Investigating Preferences for Body Size, and Developing a Program to Modify Distorted Body Size Perception.

Lucinda Jayne Gledhill

(Doctor of Philosophy)

Institute of Neuroscience, Newcastle University

February 2015

Supervisors:

Dr. Martin Tovée

Dr. Domhnall Jennings

Dedication

"For my mum- without whose love, support and endless patience none of this would have been possible".

Contents

List of Figures

List of Tables

Acknowledgements

I would like to take this opportunity to express my sincere gratitude to my supervisors: Dr. Martin Tovée for his advice and encouragement (and at times, unwelcome and unfunny jokes) during my time as both an undergraduate student and during my PhD, and Dr. Domhnall Jennings for his seemingly endless patience when explaining statistics and for always making the time to help.

I would also like to thank Professor Piers Cornelissen, for his expert help with statistics and for repeatedly taking the time to explain things when it appeared I would never "get it".

To Kara, I would like to thank for reminding me what fun is and for keeping me sane (and bringing me back when I was very close to the edge!)

To my family,

To Liam, for his constant love and support, and for giving me a much needed escape at times when I wanted to give up.

To Kate, I would like to thank for always lending an ear when I needed a good moan and for keeping me in baked goods for the duration of my time at University (without which I definitely would not have survived).

And finally, to my mum- an incredible woman to whom I owe everything. She is my inspiration, and without her none of this would have been possible.
(Mum, you can relax now!)

Abstract

The experiments presented in this thesis were designed to explore cues to body size judgements previously documented in the existing literature, investigate differences in perception of size (over- and under-estimation) across different groups, and delve into the possibilities of altering the overestimation of size found in sub-clinical populations.

The first studies (Chapter 2) aimed to not only reproduce the findings of the effect of hunger on body size preferences previously documented, but also determine whether body size preferences are determined by physiological (hunger) or psychological (time until satiation) cues. Studies in the third chapter aimed to investigate alternative cues, previously not investigated, which influence judgements of the body, i.e. torso length as a predictor of curviness. Chapter 4 involved an investigation into Contraction Bias in relation to the overestimation of body size, and whether this phenomenon is affected by individual variation in observer psychological state and BMI. Following on from this idea, the subsequent study (Chapter 5) investigated the possibility of reducing this overestimation of size in subjects with marked concerns about their bodies (and also reducing factors comorbid with Eating Disorders as secondary effects).

These results suggest that more research is needed to investigate psychological and physiological cues behind differences in body size preferences, torso length can be used as a reliable cue to both curviness and body size in the absence of any other cues, overestimation of body size is modulated by observer BMI and psychological state, and that perception training is a possible effective technique for reducing this overestimation.

Overall the most important findings in this thesis indicate that treatment for Anorexia Nervosa should take into account the idea that patients' attitudes to their own body shape, and their self-esteem is reinforced by a perceptual over-estimation of body size, and that strategies should therefore focus not only on the Cognitive component of Body Image Distortion, but also on the Perceptual Component; potentially combining perception training with cognitive therapies.

Chapter 1: Introduction

The concept of physical attractiveness has been the subject of considerable research and discussion in both evolutionary and social psychology. Outlining the ideas of both of these two schools of thought I will attempt to explain the importance of attractiveness research in the interpretation and understanding of human behaviour, and identify areas in which further research will improve understanding.

1.1. The bias of attractiveness

When meeting a person for the first time, we automatically make instant judgements about them based on the available information (Baron, Markman, & Bollinger, 2006). A mental image is formed which draws on this information and produces an expectation of how they will behave. This first impression can influence all further interactions with this person, and is based on non-verbal cues such as physical appearance or attractiveness (Park, 1986).

Many studies have investigated the effect of physical attractiveness on how we judge others. A meta-analysis of 900 studies found that people were treated differently depending on how attractive they were perceived to be (Langlois et al., 2000). More to the point, very attractive people were judged in a more positive light than those who were less physically attractive. For instance, physically attractive people were judged more successful and sociable (Dion, 1972), with more likelihood of financial success (Baron et al., 2006) than unattractive or less attractive individuals. This is known as the attractiveness bias. According to (Eagly, Makhijani, Ashmore, & Longo, 1991), when forming first impressions about a person we attempt to link them with previously established schemas, therefore leading to the formation of stereotypes. This idea would imply that attractive or unattractive people become associated with various personality traits, based on our previous knowledge of people, what they look like and what their personalities are like. If we have previously met several individuals who were both physically attractive and outgoing, we would therefore attribute the trait "outgoing" to anyone we perceive to be attractive.

Implicit Personality Theory suggests the attractiveness bias is learned through both social and cultural experiences- direct observation of attractive and unattractive

people around us, and the indirect reinforcement of attractive and unattractive ideals portrayed through the media. Therefore this would suggest that individuals observe others showing preferential treatment towards attractive people during social interactions and therefore assume that this positivity is due to their physical attractiveness, ie: several studies have shown that attractive people are more popular and are treated more favourably than their unattractive peers (Boyatzis, Baloff, & Durieux, 1998; Dion, & Dion, 1987; Kenealy, Frude, & Shaw, 1988). Some studies that support the "beautiful is good" effect also show that unattractiveness is related to negative behaviour from peers. Unattractive children have been found to be more likely to be perceived negatively by observers (Langlois, Ritter, Casey, & Sawin, 1995) and more likely to be treated less favourably by teachers and bullied during adolescence. Therefore if we see unattractive individuals being treated unfavourably, this will reinforce our preference for attractive people.

In terms of the indirect learning of attractiveness bias, media influences in society reinforce this preference for attractiveness, with thin, attractive women being presented in a more positive light on television than overweight, unattractive or "ugly" women (Greenberg, Eastin, Hofschire, Lachlan, & Brownell, 2003). This preference for attractiveness is reinforced at a young age, with many children's books and television programs promoting a positive attitude towards attractive individuals and the opposite for unattractive individuals (Herbozo, Tantleff-Dunn, Gokee-Larose, & Thompson, 2004). This study found that attractive characters in children's media are presented as more sociable, kind, content and successful, with unattractive, obese characters being portrayed negatively and being disliked by the majority.

This therefore seems to provide strong support for the idea of an attractiveness bias, with a preference for physical attractiveness causing the development of stereotypes of attractive individuals being "good" individuals. However, what is it about these individuals that we find attractive and what causes this attraction?

1.2. Natural and Sexual Selection as an explanation for Physical Attractiveness

Charles Darwin admitted that his original theory of Natural Selection could not account for why some species continued to display features that were counterproductive for their survival. For example, some species of fish are brightly coloured which make them more noticeable to predators. Darwin then suggested a theory of Sexual Selection as well as Natural Selection. Some characteristics which may be detrimental to survival

may persist in selection processes due to their advantages for mating success. Many psychologists suggest that attractive traits act as a signal of underlying quality or "good genes" (Grammer, Fink, Moller, & Thornhill, 2003), and those with "good genes" will either be able to better provide for any potential offspring with material goods or they may simply make better mates due to better reproductive potential, and fertility. However, how can anyone, human or animal, be sure that these signals are true signals of quality? In answer to this question, the "handicap principle" was proposed (Zahavi, 1975). A trait that is so exaggerated will be a costly handicap to the individual who possesses it; therefore it should have been reduced by Natural Selection. However, as the handicap is maintained throughout selection, it must signal the quality of the organism honestly. Any individual who can afford a large handicap should be of good quality.

In humans, males have therefore been selected to prefer females with detectable qualities that signal maximum reproductive potential, and females therefore honestly signal their fecundity, again through visible qualities to potential mates (Smith et al., 2007). Developing this further, Buss and Barnes (1986) found that males more than females have a preference for physical attractiveness, while females place more emphasis on good earning potential and a college education. This is said to be because a women's reproductive potential is directly linked to age and health (Symons, 1995) which in turn are shown through smooth skin, good muscle tone and thick lustrous hair (Buss, & Barnes, 1986). Therefore men have been selected to prefer these traits (youth and beauty) in women as they are strong cues to health and reproductive potential (Jokela, 2009; Tovée et al., 1999). Physical attractiveness is therefore an honest signal of both phenotypic and genotypic quality (Thornhill, & Grammer, 1999). However, (Symons, 1995) also suggested that this cue of reproductive potential is not as easy to judge in males, as age does not act as a barrier to men in terms of reproduction; therefore a youthful man is not necessarily the best choice. Instead (Symons, 1995) and (Buss, 1994) suggest that instead, females prefer males with access to resources and high social status as they see these as traits that are advantageous when producing offspring.

1.3. Cues to attractiveness

There are many different attractiveness cues that enable us to make these judgements about female health and reproductive potential. These include fluctuating

asymmetry, relative leg length, bust size, body fat and body shape. However, here we will focus on just three aspects: a measure of body mass assumed to be linked to overall body fat (the body mass index or BMI), lower body shape (the Waist-Hip Ratio or WHR), and upper body shape (Bust-Waist Ratio or BWR) as previous literature has suggested these are the primary features associated with female attractiveness (e.g. (Henss, 1995, 2000; Maisey, Vale, Cornelissen, & Tovée, 1999; Puhl, & Boland, 2001; Sell et al., 2009; Singh, 1993b; Smith et al., 2007; Streeter, & McBurney, 2003; Thornhill, & Grammer, 1999; Tovée, 2012; Tovée, Hancock, Mahmoodi, Singleton, & Cornelissen, 2002; Tovée, Reinhardt, Emery, & Cornelissen, 1998). These cues are believed to function as honest signals of a potential mate's reproductive potential (Furnham, Petrides, & Constantinides, 2005; Singh, 1993a, 1994). Many studies have concluded that for optimal attractiveness, bodies should be slim but not skinny (Tovée, & Cornelissen, 1999), and have a small waist in relation to their hips (Singh, 1993a, 1993b; Streeter, & McBurney, 2003; Tovée, & Cornelissen, 1999; Tovée et al., 1999). This leads us to ask the question: How exactly do we measure body fat in order to make these judgements of attractiveness?

