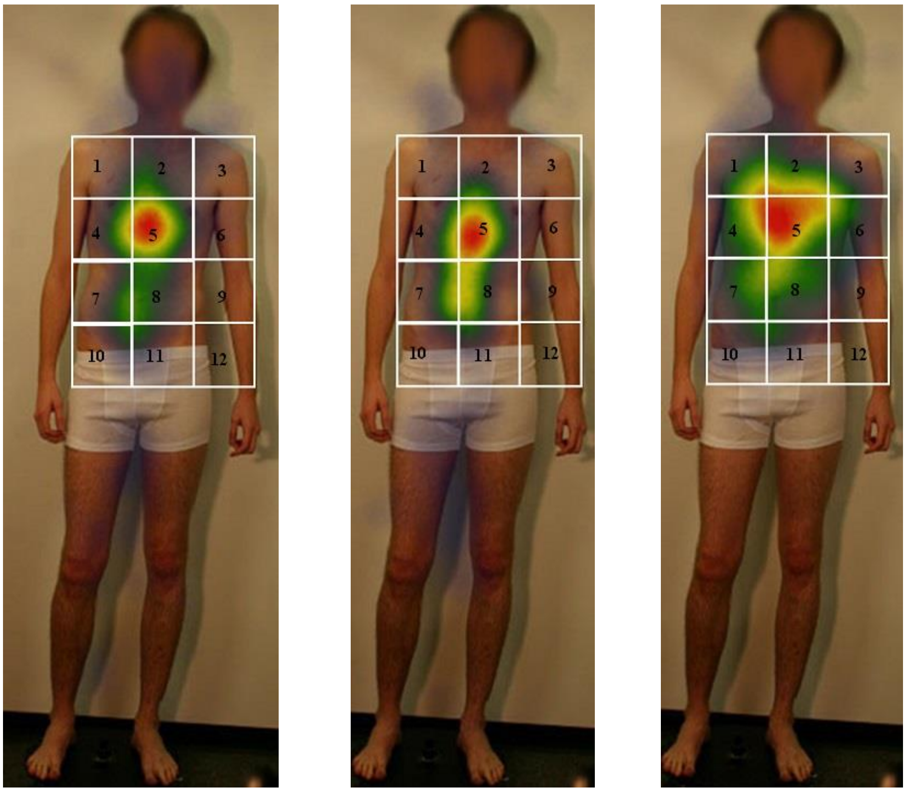


Figure 8. An example of the 12 AOIs used when participants made judgements for Attractiveness, Body Size and V-Shape, respectively.

As shown from preliminary examination of Figure 8, there are subtle differences in the distribution of fixations when participants are rating for the three different judgements. Examination of the distribution of fixations allows for the identification of regions of the body that are informative when making these behavioural judgements, however, in order to examine whether behavioural judgements are directly related to the pattern of looking on the body, twelve 14.5 x 14.5mm Areas of Interest (AOIs) were created over the torso and central body of the images and contained the total number of fixations for each participant, (Figure 8). Correlations were run between the total fixation counts in each AOI and the ratings for the three judgements.

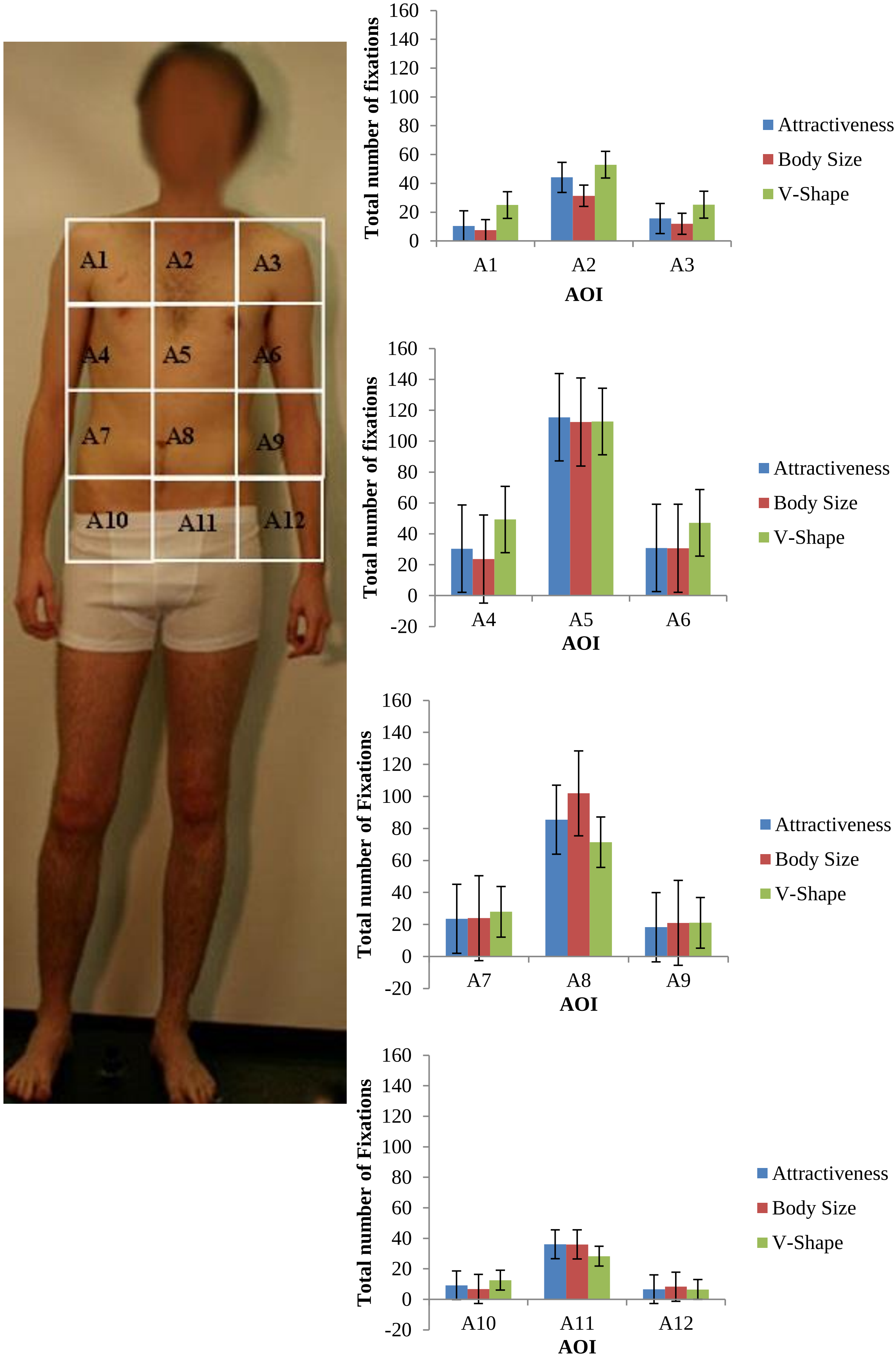


Figure 9. A visual representation of the total number of fixations collected for each participant for each of the judgements in each AOI with standard error bars included.

From the preliminary viewing of the data shown in Figure 9, it can be seen that a participant's fixation count differed when making each of the three different judgements. Furthermore, they seemed to look at corresponding areas of the body we would expect them to look at when making specific judgements. Therefore, a more detailed analysis was undertaken.

6.5.1 *Are eye movements different when judging Attractiveness, Body Size and V-Shape?*

A 2 factor repeated measures ANOVA was conducted using Factor 1 as the judgements and Factor 2 as the twelve AOIs. Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of AOI ($\chi^2_{(65)} = 643.07$, $p<.0001$) and for the main interaction effect of judgement and AOI ($\chi^2_{(252)} = 567.67$, $p<.0001$). Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon=.14$ of the main effect of AOI and .24 for the main interaction effect of judgement and AOI).

A significant effect of the type of judgement being made was found ($F_{(2,56)} = 156.43$, $p<.0001$, $r = .86$). A significant effect of AOI was found ($F_{(1.56,43.85)} = 86.35$, $p<.0001$, $r = .81$) and a significant main interaction effect was also found between the judgements being made and the AOIs ($F_{(5.6,147)} = 22.86$, $p<.0001$, $r =.36$) indicating that the separate judgements being made had different effects on the number of fixations in each AOI.

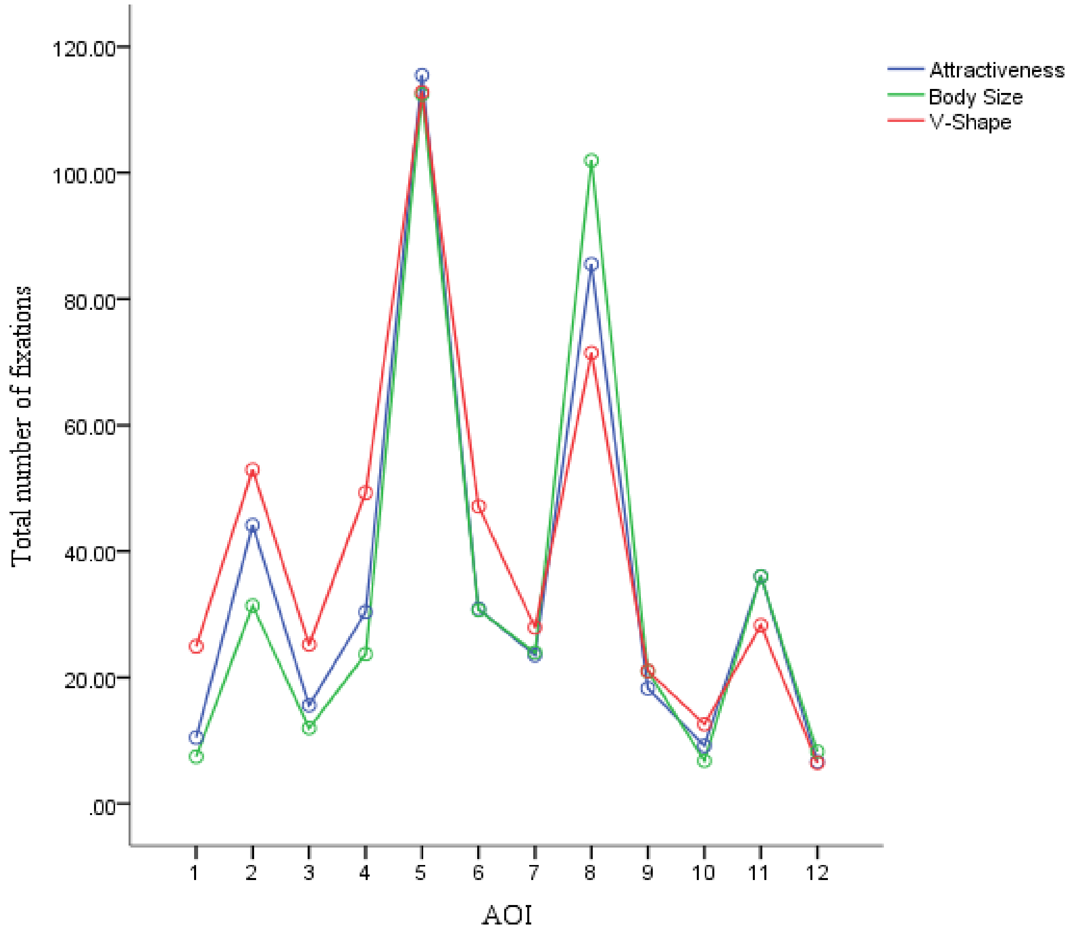


Figure 10. An interaction graph showing the total number of fixations in each AOI when observers made each judgement.

It can be seen from Figure 10 that whilst observers followed a similar gaze pattern when making the three separate judgements, subtle differences in the total number of fixations in each AOI for each judgement can be seen. For example, AOI 8 corresponding with the abdominal region on the bodies (Figure 8 and 9) is shown here to contain more fixations when being judged for body size compared to when the body is being judged for attractiveness and even less so for V-shape. This would correspond with the hypothesis that observers are using particular regions of the body to assist them in their judgements as stomach depth has been repeatedly shown to be used as an indicator for body size perception, (Rilling *et al.*, 2009; George *et al.*, 2011).

A simple effects analysis used to determine significant differences between the total number of fixations in each corresponding AOI between each judgement was then carried out. Significant differences were found between the following corresponding AOIs; AOI 1; ($F_{(2,56)} = 64.56$, $p<.0001$, $r = .73$), AOI 2; ($F_{(2,56)} = 62.08$, $p<.0001$, $r = .73$), AOI 3; ($F_{(2,56)} = 44.06$, $p<.0001$, $r =.66$), AOI 4; ($F_{(2,56)} = 31.12$, $p<.0001$, $r = .60$), AOI 6; ($F_{(2,56)}$ = 25.02, p<.0001, r = .56), AOI 8; ($F_{(2,56)}$ = 59.06, p<.0001, r = .72), AOI 10; ($F_{(2,56)}$ = 10.55, p<.0001, r = .40) and AOI 11; ($F_{(2,56)}$ = 13.06, p<.0001, r =.43).

No significant differences were found between the total number of fixations made in the remaining AOIs when observers were making each judgement.

6.5.2 *Eye movements when judging male bodies for Attractiveness*

To show that the fixations made for attractiveness judgements are not evenly spread across the body but in a specific distribution, a one way ANOVA was conducted between the total number of fixations in each AOI and were found to be significantly different ($F_{(11,336)}$ = 86.84, p<.0001, r = .45).

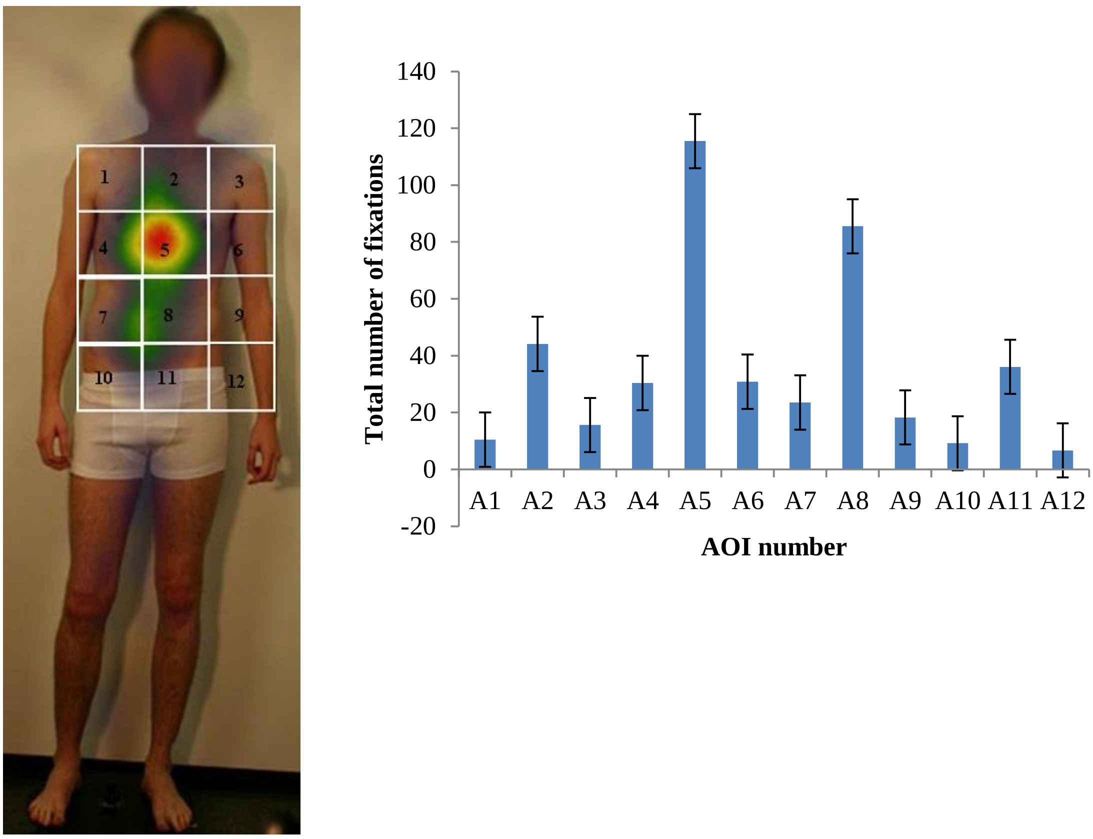


Figure 11. The total number of fixations for Attractiveness judgments averaged for each AOI for all 29 images against a corresponding example of the position of the AOIs on an image rated for Attractiveness. Standard deviation bars included.

Post hoc comparisons using the Tukey HSD test indicated that there were a significantly higher number of fixations in AOIs 2, 5, 8, 11 compared to the remaining AOIs, (Table 12).

Table 12. A summary of the post hoc comparisons comparing the total number of fixations between each AOI. Those with significant differences have been shown by the inclusion of the significance level.

	AOI1	AOI2	AOI3	AOI4	AOI5	AOI6	AOI7	AOI8	AOI9	AOI10	AOI11	AOI12
AOI1		*p*<.0001		*p*<.001	*p*<.0001	*p*<.0001		*p*<.0001			*p*<.0001	
AOI2	*p*<.0001		*p*<.0001		*p*<.0001		*p*<.0001	*p*<.0001	*p*<.001	*p*<.0001		*p*<.0001
AOI3		*p*<.0001			*p*<.0001			*p*<.0001			*p*<.0001	
AOI4	*p*<.001				*p*<.0001			*p*<.0001		*p*<.0001		*p*<.0001
AOI5	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001		*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001
AOI6	*p*<.0001				*p*<.0001			*p*<.0001		*p*<.0001		*p*<.0001
AOI7		*p*<.0001			*p*<.0001			*p*<.0001				*p*<.005
AOI8	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001		*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001
AOI9		*p*<.0001			*p*<.0001			*p*<.0001			*p*<.001	
AOI10		*p*<.0001		*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001			*p*<.0001	
AOI11	*p*<.0001		*p*<.0001		*p*<.0001		*p*<.001	*p*<.0001	*p*<.0001	*p*<.0001		*p*<.0001
AOI12		*p*<.0001		*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.0001	*p*<.001		*p*<.0001	

Taking into account that certain AOIs were shown to have a greater number of fixations compared to other AOIs, Pearson's correlations between the number of fixations in these AOIs and the attractiveness ratings was therefore undertaken. The analysis however showed that there were no significant correlations. This would suggest that the pattern of fixations is not significantly linked to the attractiveness ratings score for each body.

6.5.3 *Eye movement analysis between Attractive and Unattractive bodies*

To further test whether the fixation densities on bodies differed between those rated highly for attractiveness compared to those rated less attractive, the fixation distribution patterns on the top five bodies and the lowest five bodies rated by female observers for attractiveness, were compared.

Figure 12. Fixation density heat maps for the 5 images rated as most attractive.

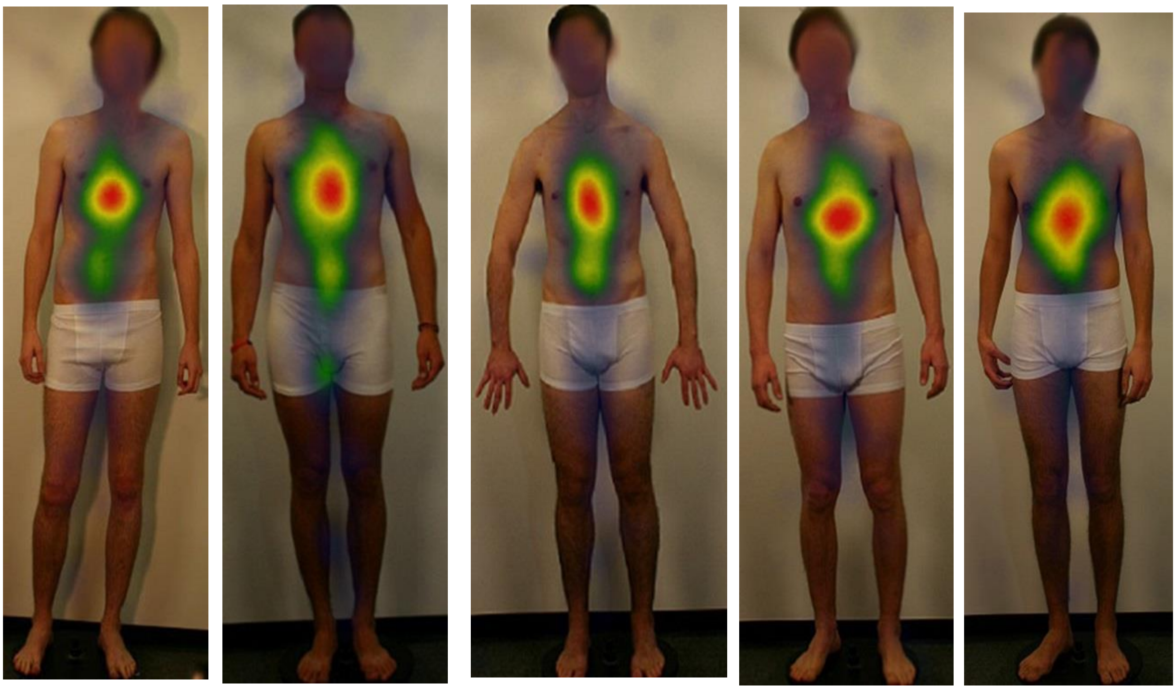


Figure 13. Fixation density heat maps for the 5 male images rated as the least attractive.

Preliminary examination of Figures 12 and 13 revealed no apparent difference in the distribution of the fixation densities between when participants observed attractive images compared to unattractive images.

A 2 factor repeated measures ANOVA using Attractive versus Unattractive as Factor 1 and the 12 AOIs as Factor 2 confirmed this preliminary viewing, finding no significant effect of judgement ($F_{(1,4)} = 1.95$, $p = 0.24$, $r = .57$). A significant effect was found between the AOIs ($F_{(11,44)} = 52.30$, $p<.0001$, $r = .74$) but no interaction effect was found between the judgements and the AOIs ($F_{(11,44)} = 0.61$, $p = 0.81$, $r = .12$).

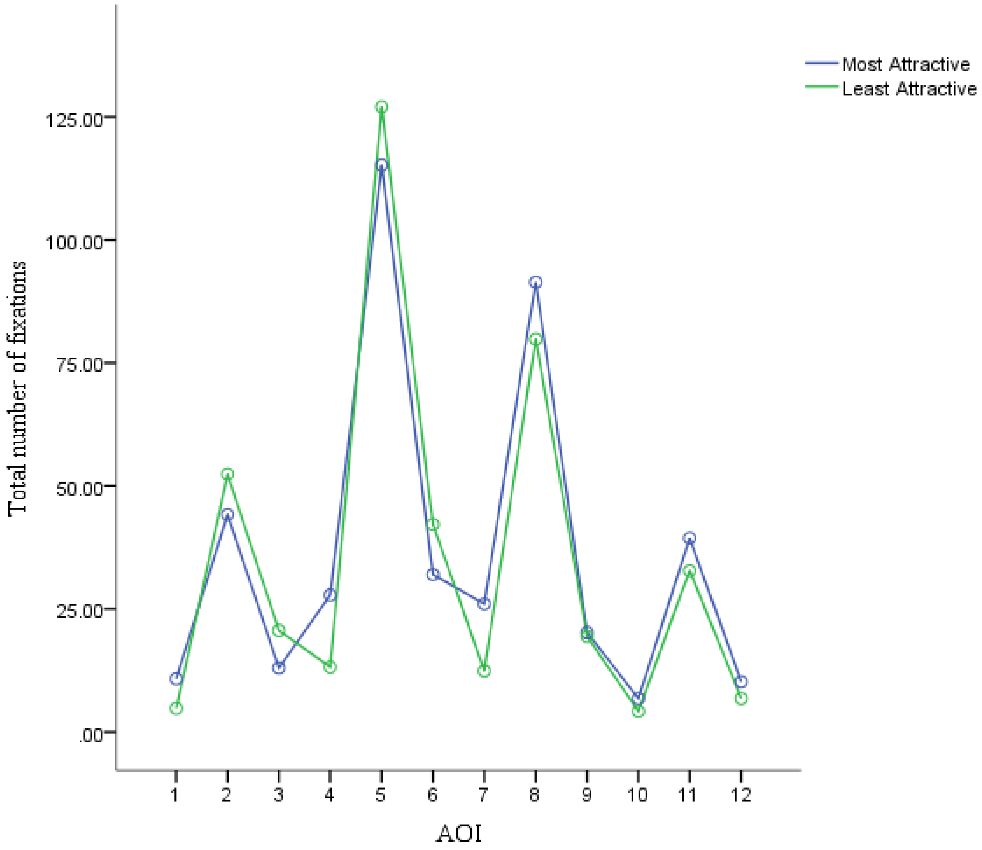


Figure 14.The interaction graph showing observers total number of fixations per AOI for when they viewed the male bodies rated the 5 most and 5 least attractive.

The interaction graph shown in Figure 14 shows that most of the fixations participants made when judging both the 5 most and 5 least attractive images, fell in AOI 5 and 8 which correspond with the mid torso region indicating that the stomach area is used to aid female participants in their judgements of male attractiveness.

A simple effects analysis was then performed to test for statistical differences between the corresponding AOIs. However, no significant differences were found.

6.5.4 *Eye movements when judging male bodies for Body Size*

To examine whether fixations made for body size judgements are specifically distributed and not evenly spread across the body, a one way ANOVA between the total number of fixations in each of the twelve AOIs was conducted. A significant relationship was found ($F_{(11,336)}$ = 100.14, p<.0001, r =.48) indicating specifically distributed fixations. Figure 15 shows a visual representation of the difference in the number of fixations each AOI contains when making the judgement.

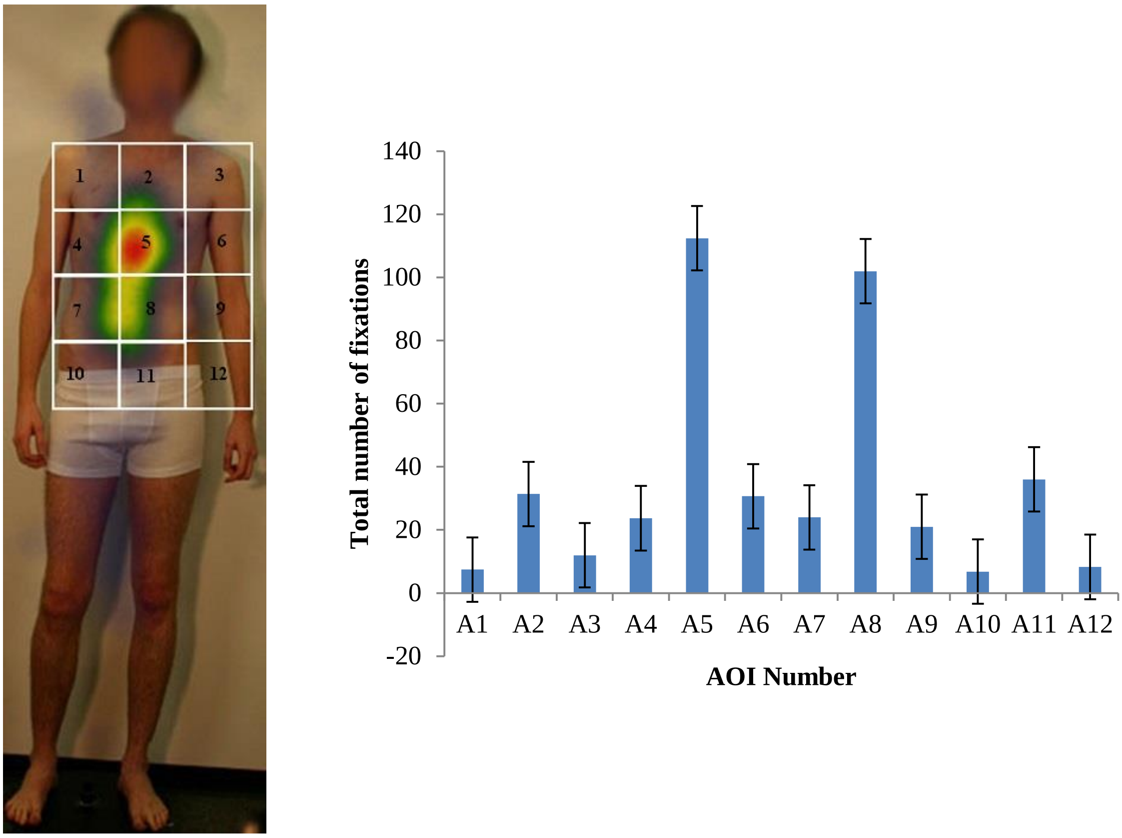


Figure 15. The total number of fixations for Body Size averaged for each AOI for all 29 images against a corresponding example of the position of the AOIs on an image rated for Body Size. Standard deviation bars included.

Further post hoc analysis revealed that AOIs 2, 5, 6, 7, 8 and 11 had potentially significantly different numbers of fixations in them compared to the remaining AOIs, (Table 13).

Table 13. A summary of the post hoc comparisons with the significant differences between the total number of fixations in each AOI indicated by the significance level.

	AOI1	AOI2	AOI3	AOI4	AOI5	AOI6	AOI7	AOI8	AOI9	AOI10	AOI11	AOI12
AOI1		$p<.0001$			$p<.0001$	$p<.0001$	$p<.05$	$p<.0001$			$p<.0001$	
AOI2	$p<.0001$		$p<.001$		$p<.0001$			$p<.0001$		$p<.0001$		$p<.0001$
AOI3		$p<.001$			$p<.0001$	$p<.001$		$p<.0001$			$p<.0001$	
AOI4					$p<.0001$			$p<.0001$		$p<.05$		
AOI5	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI6	$p<.0001$		$p<.001$		$p<.0001$			$p<.0001$		$p<.0001$		$p<.0001$
AOI7	$p<.05$				$p<.0001$			$p<.0001$		$p<.05$		
AOI8	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI9					$p<.0001$			$p<.0001$				
AOI10		$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.001$		$p<.0001$	
AOI11	$p<.0001$		$p<.0001$	$p<.001$	$p<.0001$		$p<.05$	$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$
AOI12		$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.001$		$p<.0001$	

Pearson's correlations however failed to show a significant relationship between the body size ratings for each image and the number of fixations in these specific AOIs. This therefore suggests that the fixation pattern is not related to the rating score for body size.

6.5.5 *Eye movement analysis between Heavy and Light bodies*

To test whether fixation distributions are specifically distributed when judging different body sizes, analysis was then conducted on the 5 images rated as heaviest in the data set and the 5 images rated as the lightest in. Fixation density heat maps were constructed using all the participant's fixation densities on each of the 10 bodies to illustrate potential differences in the way participants look at heavy bodies compared to when they look at light bodies.

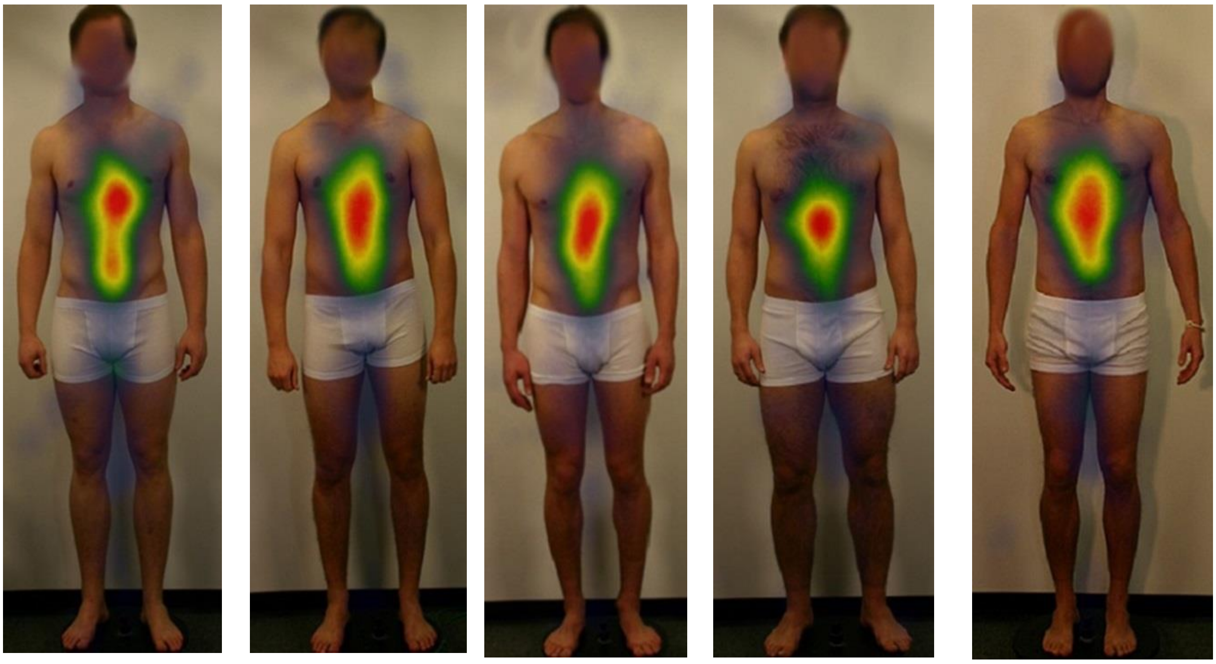


Figure 16. Fixation density heat maps of the 5 male bodies rated as the most heaviest out of the data set.

Figure 17. Fixation density heat maps of the 5 male images rated as the lightest out of the data set.

On preliminary viewing of Figures 16 and 17, there was not an obvious difference in the distribution of fixations when observers viewed the heavy and light weight bodies.

A 2 factor repeated measures ANOVA using Heaviest versus Lightest as Factor 1 and the twelve AOIs as Factor 2 confirmed the above. The analysis found no significant effect of judgement ($F_{(1,4)}$ = 1.13, p = 0.35, r =.47), a significant effect was found between the AOIs ($F_{(11,44)}$ = 21.57, p<.0001, r =.57). However no significant interaction effect was found ($F_{(11,44)}$ = 0.10, p = 1.00, r =.05).

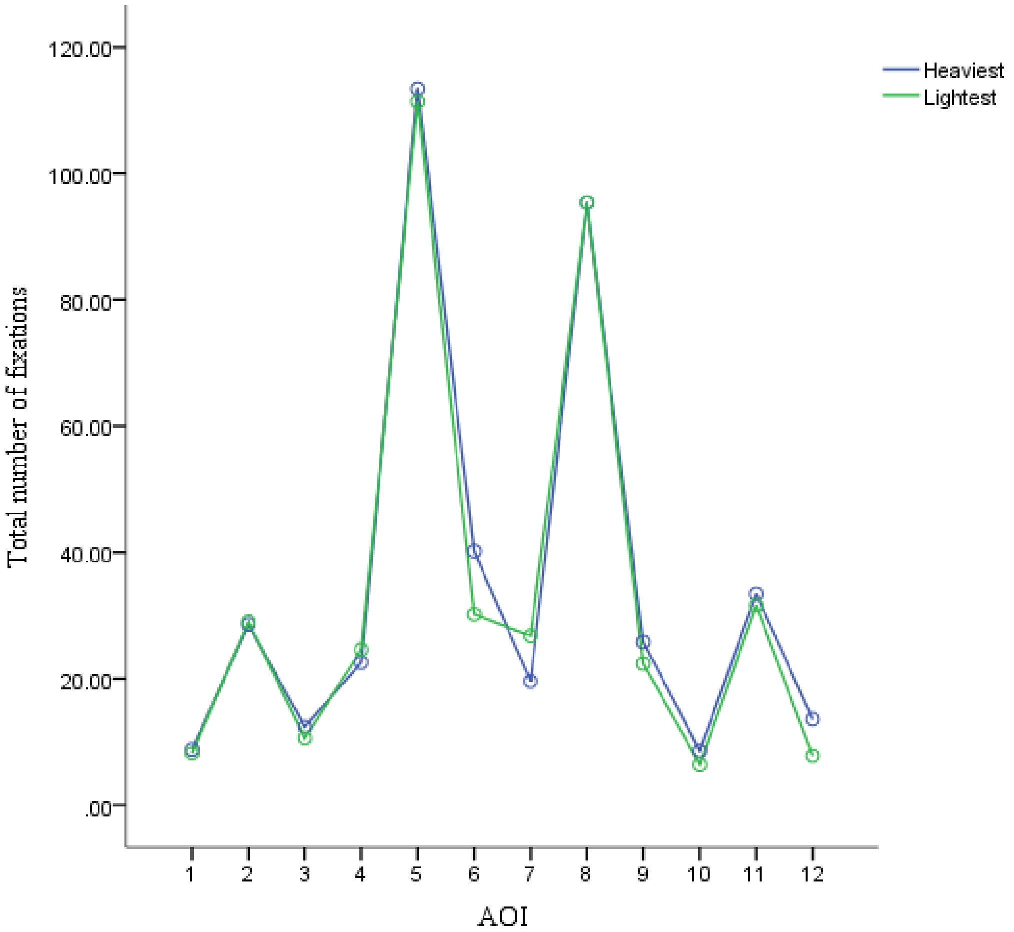


Figure 18. The interaction graph showing observers total number of fixations per AOI for when they viewed the male bodies rated the 5 heaviest and the 5 lightest.

As for attractiveness judgements, the interaction graph between the five heaviest and five lightest rated bodies shown in Figure 18 again shows AOIs 5 and 8 had the highest number of fixations in compared to the remaining AOIs. However, the figure suggests that there was no difference in the number of fixations participants made in these two specific AOIs, when the image was perceived as heavy or light.

A simple effects analysis further confirmed this as no significant differences between the corresponding AOIs were found when observers viewed the five heaviest and five lightest bodies.

6.5.6 *Eye movements when judging male bodies for V-Shape*

To test whether there are any patterns in fixation distribution when making V-shape judgements, an ANOVA was conducted for the total number of fixations in the twelve AOIs for apparent V-shape. A significant relationship was found ($F_{(11,336)} = 66.89$, $p<.0001$, $r=.41$).

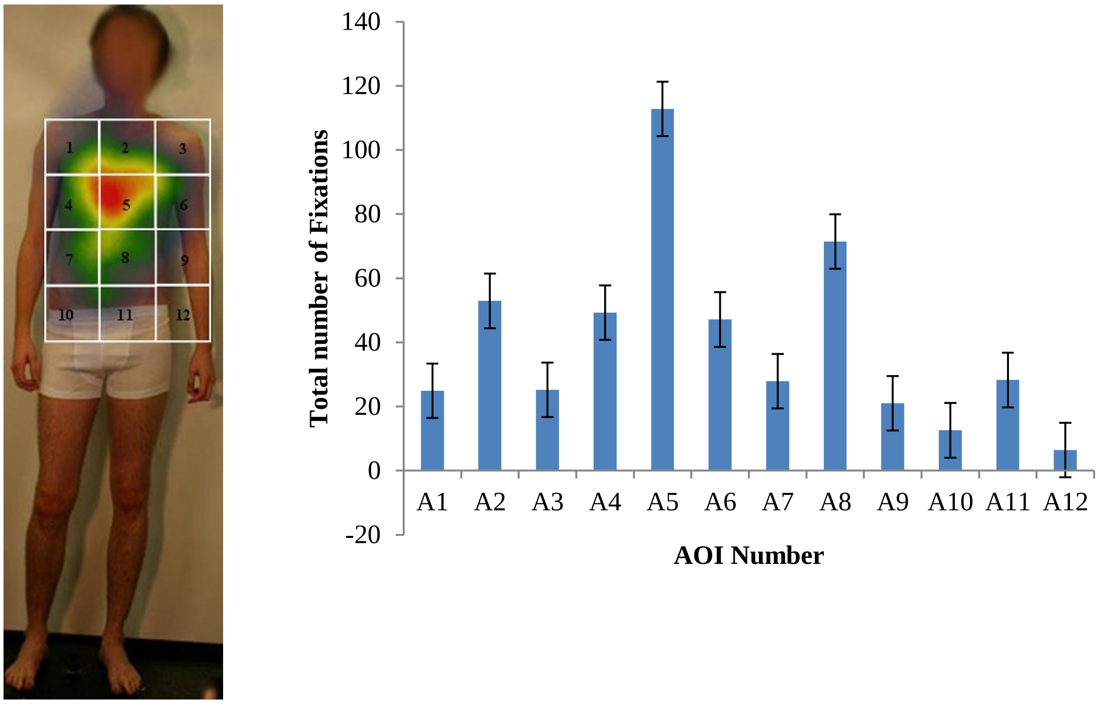


Figure 19. The total number of fixations averaged for each AOI for each image when judging apparent V-shape with the corresponding AOIs on an example image judged for V-shape. Standard deviation bars included.

As in the attractiveness and body size judgements, Figure 19 reveals that AOIs 5 and 8 had a higher number of fixations in compared to the residual AOIs. From the example image rated for V-shape, the fixation density heat map reveals a pattern that corresponds to participants looking across the shoulders and then down to the stomach creating an upside triangle shape or closed V-shape. This suggests participants were reliably looking at the areas of the body which make a V-shape, to make their corresponding judgements.

Further post hoc analysis revealed that AOIs 2, 4, 5, 8 and 12 were significantly different from the remaining AOIs, (Table 14).

Table 14. A summary of the post hoc analysis of the significant differences found between the AOIs containing the total number of fixations judging for V-shape. Significant differences are indicated by the significance level found.

	AOI1	AOI2	AOI3	AOI4	AOI5	AOI6	AOI7	AOI8	AOI9	AOI10	AOI11	AOI12
AOI1		$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$				$p<.05$
AOI2	$p<.0001$		$p<.0001$		$p<.0001$		$p<.0001$	$p<.05$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI3		$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$				$p<.001$
AOI4	$p<.0001$		$p<.0001$		$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI5	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI6	$p<.0001$		$p<.0001$		$p<.0001$		$p<.001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.001$	$p<.0001$
AOI7		$p<.0001$		$p<.0001$	$p<.0001$	$p<.001$		$p<.0001$				$p<.0001$
AOI8	$p<.0001$	$p<.001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$
AOI9		$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$				
AOI10	$p<.001$	$p<.0001$	$p<.001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$			$p<.0001$	
AOI11		$p<.0001$		$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$	.	$p<.0001$		$p<.0001$
AOI12	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$	$p<.0001$		$p<.0001$	

To determine whether the number of fixations in each AOI changes with the magnitude of the ratings, a Pearson's *r* correlation was then calculated. However, this failed to show a significant relationship between V-shape judgements and the significantly different AOIs found in the previous post hoc analysis. Therefore, again, this suggests the fixation pattern is not related to the rating score for V-shape.

6.5.7 *Eye movement analysis between prominent V-Shaped bodies and bodies with no apparent V-Shape*

To test whether fixation distributions are specifically distributed when judging bodies perceived as having a prominent or no V-shape, the 5 bodies found at either end of the V-shape continuum were analysed. Fixation density heat maps were constructed using all the participant's fixation densities on each of the 10 bodies to illustrate potential differences in the way participants look at prominent V-shaped bodies compared to when they look at bodies with no apparent V-shape.

Figure 20. Fixation density heat maps on the 5 males with the most prominent V-shape figure, as rated by participants.

Figure 21. Fixation density heat maps of the 5 males with the no apparent V-shape, as rated by participants.

Preliminary analysis in the form of fixation density heat maps revealed that there was no apparent difference in fixation density patterns when participants look at a prominent V-shape figure and a figure with a more tubular body, (Figure 20 and 21).

A 2 factor repeated measures ANOVA using prominent V-shape versus no V-shape as Factor 1 and the twelve AOIs as Factor 2 found no significant effect of judgement ($F_{(1,4)}$ = 3.86, *p* = 0.12, *r* =.70). A significant effect was found between the AOIs ($F_{(11,44)}$ = 40.41, *p*<.0001, *r* =.69) however no interaction effect was found ($F_{(11,44)}$ = 0.13, *p* =1.000, *r* =.05).