1.4. How to measure body fat?

Body fat can be measured through a variety of different ways, ie: skin fold thickness using Calipers, Bio-impedence, Hydrostatic weighing, and Dual energy X-ray absorbimetry and calculating the Body Mass Index.

The most accurate method of measuring body fat was previously thought to be Hydrodensitometry. This process involves the subject exhaling as much air as possible from their lungs before being lowered into a hydrostatic tank of water. Their underwater weight can then be measured. Using a set of bodies of average body fat, it is possible to estimate the body's percentage body fat. However, this method can be confounded by subjects whose weight or density is different from the average, i.e. a body fat estimate for someone with a high muscle mass (due to their physical fitness) will be too high as muscle weighs heavier than fat, whereas the estimate for someone with less muscle mass and higher levels of fat will be too low (Nelson et al., 1996).

However, it has subsequently been suggested that Hydrodensitometry should be replaced as the "gold standard" for measuring body composition by Dual Energy X-Ray Absorptiometry (DXA) (Kohrt, 1995; Kohrt, 1998). As the name suggests this technique uses the relative absorbance of X-rays by the body to calculate fat content.

However, this method is costly and the equipment is not usually available to most researchers. Alternative, less costly, yet effective methods of measurement must therefore be explored.

One such method which is cheaper and easier to implement, however significantly less accurate, is Bioelectrical Impedance Analysis (BIA). This works by the subject standing on a set of scales. An electrical current is passed from the scales, up one leg of the subject, across the abdominal area, and down the other leg, back to the scales. Body fat measurements are taken by how much resistance is found to this current in the body. This resistance will vary between muscle and fat mass (as muscle is a good conductor of electricity- made of electrolytes and water, while fat is a poor conductor of electricity); therefore any resistance will function as an indicator of the presence of fat. However, as water is such a good conductor of electricity, hydration levels in the body can alter the measurements of body fat found (as there will be less resistance to the current). This is supported by a significant decrease in the apparent percentage body fat for participants in a hydrated condition measured by BIA, compared to those in a dehydrated condition (Thompson et al., 1991).

Another problem with this method is the differences in fat deposition between males and females (Kuk, Lee, Heymsfield, & Ross, 2005; Nielsen, Guo, Johnson, Hensrud, & Jensen, 2004; Power, & Schulkin, 2008). Males carry most of their fat in their abdomen in the form of visceral fat- fat which BIA does not take into account (Lohman et al., 2000)-whereas females carry most of theirs on their thighs as subcutaneous fat (Lemieux, Prudhomme, Bouchard, Tremblay, & Despres, 1993). These differences in deposition of fat will affect resistance levels to the electrical currents, which will lead to completely different estimations of overall body fat for men and women. However, results suggest that this method has a tendency to underestimate the total body fat mass and underestimate fat free mass in healthy adults (compared to body fat measured through DXA) (Eisenkolbl, Kartasurya, & Widhalm, 2001), with more recent research suggesting that this method should be used with caution when measuring the total body fat of those whose total body fat is above 25% (Leahy, O'Neill, Sohun, & Jakeman, 2012).

A second, again cheaper, but more time consuming method of body fat measurement is the Skinfold Thickness method (SFT). This involves measuring pinches of skin using calibrated callipers at 3 to 9 anatomical points on the body. These pinches are usually taken from just one side of the body, with the callipers being used 2-3 times

on each point of the body in order to achieve an average measurement (for reliability). It is suggested (Durnin, & Womersley, 1974) that 4 points on the body should be pinched in order to achieve an accurate measure of body fat: Triceps, Biceps, Subscapular (on the participant's back, at the lower edge of the shoulder blade) and Suprailiac Crest (just above the highest point of the hip bone). Body density is then calculated from the average of these measures and body fat percentages can then be calculated from the density.

However, SFT only measures subcutaneous fat. Therefore it is possible for two people to have the same skin fold measurements, but have completely different body fat levels, as SFT completely ignores the deposition of visceral fat in the body (Tovée, 2012). SFT is also said to be a poor predictor of abdominal fat mass and total fat and will therefore have severe limitations when used to measure body composition in the obese (Watts et al., 2006). Some studies (Kvist, Chowdhury, Grangard, Tylen, & Sjostrom, 1988) have stated that the type of fat most related to negative health effects such as cardiovascular disease in adults is visceral fat- the type of fat that SFT does not measure. It would therefore seem counterintuitive to use this technique to measure fat if it does not give any implications about a person's health. Cross cultural differences in patterns of body fat distribution also have huge implications for the reliability of this technique (Ehtisham, Crabtree, Clark, Shaw, & Barrett, 2005; Liu et al., 2011; Rush, Freitas, & Plank, 2009; Wickramasinghe, Lamabadusuriay, Cleghorn, & Davies, 2008).

1.4.1. Body Mass Index (BMI): Pros & Cons

There are many cons to using the majority of the techniques mentioned in this chapter. Body density (measured through hydrostatic weighing) and body fat percentage (measures using calipers, bio-impedence or X-ray absorptiometry) would appear to be the most accurate and effective ways to measure human body fat, however both are expensive to conduct and inconvenient to perform on a large scale in clinical setting. Therefore a further method: Body Mass Index (BMI) or Quételet Index as it was originally known would seem to be a more viable option, as it is both the cheapest and easiest to calculate. BMI is calculated by the dividing the subject's weight by their height squared. It has the same dimensions as density and pressure, but in 2D form, therefore holding the same advantages as other methods, but with the extra advantage of convenience. However, Adolphe Quételet himself identified this as a problem with BMI; as it does not take into account the 3D depth of the body (only its height and

width). He therefore suggested that the index be altered for different age groups, with babies' index being scaled by 3 (cubed- as they are more rounded: now known as the Ponderal Index), adolescents' index being scaled by 2 (squared- as they tend to be thinner) and adults' index being scaled by 2.5 (increasing from adolescents' as they gain weight as they age). However, a study comparing the Ponderal Index with BMI using DXA shows no significant improvement in body fat estimation using a cubed formula rather than squared (Tovée, 2012).

Even though many researchers criticise BMI for its use of a squared term and its inability to take into account the differences between lean muscle mass and fat mass, BMI remains a good approximation of percentage body fat (see figure 1.1 below) (Romero-Corral et al., 2008; Shah, & Braverman, 2012). Its simplicity and ease of use make it an excellent tool to measure (Huxley, & Jacobs, 2011), and it seems to be a more realiable measure of percentage body fat than BIA and SFT (Chan, Leung, Lam, Peng, & Metreweli, 1998).
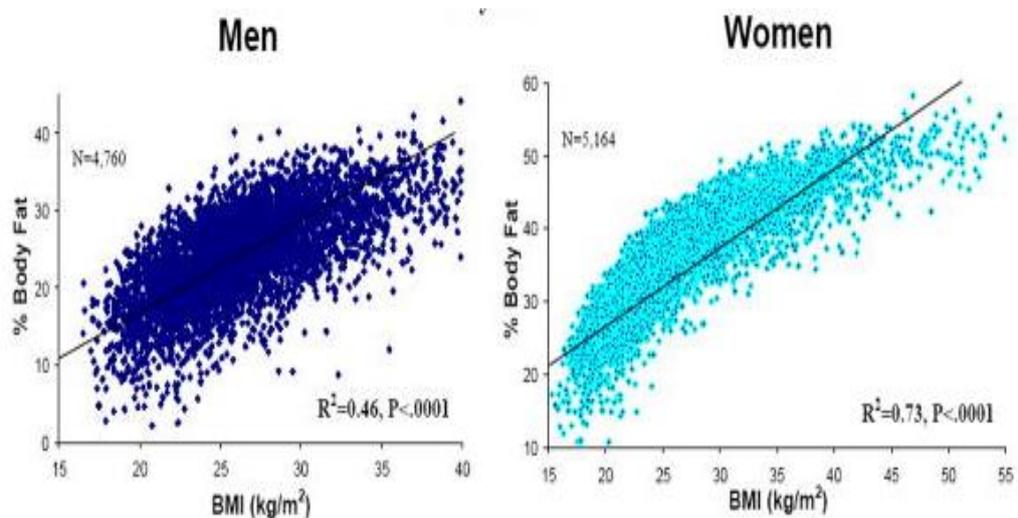
Figure 1.1. Scatter plot of Percent Body Fat (calculated by DXA) versus BMI. The results show a generally good relationship between BMI and actual percentage body fat especially for women (Romero-Corral et al., 2008).

1.4.2. Volume Height Index (VHI)

Measurement of the Volume Height Index or VHI involves the subject standing in a chamber while lasers scan their body to produce a 3D image. Based on the reflections of light a large number of points, corresponding to points on the body, are produced in a 3D space corresponding to the physical dimensions of the body. From this scan, the volume and height of the body can be calculated. Given that the volume of the

body will be proportional to its fat mass, the volume of the body scaled to its height has been proposed as an alternative measure of fat mass (Fan, Dai, Qian, Chau, & Liu, 2007; Fan, Liu, Wu, & Dai, 2004). However, the 3D scanning equipment is still comparatively rare and one disadvantage is that any movement by the subject in the chamber while the scanning is in progress can cause the apparent volume of the 3D body produced to increase and thus lead to an over-estimation of the fat mass.

1.4.3. Waist-to-Hip Ratio (WHR)

The last methods of measuring body fat that I will discuss here are WHR, WC and WHtR. Firstly, WHR has been developed as an alternative to BMI and many have suggested it is a better measure of body fat as it takes into account the shape of the body instead of just its size (Singh, & Singh, 2011). WHR is calculated by measuring the subject's waist and hip circumferences and dividing the waist measure by the hip. Measures of the waist are taken at the smallest part of the torso/ natural waist or if the waist is convex (as in pregnancy), the measure may be taken 1 inch above the line of the navel. Hip circumferences are measured at the widest part of the buttocks or hips.

However, some suggest that WHR may not be an appropriate tool in measuring adiposity levels and obesity (Ketel et al., 2007), an idea also supported by Power, Lake, and Cole (1997), who states this is due to the fact that WHR is highly age-dependent. Furthermore, it has also been postulated that differences between subjects' skeletal structures may also cause problems for results using WHR (Ley, Lees, & Stevenson, 1992). Therefore while WHR would seem to be a better measure of lower body fat, it does not take into account the height of the subject (which for mechanical reasons effects the relative thickness of the hip and thighs) or the overall fat mass and there are also several external factors which affect it (as mentioned above).

1.4.3.1. Waist Circumference (WC) & Waist Height Ratio (WHtR)

It has also been suggested that WHR is not a good representation of fat levels as it does not take into account the overall body size, just the shape of the torso. Instead, waist circumference (WC) has been reported as a better measure of fatness than WHR (Taylor, Keil, Gold, Williams, & Goulding, 1998), in particular- visceral fatness (Rankinen, Kim, Perusse, Despres, & Bouchard, 1999). WC is often combined with a height measurement (waist circumference-to-height ratio: WHtR), therefore taking into account overall size as well as shape, and unlike WHR, WHtR is also said to not be

dependent on age (Aeberli, Gut-Knabenhans, Kusche-Ammann, Molinari, & Zimmermann, 2011).

WC and WHtR have both been found to predict fatness related morbidity (McCarthy, & Ashwell, 2006) and risk of cardiovascular disease in children/young people (Kahn, Imperatore, & Cheng, 2005; Kelishadi et al., 2007; Savva et al., 2000), with WHtR recently being found to be a better predictor of total adiposity than just WC without the height indices and also BMI (Brambilla, Bedogni, Heo, & Pietrobelli, 2013). However, most of the research suggesting WHtR as a good predictor of body shape appears to use samples of children or adolescents whereas I aim to use adult females, therefore for the rest of my research I will chose to focus on BMI as the best predictor of total body fat and attractiveness, as it is a better predictor of body fat in adults.

Further support for BMI as the best measure of body fat to use in this research comes from the fact that many researchers will also not have the access to resources such as the 3D laser scanner required to calculate VHI, and as VHI is said to be highly correlated with BMI (Fan et al., 2004), BMI would seem the more viable option in measuring body fat. Wagner and Heyward (1999) suggest a multicomponent model for assessing body composition would be the best method of measuring body fat, combining DXA with Hydrodensitometry and other laboratory methods. However, Wagner & Heyward do acknowledge that this would be too time consuming, and costly Instead, for epidemiological studies involving a large number of participants, they suggest BMI may be the most practical way forward. Many researchers however have criticised BMI, instead favouring WHR, but these two have been found to be significantly correlated (Singh, & Singh, 2011).

Figure 1.2. The average shape for adult women (aged 18-45) at a BMI of 13, 17 and 21. As the BMI increases so does the WHR of the bodies.

In conclusion, BMI is the most practical method for measuring body fat in the general population where access to resources such as laser scanners etc is unavailable, however cross cultural differences in BMI categories and distribution of fat should always be taken into account if recruiting participants of different ethnic backgrounds (Deurenberg, Deurenberg-Yap, & Guricci, 2002; Gallagher et al., 1996; Jackson et al., 2002).

1.5. BMI as a cue to Attractiveness

As previously discussed, the theory of Quality Detection suggests attractiveness in females serves as a cue to males about their reproductive potential, health and fertility. Something which aids our judgements of attractiveness is our assessment of a person's overall body fat (indexed for research purposes as BMI). In terms of evolutionary psychology, BMI as a basis for mate selection has many advantages such as being an indicator of female health (Manson et al., 1995; Willett et al., 1995) and reproductive potential (Frisch, 1987; Lake, Power, & Cole, 1997; Reid, & van Vugt, 1987).

Obesity (categorised as someone with a BMI above 30) is also linked to several health conditions such as cardiovascular disease (Conard et al., 2006; Ippoliti, Canitano, & Businaro, 2013; Kenchaiah et al., 2002); and diabetes (Chan, Rimm, Colditz, Stampfer, & Willett, 1994; Ford, Williamson, & Liu, 1997; Mokdad et al., 2001; Resnick, Valsania, Halter, & Lin, 2000).

In a relatively recent study, Flegal, Graubard, Williamson, and Gail (2005), comparing data from the nationally representative National Health & Nutrition Examination Surveys (NHANES) between 1971-1994 and 1999-2002 estimated the relative risks associated between different BMI values and death rate. Both the underweight and overweight (particularly highly obese) were found to be associated with the highest mortality rate when compared to those of normal BMI. This was supported by Adams et al. (2006) who found that the risk of death was highest in the lowest and highest BMIs among both males and females, across ethnicities and age groups. Mortality risk was found to increase by 20-40% in overweight subjects, and was found to be 2/3 times higher in the obese compared to normal weight subjects.

This finding is supported further with obesity being named the fourth most important risk factor for ill health and premature death after smoking, high blood pressure, and alcohol abuse (Anderson, 2008).

There is also evidence for lower fertility levels in the overweight, with obese women having less chance of becoming pregnant than someone of a normal weight (Hall, & Neubert, 2005; Pasquali, 2006; Zaadstra et al., 1993). Manson et al. (1995) suggest that any BMI of over 24.9 will have a negative impact on fertility. Therefore, in relation to mate selection, it would make sense for a preference for a lower BMI to exist. However, there are also negative health issues related with a BMI that is too low (below 18.5) as this can be a diagnostic feature for an Eating Disorder such as Anorexia Nervosa (DSM-5: (American Psychiatric Association, 2013)). Health problems linked to low BMI include osteoporosis (Grinspoon et al., 2000; Miller et al., 2005), amenorrhea (Golden, & Carlson, 2008; Miller et al., 2005; Roberto, Steinglass, Mayer, Attia, & Walsh, 2008) and the lack of fertility concomitant with amenorrhea is a negative in a potential mate (Bulik et al., 1999; Frisch, 1996; James, 2001).

Studies have shown an optimal BMI for health and fertility of around 21 kg/m², which is roughly in the middle of the "normal" BMI category (Tovée, & Cornelissen, 1999, 2001; Tovée, Emery, & Cohen-Tovée, 2000; Tovée et al., 1998). Attractiveness studies using 2D photographs of real female bodies (faces blurred to remove effects of facial attractiveness) also found that this is the optimal BMI for attractiveness in Western observers, therefore suggesting a direct link between BMI as a cue to reproductive success and attractiveness as a detection of one's quality. This is supported by a study by Conley and McCabe (2011), in which male participants were shown real photographs of pairs of the same female (one manipulated to have a larger BMI and one a smaller BMI). Here, it was reported that male participants' attractiveness responses differed based on BMI of the image shown to them.

Tovée, Edmonds, and Vuong (2012) showed further support for BMI as a cue to attractiveness using 3 different tasks in which stimuli consisted of computer generated bodies altered for fatness: Firstly, a ratings task was used to investigate if computer generated body models were accurate representations of real bodies (i.e. were they rated in the same way). Secondly, a two-alternative forced choice task (2-AFC) was used to force observers to state whether a body was categorically attractive or unattractive and categorically healthy or unhealthy, with the hope of being able to estimate a boundary between bodies that were perceived as attractive/unattractive and healthy/unhealthy. Finally a delayed match-to-sample task (DMS) was used to test if there was a difference in performance between trials that involved bodies being spread across this categorical boundary, compared to trials that involved bodies in between the same categorical

boundary (i.e. would it be easier to judge the attractiveness of 2 bodies that were both considered attractive or would it be easier to judge between an unattractive and an attractive body).

Evidence for the categorical perception of female attractiveness and health in both males and females was found. Bodies with high fat levels were rated as unattractive and unhealthy while those with low fat were viewed in the opposite light. Participants were also found to be able to discriminate between bodies that crossed the attractive/unattractive boundary much quicker than bodies that were similar in attractiveness levels- therefore suggesting that when 2 bodies: one fatter and one thinner are presented together it is much easier to rate which is most attractive and healthy, compared to when 2 bodies: both thin or both fat are presented together. This provides support for the idea of BMI as a strong cue to attractiveness in females.

Tovée et al. (1998) provide even further support for this idea by showing observers bodies of real women varying in both WHR and BMI. BMI was found to account for more of the variance in attractiveness judgements made about these bodies (73.5%) compared to WHR (1.8%). WHR was also found to be poorly correlated with attractiveness, whereas even small alterations in the BMI of the images shown resulted in dramatic differences in attractiveness ratings.