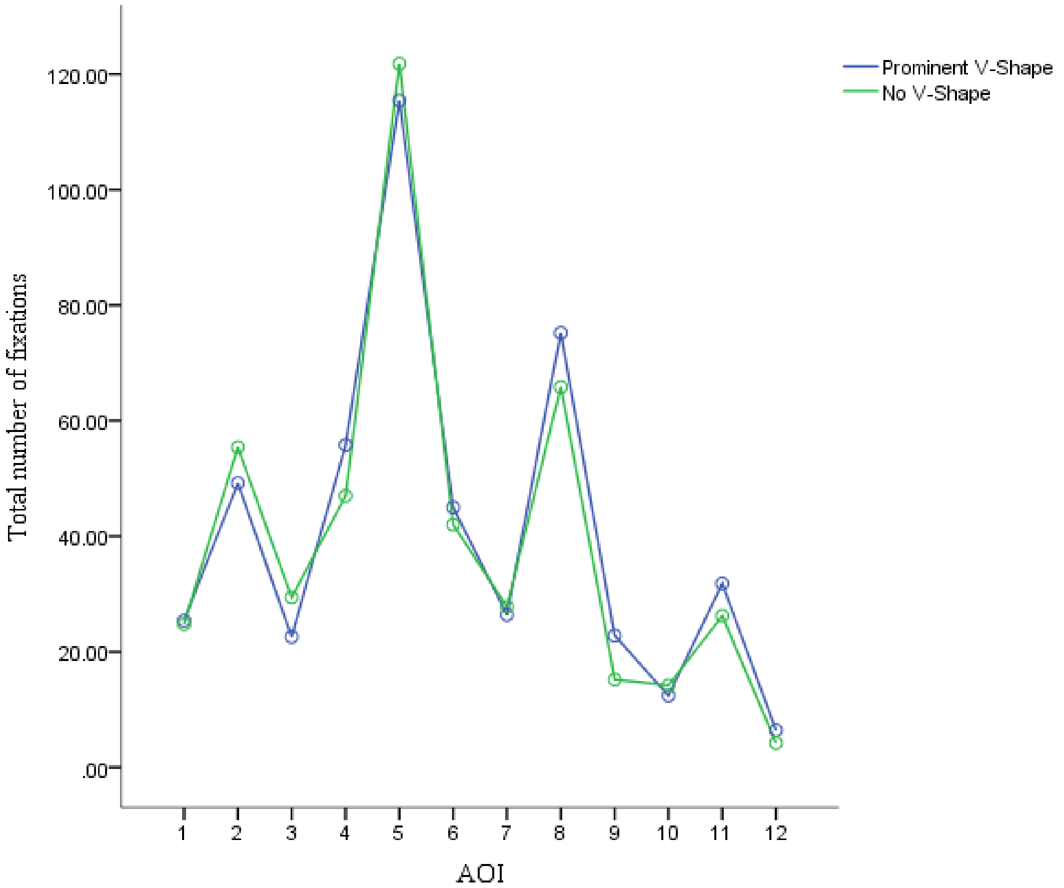


Figure 22. The interaction graph showing observers total number of fixations per AOI for when they viewed the male bodies rated as having the 5 most prominent V-Shape and the 5 having no apparent V-Shape.

The interaction graph shown in Figure 22 shows that AOI 5 contains the highest number of fixations compared to the remaining AOIs. This is true for both conditions with participants fixating slightly more on this AOI when images have no apparent V-shape compared to when they do.

A simple effects analysis found no significant differences between the corresponding AOIs between the two conditions.

6.6 Discussion

6.6.1 *What is the best predictor of male attractiveness?*

The overall results of this study correspond with the current literature on male attractiveness. V-shape and attractiveness judgements are shown to be highly correlated demonstrating that women take into account men's body shape rather than overall body size when judging attractiveness. Furthermore, they perceive a male with a prominent V-shape as more attractive than a male with a more tubular shape. This corresponds with the findings of previous studies (Maisey *et al.*, 1999; Liu *et al.*, 2005; Honekopp *et al.*, 2007; Sell *et al.*, 2009) and lends support to the evolutionary theory that male's upper body stature signals traits such as strength and masculinity, which are appealing to women (Barber, 1995).

Alternatively, a sociocultural explanation places emphasis on the role of the mass media in determining what people consider an attractive body size or shape, although other sociocultural structures (e.g., family, and peers) are also relevant (Swami *et al.*, 2007b). In most developed societies, men compare their bodies with idealized cultural images (Heinberg *et al.*, 1995; Davis and Katzman, 1997; McCreary and Sasse, 2000), and thus women also form culturally motivated ideals of male attractiveness. In one content analysis, researchers found a consistency in the V-shaped standard of male bodily attractiveness that U.S. men's magazines presented between 1960 and 1992 (Petrie *et al.*, 1996). Leit, Pope, and Gray (2001) further examined centrefold models in Playgirl from 1973 to 1997 and found that the cultural norm for the ideal male body had become increasingly muscular, especially in the 1990s.

Specifically in this study, the SHR and the CHR are shown to be the strongest predictors for both attractiveness and V-shape judgements. However, this particular finding does not entirely correspond to that of previous literature that has found the WCR to be the strongest predictor of male attractiveness (Maisey *et al.*, 1999; Liu *et al.*, 2005), however these three body indices are all highly correlated in this study (Table 2 and 8) and are therefore all arguable measures of a V-shaped physique.

A plausible explanation for this discrepancy however, is to look at the position and stance of the images that were used throughout these different studies. Looking at Maisey *et al's*., (1999) image set, their images were stood with their legs and arms wide apart, in a star-like shape. This position could be argued to distribute the weight of the bodies more evenly over the whole body, taking emphasis off the hip area which is theorised to be used as a reference point to see how much fat is situated in the abdominal area (George *et al.*, 2011). Spreading your arms widely, pulls your torso and chest area up and outwards therefore emphasising the waist and chest area and allowing participants in Maisey *et al's*., (1999) study to use these body indices more in their judgements. The images used in the present study, stood in a more natural pose with their arms naturally hanging by their side. Therefore it can be argued that participants viewed the body's weight in the specific body regions it had naturally accumulated in.

Furthermore, the clothing that the bodies were presented in may have contributed to this slight inconsistency between past literatures. For example, in Sell *et al's*., (2009) male image set; participants wore black, loose fitting gym shorts that fell to just above the knee. Whilst this allowed for observers to clearly view the male's upper body area, the shape of the upper leg/thigh region including the hip bones were concealed. This would therefore have extenuated the upper body allowing observers to make their judgments using this more visually available stimulus and would have perhaps distracted their attention away from the lower region due to it being less visually available. In addition, the bodies used in Maisey *et al's*., (1999) study wore grey leotards that covered the majority of the body and concealed reference features such as the hip bone. The images in this study however, wore boxer shorts revealing the majority of the body which therefore meant that features such as the hip bone could be easily seen by observers and therefore could be used as reference points for fat distribution for example. This would help to explain why the CHR was found to significantly correlate more with attractiveness and V-shape judgements in the present study over past studies finding the WCR to be the best predictor, however as previously stated, both the WCR and the CHR are both measures of a V-shaped torso and so this finding still supports the argument that body shape over body size is a better predictor of male attractiveness judgments (Liu *et al.*, 2005; Honekopp *et al.*, 2007).

The different clothing worn by the stimuli in different studies could also offer an explanation as to why the WHR was found to significantly correlate with attractiveness judgements in this study but not in previous research (Maisey *et al.*, 1999). Concealing distinguishable features such as the hip bone restricts participants from using them in their judgements of the body. Therefore participants being able to view such features in the current image set allowed for features such as the WHR to be shown as significantly correlating with attractiveness judgements.

6.6.2 *Differences between attractiveness perceptions of male and female bodies*

This study showed that the WHR had a positive correlation with attractiveness judgements, the opposite to what has been found in judgements of female bodies. The optimum WHR for women is perceived to be 0.7 creating an hour glass figure, with a narrow waist (Singh, 1993a). The higher this ratio gets therefore, the less attractive the body is perceived to be, creating a negative correlation between the two. This study however found a positive correlation between the attractiveness judgements of males and their WHR; males with a higher WHR are perceived as more attractive. Women therefore can be said to prefer men with a more "funnel-like" shape; slightly inverted below the chest with a straight up/down shape from there, to the hips. This narrow region between the waist and the hips indicates little or no fat deposit which women rate as more attractive. Such a finding corresponds with the results found in Crossley *et al's*., (2012) study which found that both men and women set 3D models of their ideal male body to have a narrowed lower body relative to the actual body making it less curvy and more straight up, straight down. Notably, the optimum WHR for male attractiveness shown in this study can be seen to cluster around the 0.9-0.95 ratio, the same as Singh found in his line drawings (Singh, 1995).

Again such findings can be explained in relation to a higher male chest circumference relative to their waist/hip circumference being known to signal dominance and strength which is viewed as more attractive to females (Maisey *et al.*, 1999; Honekopp *et al.*, 2007; Sell *et al.*, 2009). Furthermore, the higher a person's BMI and consequently the more body fat they have, the more likely they are to have increased mortality from a variety of diseases such as coronary artery disease and diabetes etc. (National Heart, 1998; Must, 1999; Organisation, 2000). This can be used to explain why females prefer a narrower region between the waist and hips indicating little or no fat deposit. In addition, fat cells are known to differ in morphology and physiological function depending on their location in the body (Bjorntorp, 1991). Therefore it can be said that the distribution of body fat is also an independent risk factor for a number of serious diseases and mortality over and above BMI (National Heart, 1998). This would further attempt to explain why females have a preference for a "funnel-like" male body shape as it signals better health. In further support of this, endomorph body types (high fat, low muscle) have been associated with negative attributes such as being considered less attractive, more unhealthy, and weaker (Butler *et al.*, 1993; Dixson *et al.*, 2014).

The results from this study further lend support to the argument that shape is the best predictor of attractiveness in males (Maisey *et al.*, 1999; Honekopp *et al.*, 2007; Sell *et al.*, 2009) unlike females where the most important predictor is overall body size (Tovee *et al.*, 1999; Fan *et al.*, 2004; Smith *et al.*, 2007a; Smith *et al.*, 2007b). This is suggested by the fact that V-shape is highly correlated with attractiveness judgments, yet neither body size nor the BMI of the images is. This is in contrast to the behavioural results from Chapter 5 that show that when females are judging female bodies, body size and BMI are both highly correlated with attractiveness judgements with BMI being the best predictor for both.

A possible explanation for this could be that whilst females strive for a slimmer body by undertaking various diets, males are shown to be influenced by the media and social "ideal" pressures to build up their bodies to become more muscular (McCreary and Sasse, 2000; Cafri *et al.*, 2005; Frederick *et al.*, 2005). Indeed, Crossley *et al.*, (2012) showed in their manipulation of 3D models, that female participant's set models representing their ideal partner to be lean with high muscle definition (requiring a percentage body fat below 9-12%). So whilst the BMI of the images fell at the boundary of the normal to over-weight category, the additional weight was muscle rather than fat. These findings can be applied to the results of this study that show no significant correlation between the BMI of the images and attractiveness ratings. Muscle is approximately 20% denser than fat and BMI is a measure of body weight scaled to height and is not a direct measure of percentage body fat (Flegal *et al.*, 2009). With the images shown in the current study, the majority of the body could be seen including the muscle definition. Therefore if an image had a higher fat to muscle ratio this would indicate a high BMI and low attractiveness rating. However due to muscle being denser then fat, an image could have the same BMI but the participant could view more muscle and less fat, therefore giving the image a higher attractiveness rating than the previous image with the same BMI. This finding also corresponds to past literature which states that BMI alone is an unsatisfactory measure of male attractiveness due to perceived male attractiveness depending more on body shape indicating higher versus lower levels of muscularity (Carter, 1990; Dixson *et al.*, 2003).

6.6.3 *Are eye movement patterns different when making different judgements?*

The results from the current study suggest observer's eye movement patterns differ when making the three separate judgements and moreover they corresponded with specific regions of the body known to signal certain cues. The interaction graph shown in Figure 10 revealed that observers fixated more overall on the lower mid-torso region when judging body size corresponding with past literature that observers are using stomach depth as a cue for body fat (George *et al.*, 2011).

This study further hypothesised that there would be a similar fixation density pattern when females are judging the male bodies for attractiveness and V-shape. Post hoc analysis revealed the same AOIs for both attractiveness and V-shape judgements contained a significantly higher number of fixations in them, suggesting that participants are looking at the same regions on the body to make both judgements. These increased fixations on the upper torso are consistent with the hypothesis that women use upper body strength as a signal for attractiveness as this would have enhanced the status of ancestral males (Von rueden, 2008; Sell *et al.*, 2009; Dixson *et al.*, 2014).

In further support of the prediction that when judging for body size observers will fixate more on the abdominal region, the AOIs that contained a significantly higher number of fixations were shown to be distributed down the middle of the torso and central body region, angling off towards the bodies' right hip. This further lends support to the argument that participants use features such as the hip bone as a reference point to judge fat distribution in that region. The degree of obesity is positively correlated with WHR in both men and women (Hartz *et al.*, 1984; Jones *et al.*, 1986; Shimokata *et al.*, 1989) and therefore a protruding hip bone would signal less abdominal fat and therefore a lower body size. After BMI, WHR was shown to be the best predictor of body size judgements in this study further showing that this body index is used in male body judgements.

6.6.4 *Limitations*

The limitations for the current study are similar to those suggested in Chapter 5. Notably, the AOIs on the bodies were assumed independent of one another and therefore this experiment did not control statistically for spatial co-variation. Future studies should use the GLIMMIX procedure in SAS to control for this.

Furthermore, the stimulus set used was limited in the range of body sizes and shapes and therefore was not representative of a full set of body features that may potentially determine the behavioural judgements asked.

Taking into consideration the lack of statistical significance found in the first half of the rating analysis for attractiveness and V-shape (Section 6.4.1) a statistical power analysis was performed for sample size estimation. A priori analysis for linear regression estimated a sample size of 138 participants would be needed to for the model to reach statistical significance (effect size = 0.15, $\alpha = 0.05$, power = 0.95). Therefore it could be argued that the current study was underpowered and whilst an alternative analysis using 2D measurements of the bodies was carried out and found to reach significance, future work recruiting larger sample sizes may enable more significant relationships to be found. The large number of participants necessary to achieve significance however, suggest it is a relatively weak relationship for this set of images.

6.6.5 *Conclusion*

The overall findings of this study therefore demonstrate that body shape plays a more prominent role in judgements of male attractiveness than body size, the opposite of judgements of female attractiveness. In a preliminary analysis, female observers seemed to display subtle differences in gaze patterns when judging the three behavioural variables; Attractiveness, Body Size and V-Shape, however a more detailed analysis revealed strong similarities in fixation patterns for attractiveness and V-shape judgements, with participants showing a V-shaped fixation pattern. This is in comparison to body size where participants fixate more on the central abdominal region. Future studies would benefit from recruiting a higher number of participants to reliably establish differences in fixation patterns between the three judgements, as the current data suggests trends that might become significant with more data. Nevertheless, body shape and more specifically upper body stature is shown to strongly contribute to male attractiveness judgements supporting the evolutionary theory that upper body physique indicates traits such as strength and dominance that are appealing to females (Barber, 1995).

Chapter 7. General Discussion

"The perception of the beautiful is gradual, and not a lightning revelation; it requires not only time, but some study"

Giovanni Ruffini, Italian novelist (1807-1881)

The overall aim of this thesis was to provide an insight into the question of 'what anthropometric features make a person attractive'. The thesis used eye-tracking, psychophysics and interactive body morphing programs to carry out this research.

The majority of previous literature has predominantly focussed on BMI and WHR as core predictors of attractiveness (Singh, 1993b; Tassinary and Hansen, 1998; Tovée *et al*., 1999, 2002; Dural *et al*., 2008), and whilst the current thesis lends further support to these features playing a role in attractiveness judgements, it also gives recognition to alternative anthropometric features thought to be used, such as bust size (Chapter 2) and leg length (Chapter 4) and furthermore, touches upon attitudinal processes also (Chapter 5).

Findings such as these, give sustenance to the theory that attractiveness preferences are in-fact influenced by a multiplicity of factors. Tovée *et al*., (2002) for example, used unaltered photographic images of women to show that whilst BMI was the most important predictor of attractiveness in their multivariate analysis, for images with very similar BMIs however; there was a consistent variation in attractiveness judgements that was not explained by any of the anthropometric variables. This would suggest that observer's perceptual judgements are driven by a consistent set of features, but these features had not been fully captured by the simple anthropometric indices of shape to date.

Smith *et al*., (2007) therefore came up with a novel image-driven approach to try and capture the subtle changes in body shape missed by anthropometric features previously used. By taking 60 front-view photographs of real women sampled from a "normal BMI" range (i.e. 18-25.8kg/m^2), each woman's torso was divided into 31 slices of equal thickness and a waveform was generated by plotting the width of each slice against its position in the body. Principal Components Analysis (PCA) concluded that female body shape can be adequately described by just four principal components (PCs); changes in overall body width; changes in shape of the hip region which further captures increasing chest diameter relative to waist and hips. The third component keeps waist width constant; low values are associated with wide hips and narrow chest and vice versa. The fourth component captures simultaneous fluctuations in waist and hip width with no effect on chest (see Figure 1). Using these four PCs, a new set of 625 bodies was constructed reflecting the natural shape variation of the original sample of bodies. Smith *et al.*, (2007) then asked male and female observers to rate the new image set for attractiveness and modelled the results using the four PCs.

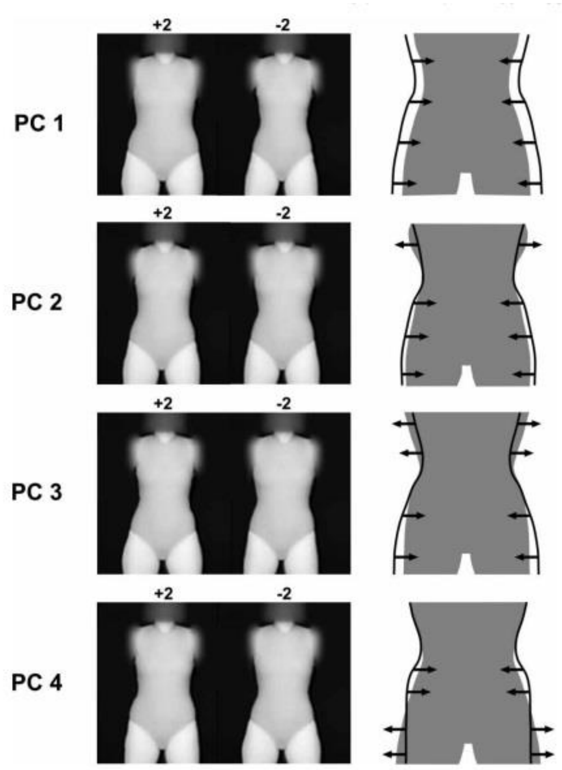


Figure 1. Principal components of body shape/size extracted by Smith *et al*., (2007).

Smith *et al*., (2007) found the best model combining quadratic terms and combinations of the principal components, to account for 90% of the variation in attractiveness in contrast to the biometric properties (BMI and WHR) which explained 66% of the variation in ratings. These biometric properties were however highly correlated with the principal components suggesting that they do go some way in explaining variation in attractiveness judgements. Nevertheless, the conclusion drawn from Smith *et al*., (2007) is that although biometric properties are good correlates of the predictors of attractiveness, the actual visual cues used appears to be more complex.

However, the image set used in Smith *et al*., (2007) can be argued to lack ecological validity as they were presenting the torso only, arms removed and in grey scale (see

Figure 1). This made them look a little unrealistic, and it removed other potential factors in attractiveness judgements such as skin colour and leg-to-body ratio (LBR) and so judgements are made purely on torso size and shape (Fink *et al*., 2001; Smith *et al*., 2007b). The bodies were further presented in 2D form eliminating depth cues which may also contribute to the perception of 3D shape, such as stomach depth which may be an important factor in attractiveness judgements (Rilling *et al*., 2009; George *et al*., 2011). Furthermore, the analysis still remained stimulus driven; the participants had to rate the limited range of bodies that were presented and varied in certain pre-determined dimensions.

The current thesis therefore attempted to address such limitations, using advanced 3D software programming that allowed participants to manipulate a full range of body features to enable the exact size and shape of their ideal body and ideal partner's body to be created. The analysis from such designs, highlighted body dissatisfaction within both male and female participants and more specifically, found that both genders produced ideal bodies with a specific shape which was independent of their ideal BMI (Chapter 3). Furthermore, as a whole, female preference for a low BMI was found, in keeping with the findings of past studies (Tovée *et al.*, 1998; Grillot *et al.*, 2014; Stephen & Perera, 2014) as well as the findings for female's ideal body shape (Perilloux, 2010; Platek & Singh, 2010; Singh, 2011). In comparison, preference for ideal male bodies was found to be heavier in relation to a more muscular body type; specifically, an increase in chest circumference and a decrease in waist and hip circumference producing a V-shaped body. This supports studies suggesting muscularity is the primary determinant of male attractiveness (Maisey *et al.*, 1999; Honekopp *et al.*, 2007; Sell *et al.*, 2009).

Such 'feasibility' studies (as presented in Chapters 2 and 3) have real-life implications as they demonstrate that people can use this advanced morphing software which could arguably be used in effective treatment programs as a way of measuring body image in eating disorders, body dysmorphia and obesity. For example, the methodology could be used to help motivate people to lose weight; showing them what they would look like if they lost weight and so motivate them in weight reduction programs.

The thesis further addressed the criticism on previous research that uses the behavioural approach to investigate visual cues to attractiveness, by utilising the eye tracking method and analysis (Chapters 5 and 6). Psycho-physical evidence is provided in the form of eye movements to where on the body observers attend to when making attractiveness judgements. Female observers were shown to fixate on the abdominal region on both male and female stimuli when making body size judgements supporting the theory that stomach depth is being used as a cue for body fat (Wells, 2007; Rilling *et al.*, 2009; George *et al.*, 2011). As the female participants in Chapter 2, and both the male and female participants in Chapter 3 were found to alter their ideal waist width to a smaller circumference than their own, this morphological manipulation coupled with the direct visual gaze fixation to that area, strengthens the apparent importance of the waist/stomach size in body size judgements. Furthermore, as body size and attractiveness judgements were shown to be highly correlated, the waist area/stomach depth seems to be a credible cue used for attractiveness judgements (Cornelissen et al., 2009; Rilling *et al*., 2009).

Female observer's attractiveness and V-shape judgements were also found to highly correlate, with the more prominent a male's V-shape; the more attractive the body was rated (Chapter 6). The eye pattern recordings mirrored this relationship showing gaze distribution across the upper torso for both judgements, implying observers use this area to make their judgement, supporting the limited research on gaze patterns and male attractiveness (Dixson *et al.*, 2014). Furthermore, Chapter 3 found males to idealise a bigger upper body stature, specifically manipulating the image's chest circumference to larger than the waist and hip size, reinforcing body shape as a predominant cue for judgements on male attractiveness.

Such behavioural rating and eye tracking methodology has therefore shown which body features are important for people's perception of what is attractive and this maybe a way into treating people for self-esteem issues related to poor body image. This may also have important implications to improving quality of life in general, as studies have found that traits such as self-esteem and self-confidence are attractive qualities. For example, Mobius and Rosenblatt (2006) found a significant relationship between self-esteem and employment success, indicating such a quality is what employers find 'attractive' in a potential employee. Hence, by improving your self-esteem, you are accumulating attractive traits and are subsequently increasing your chances of a successful career; having a successful career is associated with wealth, which leads to the accumulation of resources linked to status and health such as gym memberships and better diet, all of which can improve body image both naturally (diet and exercise) and synthetically (cosmetic; through wealth), and all of which make you desirable in the mating world also (Sobal and Stunkard, 1989).

Furthermore, additional findings of Chapter 5 suggest cognitive mechanisms influence female's judgements of their own body, rather than their actual physical features. This would suggest women have pre-conceptions about the attractiveness of their own body (Cash, 1997; Waldman, 2013), and are important to acknowledge as they can be attributed to women with eating disorders or those on the threshold for developing an eating disorder. For example, as a result of potential abnormal cognitions, perceptual distortions could arise that serve to feed distorted cognitions and evaluations relating to body size and attractiveness. This highlights the importance of acknowledging perceptual distortions and supports the use of cognitive behavioural therapy treatments of eating disorders for example (Fairburn & Harrison, 2003).

7.1 Future directions

Of course, there are some limitations to the studies presented in the current thesis that could be investigated in future work. For example, past research has emphasised cross-cultural variations in attractiveness judgements (Tovée *et al*., 1998, 1999, 2002; Marlowe and Wetsman, 2001; Furnham *et al*., 2002), limiting the generalisability of the current findings to cultures other than those from the West.

For instance, Tovée and Cornelissen (2001) emphasised that the same ideal BMI as found among Caucasians in the West (the predominant sample for the current thesis) should not be expected for all racial groups and environments. Instead, different ethnic populations may have differing levels of risk for negative health consequences with changing BMI, and, consequently, there may be a different optimal BMI for health and longevity in different ethnic groups. Differences in body weight ideals therefore, should be expected in ethnic groups that have different optimal BMIs for health and fertility.

Such a theory has been criticised by Swami and Tovée (2005b) who elicited the preferences of participants of different ethnic origin (Malay, Chinese and Indian) from the same environments. Epidemiological studies have indicated that ethnic Malays, Chinese and Indians in Southeast Asia have different optimal BMIs for risk factors for morbidity and mortality (Deurenberg *et al*., 2002), which would imply that these ethnic groups should have different preferences for body weight. This was not found to be the case however, with all three groups found to have a similar preference for slender figures (BMI:19-20).

Nevertheless, it should be noted that what matters may not be the actual association between optimal health and body weight, but rather what is perceived as healthy. If this is the case, we should expect a strong relationship between attractiveness and health ratings, which are relatively flexible to changing circumstance. Partial evidence of this has been shown by Tovée *et al*., (2007), who found ratings of women's health and attractiveness both highly correlated but also flexible to changing socio-economic circumstance. However, with current data sets, it is difficult to determine the direction of the relationship between attractiveness and health. The evolutionary model would suggest that what is perceived as healthy is beautiful, but given the 'halo effects' of physical attractiveness, it may be that what is attractive, is also healthy.

On the other hand, influences on attractiveness judgements have also been attributed to the SES of the group in question. In general, low SES observers have been found to prefer heavier bodies in both men and women (Swami and Tovée, 2005b, 2007b; Tovée *et al*., 2006, 2007). Such findings lend credence to the view that the attractiveness of body weight may be linked more to modernity or SES (Lee and Lee, 2000). However, the process by which preferences change as a function of SES remains unclear, and many researchers stress the role of media images and the profusion of a 'Western' notion of health in this process (Swami *et al*., 2007).

Therefore, an interest in cultural differences has led to a better understanding of the processes that lead to preferences for a particular body type in both men and women. Further work from around the world will therefore contribute both to how the human mind works, and also, how situational influences have the potential to affect certain behaviours.

In addition, the differences between a person's ideal and actual body size is often used as a measure of body image dissatisfaction (BID) and may be a factor in the development of eating disorders (ED). Given the evidence for gender differences in body size and shape preferences (Chapter 3) it would be interesting to compare the ideal and ideal partner's body created by participants from different socioeconomic backgrounds. Given that in Western societies in particular, access to resources and media are shown to influence preferences for a thinner body whilst less resourceful cultures idealise a heavier body (Furnham and Nordling, 1998; Marlowe and Wetsman, 2001; Freese and Meland, 2002; Swami & Tovée, 2005a,b; Tovée *et al*., 2006; Tybur and Griskevicius, 2013), asking participants from different SES levels within the UK to create their ideal body and ideal partner's body, may allow the identification of groups at risk of ED.

Furthermore, the testing could be made more realistic by using a 3D laser scanner would provide a high resolution representation of a participant's body in 3D co-ordinates which can then be imported into the Daz Studio modelling program (see figure 3). This will allow the production of photo-realistic bodies which are an accurate representation of a participant's size and shape and can be altered by the participants to their desired ideal.

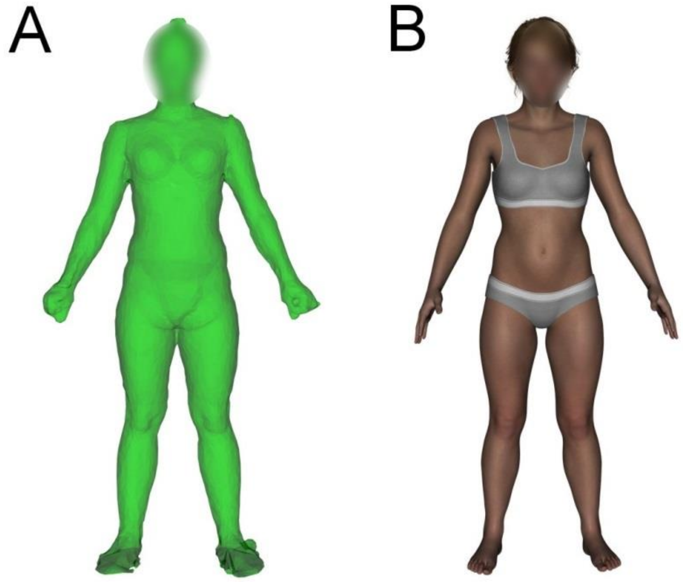


Figure 2. A) an example of an individual 3D scanned body and B) the Daz studio version using the Stephanie 6 model.

The participants can then manipulate their body size and shape to produce their ideal body. By altering the orientation of the body they can accurately judge the size and shape of this body (see Figure 3). Improvements in the quality of the modelling program and the 3D models would make this a far more realistic experience. One caveat with the Daz program is that the size and shape of the body changes is not tightly linked to biometric data base of real scanned bodies. Ideally in the future, this would be addressed by using morphs based on the variation in size and shape with changing BMI measured in the laser scanner, such as modelled by Hasler *et al*. (2009).

Figure 3. Examples of torsos from Daz Studio using the Victoria 6 model varying in body weight in A) front view and B) in ¾ view.

In addition, it would be interesting to incorporate eye tracking methodology to track participant's eye movements whilst they are manipulating the Daz, which would allow for direct measurement of which body areas are being assessed in their judgement and would complement the data on which areas were being altered.

Furthermore, given the evidence that anorexic participants over-estimate their own body size over control participants (Tovée *et al.*, 2000) and the results from Chapter 5 implying attitudinal processes influence women judging their own bodies, it would be useful to investigate the distribution gaze patterns of both anorexic and control participants when rating their own bodies compared to other women's bodies. This could provide important information as to the body size dysfunction present in many women with eating disorders.

As Hume (1757) viewed the concept of beauty as subjective, suggesting beauty can only be understood as a response to our individual feelings, emotions and thoughts, it would also be useful throughout additional investigation into attractiveness judgements, to simultaneously collect qualitative responses from observers about their bodies. For example, if such information was collected before the eye tracking paradigm to try and attribute specific gaze distributions to observer's pre-concepts, the findings could then be used in effective treatment programs to overcome both the cognitive and behavioural aspect of the issue.

7.2 Conclusion

What an individual perceives as the ideal or optimal attractive body therefore appears to be unique and complex. Consequently, whilst past studies and the current thesis have predominately focused on quantitative measures; to gain a deeper understanding of what individuals perceive as attractive and why, the use of qualitative research may help to achieve a deeper understanding of individual variation. Such results would perhaps give a first-hand account of which physical cues individuals perceive as important and why. Nonetheless, this thesis serves to demonstrate how new perspectives in research into attractiveness can contribute to knowledge about the complexion of judgements regarding attractiveness.

Appendices

A). The flyer used to advertise Study 1; Chapter 2

Research Study – Participants Needed!!!

Perception of Body Image

I am a PhD student in the **Institute of Neuroscience at Newcastle University**.

My project is looking at which specific visual cues are used when making attractiveness judgements.

The experiment is in **2 parts**, which involves looking at a series of images and entering a response and then creating an ideal female body using morphing software.

The study takes approximately **20-30min**

If you are interested in taking part please email me at

k.l.crossley@ncl.ac.uk

Thank You

B). General Consent Form

Consent form for persons participating in research projects

Name of Participant: ____

Project Title:

Name of Investigator/s:

Name of Supervisor/s (if applicable):

1. I consent to participate in the above project, the particulars of which - including details of tests or procedures - have been explained to me.

2. I authorise the investigator or his or her assistant to use with me the tests or procedures referred to under (1) above.

3. I acknowledge that:

(a) the possible effects of the tests or procedures have been explained to me to my satisfaction;

(b) I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied;

(c) The project is for the purpose of research and/or teaching and not for treatment;

(d) I have been informed that the confidentiality of the information I provide will be safeguarded, subject to any legal requirements.

Signature: ____ Date: ____________

(Participant)

Signature: ____ Date: ____________

(Researcher)

C). Participant data sheet

Date ………………… Researcher ……………..............

Participant number ....

Age……………………………………………………………….

Gender…………………………………………………………...

Height ……………………ft …………………………in

Weight ……………………st ……..…………………lbs

Bust/Chest ……………………cm ………………………..mm

Under bust ……………………cm ………………………..mm

Waist ……………………cm ………………………..mm

Hips ……………………cm ………………………..mm

Torso length ……………………cm ………………………..mm

Leg length ……………………cm ………………………..mm

Shoulder length ……………………cm ………………………..mm

D). Debrief sheet for Chapter 2

Thank you for participating in this study.

One of the main aims in this study was to examine which specific features of the body influence attractiveness judgements.

Co-variation of body features is a restraint on such research which this study attempted to overcome by asking participants to independently alter three features thought to be important in attractiveness judgements (bust, waist and hips) in a set of artificial bodies. This allowed the effect of changing just a single feature to be determined; changing the bust size will also alter the BMI of the body, but so will altering the waist or hips. By recording the BMI change however, the relative importance of the bust, waist and hip size can be explored.

Furthermore, by asking participants to rate an image set consisting of varying bust, waist and hip sizes, some will have the same BMI but with different shapes. Therefore, for bodies in the same BMI range, this study can investigate which shapes are the most attractive.

Your contribution to this study is therefore very valuable and very much appreciated. Your responses will be used to help answer the question of whether BMI is reliably the best predictor of attractiveness judgements or whether in fact, alternative features of the body are used.

If you would like to read an article on this general topic, then please see:

Rilling *et al*., (2009). "Abdominal depth and waist circumference as influential determinants of human female attractiveness"

If, for whatever reason, you later decide that you no longer want your responses to be part of this study, then please contact Kara Crossley (see details below) to have your data removed from the study and destroyed. As a final point, all data collected in this study will be analysed in an aggregated form – your responses will not be singled out; only averaged results will be reported in any future publications. You will remain anonymous.

Thank you again for participating and helping with this study. However, **please do not show this debriefing sheet or discuss any aspect of the study with other students**. In order for this study to work, it is important that future participants do not have this information or any particular expectations.

If you would like more information, or have any further questions about any aspect of this study, then please feel free to contact Kara Crossley – **k.l.crossley@ncl.ac.uk**

E). The information and demographic screen participants saw in Chapter 4.

https://jfe.qualtrics.com/form/SV_8ctQ95beFPdOPsw

The Institute of Neuroscience

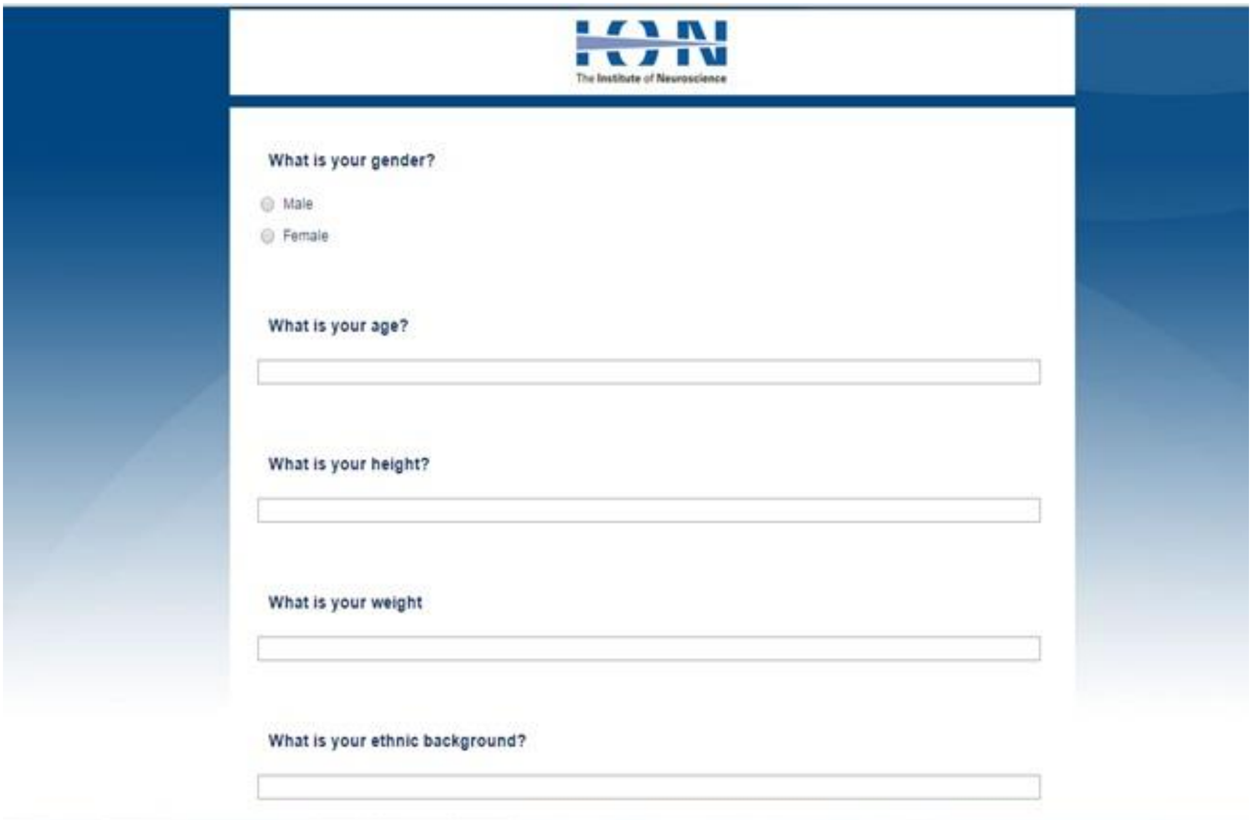
This experiment asks you to rate a set of 21 bodies for attractiveness, health, body weight and age. This experiment is part of a series addressing the quetion of which features predict judgements of body perception.

Your contribution in this study is very much appreciated and the responses you gave are very important in assisting us with our analysis. If you decide later on that you do not wish to have your responses to be used, then we will be happy to remove your data from our study and have it destroyed. All data in the study will remain anonymous and will be analysed as a whole, and that no single piece of data will be singled out.

If you have any questions or queries about this study please feel free to contact the experimenter, Kara Crossley (kara.crossley@newcastle.ac.uk)

>>

Survey Powered By Qualtrics



The Institute of Neuroscience

What is your gender?

Male

Female

What is your age?

What is your height?

What is your weight

What is your ethnic background?

F). Information sheet for the photograph study in Chapters 5 and 6

Information About This Study

Judgments of Attractiveness

Please retain this sheet for your information.

For the purpose of this study you will be asked to wear the outfit provided and have your picture taken from four different angles (front, left side, right side and back) whilst standing on a rotating platform. You will be asked to stand in a pose with your arms to the side of you with your palms facing forward for the front and back images, and in front with palms facing down for the side views.

Your height, weight, waist, hip and chest measurements, as well as your leg and torso length, will be taken and recorded for your image data purposes. At the end of the session you will be given the opportunity to view your own images and to ask any further questions that you may have.

Your participation in this study is strictly non-compulsory and you may withdraw at any stage. You can also choose to have any images or data that you provide in this study to be completely destroyed at any point. All the images and responses to any questions on the questionnaire along with your body measurements will be kept anonymous and strictly confidential. Only the researchers working on this project will have access to this data.

Thank you for your participation in this study.

G). Debrief sheet for the photograph studies

Debriefing Sheet

IMAGES

Thank you for participating in this study.

In this study we asked you to be photographed to generate pictures of your body shape and size to be part of our portfolio of images of which we will use in further studies looking at body shapes. Face pictures were also taken to allow us to generate a different portfolio which will aid us in studies looking specifically at faces in the future.

As you are aware, we asked you to stand in poses that meant your arms did not touch your torso and that your thighs did not touch. These were important for the images because it allows future participants who will look at these images to distinguish the shape and size of each part of your body separately. For instance, people who have more of their own body concerns tend to look at more of the body when judging attractiveness where as people with little or no concerns would concentrate more on the abdomen of a body.

You also know that your identity on the full body images will be hidden, this is not only to protect your identity but also because it has been found that facial features and structure act as confounding variables when judging attractiveness of a person and may produce less reliable overall results for experiments concentrating on purely body shapes and sizes.

We also took body measurements from you (i.e. your height, weight, hip, chest and waist), this is only for data analysis purposes only. It is predicted that people with little or no concerns will judge images with a similar BMI to their own and a shape most similar to their own as most attractive, whereas we predict that those with high concerns and very high or low BMIs to judge people with different BMIs and shapes to their own as more attractive. If this is the case then it may help to explain why people with eating disorders such as Anorexia Nervosa perceive their own body shape and size to be uncomfortable and unattractive.

Your contribution to the study is very much appreciated and very valuable to our research. The images you helped us generate will be used in studies to help us how people judge attractiveness and whether people do judge their own attractiveness differently to when they judge others. These are questions that have been asked by many medical professionals – particularly those specialising in eating disorders for many years.

If for any reason you would like your images to be withdrawn from the data pool then please contact Kara Crossley to have your data removed and destroyed.

We kindly ask that you **Do not show this debriefing sheet or discuss any aspect of the study with other students**. It is very important that potential future participants who do rate these images do not have any expectations of the outcome of the study in order for the results to be accurate and for the study to work.
If you have any questions or would like any further information about any aspect of this study, then please feel free to contact Kara Crossley.

H). Eye movements information sheet

Information About This Study

Eye-movements and attractiveness judgements

Please retain this sheet for your information.

In this study you will be asked to rate anonymous digital pictures of females/males, for attractiveness on a scale of 0 – 9 (0 = very unattractive, 9 = very attractive). Firstly you will be asked to position yourself in front of the eye tracking system. Your point of gaze will be calibrated by the experimenter who will ask you to look at different numbers on the screen in front of you. Once this is complete you will be shown the set of images with each image appearing separately. You will be asked to rate these images using the keyboard placed in front of you, and you will be expected to try and keep your head as still as possible during this time. After the ratings of the images is complete you will be asked to fill in a 'Body Shape Questionnaire' and 'Eating Attitudes' questionnaire, to assess how you feel about your own body weight and shape. Your height, weight, waist, hip and chest measurements will be taken and recorded for analyses purposes. At the end of the session you will be given the opportunity to ask any further questions that you may have and to find out more about the study.

Participation in this study is completely non-compulsory and you may withdraw from it at any stage. You can also request that the data you provide to be completely destroyed at any stage, either during or after the study. Any responses you do provide will be kept strictly confidential, subject to any legal requirements. Only researchers in this project will have access to your data. The questionnaires and measurements that you complete and provide will be destroyed once the project is complete. All responses are reported in collective form and no individuals' responses will be singled out in the report of the results in the study.

Thank you for your participation in this study.

I). Eye movements debrief sheet

Attractiveness Judgments

Thank you for participating in this study.

The main aim of this study was to see whether people look differently at their own body to when they look at other people's bodies when they are judging attractiveness. We further wanted to see if people could recognise their own body when they were shown it without being told. Therefore in this experiment, slight deception was used where we firstly showed you your own body and asked you to rate it for attractiveness but then we presented your body again, in amongst the pre-existing image set we have, to see whether you rated your body the same for attractiveness and to see if you looked at the same area of your body when you weren't told it was your body.

As you know, we used the eye tracking system to record where you looked on the images and how long you looked at a particular region in order to determine your rating. This is very important to the study as it allows us to see if there are any differences between where people look when judging attractiveness. Subconscious judgements of attractiveness are made in everyday situations purely based on the physical presentation of an individual. Popular examples of this are of celebrities portrayed in the media, whether they are too fat, too thin, too tall or too short, there will always be a story or rumour that coincides with this. Other day to day examples may simply be spotting someone in a nightclub or walking past someone in the street.

After you were asked to rate the images in this experiment, you were given a body shape questionnaire (BSQ) to fill in and had your weight, height and body measurements (i.e. hips, waist and chest) taken. We wanted to see if there were any relationships between your body mass index (BMI), waist-to-hip and waist-to-chest ratios (WHR and WCR) and your BSQ scores, also against those of your image ratings. For example, we wanted to see whether women with high body shape concerns over-estimated the size of the bodies relative to people with low body shape concerns.

Your contribution to the study is very much appreciated and very valuable to our research. Your responses to the images and questionnaires will be used to help answer questions of how people judge attractiveness and why there may be a difference between how we look at our own bodies compared to how we look at others.

If for any reason you would like your responses to be withdrawn from the data pool then please contact Kara Crossley to have your data removed. However, after learning about the slight deception in this study and you are still happy for your results to be used, please sign the consent form again which the researcher will give you. All data collected in this study will be analysed in a summative form – your individual responses will not be singled out in any way; only averaged results will be reported. You will remain anonymous.

We kindly ask that you **Do not show this debriefing sheet or discuss any aspect of the study with other students**. It is very important that potential future participants do not have any expectations of the outcome of the study in order for the results to be accurate and for the study to work.

If you have any questions or would like any further information or support about any aspect of this study, then please feel free to contact Kara Crossley on k.l.crossley@ncl.ac.uk.

Thank you once again for participating in this study.

J). The Body Shape Questionnaire (BSQ)

We would like to know how you have been feeling about your appearance over the PAST FOUR WEEKS. Please read each question and circle the appropriate number to the right. Please answer all the questions.