More recently, Koscinski (2013) conducted a study in which digitally manipulated silhouettes of female bodies varying in both BMI and WHR were used as stimuli. Participants were first asked to estimate which images they thought were most attractive. They were then presented with pairs of images in which 1 of the pair deviated from the participants' ideal BMI and the other from their ideal WHR. In pairs in which deviations from the preferred BMI and WHR were equivalent, the silhouette altered for WHR was regarded as the most attractive, therefore suggesting that changing BMI away from the ideal had more of an effect on perceived attractiveness than changing the WHR. The extent of this effect was also found, with BMI being shown to be doubly important when making attractiveness judgements, compared to WHR. This would lead us to believe that BMI is the more important predictor of attractiveness.

Much research into female attractiveness judgements has found this to be the case, with BMI accounting for between 58-86% of the variance in judgements (Swami, Knight, Tovée, Davies, & Furnham, 2007; Swami, Miller, Furnham, Penke, & Tovée, 2008; Swami, Neto, Tovée, & Furnham, 2007; Swami, & Tovée, 2005; Swami, & Tovée, 2007; Tovée, & Cornelissen, 1999, 2001; Tovée, Swami, Furnham, &

Mangalparsad, 2006). This is supported by Fan et al. (2004) and who investigated the perception of attractiveness using 3D images instead of 2D bodies such as line drawings. Fan et al. (2004) produced 3D wire-frame representations of Caucasian female bodies, obtained through the use of 3D scanners. Hong Kong Chinese participants were then shown short video clips of these images rotating through 360˚, which they used to make their ratings of attractiveness. From this study it was concluded that VHI explains 90% of the variance in attractiveness judgements, while BMI explains 80%. As there is a strong linear relationship between VHI and BMI, Fan et al. (2004) therefore suggest that BMI is the dominant predictor of female attractiveness.

However, to be a reliable cue to attractiveness, body measures such as BMI and WHR need to be view-invariant (i.e. the apparent attractiveness of a body does not vary greatly depending on the viewing angle and therefore this should be true of the putative cues to attractiveness). Tovée and Cornelissen (2001) tested this hypothesis using digital photographs of 50 women in front-view and profile, and found that BMI was the primary predictor of attractiveness in both viewing angles and that visual cues to BMI showed a significantly higher degree of view-invariance than WHR. This suggests that mirroring attractiveness judgements, the judgement of BMI is largely view-invariant and provides a plausible basis for attractiveness judgements.

Similar to previous studies (2007; Fan et al., 2004), Smith et al. (2007) used 3D bodies to investigate attractiveness judgements. However, "wire frame" bodies were replaced with real women's bodies. These bodies were rotated through 360˚ which enabled people to take cues from overall body fat as well as colour, texture, curvature and shading. Results showed support for previous studies such as Cornelissen, Tovée, and Bateson (2009) in that percentage of body fat or BMI was found to best explain judgements of attractiveness even when visual information about the size of waist and hips was available.

Cornelissen, Tovée, et al. (2009) also suggest that BMI and WHR will naturally co-vary in a female population, but their relative contributions can be separated out using statistical modelling. They proposed an additive model which predicts a positive relationship between BMI and WHR (as bodies become narrower (low BMI), the difference between the size of the waist and hips becomes larger relative to the total width of the body, therefore making bodies appear more curvaceous (low WHR)). In this study, Cornelissen and colleagues separated out WHR into two independent

components: WHR explained by body shape change due to changing body fat levels (BMI), and WHR explained by of the level of oestrogen in the body. Results showed that WHR linked to body fat (BMI) explained a significant proportion of the variance in attractiveness judgements, whereas the other component (WHR due to oestrogen) did not. This suggests that overall body mass (indexed by BMI) is a better predictor of attractiveness than oestrogen-mediated lower torso shape (indexed by WHR).

Furnham et al. (2005), again using the method of rating line drawings of bodies, also found in support of Tovée and Cornelissen (2001) and other studies mentioned previously, that while BMI and WHR both have an effect on attractiveness judgements, BMI accounted for more of the variance. This was further supported by Tovée et al. (1998) who, in a study using unmodified real bodies, found that BMI accounted for 74% of the variance in attractiveness judgements, compared to just 2% by WHR. This is a phenomenon that has been widely replicated (Swami, Antonakopoulos, Tovée, & Furnham, 2006; Swami, Caprario, Tovée, & Furnham, 2006; Swami, Knight, et al., 2007; Swami et al., 2008; Tovée, & Cornelissen, 2001; Tovée et al., 2006), with BMI explaining between 58-86% of the variance while WHR trails behind explaining between 0-30% in attractiveness judgements when using 2D stimuli. Similarly, Fan et al. (2004) found that BMI explained 73% while WHR explained just 1% of the variance in attractiveness judgements when using 3D bodies.

Challenges to the importance of BMI as a cue to attractiveness were raised however when it was suggested that the range of BMIs used in these ratings studies was significantly larger than the range of WHRs used. This concern was addressed by Tovée et al. (2002) who instead used a set of bodies with a significantly smaller range of BMIs (18-26 kg/m^2) and an unlimited range of WHRs. They selected images in which BMI and WHR were inversely correlated (high BMI and low WHR or low BMI with high WHR). Results from this study provided further support for BMI over WHR as a predictor of attractiveness. Images with a low BMI and high WHR were rated as most attractive; therefore if given the choice it would appear that observers would rather an "attractive BMI" than an "attractive WHR".

Further support is provided by eye movement studies. Cornelissen, Hancock, Kiviniemi, George, and Tovée (2009) found that when making attractiveness judgements, eye movements are focused around the central and upper torso (the same area used to judge body fat, but not the same area used to make judgements about WHR).

However, this area of research is widely debated; with many people believing that waist-to-hip ratio (WHR) is the better predictor of attractiveness.

1.6. WHR as a cue to Attractiveness

In relation to shape, past research has focused on the ratio between hip circumference and waist circumference (the WHR) which is a measure of lower body fat distribution or curvaceous-ness (Singh, 1993a, 1993b; Weeden, & Sabini, 2005). A low WHR is indicated by a curvaceous body shape: small waist and larger hips, which has been suggested to be the optimal fat distribution for fertility in artificial insemination procedures in western countries (Waldenstrom, Wass, Rossner, & Hellberg, 1997; Wass, Waldenstrom, Rossner, & Hellberg, 1997; Zaadstra et al., 1993). If WHR is a good predictor of female fertility, then an evolutionary psychology explanation of attractiveness would predict that it should also be a strong visual cue attractiveness judgements.

Figure 1.3. The set of line drawings produced by Singh (1993b). Across the page the WHR is intended to increase and moving down the page the body weight is intended to increase. Thus, Singh tried to separately vary body mass and WHR separately in his set of figures.

A study by Singh (1993b) asked subjects to rate line drawings of women for attractiveness, and found an optimal attractiveness rating for a WHR of 0.7 across three different weight ranges, concluding that WHR was the most important cue to female physical attractiveness. This is also supported by findings from Singh (1994) who, using the same line drawings, also found the inverse relationship between WHR and female attractiveness ratings. However, Singh (1994) also concluded that Body weight was negatively correlated with attractiveness, showing that irrespective of WHR, a woman should not deviate much from a "normal" weight in order to be judged attractive. In a replication of the Singh studies, Henss (1995) found an optimum WHR of 0.8, with attractiveness being significantly affected by the female bodies' fat distribution. However, he concluded that this could be due to their methodology of rating rather than ranking images. A further attempt at replication came from Furnham, Tan, and McManus (1997) who, again using line drawings, asked participants to rate male and females on bipolar scales of unattractive-attractive and various other variables. Similar to Henss (1995) they concluded a WHR of 0.8 as most desirable.

Furthermore, when looking at the bodily measurements of Playboy Centrefolds and Miss America Pageant Contestants (Garner, & Garfinkel, 1980; Mazur, 1986) Singh (1993a) found that between 1955-1965 and 1976-1990 the WHR for Playboy models increased from .68 to .71, whereas the Miss America winners' WHR decreased from .72 to .69; therefore the WHR for both samples fell within the range of .68-.72. It would therefore seem that in western societies, a narrow waist and full hips has been a consistent feature for female attractiveness over the years, whereas other bodily features such as bust, weight and physique, have accounted for varying degrees of importance in attractiveness judgements. From the evidence, Singh (1993a) then concluded that a narrow waist was the most important, most stable, and most enduring feature associated with attractiveness.

However, a study by Tovée, Mason, Emery, McCluskey, and Cohen-Tovée (1997) found evidence of a lack of reliability for WHR as a cue to health and fertility. They found a considerable overlap in WHR between "normal" subjects and those with Anorexia Nervosa (who are very underweight and do not have menstrual cycles). Although a WHR of 0.7 may indicate the most fertile distribution of fat for women in artificial insemination studies, with those under and over-weight having lower fecundity Zaadstra et al. (1993) a particular WHR in one individual might signal good health and

fertility, while in another signalling the opposite. Therefore it would seem that to judge attractiveness on this cue would be counterintuitive.

The idea of a universal WHR of 0.7 being the most attractive is also called into dispute by Freese and Meland (2002) who, in response to Singh (1993a)'s investigation into bodily features of Miss America Pageant winners and Playmate Centrefolds, found no such existence of a common WHR. Instead they found much more variance from this "optimum" than previously suggested and a significant variation in WHR over time, with only 9 of the 59 Miss America Pageant winners (15%) and 31.4% of Centrefold models studied being found to have WHRs that fell between the 0.68-0.72 range suggested by Singh (1993a). In addition, the WHRs of the Centrefold sample ranged from 0.529 to 0.788 supporting a much wider variance in WHR over time than that initially proposed by Singh.

In terms of an ideal WHR in Developed Western countries, evidence is slightly confused. Singh and Young (1995) found that a lower WHR (approx. 0.7) was judged as more attractive than a higher WHR (approx. 0.85), an effect also found by Singh (1993a; 1994), whereas Puhl and Boland (2001) found the opposite effect, with both male and female subjects rating a higher than average WHR as most attractive.

A key prediction of Singh's' argument which proposes a "hard-wired" preference for a curvy body as a predictor of fertility is that it should be a universal preference and be found across cultures and environments. However, Yu and Shepard (1998) challenge Singh (1993a; 1994)'s view of a curvaceous body of WHR 0.7 being the most attractive in their study of Peruvian Indians. Using Singh's line drawings of female bodies, their results showed a more tubular body shape was preferred to a curvy one. Furthermore, in a study of Ecuadorian Amazonian males (Shiwiar forager-horticulturists), Sugiyama (2004) found that male observers also found that a higher WHR of 0.8 was preferred. However, these results may be contaminated by the covariance of multiple body features within the WHR images. The WHR of Singh's images are altered by altering the torso width (including the waist).

When torso width is altered, BMI is undoubtedly also altered unintentionally. Tovée et al. (1999) calculated PAR (perimeter-area ratio) by measuring the pathway around the bodies and dividing it by the area within the perimeter of the bodies. The PAR value calculated from women in digital photographs is correlated with their actual BMI at better than 97%. Thus PAR forms a good proxy for BMI and can be used to analyse the BMI of figures whose BMI is unknown. Applying the PAR measurements

to the Singh line-drawings, it was possible to show that WHR and PAR are correlated (i.e. as the bodies became less curvy they also became heavier). Several studies have suggested that peoples preferences for an ideal BMI varies in different environments (Swami, & Tovée, 2005; Tovée et al., 2006), and the apparent preference for a higher WHR found by Yu and Shepard (1998) and Sugiyama (2004) may reflect a preference for a higher ideal BMI rather than a higher WHR (i.e. as the two features are covarying, the preference for a low WHR may be overwhelmed by a stronger preference for a higher BMI). For a more detailed discussion of the effectiveness of WHR as a cue to attractiveness, please refer to chapter 3.

1.7. BWR as a cue to Attractiveness

A low BWR is comprised of a narrow waist and large breasts, features which are consistently linked to increased health and reproductive potential (Jasienska, Ziomkiewicz, Ellison, Lipson, & Thune, 2004). Singh (1993b) and Singh and Young (1995) suggest that males prefer the typical hourglass figure- larger, fuller breasts, larger hips and a smaller waist between the two. However, Dixson, Grimshaw, Linklater, and Dixson (2011), in an eye movement study, found that while men looked for longer at both the waist and breasts, a narrow waist was rated as most attractive regardless of breast size, suggesting that breast size is not as important as WHR as a cue to attractiveness.

In direct contrast to this result, Furnham, Swami, and Shah (2006) found that larger breasts caused an increase in attractiveness ratings of heavier bodies, regardless of WHR. This shows that as with WHR research, there is much controversy over whether this preference for an hourglass figure and larger breasts is actually evident and whether it is also present across all environments and cultures or whether it is merely a western ideal (Dixson, Vasey, et al., 2011; Manning, Trivers, Singh, & Thornhill, 1999; Swami, & Tovée, 2013; Yu, & Shepard, 1998).

1.8. Stability of Attractiveness Cues

We have so far discussed how to measure body size and shape and how these measures can be linked to cues about fitness or attractiveness. However, there is some debate about whether these attractiveness cues are stable across things such as different cultures, and whether they can be affected or changed by external influences such as media or stress. Therefore, what is it that affects people's preference for size and shape

and alters their perceptions of what is attractive? A few possible explanations such as media influences, stress, culture and resource scarcity will now be discussed.

1.8.1. Media Influences

Current research into the influence media can have on a person's body image and self-esteem shows that this effect is a strong one. In particular, music videos shown on television have been found to focus on bodily appearance. A positive relationship has been found between the time spent watching music videos and the importance placed on attractiveness, weight concerns (Borzekowski, Robinson, & Killen, 2000) and a drive for thinness (Tiggemann, & Pickering, 1996) in adolescent females. It has been suggested that the size of the bodies you see every day (including in the media) sets your internal ideal of what is a normal and attractiveness body size and shape (Winkler, & Rhodes, 2005). This idea has been refined by Boothroyd, Tovée, and Pollet (2012) who suggested it is less the size of the bodies you see, but the context in which they are viewed. Thin bodies are depicted as high status and healthy in the media, with the opposite being the case for heavy bodies. This "visual valency" drives a preference for a very low BMI in western cultures as these low BMI bodies are widely promoted in magazines, TV and film.

Support for this role of the media in setting body ideals comes from a study by Mischner, van Schie, Wigboldus, van Baaren, and Engels (2013) who found that exposure to music videos that promote a thin ideal had an effect on adolescent females' perceived and ideal body size. Furthermore, there was a more pronounced effect in those already suffering from low self-esteem with a shift in their perception of size (resulting in an overestimation). This therefore suggests that low self-esteem may be a risk factor for developing body image disturbance following media exposure to particular ideals of beauty and attractiveness. This is further supported by Bell, Lawton, and Dittmar (2007) and Tiggemann and Slater (2004) who also found a link between increased body dissatisfaction and exposure to music videos emphasising the importance of body appearance.

A meta-analysis conducted by Grabe, Ward, and Hyde (2008) investigating the effects of exposure to the "thin ideal" portrayed through the media, found a positive relationship between this and body dissatisfaction (Rivadeneyra, Ward, & Gordon, 2007), internalisation of the thin/beautiful ideal (integrating the standards of beauty that society sets out for us, into our own opinions and beliefs about ourselves), eating

disorders, and beliefs associated with maladaptive eating/dieting. This is supported by Posavac, Posavac, and Posavac (1998) and Stice and Shaw (1994) who also found a decrease in positive self-evaluation in young women following exposure to particular thin female ideals portrayed by the media.

In a study of 294 college-aged males and females, Fernandez and Pritchard (2012) found a strong relationship between media influence and a drive for thinness, with exposure to media models being the primary predictor for a drive for thinness in both male and female participants. This is supported by Tucci and Peters (2008) and Ahern, Bennett, and Hetherington (2008) who found that when given magazines or shown websites that feature thin women, female participants tended to have increased negative feelings about their own bodies, including a drive for thinness. This is further reinforced by Gurari, Hetts, and Strube (2006) who exposed participants to idealised images and found a resulting change in behaviour as well as attitudes: participants consuming less junk food and spending more time reading health related magazines than control subjects.

Thomsen (2002), in a study of 340 college-aged women, found that reading health and fitness magazines was directly linked to body shape concern, while reading beauty and fashion magazines was indirectly linked to body shape concerns via men's expectations of thinness- portrayed in said magazines (Park, 2005; Thomsen, McCoy, Gustafson, & Williams, 2002). Body shape concerns are a key diagnostic feature of Anorexia and Bulimia Nervosa (DSM-5, APA, 2013), therefore this would lead us to think that reading these magazines may cause us to develop concerns about our bodies, which in turn may make us more vulnerable to developing an eating disorder. This idea is suggested by Wright and Pritchard (2009) who stated that media images may be an important predictor of eating disordered behaviour in both adolescent men and women. Support for this idea comes from Becker, Burwell, Gilman, Herzog, and Hamburg (2002) who found an association between television exposure and eating disordered behaviours in a group of adolescent Fijian women. Dieting is not thought to be an indigenous practice in Fiji, however studies have shown that it is becoming a more prevalent practice among teenage girls following the introduction of Westernized television programming such as advertisements for cosmetics and exercise equipment (Becker, Burwell, Navara, & Gilman, 2003).

Engeln-Maddox (2005) goes on to develop this further, suggesting that those who already have low self-esteem and issues surrounding body image will be more susceptible to media ideals as they will internalise these ideals.

However, Singh and Singh (2011) suggest the media's ability to affect beauty ideals is limited to aspects of the body that do not convey information about health and hormone levels. They suggest that when given the choice, both men and women will prefer a "normal" weight body to the "skinny" one portrayed by the media. Instead, they state the reason some women seek to imitate the "skinny" models is that the media does not provide them with the knowledge about the health of these models. People often compare themselves based on beauty, but no one aims to have a competition about who is the healthiest. Singh and Singh (2011) therefore conclude that the media would have less influence in reinforcing the thin ideal if people were made aware of the negative health connotations associated with the thinness of the models used.

This would therefore give support to the idea of BMI and WHR preferences not being stable or constant, as preferences can easily be shifted or altered by external factors such as the media and the thin ideals it portrays. Another factor which has been found to alter people's preferences for body size and attractiveness is stress of a particular environment.

1.8.2. Stress & the Environment

The Environmental Security Hypothesis suggests that when socioeconomic conditions are poor, individuals will prefer members of the opposite sex with more mature physical characteristics (such as a heavier body size), compared to when socioeconomic conditions are good (Pettijohn, & Tesser, 1999; Swami, & Tovée, 2012).

In a study by Pettijohn and Tesser (2005) made male and female participants believe they were to be given either a harmful or un-harmful electric shock. Results showed that in the harmful shock condition, where participants were obviously experiencing more stress, a marked preference for women with smaller eye size was found, compared to those experiencing less stress that preferred women with larger eyes, suggesting that attractiveness preferences change when conditions become more stressful.

Following on from the effects of physical pressure, Swami and Tovée (2012) investigated the impact of psychological stress on men's preferences for female body size. Their results showed that when experiencing stress, preferences shifted towards a

heavier female body size (rating overweight- and at times- even obese body sizes as most attractive). Therefore this would suggest that individuals are more likely to prefer physical characteristics signalling maturity (including a heavier body) when experiencing environmental threat which causes stress.