		Never	Rarely	Sometimes	Often	Very Often	Always
1	Have you been so worried about your shape that you have been feeling that you ought to diet?	1	2	3	4	5	6
2	Has being with thin people made you feel self-conscious about your shape?	1	2	3	4	5	6
3	Have you noticed the shape of other people and felt that your own shape compared unfavourably?	1	2	3	4	5	6
4	Has being undressed such as when taking a bath, made you feel fat?	1	2	3	4	5	6
5	Has eating sweets, cakes or other high calorie food made you feel fat?	1	2	3	4	5	6
6	Have you felt excessively large and rounded?	1	2	3	4	5	6
7	Have you felt ashamed of your body?	1	2	3	4	5	6
8	Has worry about your shape made you diet?	1	2	3	4	5	6
9	Have you thought that you are the shape you are because of lack of self-control?	1	2	3	4	5	6
10	Have you worried about other people seeing rolls of fat around your waist or stomach?	1	2	3	4	5	6
11	Have you felt that it is not fair that other people are thinner than you?	1	2	3	4	5	6
12	Has seeing your reflection (eg. In a mirror or shop window) made you feel bad about your shape?	1	2	3	4	5	6
13	Have you been particularly self-conscious about your shape when in the company of other people?	1	2	3	4	5	6
14	Has worry about your shape made you feel you ought to exercise?	1	2	3	4	5	6
15	Have you felt happy with the shape of your body?	1	2	3	4	5	6

K). The Eating Attitudes Test (EAT-26)

Please choose a response for each of the following statements:

	Always	Usually	Often	Sometimes	Rarely	Never
1. I am terrified about being overweight.	○	○	○	○	○	○
2. I avoid eating when I am hungry.	○	○	○	○	○	○
3. I find myself preoccupied with food.	○	○	○	○	○	○
4. I have gone on eating binges where I feel that I may not be able to stop.	○	○	○	○	○	○
5. I cut my food into small pieces.	○	○	○	○	○	○
6. I aware of the calorie content of foods that I eat.	○	○	○	○	○	○
7. I particularly avoid food with a high carbohydrate content (i.e. bread, rice, potatoes, etc.)	○	○	○	○	○	○
8. I feel that others would prefer if I ate more.	○	○	○	○	○	○
9. I vomit after I have eaten.	○	○	○	○	○	○
10. I feel extremely guilty after eating.	○	○	○	○	○	○
11. I am occupied with a desire to be thinner.	○	○	○	○	○	○
12. I think about burning up calories when I exercise.	○	○	○	○	○	○
13. I other people think that I am too thin.	○	○	○	○	○	○
14. I am preoccupied with the thought of having fat on my body.	○	○	○	○	○	○
15. I take longer than others to eat my meals.	○	○	○	○	○	○
16. I avoid foods with sugar in them.	○	○	○	○	○	○
17. I eat diet foods.	○	○	○	○	○	○
18. I feel that food controls my life.	○	○	○	○	○	○
19. I display self-control around food.	○	○	○	○	○	○
20. I feel that others pressure me to eat.	○	○	○	○	○	○
21. I give too much time and thought to food.	○	○	○	○	○	○
22. I feel uncomfortable after eating sweets.	○	○	○	○	○	○
23. I engage in dieting behaviour.	○	○	○	○	○	○
24. I like my stomach to be empty.	○	○	○	○	○	○
25. I have the impulse to vomit after meals.	○	○	○	○	○	○
26. I enjoy trying new rich foods.	○	○	○	○	○	○

Have you gone on eating binges where you feel that you may not be able to stop? Eating much more food than most people would eat under the same circumstances? **Yes** **No**

Have you ever made yourself sick (vomited) to control your weight or shape? **Yes** **No**

Have you ever used laxatives, diet pills or diuretics (water pills) to control your weight or shape? **Yes** **No**

Have you ever been treated for an eating disorder? **Yes** **No**

Have you recently thought of or attempted suicide? **Yes** **No**

References

American Association of Plastic Surgeons (2005) '*Top five surgical cosmetic procedures in 2005*'. Online publication at: http://plasticsurgery.org/media/statistics.

Andersen, A.E. and Didomenico, L. (1992) 'DIET VS SHAPE CONTENT OF POPULAR MALE AND FEMALE MAGAZINES - A DOSE-RESPONSE RELATIONSHIP TO THE INCIDENCE OF EATING DISORDERS', *International Journal of Eating Disorders*, 11(3), pp. 283-287.

Anderson-Fye, E.P. (2004) 'A "Coca-Cola Shape: Cultural change, Body Image, and Eating Disorders in San Andrés, Belize', *Culture, Medicine and Psychiatry*, 28, 561-595.

Anderson-Fye, E.P. and Floersch, J. (2011) ' "I'm not you typical 'Homework stresses me out' kind of girl": Psychological Anthropology in Research on College Student Usage of Psychiatric Medications and Mental Health Services', *Journal of the Society for Psychological Anthropology*, 39, 501-521.

Anderson-Fye, E.P., and Lin, J. (2009) 'Belief and Behaviour Aspects of the EAT-26: The Case of Schoolgirls in Belize', *Cult Med Psychiatry*, 33, 623-638.

Andersson, M. (1994) *Sexual Selection*. Princeton University Press.

Andrist, L.C. (2003) 'Media images, body dissatisfaction and disordered eating in adolescent women', *Amer Jour Maternal Child Nursing*, 28, pp. 119-23.

Armstrong, J. (2004) *The secret power of beauty*. London: Penguin.McArthur, L.Z. and Baron, R.M. (1983) 'TOWARD AN ECOLOGICAL THEORY OF SOCIAL-PERCEPTION', *Psychological Review*, 90(3), pp. 215-238.

Bamman, M.M., Petrella, J.K., Kim, J.S., Mayhew, D.L and Cross, J.M. (2007) 'Cluster analysis tests the importance of myogenic gene expression during myofiber hypertrophy in human', *J Appl Physiol*, 102, pp. 2232-2239.

Barber, N. (1995) 'The evolutionary psychology of physical attractiveness: Sexual selection and human morphology', *Ethology and Sociobiology*, 16(5), pp. 395-424.

Baron, R., Byrne, D and Branscombe, N (2006) *Social Psychology*. Boston: MA: Pearson.

Barrett, L., Dunbar, R and Lycett, J (2002) '*Human evolutionary psychology*'. Basingstoke: Palgrave.

Baize, H.R., & Schroeder, J. E (1995) 'Personality and mate selection in personal ads: Evolutionary preferences in a public mate selection process.', *Journal of Social Behaviour and Personality* 19, pp. 517-536.

Bateson, M., Cornelissen, P. L., & Tovee, M. J (2007) 'Methodological issues in judgements of female body attractiveness', in Furnham, A., & Swami, V (ed.) *The Body Beautiful: Evolutionary and Socio-cultural Perspectives*. Basingstoke, UK: Macmillan, pp. 46-62.

Becker, A.E. and Hamburg, P (1996) 'Culture, the media, and eating disorders'. *Harvard Review of Psychiatry*, 4, 163-167.

Becker, A.E. (2004) 'Television, disordered eating and young women in Fiji: Negotiating body image and identity during rapid social change', *Culture, Medicine and Psychiatry*, 28, 533-559.

Becker, A.E., Gilman, S.E. and Burwell, R.A. (2005) 'Changes in prevalence of overweight and in body image among Fijian women between 1989 and 1998', *Obesity Research*, 13, 110-117.

Beckerman, S. (2000) 'Mating and marriage, husbands and lovers: Commentary on Gangestad and Simpson (2000). *Behavioural and Brain Sciences*, 23, 590-591.

Bergstrom, R.L., Neighbors, C. and Lewis, M.A. (2004) 'Do men find "bony" women attractive?: Consequences of misperceiving opposite sex perceptions of attractive body image', *Body image*, 1(2), pp. 183-91.

Berscheid, E., Dion, K., Walster, E and Walster, G.W. (1973) 'Physical attractiveness and dating choice: A test of the matching hypothesis', *Journal of Experimental Social Psychology*, 7, 173-189.

Bertamini, M and Bennett, K.M. (2009) A study on the effect of leg to body ratio on perceived attractiveness of simplified stimuli. *Journal of Social, Evolutionary and Cultural Psychology*, 3, 233-250.
Bivans, A.M (1991) *Miss America: In pursuit of the crown.* New York: Mastermedia.
Bjorntorp, P. (1988) The associations between obesity, adipose tissue distribution and disease. *Acta Medica Scandinavica*, 723, 121-134.
Bjorntorp, P. (1991) 'ADIPOSE-TISSUE DISTRIBUTION AND FUNCTION', *International Journal of Obesity*, 15, pp. 67-81.
Bogin, B., and Varela-Silva, M. (2010) 'Leg length, body proportion and health: A review with a note on beauty', *Environmental research and public health*, 7, pp. 1047-1075.
Boyd, K and Fouts, G (1999) 'Young women's magazines: A content analysis'. Paper presented at the meeting of the Canadian Communications Association, Sherbrooke, Quebec, June.
Boyd, R., and Silk, J.B. (2009) '*How humans evolved*' (5th edition). New York: Norton.
Boyson, A.R., Pryor, B & Butler, J. (1999) 'Height as power in women', *North American Journal of Psychology*, 1, pp. 109-114.
Bramble, D.M and Lieberman, D.E. (2004) 'Endurance running and the evolution of Homo', *Nature*, 432, pp. 345-352.
Brewer, C.J. and Balen, A.H. (2010) 'The adverse effects of obesity on conception and implantation', *Reproduction*, 140(3), pp. 347-364.
Brodie, D.A., Slade, P.D. and Riley, V.J. (1991) 'SEX-DIFFERENCES IN BODY-IMAGE PERCEPTIONS', *Perceptual and Motor Skills*, 72(1), pp. 73-74.
Brown, P.J. and Konner, M. (1987) 'AN ANTHROPOLOGICAL PERSPECTIVE ON OBESITY', in *Wurtman, R. J. And J. J. Wurtman*. pp. 29-46.
Bryant, J and Zhilman, D. (2002) '*Media effects: Advances in theory and research*' Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
Buss, D.M. (1989) 'SEX-DIFFERENCES IN HUMAN MATE PREFERENCES - EVOLUTIONARY HYPOTHESIS TESTED IN 37 CULTURES', *Behavioral and Brain Sciences*, 12(1), pp. 1-14.
Buss, D.M. (1992) *Mate preference mechanisms: Consequences for partner choice and intra-sexual competition*. Oxford: Oxford University Press.
Buss, D.M. (1995) 'ON THE EVOLUTION OF DESIRE', *Contemporary Psychology*, 40(7), pp. 711-711.
Buss, D. (2001) 'Human nature and culture: An evolutionary psychological perspective', *Journal of Personality*, 69, 955-978.
Buss, D.M. (2003) *The evolution of desire: Strategies of human mating*. New York: Basic Books.
Buss, D.M. (2007) 'The Evolution of Human Mating', *Acta Psychologica Sinica*, 39(3), pp. 502-512.
Buss, D.M. and Schmitt, D.P. (1993) 'SEXUAL STRATEGIES THEORY - AN EVOLUTIONARY PERSPECTIVE ON HUMAN MATING', *Psychological Review*, 100(2), pp. 204-232.
Butler, J.C., Ryckman, R.M., Thornton, B. and Bouchard, R.L. (1993) 'ASSESSMENT OF THE FULL CONTENT OF PHYSIQUE STEREOTYPES WITH A FREE-RESPONSE FORMAT', *Journal of Social Psychology*, 133(2), pp. 147-162.
Cafri, G., Thompson, J.K., Ricciardelli, L., McCabe, M., Smolak, L. and Yesalis, C. (2005) 'Pursuit of the muscular ideal: Physical and psychological consequences and putative risk factors', *Clinical Psychology Review*, 25(2), pp. 215-239.
Cant, J.G.H. (1981) 'HYPOTHESIS FOR THE EVOLUTION OF HUMAN BREASTS AND BUTTOCKS', *American Naturalist*, 117(2), pp. 199-204.
Carter, J.E.L., & Heath, B. H (1990) *Somatotyping: Development and applications*. Cambridge, England.

Case, A. and Paxson, C. (2008) 'Height, health, and cognitive function at older ages', *American Economic Review*, 98(2), pp. 463-467.
Cash, T.F. (2003) 'Body Image: Past, present, future', *Body image*, 1, pp. 1-5.
Cash, T.F., & Deagle, E. A. (1997) 'The nature and extent of body-image disturbances in Anorexia Nervosa and Bulimia Nervosa: A Meta-Analysis', *Journal of Eating Disorders*, 22, pp. 107-125.
Cash, T.F. and Green, G.K. (1986) 'BODY-WEIGHT AND BODY-IMAGE AMONG COLLEGE-WOMEN - PERCEPTION, COGNITION, AND AFFECT', *Journal of Personality Assessment*, 50(2), pp. 290-301.
Cash, T.F and Hicks, K.L. (1990) Being fat versus thinking fat – relationships with body image, eating behaviours and well-being, *Cognitive therapy and research,* 14, 327-341.
Cashdan, E. (2008) 'Waist-toHip Ratio acrros Cultures: Trade-Offs between Androgen and Estrogen Dependent Traits', *The Wenner-Gren Foundation for Anthropological Research*, 49(6), pp. 1099-1107.
Coetzee, V. and Perrett, D.I. (2011) 'African and Caucasian body ideals in South Africa and the United States', *Eating Behaviors*, 12(1), pp. 72-74.
Cohn, L.D.A., N. E (1992) 'Female and male perceptions of ideal body shapes: Distorted views among Caucasian college students', *Psychol Women Q*, 16, pp. 66-79.
Collaboration, E.R.F. (2011a) 'Separate and combined associations of body-mass index and abdominal adiposity with cardiovascular disease: collaborative analysis of 58 prospective studies', *Lancet*, 377, pp. 1085-95.
Collaboration, P.S. (2011b) 'Body-mass index and cause-specific mortality in 900,000 adults: collaborative analyses of 57 prospective studies', *Lancet*, 373, pp. 1083-1096.
Cornelissen, P.L., Hancock, P.J.B., Kiviniemi, V., George, H.R. and Tovée, M.J. (2009a) 'Patterns of eye movements when male and female observers judge female attractiveness, body fat and waist-to-hip ratio', *Evolution and Human Behavior*, 30(6), pp. 417-428.
Cornelissen, P.L., Johns, A. and Tovée, M.J. (2013) 'Body size over-estimation in women with anorexia nervosa is not qualitatively different from female controls', *Body image*, 10(1), pp. 103-111.
Cornelissen, P.L., Tovée, M.J. and Bateson, M. (2009b) 'Patterns of subcutaneous fat deposition and the relationship between body mass index and waist-to-hip ratio: Implications for models of physical attractiveness', *Journal of Theoretical Biology*, 256(3), pp. 343-350.
Courtiol, A., Picq, S., Godelle, B., Raymond, M. and Ferdy, J.B. (2010) 'From Preferred to Actual Mate Characteristics: The Case of Human Body Shape', *Plos One*, 5(9), p. 8.
Crossley, K.L., Cornelissen, P.L. and Tovée, M.J. (2012) 'What Is an Attractive Body? Using an Interactive 3D Program to Create the Ideal Body for You and Your Partner', *Plos One*, 7(11).
Dagnino, B., Navajas, J. and Sigman, M. (2012) 'Eye Fixations Indicate Men's Preference for Female Breasts or Buttocks', *Archives of Sexual Behavior*, 41(4), pp. 929-937.
Danel, D., and Pawlowski, B (2006) ‘Attractiveness of Men’s Faces in Relation to Women’s Phase of Menstrual Cycle’, *Coll. Anthropol*, 30, 285-289.
Darwin, C. (1887/1959) *The autobiography of Charles Darwin: With original omissions restored*. London: Norton.
Davis, C. and Katzman, M. (1997) 'Charting new territory: Body esteem, weight satisfaction, depression, and self-esteem among Chinese males and females in Hong Kong', *Sex Roles*, 36(7-8), pp. 449-459.
Desouza, M.J and Metzger, D.A. (1991) Reproductive dysfunction in amenorrheic athletes and anorexic patients – a review, *Medicine and Science in Sports and Exercise*, 23, 995-1007.

Deurenberg, P., Deurenberg-Yap, M., and Guricci, S. (2002) ‘Asian are different from Caucasians and from each other in their body mass index/body fat per cent relationship’, *Obesity*, 3, pp. 141-6.
Dion, K., Walster, E. and Berschei.E (1972) 'WHAT IS BEAUTIFUL IS GOOD', *Journal of Personality and Social Psychology*, 24(3), pp. 285-&.
Dixson, B.J., Grimshaw, G.M., Linklater, W.L. and Dixson, A.F. (2010) 'Watching the Hourglass Eye Tracking Reveals Men's Appreciation of the Female Form', *Human Nature-an Interdisciplinary Biosocial Perspective*, 21(4), pp. 355-370.
Dixson, B.J., Grimshaw, G.M., Linklater, W.L. and Dixson, A.F. (2011) 'Eye-Tracking of Men's Preferences for Waist-to-Hip Ratio and Breast Size of Women', *Archives of Sexual Behavior*, 40(1), pp. 43-50.
Dixson, B.J., Grimshaw, G.M., Ormsby, D.K. and Dixson, A.F. (2014) 'Eye-tracking women's preferences for men's somatotypes', *Evolution and Human Behavior*, 35(2), pp. 73-79.
Dixson, A.F., Halliwell, G., East, R., Wignarajah, P. and Anderson, M.J. (2003) 'Masculine somatotype and hirsuteness as determinants of sexual attractiveness to women', *Archives of Sexual Behavior*, 32(1), pp. 29-39.
Dixson, B.J., Vasey, P.L., Sagata, K., Sibanda, N., Linklater, W.L. and Dixson, A.F. (2011) 'Men's Preferences for Women's Breast Morphology in New Zealand, Samoa, and Papua New Guinea', *Archives of Sexual Behavior*, 40(6), pp. 1271-1279.
Dunkake, I., Kiechle, T., Klein, M. and Rosar, U. (2012) 'Good Looks, Good Grades? An Empirical Analysis of the Influence of Students' Physical Attractiveness on Grading by Teachers', *Zeitschrift Fur Soziologie*, 41(2), pp. 142-161.
Dural, S., Cetinkaya, H. and Guelbetekin, E. (2008) 'The role of waist-to-hip ratio in evaluation of female physical attractiveness: Eye-tracker data', *Turk Psikoloji Dergisi*, 23(61), pp. 75-91.
Eagly, A.H. and Wood, W. (1999) ‘The origins of sex differences in human behaviour: Evolved dispositions versus social roles’, *American Psychologist*, 54, 408-423.
Eagly, A.H and Wood, W. (2013) ‘Feminism and Evolutionary Psychology: Moving Forward’, *Sex Roles*, 69, 549-556.
Eijkemans, M.J.C., Imani, B., Mulders, A., Habbema, J., and Fauser, B. (2003) ‘High singleton live birth rate following classical ovulation induction in normogonadotrophic anovulatory infertility (WHO_2), *Human Reproduction*, 18, 2357-2362.
Einon, D. (2007) *The shaping of women's bodies: Men's choice of fertility or heat stress avoidance*. Basingstoke, UK: Palgrave Macmillan.
El-Bayoumy, I., Shady, I and Lotfy, H. (2009) ‘Prevalence of Obesity among adolescents (10-40 years) in Kuwait’, *Asia-Pacific Journal of Public Health*, 21, pp. 153-159.
England, H.S.f. (2003) *National Centre for Social Reseach and University College London.* Norwich
England, H.S.f. (2008) *National Centre for Social Research and University College London*. Colchester: Essex.
Esnaola, I., Rodriguez, A. and Goni, A. (2010) 'Body dissatisfaction and perceived sociocultural pressures: gender and age differences', *Salud Mental*, 33(1), pp. 21-29.
Evans, C. and Dolan, B. (1993) 'BODY SHAPE QUESTIONNAIRE - DERIVATION OF SHORTENED ALTERNATE FORMS', *International Journal of Eating Disorders*, 13(3), pp. 315-321.
Evans, J.P. and Magurran, A.E. (2000) ‘Multiple benefits of multiple mating in guppies’, *Proceedings of the National Academy of Sciences*, 97, 10074-10076.
Fairburn, C.G. and Harrison, P.J (2003) Eating Disorders, *Lancet*, 361, 407-415.
Fallon, A.E. and Rozin, P. (1985) 'SEX-DIFFERENCES IN PERCEPTIONS OF DESIRABLE BODY SHAPE', *Journal of Abnormal Psychology*, 94(1), pp. 102-105.
Fan, J,T. (2007) ‘The volume-height index as a body attractiveness index’. In V.Swami and A.Furnham (Ed.) *The Body Beautiful* (pp.29-46). Macmillan: UK.