This is an effect similarly found with the female attractiveness preferences of South African Zulus living in rural areas (Tovée et al., 2006) who also showed a preference for a heavier body, which could be linked to their living in a stressful environment. This shows that preferences for attractiveness are not as stable as Singh, Dixson, Jessop, Morgan, and Dixson (2010) suggested as these studies clearly show that preferences for certain BMIs and WHRs are affected by external factors such as environmental stress.

This also leads us onto another factor which can shift these preferences. In certain countries, a particular environment that can be stressful (such as the South African Zulus experience) because of limited access to resources, which may lead to hunger and malnutrition.

1.8.3. Cross-cultural Differences in Preferences for BMI & WHR

While one interpretation from evolutionary psychology suggests that attractiveness judgements reflect preferences innate in humans therefore should be the same across all cultures (Singh, 1993a), a large amount of studies suggest that attractiveness judgements based on body size and shape are changeable both between and even within different cultures (Swami, & Tovée, 2005). Ford and Beach (1951) sum this up in their statement: "cross-cultural evidence makes it clear that there are few, if any, universal standards of sexual attractiveness."

In their study into the perceptual differences between Kenyan and British women (matched on socio-economic background), Furnham and Alibhai (1983) found that Kenyan Asians tended to show negativity towards thinness and instead regarded an obese body as more favourable. However, in this study a sample of British Kenyans (Kenyans living in Britain for more than 7 years) were found to view bodies in a similar way to the British subjects, instead preferring the thin ideal rather than viewing obesity in a positive light like their Asian Kenyan counterparts. This shows a shift in preference towards the western ideal of thinness as attractive, and suggests that either there is a socio-cultural effect on body size preferences, or this shift is adaptive as emigrating

from a relatively poor country to a more affluent one may lead to a discrepancy in the most adaptive BMI between the two countries.

While past research has found cross-cultural differences in body size and shape preferences, Singh and Luis (1995) found no such difference, with Indonesian, Afro-American and Caucasian men and women all rating a low waist-to-hip ratio as being much more attractive and healthy. Singh et al. (2010) also found that a similar preference for low WHR is evident in both western and non-westernized cultures. However, this confusion may just be in relation to WHR research, as Singh's figures only had 3 levels of fatness and 5 levels of WHR, therefore were not a very sensitive measure. In contrast, Swami, Henderson, Custance, and Tovée (2011), using a much wider range of bodies (50) which allowed a continuous variation in BMI and WHR, found that Indonesian men consistently rated a heavier female figure (high BMI) as more attractive when compared to a British sample.

Wetsman and Marlowe (1999) have also investigated WHR cross-culturally, testing the hunter-gatherer "Hadza" tribe of Tanzania by showing them images of bodies varying in both body weight and shape. Results showed that a low WHR was not preferred (a result found in studies using western populations). Instead, this study shows support for the importance of BMI over WHR, as male observers appeared to make judgements of attractiveness based on size rather than shape. Again, this seems to throw into question the cross-cultural preferences for WHR suggested by Singh et al. (2010) and Singh and Luis (1995), instead supporting the findings of Swami et al. (2011) of a cross-cultural effect of BMI.

A follow-up study by Marlowe and Wetsman (2001) compared the Hadza tribe to a US sample. US men were predictably found to dislike a higher (0.9) and lower (0.4) WHR, instead preferring the WHR of 0.7. In the previous 1997 experiment discussed in Wetsman and Marlowe (1999), the Hadza tribe were indifferent to WHR. However, in this experiment (with the removal of a varied BMI) in direct contrast to the US sample, Hadza men preferred a higher WHR, with 0.8, 0.9 and 1.0 being rated as more attractive than the western ideal of 0.7. However, Wetsman and Marlowe put this new finding of a preference for a high WHR down to Tovée and Cornelissen (2001)'s idea of BMI being hard to separate from WHR, therefore they still conclude that BMI is a more important cross-cultural factor in determining attractiveness judgements.

Tovée et al. (2006) have also found that preferences appear to change between cultures. Testing UK Caucasian, South African Britons and South African Zulu

observers, they found huge differences in the perception of female attractiveness between the Zulus and UK Caucasian populations. UK Caucasians showed a preference for a "middle" BMI, disliking the higher and lower BMIs, which is consistent with previous research already mentioned. However, in direct contrast, South African Zulus showed a preference for the higher BMIs, and where attractiveness ratings in the UK population dip towards the higher end of the BMI scale, preferences in the Zulu sample did not. No difference was found between the UK Caucasian sample and the UK African sample, instead they seemed to have adopted the preferences associated with the westernized culture. In terms of WHR, both UK groups show a preference for a curvier body, whereas no such pattern was found in the South African Zulu sample (however this may be due to the fact that they have a preference for a heavier body, and heavier bodies tend to be less curvaceous).

1.8.4. Resource Scarcity & Hunger

As cues to attractiveness should also predict genotypic and phenotypic quality, they should also be adaptive. Therefore judgements of size and shape will be affected by environmental pressures, for example, people in cultures in which resources such as food are scarce might prefer a larger body size as this would indicate greater access to food and they have an energy store in the form of fat, whereas a smaller body size would indicate limited access to food and no fat reserve (Brown, & Konner, 1987; Furnham, Moutafi, & Baguma, 2002). In these cultures, judgements of attractiveness will therefore also be affected, with larger bodies being rated as more attractive than the same body size in a western population.

This positive relationship between resource scarcity and fatness being valued was reported by Anderson, Crawford, Nadeau, and Lindberg (1992), and was later reinforced by Ember, Ember, Korotayev, and de Munck (2005), suggesting that as resources become scarce, body weight preferences shift to favour a larger body size as this indicates someone who has access to resources and status. In such cultures, females with a larger body weight are often preferred as this represents success and economic comfort (Swami, Tovée, & Furnham, 2009).

Another factor thought to influence perceptions of attractiveness, is Socio Economic Status (SES). As previously mentioned, in non-westernized cultures, fatness may be an indicator of access to resources and wealth. In less affluent populations therefore, there is often an association between high SES and body weight. Only high

status individuals would be able to put on weight. This might explain why some cultures in the developing world seem to view fatness as ideal (Swami, Frederick, et al., 2009), as opposed to the thin ideal found in western culture. Thinness is valued in the western world as here we have an abundance of cheap high calorie processed foods, and more limited supplies of foods of a higher nutritional which are significantly more expensive, therefore low SES individuals would be fatter, reflecting their high fat and sugar diet. Thus a heavier BMI has become associated with poverty, poor health and poor diet .

As stated previously, in Tovée et al. (2006), a study in which attractiveness ratings of real women (varying in BMI and WHR) were compared between South African and British samples, huge differences were found between the two populations. Compared to the British sample, the rural South African's were living in an economically deprived society (low SES), with low access to resources (many households not even having running water or electricity). Therefore the finding that they prefer a heavier body is not surprising, as a heavier body indicates access to resources and wealth (something which they themselves lack), which also indicates higher SES. Therefore Tovée et al. (2006) concluded that low SES causes a shift in preference towards a larger body size in non-westernized populations. Findings from Swami and Tovée (2007) also confirmed this, with high SES individuals in Kuala Lumpur (Malaysia) and London consistently rating a more slender image as more attractive, while those of low SES in rural Sabah (Malaysian Borneo) rating a heavier body as more attractive.

However, until recently, the link between resource availability and its effect on preferences for female body weight has been missing. Nelson and Morrison (2005) suggested this missing link was a psychological mechanisms affected by environmental pressures and conditions. As a consequence of collective resource scarcity (within an entire population), individual members of a resource scarce society will lack resources themselves, and the psychological states resulting from this will play a vital role in the formation of judgements such as those of body size. Nelson and Morrison (2005), inducing a temporary affective state of hunger and financial dissatisfaction in participants, found that financially dissatisfied and hungry men preferred a heavier female body than financially satisfied and sated men.

Building on this finding, Swami and Tovée (2006) conducted a similar study but instead used photographs of real women's bodies in order to improve the link between these judgements and "real-life decisions". In affluent societies, the level of financial

manipulation available to experimenters is limited, so this study focussed on food and found that hungry men prefer heavier women when compared to satiated men. They also concluded that hungry men are less reliant on shape as a cue to attractiveness and regard a less curvy shape as attractive (but this may be a secondary effect of a preference for heavier bodies). This shows that a temporary affective state can produce individual variation in mate preferences. While this finding is common in many cross-cultural studies that relate judgements of weight to socio-economic status, with the less affluent preferring heavier less curvaceous women (Swami, Knight, et al., 2007), in the Swami & Tovee study the men are temporarily experiencing a form of resource scarcity (hunger) and are also showing this preference.

1.9. Aims

The literature reviewed above suggest that a concept of an ideal BMI or WHR is a not a very stable fixed ideal, but is quite flexible and will be influenced by environmental conditions. This thesis will test three main hypotheses:

1. *Can these ideal values of size and shape be directly manipulated in a specific direction? And would this shift be based on psychological or physiological factors.*

2. *Are these measures (BMI & WHR) actually capturing an observer's perception of size and shape?*

3. *How accurate are our judgements of these measures? And can these judgements be influenced by our own size and cognitive state?*

Chapter 2. The Effects of Hunger on Body Size perception: Psychological or Physiological?