Fan, J.T., Dai, W., Liu, F. and Wu, J. (2005) 'Visual perception of male body attractiveness', *Proceedings of the Royal Society B-Biological Sciences*, 272(1560), pp. 219-226.
Fan, J.T., Liu, F., Wu, J. and Dai, W. (2004) 'Visual perception of female physical attractiveness', *Proceedings of the Royal Society B-Biological Sciences*, 271(1537), pp. 347-352.
Faries, M.D and Bartholomew, J.B. (2012) 'The role of body fat in female attractiveness', *Evolution and Human Behaviour,* 33, pp. 672-681.
Feingold, A. (1992) 'Good-looking people are not what we think', *Psychological Bulletin,* 111, 304-241.
Felson, R.B. (1980) 'PHYSICAL ATTRACTIVENESS, GRADES AND TEACHERS ATTRIBUTIONS OF ABILITY', *Representative Research in Social Psychology*, 11(1), pp. 64-71.
Field, A.E., Austin, S.B., Camargo, C.A., Taylor, C.B., Striegel-Moore, R.H., Loud, K.J. and Colditz, G.A. (2005) 'Exposure to the mass media, body shape concerns, and use of supplements to improve weight and shape among male and female adolescents', *Pediatrics*, 116(2), pp. E214-E220.
Field, A.E., Carmago, C.A., Taylor, C.D., Berkey, C.S., Roberts, S.B and Coldizt, G.A. (2001) 'Peer, parent and media influences on the development of weight concerns and frequent dieting among preadolescent and adolescent girls and boys', *Paediatrics*, 107, 54-60.
Fielding, R., Schooling, C.M., Adab, P., Cheng, K.K., Lao, X.Q., Jiang, C.Q. and Lam, T.H. (2008) 'Are longer legs associated with enhanced fertility in Chinese women?', *Evolution and Human Behavior*, 29(6), pp. 434-443.
Fink, B., Grammer, K and Thornhill, R. (2001) Human facial attractiveness in relation to skin texture and color, *Comparative Psychology,* 115, 92-99.
Fink, B., Klappauf, D., Brewer, G *et al*. (2014) 'Female physical characteristics and intra-sexual competition in women', *Personality and Individual Differences,* 58, pp. 138-141.
Fisher, H.E. (1992) *Anatomy of love*. New York: Norton
Fisher, R.A. (1930) '*The genetical theory of natural selection*' (2edn). New York: Dover.
Fisher, R.A. (1958) '*The Genetical Theory of Natural Selection*'. New York: Dover.
Flegal, K.M., Graubard, B.I., Williamson, D.F and Gail, M.H (2008) 'Correcting bias, or biased corrections?', *Obesity,* 16, pp. 229-231.
Flegal, K.M., Shepherd, J.A., Looker, A.C., Graubard, B.I., Borrud, L.G., Ogden, C.L., Harris, T.B., Everhart, J.E. and Schenker, N. (2009) 'Comparisons of percentage body fat, body mass index, waist circumference, and waist-stature ratio in adults', *American Journal of Clinical Nutrition*, 89(2), pp. 500-508.
Foley, R (1996) 'The adaptive legacy of human evolution: A search for the environment of evolutionary adaptedness', *Evolutionary Anthropology,* 4, 194-203.
Ford, C.S. and Beach, F.A. (1952) '*Patterns of sexual behaviour*'. New York: Harper.
Franzoi, S.L. (1995) 'The body-as-object versus the body-as-process: Gender differences and gender considerations', *Sex Roles*, 33, 417-437.
Franzoi, S.L. and Herzog, M.E. (1987) 'JUDGING PHYSICAL ATTRACTIVENESS - WHAT BODY ASPECTS DO WE USE', *Personality and Social Psychology Bulletin*, 13(1), pp. 19-33.
Frederick, D.A., Fessler, D.M.T. and Haselton, M.G. (2005) 'Do representations of male muscularity differ in men's and women's magazines?', *Body image,* 2(1), pp. 81-6.
Frederick, D.A. and Haselton, M.G. (2007) 'Why is muscularity sexy? Tests of the fitness indicator hypothesis', *Personality and Social Psychology Bulletin*, 33(8), pp. 1167-1183.
Frederick, D.A., Hadji-Michael, M., Furnham, A. and Swami, V. (2010) 'The influence of leg-to-body ratio (LBR) on judgments of female physical attractiveness: Assessments of computer-generated images varying in LBR', *Body image*, 7(1), pp. 51-55.

Freese, J. and Meland, S. (2002) 'Seven tenths incorrect: Heterogeneity and change in the waist-to-hip ratios of Playboy centerfold models and Miss America pageant winners', *Journal of Sex Research*, 39(2), pp. 133-138.
Frisch, R.E. (1988) 'FATNESS AND FERTILITY', *Scientific American*, 258(3), pp. 88-95.
Frisch, R.E. (1990) *Body fat, menarche, fitness and fertility*. Basil: Harger.
Frisch, R.E. and McArthur, J.W. (1974) 'MENSTRUAL CYCLES - FATNESS AS A DETERMINANT OF MINIMUM WEIGHT FOR HEIGHT NECESSARY FOR THEIR MAINTENANCE OR ONSET', *Science*, 185(4155), pp. 949-951.
Furnham, A., Hester, C. and Weir, C. (1990) 'SEX-DIFFERENCES IN THE PREFERENCES FOR SPECIFIC FEMALE BODY SHAPES', *Sex Roles*, 22(11-12), pp. 743-754.
Furnham, A., Moutafi, J. and Baguma, P. (2002). ‘A cross-cultural study on the role of weight and waist-to-hip ratio on judgements of women’s attractiveness’, *Personality and Individual Differences*, 32, 729-745.
Furnham, A. and Nordling, R. (1998) 'Cross-cultural differences in preferences for specific male and female body shapes', *Personality and Individual Differences*, 25(4), pp. 635-648.
Furnham, A. and Radley, S. (1989) 'SEX-DIFFERENCES IN THE PERCEPTION OF MALE AND FEMALE BODY SHAPES', *Personality and Individual Differences*, 10(6), pp. 653-662.
Furnham, A. and Reeves, E. (2006) 'The relative influence of facial neoteny and waist-to-hip ratio on judgements of female attractiveness and fecundity', *Psychology, health & medicine*, 11(2), pp. 129-41.
Furnham, A and Swami, V. (2007) ‘Perception of female buttocks and breast size in profile’, *Social Behaviour and Personality*, 35, pp. 1-7.
Furnham, A., Tan, T. and McManus, C. (1997) 'Waist-to-hip ratio and preferences for body shape: A replication and extension', *Personality and Individual Differences*, 22(4), pp. 539-549.
Gallup, G.G. (1982) 'PERMANENT BREAST ENLARGEMENT IN HUMAN FEMALES - A SOCIOBIOLOGICAL ANALYSIS', *Journal of Human Evolution*, 11(7), pp. 597-601.
Gangestad, S.W.a.S., J. A (1992) *On Human Sociosexual Variation: An Evolutionary View of Female Mating Propensities.* University of New Mexico.
Gangestad, S.W. (1993) 'SEXUAL SELECTION AND PHYSICAL ATTRACTIVENESS - IMPLICATIONS FOR MATING DYNAMICS', *Human Nature-an Interdisciplinary Biosocial Perspective*, 4(3), pp. 205-235.
Gangestad, S.W. and Simpson, J.A. (2000) 'The evolution of human mating: Trade-offs and strategic pluralism', *Behavioral and Brain Sciences*, 23(4), pp. 573-+.
Gangestad, S.W., Thornhill, R., & Garver-Apgar, C. E (2005) 'Human sexual selection and developmental stability', in Buss, D.M. (ed.) *The handbook of evolutionary psychology*. New York: Wiley, pp. 334-371.
Gardner, R.M. and Brown, D.L. (2010) 'Comparison of video distortion and figural drawing scale for measuring and predicting body image dissatisfaction and distortion', *Personality and Individual Differences*, 49(7), pp. 794-798.
Garner, D.M. and Garfinkel, P.E. (1981) 'BODY-IMAGE IN ANOREXIA-NERVOSA - MEASUREMENT, THEORY AND CLINICAL IMPLICATIONS', *International Journal of Psychiatry in Medicine*, 11(3), pp. 263-284.
Garner, D.M., Garfinkel, P.E., Schwartz, D. and Thompson, M. (1980) 'CULTURAL EXPECTATIONS OF THINNESS IN WOMEN', *Psychological Reports*, 47(2), pp. 483-491.
Garner, D.M., Olmsted, M.P., Bohr, Y. and Garfinkel, P.E. (1982) 'THE EATING ATTITUDES TEST - PSYCHOMETRIC FEATURES AND CLINICAL CORRELATES', *Psychological Medicine*, 12(4), pp. 871-878.

George, H.R., Cornelissen, P.L., Hancock, P.J.B., Kiviniemi, V.V. and Tovee, M.J. (2011) 'Differences in eye-movement patterns between anorexic and control observers when judging body size and attractiveness', *British Journal of Psychology,* 102, pp. 340-354.

Gertler, M.M., & White, P. D (1954) *Coronary disease in young adults: A multidisciplinary study*. Cambridge, MA.

Gitter, A.G., Lomranz, J., Saxe, L. and Bartal, Y. (1983) 'PERCEPTIONS OF FEMALE PHYSIQUE CHARACTERISTICS BY AMERICAN AND ISRAELI STUDENTS', *Journal of Social Psychology*, 121(1), pp. 7-13.

Glauert, R., Rhodes, G., Byrne, S., Fink, B. and Grammer, K. (2009) 'Body Dissatisfaction and the Effects of Perceptual Exposure on Body Norms and Ideals', *International Journal of Eating Disorders,* 42(5), pp. 443-452.

Goldfarb, L.A., Dykens, E.M. and Gerrard, M. (1985) 'THE GOLDFARB FEAR OF FAT SCALE', *Journal of Personality Assessment*, 49(3), pp. 329-332.

Gordon, R.A. (2000) '*Eating disorders: Anatomy of a social epidemic*' (2nd edn). Oxford: Blackwell.

Gordon, P. (2001) 'Obesity-related knowledge, attitudes, and behaviours in Obese and non-obese urban Philadelphia female adolescents', *Obesity Research*, 9, 112-118.

Gowaty, P. (1992) 'Evolutionary Biology and Feminism', *Human nature* 3, pp. 217-249.

Grabe, S., Ward, L.M. and Hyde, J.S. (2008) 'Role of the media in body image concerns among women: A meta-analysis of experimental and correlational studies', *Psychological Bulletin*, 134(3), pp. 460-476.

Grammer, K., Fink, B., Moller, A.P. and Thornhill, R. (2003) 'Darwinian aesthetics: sexual selection and the biology of beauty', *Biological Reviews,* 78(3), pp. 385-407.

Gregory, A. (1970) Mechanisms of perception, *Educational Psychology,* 40, 363.

Grillot, R.L., Simmons, Z.L., Lukaszewski, A.W. and Roney, J.R. (2014) 'Hormonal and morphological predictors of women's body attractiveness', *Evolution and Human Behavior*, 35(3), pp. 176-183.

Grover, V.P., Keel, P.K. and Mitchell, J.P. (2003) 'Gender differences in implicit weight identity', *International Journal of Eating Disorders*, 34(1), pp. 125-135.

Guillen, E.O. and Barr, S.I (1994) 'Nutrition, dieting and fitness messages in a magazine for adolescent women, 1970-1990', *Journal of Adolescent Health*, 15, 464-472.

Gunnell, D., Oliver, S.E., Donovan, J.L., Peters, T.J., Gillatt, D., Persad, R., Hamdy, F.C., Neal, D.E. and Holly, J.M.P. (2004) 'Do height-related variations in insulin-like growth factors underlie the associations of stature with adult chronic disease?', *Journal of Clinical Endocrinology & Metabolism*, 89(1), pp. 213-218.

Gunnell, D.J., Smith, G.D., Frankel, S.J., Kemp, M. and Peters, T.J. (1998) 'Socio-economic and dietary influences on leg length and trunk length in childhood: a reanalysis of the Carnegie (Boyd Orr) survey of diet and health in prewar Britain (1937-39)', *Paediatric and Perinatal Epidemiology,* 12, pp. 96-113.

Gunnell, D., Whitley, E., Upton, M.N., McConnachie, A., Smith, G.D. and Watt, G.C.M. (2003) 'Associations of height, leg length, and lung function with cardiovascular risk factors in the Midspan Family Study', *Journal of Epidemiology and Community Health*, 57(2), pp. 141-146.

Hall, C., Hogue, T., Guo, K. (2011) Differential gaze behaviour towards sexually preferred and non-preferred human figures, *Sex Research,* 48, 461-469.

Harris, C.R. (2011) 'Menstrual cycle and facial preferences reconsidered', *Sex Roles,* 64, 669-681.

Harris, C.R., Chabot, A., Mickes, L. (2013) 'Shifts in methodology and theory in menstrual cycle research on attraction', *Sex Roles,* this issue.

Harrison, K (1997) 'Does interpersonal attraction to thin media personalities promote eating disorders? *Journal of Broadcasting and Electronic Media*, 41, 478-500.

Hartz, A.J., Rupley, D.C. and Rimm, A.A. (1984) 'THE ASSOCIATION OF GIRTH MEASUREMENTS WITH DISEASE IN 32,856 WOMEN', *American Journal of Epidemiology*, 119(1), pp. 71-80.
Haselton, M.G. and Gangestad, S.W. (2006) 'Conditional expression of women's desires and men's mates guarding across the ovulatory cycle', *Hormones and Behaviour*, 49, 509-518.
Haselton, M.G., and Miller, G.F. (2006) 'Women's fertility across the cycle increases the short-term attractiveness of creative intelligence', *Human Nature*, 17, 50-73.
Hasler, N., Stoll, C., Sunkel, M et al. (2009) A statistical model of human pose and body shape, *Computer Graphics Forum,* 28, 337-346.
Heinberg, L.J. and Thompson, J.K. (1995) 'Body image and televised images of thinness and attractiveness: A controlled laboratory investigation', *Journal of Social and Clinical Psychology*, 14, 325-338.
Heinberg, L.J., Thompson, J.K. and Stormer, S. (1995) 'DEVELOPMENT AND VALIDATION OF THE SOCIOCULTURAL ATTITUDES TOWARDS APPEARANCE QUESTIONNAIRE', *International Journal of Eating Disorders*, 17(1), pp. 81-89.
Helfert, S.W., P (2011) 'A prospective study on the impact of peer and parental pressure on body dissatisfaction in adolescent girls and boys', *Body image*, 8, pp. 101-109.
Henss, R. (1995) 'WAIST-TO-HIP RATIO AND ATTRACTIVENESS - REPLICATION AND EXTENSION', *Personality and Individual Differences*, 19(4), pp. 479-488.
Henss, R. (2000) 'Waist-to-hip ratio and female attractiveness. Evidence from photographic stimuli and methodological considerations', *Personality and Individual Differences*, 28(3), pp. 501-513.
Hogg,M.A and Vaughan, G.M. (2005) '*Social Psychology*' (4th edn). Harlow: Pearson.
Holliday, R.E., Humphries, J.E., Milne, R et al. (2012) Reducing misinformation effects in older adults with cognitive interview mnemonics, *Psychology and Aging,* 27, 1191-1203.
Homan, K. (2010) 'Athletic-ideal and thin-ideal internalization as prospective predictors of body dissatisfaction, dieting and compulsive exercise', *Body Image*, 7, pp. 240-245.
Honekopp, J., Rudolph, U., Beier, L., Liebert, A. and Muller, C. (2007) 'Physical attractiveness of face and body as indicators of physical fitness in men', *Evolution and Human Behavior,* 28(2), pp. 106-111.
Huffman, D.M. and Barzilai, N. (2010) 'Contribution of Adipose Tissue to Health Span and Longevity', in Mobbs, C.V. and Hof, P.R. (eds.) *Body Composition and Aging*. Basel: Karger, pp. 1-19.
Hume, D. (1757) '*Four dissertations. IV: Of the standard of taste*'. London: Millar.
Irving, L.M., Wall, M., Neumark-Sztainer, D and Story, M (2002) 'Steroid use among adolescents: Findings from Project EAT', *Journal of Adolescent Health*, 30, 243-252.
Jackson, L.A. and Ervin, K.S. (1992) 'HEIGHT STEREOTYPES OF WOMEN AND MEN - THE LIABILITIES OF SHORTNESS FOR BOTH SEXES', *Journal of Social Psychology*, 132(4), pp. 433-445.
Jackson, B.S., Keel, P.K., and Lee, Y.H. (2006) 'Trans-cultural comparison of disordered eating in Korean women', *International Journal of Eating Disorders*, 39, 498-502.
Jacobi, L. and Cash, T.F. (1994) 'IN PURSUIT OF THE PERFECT APPEARANCE - DISCREPANCIES AMONG SELF-IDEAL PERCEPTS OF MULTIPLE PHYSICAL ATTRIBUTES', *Journal of Applied Social Psychology*, 24(5), pp. 379-396.
Jagust, W., Harvey, D., Mungas, D., & Haan, M. (2005) 'Central obesity and the aging brain', *Archives of Neurology*, 62, 1545-1548.
Jansen, A., Nederkoorn, C. and Mulkens, S. (2005) 'Selective visual attention for ugly and beautiful body parts in eating disorders', *Behaviour Research and Therapy*, 43(2), pp. 183-196.

Jasienska, G., Ziomkiewicz, A., Ellison, P.T., Lipson, S.F. and Thune, I. (2004) 'Large breasts and narrow waists indicate high reproductive potential in women', *Proceedings of the Royal Society B-Biological Sciences*, 271(1545), pp. 1213-1217.

Jeffreys, S. (2005) *Beauty and misogyny: Harmful cultural practices in the west*. London.

Jenkins, J.M., Brook, P.F., Sargeant, S. and Cooke, I.D. (1995) 'ENDOCERVICAL MUCUS PH IS INVERSELY RELATED TO SERUM ANDROGEN LEVELS AND WAIST-TO-HIP RATIO', *Fertility and Sterility*, 63(5), pp. 1005-1008.

Jennions, M.D. and Petrie, M. (2000) ‘Why do females mate multiply? A review of the genetic benefits’, *Biological Review of the Cambridge Philosophical Society*, 75, 21-64.

Jones, D. (2001) ‘Social comparison and body image: Attractiveness comparisons to models and peers among adolescent boys and girls’, *Sex Roles*, 45, 645-664.

Jones, P.R.M., Hunt, M.J., Brown, T.P. and Norgan, N.G. (1986) 'WAIST-HIP CIRCUMFERENCE RATIO AND ITS RELATION TO AGE AND OVERWEIGHT IN BRITISH MEN', *Human Nutrition-Clinical Nutrition*, 40C(3), pp. 239-247.

Judge, T.A. and Cable, D.M. (2004) 'The effect of physical height on workplace success and income: Preliminary test of a theoretical model', *Journal of Applied Psychology*, 89(3), pp. 428-441.

Kahle, L.R. and Homer, P.M. (1985) 'PHYSICAL ATTRACTIVENESS OF THE CELEBRITY ENDORSER - A SOCIAL ADAPTATION PERSPECTIVE', *Journal of Consumer Research*, 11(4), pp. 954-961.

Kissebah, A.H., & Karkower, G. R (1995) 'Regional adiposity and mortality', *Physiological Review*, 74, pp. 761-811.

Kline (1999) *The handbook of psychological testing*. London: Routledge.

Klohnen, E.C. and Mendelsohn, G.A (1998) ‘Partner selection for personality characteristics: A couple-centred approach’, *Personality and Social Psychology Bulletin*, 24, 268-278.

Koehler, N., Simmons, L.W., Rhodes, G et al. (2004) The relationship between sexual dimorphism in human faces and fluctuating asymmetry, *Royal Society Biological Sciences*, 271, 233-236.

Krzywicki, H.J. and Chinn, K.S. (1967) 'Human body density and fat of an adult male population as measured by water displacement', *The American journal of clinical nutrition*, 20(4), pp. 305-10.

Kurzban, R. and Weeden, J. (2005) 'HurryDate: Mate preferences in action', *Evolution and Human Behavior*, 26(3), pp. 227-244.

Lake, J.K., Power, C. and Cole, T.J. (1997) 'Women's reproductive health: The role of body mass index in early and adult life', *International Journal of Obesity*, 21(6), pp. 432-438.

Laland, K.N., and Brown, G.R. (2002) ‘*Sense and non-sense: Evolutionary perspectives on human behaviour*’. Oxford: Oxford University Press.

Laland, K.N. and Brown, G.R. (2006) ‘Niche construction, human behaviour and the adaptive lag hypothesis’, *Evolutionary Anthropology*, 15, 95-104.

Lassek, W.D. and Gaulin, S.J.C. (2008) 'Waist-hip ratio and cognitive ability: is gluteofemoral fat a privileged store of neurodevelopmental resources?', *Evolution and Human Behavior*, 29(1), pp. 26-34.

Lassek, W.D. and Gaulin, S.J.C. (2009) 'Costs and benefits of fat-free muscle mass in men: relationship to mating success, dietary requirements, and native immunity', *Evolution and Human Behavior*, 30(5), pp. 322-328.

Lavrakas, P.J. (1975) 'FEMALE PREFERENCES FOR MALE PHYSIQUES', *Journal of Research in Personality*, 9(4), pp. 324-334.

Lawlor, D.A., Ebrahim, S. and Smith, G.D. (2002) 'Socioeconomic position in childhood and adulthood and insulin resistance: cross sectional survey using data from British women's heart and health study', *British Medical Journal*, 325(7368), pp. 805-807.

Lean, M.E.J., Han, T.S. and Morrison, C.E. (1995) 'WAIST CIRCUMFERENCE AS A MEASURE FOR INDICATING NEED FOR WEIGHT MANAGEMENT', *British Medical Journal*, 311(6998), pp. 158-161.

Lee, S. and Lee, A.M. (2000) ‘Disordered eating in three communities of China: A comparative study of female high school students in Hong Kong, Shenzhen, and rural Hunan’, *International Journal of Eating Disorders,* 27, 317-327.

Leit, R.A., Pope, H.G. and Gray, J.J. (2001) Cultural expectations of muscularity in men: the evolution of playgirl centerfolds, *Eating Disorders,* 29, 90-93.

Leitch, I. (1951) 'Growth and health', *The British journal of nutrition*, 5(1), pp. 142-51.

Levi, D.M., Klein, S.A. and Aitsebaomo, A.P. (1985) 'VERNIER ACUITY, CROWDING AND CORTICAL MAGNIFICATION', *Vision Research*, 25(7), pp. 963-977.

Levine, M.P. and Smolak, L. (2010) ‘Cultural influences on body image and the eating disorders’, *The Oxford handbook of eating disorders*, 223-246.

Lin, N.P., Bailey, J.M., Kenrick, D.T. and Linsenmeier, J.A. (2002) ‘The necessities and luxuries of mate preferences: Testing the tradeoffs’, *Journal of Personality and Social Psychology*, 82, 947-955.

Lindner, K. (2004) ‘Images of women in general interest and fashion magazine advertisements from 1955 to 2002’, *Sex Roles,* 51, pp. 409-421.

Littleton, H. (2008) 'Body image: Understanding body dissatisfaction in men, women, and children', *Sex Roles*, 59(3-4), pp. 292-293.

Lopez-Guimera, G., Levine, M.P., Sanchez-Carracedo, D. and Fauquet, J. (2010) 'Influence of Mass Media on Body Image and Eating Disordered Attitudes and Behaviors in Females: A Review of Effects and Processes', *Media Psychology*, 13(4), pp. 387-416.

Lorenzo, G.L., Biesanz, J.C. and Human, L.J. (2010) 'What Is Beautiful Is Good and More Accurately Understood: Physical Attractiveness and Accuracy in First Impressions of Personality', *Psychological Science*, 21(12), pp. 1777-1782.

Low, B.S. (1979) 'Sexual selection and human ornamentation', in Chagnon, N.A.I., W. (ed.) *Evolutionary biology and human social behaviour*. North Scituate, MA: Duxbury.

Low, B.S. (1990b) 'Sex, Power and Resources: Male and Female Strategies of Resource Acquisition', *International Journal of Contemporary Sociology*, 27, pp. 49-73.

Low, B.S., Alexander, R.D. and Noonan, K.M. (1987) 'HUMAN HIPS, BREASTS AND BUTTOCKS - IS FAT DECEPTIVE', *Ethology and Sociobiology*, 8(4), pp. 249-257.

Low, L.C.K. (2010) ‘Childhood obesity in developing countries’, *World Journal of Pediatrics,* 6, pp.197-199.

Luo, S and Klohnen, E.C. (2005) ‘Assortative mating and marital quality in newly-weds: A couple-centred approach’, *Journal of Personality and Social Psychology*, 88, 304-326.

Lynch, S.M. and Zellner, D.A. (1999) 'Figure preferences in two generations of men: The use of figure drawings illustrating differences in muscle mass', *Sex Roles*, 40(9-10), pp. 833-843.

McCabe, M.P., Ricciardelli, L.A and Holt, K. (2010) ‘Are there different sociocultural influences on body image and body change strategies for overweight adolescent boys and girls?’, *Eating Behaviours,* 11, pp. 156-163.

McCreary, D.R. and Sadava, S.W. (2001) Gender differences in relationships among percieved attractiveness, life satisfaction and health in adults as a function of body mass index and perceived weight, *Psychology of Men and Masculinity,* 2, 108-116.

McCreary, D.R. and Sasse, D.K. (2000) 'An exploration of the drive for muscularity in adolescent boys and girls', *Journal of American College Health*, 48(6), pp. 297-304.

McGraw, K.J. (2002) ‘Environmental predictors of geographic variation in human mating preferences’, *Ethology,* 108, 303-317.

Maisey, D.S., Vale, E.L.E., Cornelissen, P.L. and Tovée, M.J. (1999) 'Characteristics of male attractiveness for women', *Lancet*, 353(9163), pp. 1500-1500.

Malinauskas, B.M., Raedeke, T.D., Aeby, V.G., Smith, J.L. and Dallas, M.B. (2006) 'Dieting practices, weight perceptions, and body composition: A comparison of normal weight, overweight, and obese college females', *Nutrition Journal*, 5.
Malson, H (1998) '*The thin woman: Feminism, post-structuralism and the social psychology of anorexia nervosa*'. London: Routledge.
Manolopoulos, K.N., Karpe, F. and Frayn, K.N. (2010) 'Gluteofemoral body fat as a determinant of metabolic health', *International Journal of Obesity*, 34(6), pp. 949-959.
Manson, J.E., Graham, A.C., Colditz, M.B et al. (1992) A prospective study of obesity and risk of cornonary heart disease in women, *Journal of Medicine*, 322, 882-889.
Manson, J.E., Willet, W. C., Stampfer, M. J., Colditz, G. A., Hunter, D. J., Hankinson, S. E., Hennekens, C. H., & Speizer, F. E. (1995) 'Body weight and mortality among women ', *New Engl. J. Med*, 333, pp. 677-685.
Margo, J. (2002) 'For Adonis, the gym is abs fabulous', *Australian Financial Review*, p. 43.
Markey, C.N. (2004) 'Culture and the development of eating disorders: A tripartite model', *Eating Disorders: J Treat Prev*, 12, pp. 139-156.
Markey, C.N. (2010) 'Invited commentary: why body image is important to adolescent development', *Journal of Youth and Adolescence*, 39, pp. 1387-1391.
Markey, C.N. and Markey, P.M. (2006) 'Romantic relationships and body satisfaction among young women', *Journal of Youth and Adolescence*, 35(2), pp. 271-279.
Marlowe, F. (1997) 'The Nubility Hypothesis: The Human Breast as an Honest Signal of Residual Reproductive Value' *Human Nature*, 9, 263-271.
Marlowe, F.W. and Wetsman, A. (2001) 'Preferred waist-to-hip ratio and ecology', *Personality and Individual Differences*, 30(3), pp. 481-489.
Marti, B., Tuomilehto, J., Saloman, V., Kartovaara, H.J and Pietinen, P. (1991) 'Body fat distribution in the Finnish population: Environmental determinants and predictive power for cardiovascular risk factor level'. *Journal of Epidemioloy and Community Health*, 45, 131-137.
Maruyama, G. and Miller, N. (1980) 'PHYSICAL ATTRACTIVENESS, RACE AND ESSAY EVALUATION', *Personality and Social Psychology Bulletin*, 6(3), pp. 384-390.
Mazur, A. (1986) 'U.S. trends in feminine beauty and overadaptation', *Journal of Sex Research*, 22, pp. 281-303.
Melamed, T. (1992) 'PERSONALITY-CORRELATES OF PHYSICAL HEIGHT', *Personality and Individual Differences*, 13(12), pp. 1349-1350.
Menard, S (1995) 'Applied logistic regression analysis'. Sage university paper series on quantitative applications in the social sciences, 07-106. Thousand Oaks, CA: Sage.
Menzel, J.E., Schaefer, L.M., Burke, N.L *et al*., (2010) 'Appearance-related teasing, body dissatisfaction, and disordered eating: A meta-analysis', *Body Image,* 7, pp. 261-270.
Mikash, S.H. and Bailey, J.M. (1999) 'What distinguished women with high numbers of sex partners?' *Evolution and Human Behaviour*, 20, 141-150.
Milinski, M. (2006) 'The major histocompatibility complex, sexual selection, and mate choice', *Annual Review of Ecology, Evolution, and Systematics*, 159-186.
Miller, J.M. and Bockisch, C. (1997) 'Visual perception - Where are the things we see?', *Nature*, 386(6625), pp. 550-551.
Misra, A and Vikram, N (2003) 'Clinical and pathophysiological consequences of abdominal adiposity and abdominal adipose tissue depots. *Nutrition*, 19, 456-457.
Mo, J.Y., Cheung, K.W., Gledhill, L.J et al (2014) Perception of female body size and shape in China, Hong Kong and the UK, *Cross-cultural Research*, 48, 78-103.
Mobius, M.M and Rosenblatt, T.S. (2006) 'Why beauty matters', *American Economic Review*, 96,222-235.
Montagna, W. (1983) 'The evolution of human skin', *Journal of Human Evolution*, 14, 3-22.
Morris, D. (1967) *The naked ape: A zoologist's study of the human animal*. Toronto: Bantam Books.

Morris, D. (1987) '*Bodywatching*'. London: Grafton Books.
Moscovici, S (1981) '*On social representation*'. In R.M.Farr and S.Moscovici (Eds), Social representations (pp. 3-69). Cambridge: Cambridge University Press.
Mueller, U. and Mazur, A. (2001) 'Evidence of unconstrained directional selection for male tallness', *Behavioral Ecology and Sociobiology*, 50(4), pp. 302-311.
Murphy, R. (2002) 'Adonis man: he thinks he looks like a wimp: he's a bodybuilder suffering from muscle dysmorphia-one of a growing number of men who believe they'll never be "big" enough', *The Mirror*, p. 36.
Must, A., Spadano, J., Coakly, E. H., Field, A. E., Colditz, G., & Dietz, W. H (1999) 'The disease burden associated with overweight and obesity', *Journal of the American Medical Association*, 282, pp. 1523-1529.
Mutangadura, G.B. (2004) 'World health report 2002: Reducing risks, promoting healthy life', *Agricultural Economics*, 30(2), pp. 170-172.
Myers, R. (1990) '*Classical and modern regression with applications*' (2nd ed.). Boston, MA: Duxbury.
National Heart, L., and Blood Institute (1998) *Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: The evidence report*.
Nelson, L.D and Morrison, E.L. (2005) 'The symptoms of resource scarcity: Judgements of food and finances influence preference for potential partners'. *Psychological Science,* 16, 167-173.
Nelson, L.D., Pettijohn, T.F. and Galak, J. (2007) 'Mate preferences in a social cognitive context: When environment and personal change leads to predictable cross-cultural variation'. In V.Swami and A. Furnham (Eds), *The Body Beautiful: Evolutionary and socio-cultural perspectives*. London: Macmillan.
Nettle, D. (2002a) 'Height and reproductive success in a cohort of British men', *Human Nature-an Interdisciplinary Biosocial Perspective*, 13(4), pp. 473-491.
Nettle, D. (2002b) 'Women's height, reproductive success and the evolution of sexual dimorphism in modern humans', *Proceedings of the Royal Society B-Biological Sciences*, 269(1503), pp. 1919-1923.
Nisbett, R.E. & Wislon, T.D. (1977) 'The halo effect: Evidence for unconscious alteration of judgements', *Journal of Personality Social Psychology*, 35, 250-256.
Norris, M.L., Boydell, K. M., Pinhas, L. and Katzman, D. B (2006) 'Ana and the internet: A review of pro-anorexia websites', *International Journal of Eating Disorders*, 39, pp. 443-447.
Nummenmaa, L., Hietanen, J.K., Santtila, P. and Hyona, J. (2012) 'Gender and Visibility of Sexual Cues Influence Eye Movements While Viewing Faces and Bodies', *Archives of Sexual Behavior*, 41(6), pp. 1439-1451.
Oakes, M.E., Slotterback, C.S. and Mecca, E.K. (2003) 'Gender differences in perceptions of normal body weights', *Current Psychology*, 22(2), pp. 93-99.
Ogden, C.L., Carroll, M. D., Kit, B. K anf Flegal, K. M (2012) 'http://www.cdc.gov/nchs/data/databriefs/db82.htm', *Prevalence of Obesity in the United States, 2009-2010*.
Olivardia, R., Pope, H. G., Borowiecki, J. J & Cohane, G. H (2004) 'Biceps and body image: The relationship between muscularity and self-esteem, depression and eating disorder symptoms', *Psychol Men Masc*, 5, pp. 112-120.
Organisation, W.H. (1995) *Physical status: the use and interpretation of anthropometry.* Geneva: World Health Organisation.
Organisation, W.H. (2000) *Obesity: preventing and managing the global epidemic*. Geneva: World Health Organisation.
Osborn, D.R. (2004) 'A biological, cultural and interactional (BIC) model of physical attractiveness judgements'. Poster presented at the 16th Annual Convention of the American Psychological Society, Chicago, May 27-30.

Pawlowski, B. (1999) 'Permanent breasts as a side effect of subcutaneous fat tissue increase in human evolution', *Homo*, 50(2), pp. 149-162.
Pawlowski, B. (2003) 'Variable preferences for sexual dimorphism in height as a strategy for increasing the pool of potential partners in humans', *Proceedings of the Royal Society B-Biological Sciences*, 270(1516), pp. 709-712.
Pawlowski, B. and Koziel, S. (2002) 'The impact of traits offered in personal advertisements on response rates', *Evolution and Human Behavior*, 23(2), pp. 139-149.
Penton-Voak, I.S., Jones, B.C., Little, A.C. et al. (2001) Symmetry, sexual dimorphism in facial proportions and male facial attractiveness. *Royal Society Biological Sciences,* 268, 1617-1623.
Penton-Voak, I.S. and Perrett, D.I. (2000) 'Consistency and individual differences in facial attractiveness judgements: An evolutionary perspective', *Social Research*, 67, 219-245.
Penton-Voak, I.S., Perrett, D.I., Castles, D.L., Kobayashi, T., Burt, D.M., Murray, L.K. and Minamisawa, R. (1999a) 'Menstrual cycle alters face preference', *Nature*, 399(6738), pp. 741-742.
Penton-Voak, I.S., Perrett, D.I and Pierce, J (1999b) 'Computer graphic studies of the role of facial similarity in attractiveness judgements', *Current Psychology*, 18, 104-117.
Perilloux, H.K., Webster, G. D., & Gaulin, S. J. C. (2010) 'Signals of genetic quality and maternal investment capacity: The dynamic effects of fluctuating asymmetry and waist-to-hip ratio on men's rating of women's attractiveness', *Social Psychological and Personality Science*, 1(1), pp. 34-42.
Perusse, D. (1993) 'Cultural and Reproductive Success in Industrial Societies: Testing the Relationship at Proximate and Ultimate Levels', *Behavioural and Brain Sciences*, 16, pp. 267-322.
Petrie, T.A., Austin, L.J., Crowley, B.J., Helmcamp, A., Johnson, C.E., Lester, R., Rogers, R., Turner, J. and Walbrick, K. (1996) 'Sociocultural expectations of attractiveness for males', *Sex Roles*, 35(9-10), pp. 581-602.
Platek, S.M. and Singh, D. (2010) 'Optimal Waist-to-Hip Ratios in Women Activate Neural Reward Centers in Men', *Plos One*, 5(2), p. 5.
Pollock, M.L., Laughridge, E.E., Coleman, B., Linnerud, A.C. and Jackson, A. (1975) 'PREDICTION OF BODY DENSITY IN YOUNG AND MIDDLE-AGED WOMEN', *Journal of Applied Physiology*, 38(4), pp. 745-749.
Pope, H.G., Gruber, A. J., Mangweth, B., Bureau, B., delCol, C., Jouvent, R et al. (2000) 'Body image perception among men in three countries', *American Journal of Psychiatry,* 157, pp. 1297-1301.
Pope, H.G., Olivardia, R., Gruber, A. and Borowiecki, J (1999) 'Evolving ideals of male body image as seen through action toys', *International Journal of Eating Disorders*, 26, pp. 65-72.
Pope, H.G., Phillips, K. A., Olivardia, R (2000) *The Adonis complex: How to identify, treat and prevent body obsession in men and boys*. New York.
Pope, H.G., Gruber, A.J., Mangweth, B., Bureau, B., deCol, C., Jouvent, R *et al*., (2000) 'Body image perception among men in three countries', *American Journal of Psychiatry,* 157, 1297-1301.
Prantl, L. and Gruendl, M. (2011) 'Males Prefer a Larger Bust Size in Women Than Females Themselves: An Experimental Study on Female Bodily Attractiveness with Varying Weight, Bust Size, Waist Width, Hip Width, and Leg Length Independently', *Aesthetic Plastic Surgery*, 35(5), pp. 693-702.
Prantl, L., and Grundl, M (2012) 'Breasts – The latest psychological research finds women don't care what men want' http://www.huffingtonpost.co.uk/dr-raj-persaud/kate-middleton-topless_b_1892483.html (cited 04/2015)
Puhl, R.M., & Boland, F. J (2001) 'Predicting female physical attractiveness: Waist-to-hip ratio versus thinness', *Psychol Evol Gender*, 3, pp. 27-46.

Puhl, R. and Brownell, K.D. (2001) 'Bias, discrimination, and obesity', *Obesity Research*, 9(12), pp. 788-805.
Puhl, R.M. and Brownell, K.D. (2003) 'Psychosocial origins of obesity stigma: toward changing a powerful and pervasive bias', *Obesity reviews : an official journal of the International Association for the Study of Obesity*, 4(4), pp. 213-27.
Puhl, R.M. and Heuer, C.A. (2009) 'The Stigma of Obesity: A Review and Update', *Obesity*, 17(5), pp. 941-964.
Puoane, T., Tsolekile, L., and Steyn, N. (2010) ‘Perceptions about body image and sizes among Black African girls living in Cape Town’, *Ethnicity and Disease*, 20, 29-34.
Puts, D.A. (2010) 'Beauty and the beast: mechanisms of sexual selection in humans', *Evolution and Human Behavior*, 31(3), pp. 157-175.
Ramasubramanian, S. and Jain, P. (2009) 'Gender stereotypes and normative heterosexuality in matrimonial ads from globalizing India', *Asian Journal of Communication*, 19(3), pp. 253-269.
Rantala, M.J., Coetzee, V., Moore, F.R., Skrinda, I., Kecko, S., Krama, T., Kivleniece, I. and Krams, I. (2013) 'Adiposity, compared with masculinity, serves as a more valid cue to immunocompetence in human mate choice', *Proceedings of the Royal Society B-Biological Sciences*, 280(1751), p. 6.
Rawlings, A.V. (2006) 'Cellulite and its treatment', *International Journal of Cosmetic Science*, 28(3), pp. 175-190.
Regan, P.C. (1998) ‘What if you can’t get what you want? Willingness to compromise ideal mate selection standards as a function of sex, mate value, and relationship context’, *Personality and Social Psychology Bulletin*, 24, 1294-1303.
Reichert, T and Carpenter, C. (2004) ‘An update on sex in magazine advertising: 1983 to 2003’, *Journalism and Mass Communication,* 81, pp. 823-837.
Reid, R.L. and Vanvugt, D.A. (1987) 'WEIGHT-RELATED CHANGES IN REPRODUCTIVE FUNCTION', *Fertility and Sterility*, 48(6), pp. 905-913.
Reinagel, P. and Zador, A.M. (1999) 'Natural scene statistics at the centre of gaze', *Network-Computation in Neural Systems*, 10(4), pp. 341-350.
Rhodes, G., Jeffery, L., Watson, T.L., Clifford, C.G., and Nakayama, K. (2003) Fitting the mind to the world: face adaptation and attractiveness aftereffects, *Psychological Science*, 558-566.
Richardson, R.C. (2007). ‘*Evolutionary psychology as maladapted psychology*’. Cambridge, MA: MIT press.
Rilling, J.K., Kaufman, T.L., Smith, E.O., Patel, R. and Worthman, C.M. (2009) 'Abdominal depth and waist circumference as influential determinants of human female attractiveness', *Evolution and Human Behavior*, 30(1), pp. 21-31.
Riniolo, T.C., Johnson, K.C., Sherman, T.R. and Misso, J.A. (2006) 'Hot or not: Do professors perceived as physically attractive receive higher student evaluations?', *Journal of General Psychology*, 133(1), pp. 19-35.
Roefs, A., Jansen, A., Moresi, S., Willems, P., van Grootel, S. and van der Borgh, A. (2008) 'Looking good. BMI, attractiveness bias and visual attention', *Appetite*, 51(3), pp. 552-555.
Romero-Corral, A., Somer, V.K., Sierra-Johnson, J., Thomas, R. J., Collazo-Clavell, M., Korinek, J., Allison, T.G., Batsis, J.A., Sert-Kuniyoshi, F.H and Lopez-Jimenez, F. (2008) ‘Accuracy of body mass index in diagnosing obesity in the adult general population’, *International Journal of Obesity,* 32, pp. 959-966.
Ross, W.D., & Ward, R. (1982) *Human proportionality and sexual dimorphism*. New York: Praeger.
Rozin, P. and Fallon, A. (1988) 'BODY-IMAGE, ATTITUDES TO WEIGHT, AND MISPERCEPTIONS OF FIGURE PREFERENCES OF THE OPPOSITE SEX - A

COMPARISON OF MEN AND WOMEN IN 2 GENERATIONS', *Journal of Abnormal Psychology*, 97(3), pp. 342-345.
Rozmus-Wrzesinska, M and Pawlowski, B. (2005) 'Men's ratings of female attractiveness are influenced more by changes in female waist size compared with changes in hip size', *Biological Psychology,* 68, pp. 299-308.
Russock, H.I. (2011) 'An evolutionary interpretation of the effect of gender and sexual orientation on human mate selection preferences, as indicated by an analysis of personal advertisements', *Behaviour*, 148(3), pp. 307-323.
Rysst, M. (2010) '"Healthism" and looking good: Body ideals and body practices in Norway', *Scandinavian Journal of Public Health*, 38, pp. 71-80.
Salussodeonier, C.J., Markee, N.L. and Pedersen, E.L. (1993) 'GENDER DIFFERENCES IN THE EVALUATION OF PHYSICAL ATTRACTIVENESS IDEALS FOR MALE AND FEMALE BODY BUILDS', *Perceptual and Motor Skills*, 76(3), pp. 1155-1167.
Sanchez, D.T., Kiefer, A. K., & Ybarra, O. (2006) 'Sexual submissiveness in women: Costs for sexual autonomy and arousal', *Personality and Social Psychology Bulletin*, 32, pp. 512-524.
Schooling, C.M., Jiang, C.Q., Heys, M., Zhang, W.S., Adab, P., Cheng, K.K., Lam, T.H. and Leung, G.M. (2008) 'Are height and leg length universal markers of childhood conditions? The Guangzhou Biobank cohort study', *Journal of Epidemiology and Community Health*, 62(7), pp. 607-614.
Schwartz, M.B., Vartanian, L.R., Nosek, B.A. and Brownell, K.D. (2006) 'The influence of one's own body weight on implicit and explicit anti-fat bias', *Obesity*, 14(3), pp. 440-447.
Scott, A.L., Humphries, K.H., Frohlich, J.J and Birmingham, L. (2007) 'Appropriateness of current thresholds for obesity-related measures among Aboriginal people', *Canadian Medical Association Journal,* 177, pp. 1499-1505.
Sell, A., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C. and Gurven, M. (2009) 'Human adaptations for the visual assessment of strength and fighting ability from the body and face', *Proceedings of the Royal Society B-Biological Sciences*, 276(1656), pp. 575-584.
Shaw, J (1995) 'Effects of fashion magazines on body dissatisfaction and eating psychopathology in adolescent and adult females'. *Eating Disorders Review*, 3, 15-23.
Shimokata, H., Andres, R., Coon, P.J., Elahi, D., Muller, D.C. and Tobin, J.D. (1989) 'STUDIES IN THE DISTRIBUTION OF BODY-FAT .2. LONGITUDINAL EFFECTS OF CHANGE IN WEIGHT', *International Journal of Obesity*, 13(4), pp. 455-464.
Silventoinen, K., Lahelma, E. and Rahkonen, O. (1999) 'Social background, adult body-height and health', *International Journal of Epidemiology*, 28(5), pp. 911-918.
Singh, D. (1993a) 'ADAPTIVE SIGNIFICANCE OF FEMALE PHYSICAL ATTRACTIVENESS - ROLE OF WAIST-TO-HIP RATIO', *Journal of Personality and Social Psychology*, 65(2), pp. 293-307.
Singh, D. (1993b) 'BODY SHAPE AND WOMENS ATTRACTIVENESS - THE CRITICAL ROLE OF WAIST-TO-HIP RATIO', *Human Nature-an Interdisciplinary Biosocial Perspective*, 4(3), pp. 297-321.
Singh, D. (1994a) 'BODY-FAT DISTRIBUTION AND PERCEPTION OF DESIRABLE FEMALE BODY SHAPE BY YOUNG BLACK-MEN AND WOMEN', *International Journal of Eating Disorders*, 16(3), pp. 289-294.
Singh, D. (1994b) 'Waist-to-hip ratio and judgment of attractiveness and healthiness of female figures by male and female physicians', *International Journal of Obesity*, 18, pp. 731-737.
Singh, D. (1994c) 'Is thin really beautiful and good? Relationship between waist-to-hip ratio (WHR) and female attractiveness', *Personality and Individual Differences*, 16, 123-132.
Singh, D. (1995) 'FEMALE JUDGMENT OF MALE ATTRACTIVENESS AND DESIRABILITY FOR RELATIONSHIPS - ROLE OF WAIST-TO-HIP RATIO AND