2.1. Introduction

Modern Western cultures idealise relatively thin bodies and as a result body dissatisfaction and eating disorders are reaching near epidemic levels within these cultures. These ideals are often attributed to media influences; specifically the promotion of a small and often unachievable/unhealthy body ideal, accompanied by the suggestion that these bodies are superior or more attractive (Derenne, & Beresin, 2006). The context in which a body is seen has been shown to influence body size preferences of young women and a media biased towards a particular body size could significantly impact on populations' size preferences (Boothroyd et al., 2012).

As previously discussed, evolutionary psychologists studying attractiveness suggest that preferences for certain body shapes and sizes are not arbitrary (Buss, 2006): instead certain features honestly signal information about an individual, and therefore being sensitive to these cues would be adaptive (Buss, 1994; Swami, & Tovée, 2007). As mentioned previously, BMI over WHR has been suggested as the primary predictor of female physical attractiveness across cultures (Swami, Knight, et al., 2007) and has been reliably correlated with women's health (Manson et al., 1995; Willett et al., 1995) and reproductive potential and is thus consistent as a cue of female quality (Frisch, 1987; Lake et al., 1997; Reid, & van Vugt, 1987; Wang, Davies, & Norman, 2000). Although the majority of research into physical attractiveness has focussed on the female body, it is also possible to apply this theory to males, assuming that male BMI is a reliable predictor of male health and reproductive potential (Swami et al., 2008). If as one interpretation of evolutionary psychology theory predicts, these preferences have been selected for, and are therefore innate, a logical hypothesis would follow that they are universal across cultures (Singh, 2002; Singh, & Young, 1995).

Although some research has supported this (Furnham, McClelland, & Omer, 2003; Furnham, Moutafi, et al., 2002; Furnham et al., 1997; Henss, 2000; Markey, Tinsley, Ericksen, Ozer, & Markey, 2002; Singh, 2002; Singh, & Luis, 1995; Singh, & Young, 1995; Streeter, & McBurney, 2003), these studies have tended to use observers solely from industrialised environments. In contrast, where research has focussed on

comparing observers from both rural and non-rural societies a different pattern emerges with marked differences between cultures (Craig, Swinburn, MatengaSmith, Matangi, & Vaughan, 1996; Furnham, & Alibhai, 1983; Furnham, & Baguma, 1994; Furnham, Moutafi, et al., 2002; Marlowe, & Wetsman, 2001; Wetsman, & Marlowe, 1999; Wilkinson, Ben-Tovim, & Walker, 1994; Yu, & Shepard, 1998, 1999). This highlights the fact that there is large variation in cross-cultural attitudes towards body shape and size (Brown, & Konner, 1987; Cassidy, 1991; Sobal, & Stunkard, 1989; Swami, & Furnham, 2008). These studies tend to show that in less developed countries a larger body ideal emerges, whilst in economically developed countries, mainly in the West, a much smaller body is preferred (Swami, & Furnham, 2008).

Ethnographers have long acknowledged this difference in body size preferences between cultures and one influence often cited as causing this effect is the media. However, body size preferences not only seem to vary between cultures but also within cultures based on socio economic status (SES) (Swami, & Furnham, 2008). A series of studies have examined the link between SES and body size preferences, showing that in general, as SES increases a smaller body is preferred (Swami, & Furnham, 2008). One such study by Swami and Tovée (2005) showed that low SES participants in both Britain and Malaysia preferred a heavier female body to their high SES counterparts. Furthermore Lee and Lee (2000) examined eating disorders among female students in three Chinese communities, with varied SES, demonstrating that body size preferences lay on a gradient, such that as SES decreased a preference for a heavier female body emerged. Along with other studies this gives support to the theory that body size preferences are linked not to race or ethnicity but instead to SES.

Counterintuitively this does not contradict evolutionary theory and instead may reflect the fact that our preferences are highly malleable; in changing conditions individuals are able to calibrate their preferences according to the environment; an idea consistent with an evolutionary perspective (Marlowe, Apicella, & Reed, 2005; Sugiyama, 2004; Swami, & Tovée, 2007). If this is the case then our preferences should shift as we change environments, as differing BMIs will have differing health values depending on ecological conditions (Kopelman, 2000; Swami, & Furnham, 2008). Tovée et al. (1999) explored this idea by asking 4 different groups of observers, South African Zulus of low SES, Zulu migrants to Britain, Britons of Asian descent and British Caucasians, to rate images of real female bodies with varying BMI. Results indicated a large difference between the South African Zulus and both the British

groups (who did not differ), with the former preferring women with a significantly higher BMI. The final group of Zulu migrants exhibited an intermediate preference that lay between the other two groups, supporting the hypothesis that our preferences for body size are adaptive and can change according to ecological conditions.

Observers in rural South Africa are living in an environment that is economically deprived and lacks resources, with much of the population reporting going hungry (Swami, & Furnham, 2008). A higher body weight may therefore be found more attractive as it is seen as representing health, high status, affluence and access to resources (Clark, Niccolai, Kissinger, Peterson, & Bouvier, 1999; Mvo, Dick, & Steyn, 1999), whereas a thin body may reflect a lack of resources, in particular food (Brown, 1991; Treloar et al., 1999). Furthermore, certain diseases associated with significant weight loss are prevalent in South Africa, such as AIDS, HIV and Tuberculosis, meaning smaller bodies may be interpreted as parasitic (Clark et al., 1999; Mvo et al., 1999; Swami, & Furnham, 2008).

In contrast, in Britain, a high body weight carries various health risk factors like obesity, which is likely reflected in the preferences for a smaller body in observers living in this environment (Calle, Rodriguez, Walker-Thurmond, & Thun, 2003; Swami, & Furnham, 2008; Tovée et al., 2006). Tovée et al. (2006) provided support for this idea: rural South Africans rated women who were obese and overweight as being just as healthy as normal women, whereas British observers rated these bodies as unhealthy and unattractive. Therefore this would imply that what is considered healthy appears to be what is considered attractive, supporting the idea that preferences may have some adaptive evolutionary basis.

Considering the varying preferences of individuals in differing ecological conditions it appears that when confronted with insecurities, attractiveness judgements are based on a strategy that will, theoretically, enable an individual to overcome these insecurities (Swami, & Furnham, 2008). In order to explain the fact that our preferences change according to ecological conditions Pettijohn and Tesser (1999) proposed The Environmental Security Hypothesis (ESH); stating that when the environment changes so too will an individual's view of what is attractive, in order to reflect the most adaptive mate choice at any given time. For example when resources are scarce it would be adaptive to choose a mate who has an abundance of resources. The ESH further postulates that in times of insecurity individuals will show a preference for more mature themes that may aid them in overcoming insecurities (Nelson, Pettijohn, & Galak,

2007). It is therefore logical to hypothesise that hungry individuals will prefer a heavier female as hunger is a good indicator of physiological threat and signals resource availability Swami and Tovée (2006). Furthermore as people age their body weight usually increases and this would therefore fit the theme of a more mature mate preference (Swami, & Furnham, 2008).

Combining these ideas with the finding that the preference for a heavier female body in cultures lacking in resources seems to be ubiquitous, Nelson and Morrison (2005) manipulated male's perception of resources, both financial and calorific, and considered their body size preferences. The results from a series of studies demonstrated that males who were hungry or perceived financial insecurity preferred a heavier female body compared to their satiated and financially satisfied counterparts. Furthermore it has been shown that males experiencing psychological stress prefer a larger female body supporting the idea that temporary affective states can effect judgements of attractiveness (Swami, & Tovée, 2012). However Swami, Tovée, et al. (2009) failed to replicate the findings concerning financial security, using different stimuli which depicted real women. They found no difference between financially satisfied and dissatisfied male's body size preferences.

In contrast Nelson and Morrison (2005) findings concerning food scarcity have been replicated: Swami and Tovée (2006) demonstrated that hungry male participants preferred heavier female bodies and rated these as more attractive in comparison to their sated counterparts. This affect is specific to judgements of body size; research indicates that hungry individuals do not find heavier objects in general more aesthetically pleasing (Swami, Poulogianni, & Furnham, 2006). It is therefore suggested that hunger is a more useful proxy of resource scarcity and this idea is supported throughout the literature.

Firstly it is widely acknowledged that physiology has an effect on many judgements in differing areas (Friedman, & Forster, 2000; Stepper, & Strack, 1993), and is therefore likely to influence judgements of physical attractiveness (Swami, & Tovée, 2006). Furthermore, all cultures do not view financial dissatisfaction in the same way as Western societies, as this has not always been an indicator of resource scarcity. Instead, throughout human history the best gauge of resource scarcity has been connected not to money, but to food and this may explain why hunger affects judgements of physical attractiveness whilst financial insecurity does not (Swami, & Furnham, 2008; Swami, & Tovée, 2006).

37

This idea is suggested in the food security hypothesis which assumes that the function of fat is to store calories, since the primary function of the adipose tissues is to store calories. For this reason fat is a good indicator of food availability and in environments lacking in resources, individuals would prefer to be relatively fat, and these individuals would be preferred mates as they would have better health (Anderson et al., 1992; Swami, & Furnham, 2008). For this reason hunger is a reliable cue of resource scarcity, and thus would make a good mechanism by which body size preferences are moulded. This theory predicts that differences will be found across cultures and within cultures with varying SES and this has indeed been found to be the case (Anderson et al., 1992; Craig et al., 1996; Furnham, & Alibhai, 1983; Furnham, & Baguma, 1994; Furnham, Moutafi, et al., 2002; Lee, & Lee, 2000; Marlowe, & Wetsman, 2001; Swami, & Tovée, 2005; Swami, & Tovée, 2007; Wetsman, & Marlowe, 1999; Wilkinson et al., 1994; Yu, & Shepard, 1999).