FINANCIAL STATUS', *Journal of Personality and Social Psychology*, 69(6), pp. 1089-1101.
Singh, D. (2002) 'Female mate value at a glance: relationship of waist-to-hip ratio to health, fecundity and attractiveness', *Neuro endocrinology letters*, 23 Suppl 4, pp. 81-91.
Singh, D. (2011) 'Shape and Significance of Feminine Beauty: An Evolutionary Perspective', *Sex Roles*, 64(9-10), pp. 723-731.
Singh, D., Dixson, B.J., Jessop, T.S., Morgan, B. and Dixson, A.F. (2010) 'Cross-cultural consensus for waist-hip ratio and women's attractiveness', *Evolution and Human Behavior*, 31(3), pp. 176-181.
Singh, D. and Luis, S. (1995) 'ETHNIC AND GENDER CONSENSUS FOR THE EFFECT OF WAIST-TO-HIP RATIO ON JUDGMENT OF WOMENS ATTRACTIVENESS', *Human Nature-an Interdisciplinary Biosocial Perspective*, 6(1), pp. 51-65.
Singh, D., & Randall, P. K. (2007) 'Beauty is in the eye of the plastic surgeon: waist-hip ratio (WHR) and women's attractiveness', *Personality and Individual Differences*, 43, pp. 329-340.
Singh, D., Renn, P., and Singh, A (2007) 'Did the perils of abdominal obesity affect depiction of feminine beauty in the sixteenth to eighteenth century Bristish literature? Exploring the health and beauty link'. *Proceedings of Royal Society of London B*.
Singh, D., & Singh, D. (2011) 'Shape and Significance of Feminine Beauty: An Evolutionary Perspective', *Sex Roles*, 64, pp. 723-731.
Singh, D. and Young, R.K. (1995) 'Body weight, waist-to-hip ratio, breasts, and hips: Role in judgments of female attractiveness and desirability for relationships', *Ethology and Sociobiology*, 16(6), pp. 483-507.
Slater, A and Tiggemann, M. (2006) 'The contribution of physical activity and media use during childhood and adolescence to adult women's body image', *Health Psychology*, 11, pp. 553-565.
Smith, K.L. (2007) *The Visual cues to female physical attractiveness, health and fertility*.PhD. Newcastle University.
Smith, K.L., Cornelissen, P.L. and Tovée, M.J. (2007) 'Color 3D bodies and judgements of human female attractiveness', *Evolution and Human Behavior*, 28(1), pp. 48-54.
Smith, K.L., Tovée, M.J., Hancock, P.J.B., Bateson, M., Cox, M.A.A. and Cornelissen, P.L. (2007b) 'An analysis of body shape attractiveness based on image statistics: Evidence for a dissociation between expressions of preference and shape discrimination', *Visual Cognition*, 15(8), pp. 927-953.
Smith, N.W. (1986) 'Psychology and evolution of breasts', *Human evolution*, 1, pp. 285-286.
Smolak, L. (2006) 'Body Image', in Goodheart, J.W.a.C.D. (ed.) *Handbook of girls' and womens' psychological health: Gender and well-being across the lifespan*. New York: Oxford University Press, pp. 69-76.
Sobal, J and Stunkard, A.J. (1989) 'Socio-economic status and obesity: A review of the literature', *Psychological Bulletin*, 105, 260-275.
Sorokowski, P. and Pawlowski, B. (2008) 'Adaptive preferences for leg length in a potential partner', *Evolution and Human Behavior*, 29(2), pp. 86-91.
Sorokowski, P., Sorokowska, A., and Mberira, M. (2012) 'Are preferences for legs length universal? Data from a semi-nomadic himba population from namibia', *Social Psychology*, 152, pp. 370-378.
Sorokowski, P., Szmajke, A., Sorokowska, A *et al*. (2011) 'Attractiveness of Leg Length: report from 27 nations', *Cross-cultural psychology*, 42, pp.131-139.
Spain, D.M., Nathan, D. J., & Gellis, M (1963) 'Weight, body type and the prevalence of coronary atherosclerotic heart disease in males', *American Journal of Medical Science*, 245, pp. 63-69.

Spettigue, W. and Henderson, K.A. (2004) 'Eating disorders and the role of the media', *The Canadian child and adolescent psychiatry review = La revue canadienne de psychiatrie de l'enfant et de l'adolescent*, 13(1), pp. 16-9.

Spies, C., Farzaneh-Far, R., Na, B., Kanaya, A., Schiller, N.B. and Whooley, M.A. (2009) 'Relation of Obesity to Heart Failure Hospitalization and Cardiovascular Events in Persons With Stable Coronary Heart Disease (from the Heart and Soul Study)', *American Journal of Cardiology*, 104(7), pp. 883-889.

Stephen, I.D. and Perera, A.T.M. (2014) 'Judging the differences between women's attractiveness and health: Is there really a difference between judgments made by men and women?', *Body Image*, 11(2), pp. 183-186.

Stice, E. (1994) 'REVIEW OF THE EVIDENCE FOR A SOCIOCULTURAL MODEL OF BULIMIA-NERVOSA AND AN EXPLORATION OF THE MECHANISMS OF ACTION', *Clinical Psychology Review*, 14(7), pp. 633-661.

Stice, E., Maxfield, J., and Wells, T. (2003) ‘Adverse effects of social pressure to be thin on young women: An experimental investigation of the effects of “fat talk”, *International Journal of Eating Disorders*, 34, 108-117.

Stice, E. and Shaw, H.E. (1994) 'ADVERSE-EFFECTS OF THE MEDIA PORTRAYED THIN-IDEAL ON WOMEN AND LINKAGES TO BULIMIC SYMPTOMATOLOGY', *Journal of Social and Clinical Psychology*, 13(3), pp. 288-308.

Stice, E., Shaw, H. and Nemeroff, C. (1998) 'Dual pathway model of bulimia nervosa: Longitudinal support for dietary restraint and affect-regulation mechanisms', *Journal of Social and Clinical Psychology*, 17(2), pp. 129-149.

Stice, E., Spangler, D. and Agras, W.S. (2001) 'Exposure to media-portrayed thin-ideal images adversely affects vulnerable girls: A longitudinal experiment', *Journal of Social and Clinical Psychology*, 20(3), pp. 270-288.

Streeter, S.A. and McBurney, D.H. (2003) 'Waist-hip ratio and attractiveness - New evidence and a critique of "a critical test"', *Evolution and Human Behavior*, 24(2), pp. 88-98.

Stulp, G., Buunk, A.P., Kurzban, R., Verhulst, S. (2013). ‘The height of choosiness: mutual mate choice for stature results in suboptimal pair formation for both sexes’, *Animal Behaviour*, 86, pp. 37-46.

Surgeons, A.S.O.P. (2010) *Report of the 2010 plastic surgery statistics. http://www.plasticsurgery.org/Documents/news-resources/statistics/2010-statisticss/Top-Level/2010-US-cosmetic-reconstructive-plastic-surgery-minimally-invasive-statistics2.pdf*.

Suschinsky, K.D., Elias, L. J., & Krupp, D. B (2007) 'Looking for Ms Right: Allocating attention to facilitate mate choice decisions', *Evolutionary Psychology*, 5, pp. 428-441.

Swami, V (2006) ‘Female physical attractiveness and body image disorders in Malaysia’, *Malaysian Journal of Psychiatry*, 14, 3-7.

Swami, V. (2007) *The missing arms of Venus de Milo: Reflections on the science of physical attractiveness*. Brighton: Book Guild.

Swami, V., Caprario, C., Tovee, M.J. and Furnham, A. (2006) 'Female physical attractiveness in Britain and Japan: A cross-cultural study', *European Journal of Personality*, 20(1), pp. 69-81.

Swami, V., Einon, D. and Furnham, A. (2006) 'The leg-to-body ratio as a human aesthetic criterion', *Body image*, 3(4), pp. 317-23.

Swami, V., Einon, D. and Furnham, A. (2007) 'Cultural significance of leg-to-body ratio preferences? Evidence from Britain and rural Malaysia', *Asian Journal of Social Psychology*, 10(4), pp. 265-269.

Swami, V and Furnham, A. (2007) ‘*The Body Beautiful: Evolutionary and socio-cultural perspectives*’. London: Macmillan.

Swami, V., and Furnham, A (2008) *The psychology of physical attraction*. East Sussex: Routledge.
Swami, V., Furnham, A., Amin, R., Chaudhri, J., Joshi, K., Jundi, S., Miller, R., Mirza-Begum, J., Begum, F.N., Sheth, P. and Tovée, M.J. (2008) 'Lonelier, Lazier, and Teased: The Stigmatizing Effect of Body Size', *Journal of Social Psychology,* 148(5), pp. 577-593.
Swami, V., and Hull, C. (2009) 'Men's ratings of physical attractiveness, health and partner suitability simultaneously versus separately: Does it matter whether within-or between-subjects designs are used?' *Body Image,* 6, 330-333.
Swami, V., Jones, J., Einon, D and Furnham, A (2009) 'Men's preferences for women's waist-to-hip ratio, breast size, and ethnic group in Britain and South Africa.' *The British Psychological Society,* 100, 313-325.
Swami, V., Kannan, K., and Furnham, A. (2012) 'Positive body image: Inter-ethnic and rural-urban differences among an indigenous sample from Malaysian Borneo', *International Journal of Social Psychiatry,* 58, 568-576.
Swami, V., Knight, D., Tovée, M.J., Davies, P and Furnham, A. (2007g) 'Perceptions of female body size in Britain and the South Pacific', *Body Image: An International Journal of Research,* 4, 219-223.
Swami, V., Pietschnig, J., Stieger, S., Tovee, M.J. and Voracek, M. (2010) 'An investigation of weight bias against women and its associations with individual difference factors', *Body Image,* 7(3), pp. 194-199.
Swami, V., Smith, J., Tsiokris, A., Georgiades, C., Sangareau, Y., Tovee, M.J. and Furnham, A. (2007) 'Male physical attractiveness in Britain and Greece: A cross-cultural study', *Journal of Social Psychology,* 147(1), pp. 15-26.
Swami, V. and Tovée, M.J. (2005) 'Male physical attractiveness in Britain and Malaysia: A cross-cultural study', *Body image,* 2(4), pp. 383-93.
Swami, V., and Tovée, M.J. (2006a) 'Does hunger influence judgements of female physical attractiveness?' *British Journal of Psychology,* 97, 353-363.
Swami, V and Tovée, M.J. (2007) The relative contribution of profile body shape and weight to judgements of women's physical attractiveness in Britain and Malaysia, *Body Image,* 4, 391-396.
Swami, V., and Tovée, M.J. (2007b) 'Perceptions of female body weight and shape among indigenous and urban Europeans'. *Scandinavian Journal of Psychology,* 48, 43-50.
Swami, V. and Tovée, M.J. (2013a) 'Men's Oppressive Beliefs Predict Their Breast Size Preferences in Women', *Archives of sexual behavior,* 42(7), pp. 1199-207.
Swami, V. and Tovée, M.J. (2013b) 'Resource Security Impacts Men's Female Breast Size Preferences', *Plos One,* 8(3).
Tantleff-Dunn, S. (2001) 'Breast and chest size: Ideals and stereotypes through the 1990s', *Sex Roles,* 45, pp. 231-242.
Tantleff-Dunn, S. (2002) 'Biggest isn't always best: The effect of breast size on perceptions of women', *Journal of Applied Social Psychology,* 32, pp. 2253-2265
Tassinary, L.G. and Hansen, K.A. (1998) 'A critical test of the waist-to-hip-ratio hypothesis of female physical attractiveness', *Psychological Science,* 9(2), pp. 150-155.
The Data Monitor Research…2007
The Diagram Group (1983) '*Woman's Body: An Owner's Manual*'. New York: Bantam.
Thibos, L.N., Cheney, F.E. and Walsh, D.J. (1987) 'RETINAL LIMITS TO THE DETECTION AND RESOLUTION OF GRATINGS', *Journal of the Optical Society of America a-Optics Image Science and Vision,* 4(8), pp. 1524-1529.
Thompson, J.K. and Stice, E. (2001) 'Thin-ideal internalization: Mounting evidence for a new risk factor for body-image disturbance and eating pathology', *Current Directions in Psychological Science,* 10(5), pp. 181-183.

Thompson, J.K and Tantleff, S. (1992) ‘Female and male ratings of upper torso- actual, ideal and stereotypical conceptions’, *Journal of Social Behaviour and Personality*, 7, 345-354.
Thornhill, R. and Gangestad, S.W. (1999) 'Facial attractiveness', *Trends in Cognitive Sciences*, 3(12), pp. 452-460.
Thornhill, R. and Grammer, K. (1999) 'The body and face of woman: One ornament that signals quality?', *Evolution and Human Behavior*, 20(2), pp. 105-120.
Tooby, J., and Cosmides, L. (1992) ‘The psychological foundations of culture’ In J.H.Barkow, L. Cosmides and J. Tooby (Eds), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 19-136). New York: Oxford Unviersity Press.
Tooby, J., and Cosmides, L. (2005) ‘Conceptual foundations of evolutionary psychology’. In D.M.Buss (ed), The handbook of evolutionary psychology (pp. 5-67). Hoboken, NJ: John Wiley & Sons, Ltd.
Tovée, M.J., Benson, P.J., Emery, J.L., Mason, S.M. and Cohen-Tovée, E.M. (2003) 'Measurement of body size and shape perception in eating-disordered and control observers using body-shape software', *British Journal of Psychology*, 94, pp. 501-516.
Tovée, M.J. and Cornelissen, P.L. (2001) 'Female and male perceptions of female physical attractiveness in front-view and profile', *British Journal of Psychology*, 92, pp. 391-402.
Tovée, M.J., Edmonds, L. and Vuong, Q.C. (2012) 'Categorical perception of human female physical attractiveness and health', *Evolution and Human Behavior*, 33(2), pp. 85-93.
Tovée, M.J., Emery, J.L. and Cohen-Tovee, E.M. (2000) 'The estimation of body mass index and physical attractiveness is dependent on the observer's own body mass index', *Proceedings of the Royal Society B-Biological Sciences*, 267(1456), pp. 1987-1997.
Tovée, M.J., Hancock, P.J.B., Mahmoodi, S., Singleton, B.R.R. and Cornelissen, P.L. (2002) 'Human female attractiveness: waveform analysis of body shape', *Proceedings of the Royal Society B-Biological Sciences*, 269(1506), pp. 2205-2213.
Tovée, M.J., Maisey, D.S., Emery, J.L. and Cornelissen, P.L. (1999) 'Visual cues to female physical attractiveness', *Proceedings of the Royal Society B-Biological Sciences*, 266(1415), pp. 211-218.
Tovée, M.J., Reinhardt, S., Emery, J.L. and Cornelissen, P.L. (1998) 'Optimum body-mass index and maximum sexual attractiveness', *Lancet*, 352(9127), pp. 548-548.
Tovée, M.J., Swami, V., Furnham, A. and Mangalparsad, R. (2006) 'Changing perceptions of attractiveness as observers are exposed to a different culture', *Evolution and Human Behavior*, 27(6), pp. 443-456.
Trampe, D., Stapel, D.A., Siero, F.W. and Mulder, H. (2010) 'Beauty as a Tool: The Effect of Model Attractiveness, Product Relevance, and Elaboration Likelihood on Advertising Effectiveness', *Psychology & Marketing*, 27(12), pp. 1101-1121.
Trivers, R.L. (1972) 'Parental investment and sexual selection', in Campbell, B. (ed.) *Sexual selection and the descent of man: 1871-1971*. Chicago: Aldine, pp. 136-179.
Tsiros, M.D., Coates, A.M., Howe, P.R.C., *et al*. (2011) ‘Obesity: the new childhood disability?’, *Obesity Reviews*, 12, pp. 26-36.
Tybur, J.M. and Griskevicius, V. (2013) 'Evolutionary Psychology: A Fresh Perspective for Understanding and Changing Problematic Behavior', *Public Administration Review*, 73(1), pp. 12-22.
Van Den Berg, P., Paxton, S.J., Keery, H., Wall, M., Guo, J. and Neumark-Sztainer, D. (2007) 'Body dissatisfaction and body comparison with media images in males and females', *Body Image*, 4(3), pp. 257-268.
van Hooff, M.H.A., Voorhorst, F.J., Kaptein, M.B.H., Hirasing, R.A., Koppenaal, C. and Schoemaker, J. (2000) 'Insulin, androgen, and gonadotropin concentrations, body mass index, and waist to hip ratio in the first years after menarche in girls with regular menstrual cycles, irregular menstrual cycles, or oligomenorrhea', *Journal of Clinical Endocrinology & Metabolism*, 85(4), pp. 1394-1400.

Vincent, M.A., and McCabe, M.P. (2000) ‘Gender differences among adolescents in family and peer influences on body dissatisfaction, weight loss and binge eating behaviours’. *J Youth Adolesc*, 29, 205-211.
Von rueden, C., Gurven, M., & Kaplan, H (2008) 'The multiple dimensions of male social status in an Amazonian society', *Evolution and Human Behavior*, 29, pp. 402-415.
Voracek, M. and Fisher, M.L. (2002) 'Shapely centrefolds? Temporal change in body measures: trend analysis', *British Medical Journal*, 325(7378), pp. 1447-1448.
Waldman, A., Loomes, R., Mountford, V. A., & Tchanturia, K. (2013) 'Attitudinal and perceptual factors in body image distortion: an exploratory study in patients with anorexia nervosa', *Journal of Eating Disorders*, 1(17).
Waldstein, S.R. & Katzel, L.I. (2006) ‘Interactive relations of central versus total obesity and blood pressure to cognitive function’, *International Journal of Obesity*, 30, 201-207.
Walster, E., Walster, G.W and Berscheid, E (1978) ‘*Equity theory and research*’. Boston, MA: Allyn and Bacon.
Wang, C., Swerdloff, R.S., Iranmanesh, A., Dobs, A., Snyder, P.J., Cunningham, G., Matsumoto, A.M., Weber, T., Berman, N. and Testosterone Gel Study, G. (2000) 'Transdermal testosterone gel improves sexual function, mood, muscle strength, and body composition parameters in hypogonadal men (vol 85, pg 2839, 2000)', *Journal of Clinical Endocrinology & Metabolism*, 85(10), pp. 3525-3525.
Wass, P., Waldenstrom, U., Rossner, S. and Hellberg, D. (1997) 'An android body fat distribution in females impairs the pregnancy rate of in-vitro fertilization-embryo transfer', *Human Reproduction*, 12(9), pp. 2057-2060.
Watkins, L.M. and Johnston, L. (2000) 'Screening job applicants: The impact of physical attractiveness and application quality', *International Journal of Selection and Assessment*, 8(2), pp. 76-84.
Watson, D., Klohnen, E.C., Casillas, A., Nus Simms, E., Haig, J and Berry, D.S. (2004) ‘Match makes and deal breakers: Analyses of assortative mating in newly-wed couples’, *Journal of Personality*, 72, 1029-1068.
Waynforth, D and Dunbar, R. (1995) ‘Conditional mate choice strategies in humans: Evidence of lonely hearts advertisements’. *Behaviour*, 132, 735-779.
Weeden, J. and Sabini, J. (2005) 'Physical attractiveness and health in western societies: A review', *Psychological Bulletin*, 131(5), pp. 635-653.
Wells, J.C.K (2009) Thrift: a guide to thrifty genes, thrifty phenotypes and thrifty norms, *Obesity*, 33, 1331-1338.
Wells, J.C.K., Treleaven, P., & Cole, T. J (2007) 'BMI compared with 3-dimensional body shape: The UK National Sizing Survey', *American Journal of Clinical Nutrition*, 85, pp. 419-425.
Wells, J.C.K., Treleaven. J., Bruner, D., & Treleaven, P (2008) 'Body Shape in American and British Adults: Between country and inter-ethnic comparisons', *International Journal of Obesity*, 32, pp. 152-159.
Willet, W.C., Manson, J. E., Stampfer, M. J., Colditz, G. A., Rosner, B., Speizer, F. E., & Hennekens, C. H (1995) 'Weight, weight change and coronary heart disease in women: Risk within the 'normal' weight range', *Jl Am. Med. Ass*, 273, pp. 461-465.
Williams, S.R.P., Goodfellow, J., Davies, B., Bell, W., McDowell, I. and Jones, E. (2000) 'Somatotype and angiographically determined atherosclerotic coronary artery disease in men', *American Journal of Human Biology*, 12(1), pp. 128-138.
Wood, W.,& Eagly, A.H. (2010) ‘Gender’. In S.T.Fiske, D.T.Gilbert & G.Lindzey (Eds), Handbook of social psychology (5^{th} ed., Vol 1, pp 629-667). Hoboken: Wiley.
Wood, W., & Eagly, A.H. (2012) ‘Biosocial construction of sex differences and similarities in behaviour’. In J.M.Olson & M.P.Zanna (Eds), *Advances in experimental social psychology* (Vol 46, pp. 55-123). London: Elsevier.

Wood, W., Kressel, L., Joshi, P., & Louie, B (in press). 'Meta-analysis of menstrual cycle effects on women's mate preferences. *Emotion Review*.
Yajnik, C.S and Yudkin, J.K. (2004) 'The Y-Y paradox', *Lancet*, 363, pp. 163-163.
Yamamiya, Y., Cash, T.F., Melnyk, S.E., Posavac, H.D. and Posavac, S.S. (2005) 'Women's exposure to thin-and-beautiful media images: body image effects of media-ideal internalization and impact-reduction interventions', *Body image,* 2(1), pp. 74-80.
Yu, D.W., Proulx, S.R. and Shepard, G.H. (2007) 'Masculinity, culture and the paradox of the leks'. In V.Swami and A.Furnham (Eds), *The Body Beautiful: Evolutionary and socio-cultural perspectives*. London: Macmillan.
Zaadstra, B.M., Seidell, J.C., Vannoord, P.A.H., Tevelde, E.R., Habbema, J.D.F., Vrieswijk, B. and Karbaat, J. (1993) 'FAT AND FEMALE FECUNDITY - PROSPECTIVE-STUDY OF EFFECT OF BODY-FAT DISTRIBUTION ON CONCEPTION RATES', *British Medical Journal*, 306(6876), pp. 484-487.
Zahavi, A. (1975) 'MATE SELECTION - SELECTION FOR A HANDICAP', *Journal of Theoretical Biology*, 53(1), pp. 205-214.
Zelazniewicz, A.M. and Pawlowski, B. (2011) 'Female Breast Size Attractiveness for Men as a Function of Sociosexual Orientation (Restricted vs. Unrestricted)', *Archives of Sexual Behavior*, 40(6), pp. 1129-1135.
Zhao, Y., Zu, P., Zhu, P., *et al*. (2014) 'Changes in BMI and waist circumference among primary and secondary school students from 2005 to 2010 in Anhui China', *Annals of Human Biology,* 41, pp. 201-204.
Zhu, S., Wang, Z., Heshka, S., *et al*. (2002) 'Waist circumference and obesity-associated risk factors among whites in the third National Health and Nutrition Examination Survey: clinical action thresholds', *Am J Clin Nutr,* 76, pp. 743-749.