In order to explain the relationship between resource availability and preferences for female body size it has been suggested that this pattern is a result of an individual's direct evaluation of collective resources (Swami, & Tovée, 2006). However since individual evaluations of resources are not particularly reliable, and often represent an individual's political view as opposed to the actual state of the economy it is unlikely that this is the case (Mutz, 1998; Nelson, & Morrison, 2005; Swami, Caprario, et al., 2006). It is also improbable that people consciously perceive resource scarcity and reason that because of this a heavier body is preferable; and, even when people consciously report their preferences, they are not formed on a conscious level (Wiederman, & Dubois, 1998). Thus until recently this phenomenon has lacked an obvious psychological mechanism (Nelson, & Morrison, 2005).

Therefore Nelson and Morrison (2005) suggested an implicit psychological mechanism, which relies on the individual perception of resource scarcity; positing that in cultures where resources are scarce, individuals are likely to lack resources themselves. Consequently the affective and physiological states associated with this lack of resources provide information, which influences an individual's judgments and therefore their body size preferences. This socio-cognitive explanation has solid grounding throughout the literature. Research has shown that physiological states can have a direct effect on judgments in a variety of areas; that affective states often serve to give us information about the environment, and feelings are widely acknowledged as

influencing behaviour (Cacioppo, Bernston, & Crites, 1996; Nelson, & Morrison, 2005; Schwartz, 1990).

Therefore it seems that the individual experience of resource scarcity may be an implicit cue, which is associated with the formation of body size preferences. Considering the literature, hunger seems to be a good indicator of resource scarcity. As a cue for food scarcity this may reflect a biological adaptation, where in nutritionally poor environments bigger bodies are found more attractive as they indicate that an individual has good nutritional status. Hunger however, is a transient cue and people in underdeveloped countries (or of low SES) are often chronically hungry, thus the question remains as to whether hunger is the cue or whether it is perceived food scarcity i.e. will hunger shortly be satisfied?.

The following two studies will consider whether body size preferences are determined by physiological cues (hunger) or psychological cues (the delay in when the participants believe they will be fed). In order to do this the first study will consider whether body size preferences are affected by physical hunger or by perceived food scarcity. To examine this, two variables will be manipulated- (1) the length of time participants have fasted and (2) when they think they will break their fast. If psychological cues are responsible for changes in body size preferences then it is predicted that those who believe that their opportunity to eat will be delayed will find bodies with a higher BMI more attractive than those who believe that they will be fed as soon as they have rated the images, however if physiological cues are responsible, there will be no difference between the preferred BMI of the two groups (as they have both fasted and are both hungry). The second study aims to differentiate between physiological factors and psychological factors affecting body size preferences by manipulating participants' beliefs about their own diet. If a physiological cue is responsible for body size preferences then it is predicted that preferences will differ between those who have a significant calorie intake and those who have not. The two nutritional intakes for both sets of observers are designed to look and taste identical (although differing in calorie content), therefore if body size preferences are determined by psychological factors then there will be no difference between the two groups.

2.2. Study 1: Psychological Effects of Hunger

2.2.1. Participants

Eligibility criteria for this study were male and female participants ranging in age from 18-30 (student population). Both male and female participants were recruited for this study in order to both replicate results of previous research into male hunger and to build on them by investigating this effect in females.

A total of 142 participants completed the experimental condition of this study, of which, 46 were removed from analysis, as although they were asked to fast overnight their self-reported hunger fell below the inclusion criteria (less than 5). The remaining 96 participants were enrolled in undergraduate Psychology at Newcastle University at the time of the study and took part for credit in their degree programme. Participants were split into two groups depending on which condition they were assigned to. The first (group 1) comprised of 46 participants, 7 males and 39 females (Mean age: 18.80; SD: 0.94) and the second (group 2) of 50 participants, 10 males and 40 females, (mean age: 18.96; SD: 0.96). All participants gave informed consent. Individuals who fasted on a regular basis (for religious reasons) or those with health problems such as diabetes were excluded from participation in this study.

60 participants (40 female and 20 male; mean age 23.83 years, SD 11.29, range 18-80 years) were also recruited as a control sample through social networking sites such as Facebook.com and through opportunity sampling. Advertisements to recruit participants for the control sample, including links to the online questionnaires, were sent out using social networking sites such as Facebook.com. In the advertisement potential participants were asked only to participate in the study after eating a meal (therefore ensuring that hunger levels are as low as possible). Therefore, those participants who reported a hunger level of above 5 (hungry) were removed from analysis as it was thought that their data may confound the results of this as a control sample. This reduced our sample size down from 60 to 41 participants. See table 2.1 for information about this group. This study was approved by the Faculty of Medical Sciences ethics committee at Newcastle University (00511/2011).

Table 2.1. The ages and numbers of each sex within the control group.

	Male	Female
Number	15	26
Mean age (years)	24.93	25.15
SD	15.37	12.40
Age range (years)	18-80	19-64

2.2.2. Apparatus/Materials

No complex apparatus or materials were used for the completion of this study. Microsoft Office PowerPoint (2010) was used to create a presentation for the experimental condition containing 100 photographs of male (50) and female (50) bodies (see Maisey et al. (1999) and Tovée et al. (1999) for details of the images used and figure 2.1 for an example). These female images were selected as they have been previously used, with a resulting significant effect, by Swami and Tovée (2006) in an investigation into the effects of hunger in a group of male observers. The male images represented an equivalent group of men, and were taken from an original set of 214 images; the 50 chosen represented a standard deviation of 1.7 either side of the mean distribution of BMI, WCR and WHR. The final set ranged in BMI from 18.94 kg/m2 to 28.07 kg/m2, in WCR from 0.69 to 0.89 and WHR from 0.83 to 0.98 (Swami, & Tovée, 2006). The 50 female images consisted of 10 females from each of the five BMI categories: emaciated (below 15kg/m2), underweight (15-18.5 kg/ m2), normal (18.5-24.9 kg/ m^2), overweight (25.0-29.9kg/m^2) and obese (over 30kg/ m^2). The women in the study ranged in WHR from 0.68 to 0.98, with the ranges of BMI and WHR values representing the widest range available in the researcher's library (Tovée et al., 1999).

Figure 2.1. An example of a female body (left) and a male body (right) taken from Tovée et al. (1999) and used as stimuli in this study.

These bodies were a good representation of the average female body, and this is supported by Marti et al. (1991) who's survey of 2,756 Finnish women found a range of BMI and WHR similar to Tovée et al. (1999)'s images. Heads and faces of the images were blurred to remove any effects of facial attractiveness on ratings.

While it can be said that bodies such as these (wearing leggings and leotards) are not ideal as there is a tendency for the images to appear flat, i.e. we are unable to see patterns of shading and texture on the surface that would allow us to perceive 3D structures such as fat distribution in the torso, previous available sets of bodies such as those used in Smith et al. (2007) do not have a BMI range as wide as these bodies. The decision was therefore made that it would be more beneficial to have a wider range of BMIs over being able to see shading and texture in the torso.

In the experimental condition, each participant was given a booklet containing a sheet of questions about personal demographics, a consent form, and 2 numerical scales for each of the 100 images on which to rate each body shown in the presentation.

2.2.3. Procedure

For the experimental sample, the study was presented in the form of a PowerPoint presentation. This PowerPoint was composed by pasting each digital photograph onto a separate slide. The first 50 slides contained randomised images of female bodies, while the last 50 contained randomised images of males.

An advertisement for the study was sent out the day before it was due to take place. This advertisement informed participants that in order to take part in the experiment they would have to fast from 8pm that night until completion of the experiment the following morning (approx. 10am). Participants were informed that the only substance they were allowed to consume between these hours was water and that they were to avoid "tanking" (drinking excessive amounts of water to make themselves feel full) or eating excessively large meals before the fast began (to make up for not eating later).

The image rating was conducted in a Newcastle University lecture theatre and all those present were given an information sheet, a consent form and a booklet in which to fill in their age, sex, height, weight (the latter two were used to calculate participant BMI) and their current dietary status and daily calorie intake (see appendix A). Participants were also required to sign an honesty declaration to clarify that they had strictly followed the guidelines given for fasting (see appendix B).

Before the experiment began participants were split into two groups. Those in group 1 were told (falsely) that they would have to continue to fast for a further two hours after the experiment had taken place. Those allocated to group 2 and were told that they could eat immediately after finishing the experiment and could help themselves to snacks provided by the experimenter on completion of the study.

Participants were then required to rate their hunger levels on a scale of 0-10 (not hungry-hungry); see figure 2.2 for an example. This is the same way of assessing hunger as in the Swami and Tovée (2006) study.

At the moment, on a scale from 0-10, how hungry are you feeling?
Please make your estimation by placing an "x" on the scale at the number that best represents your hunger level

```
_____
  1     2     3     4     5     6     7     8     9      10
Low                                                   High
```

Figure 2.2. The scale given to participants on which to make their hunger level estimation. Again, the line used was 10cm long making it easier to measure each participant's responses during data analysis: eg in this example the participant's "x" lies at 9cm therefore showing they estimate their hunger level to be at 9 out of a possible 10.

The booklet then contained 11 point Likert-scales on which participants rated the stimuli. Each individual image was presented on the projector for 10 seconds, starting with the female stimuli and followed by the male stimuli. Participants provided two ratings for each image: for body size and attractiveness (0= low, 10= high); see figure 2.3 for an example of the scale. The process took approximately 30 minutes. Upon completion all participants (both groups) were served breakfast. All participants had the opportunity to read a Debrief after the experiment, explaining the nature of the study and why the deception they experienced was necessary.
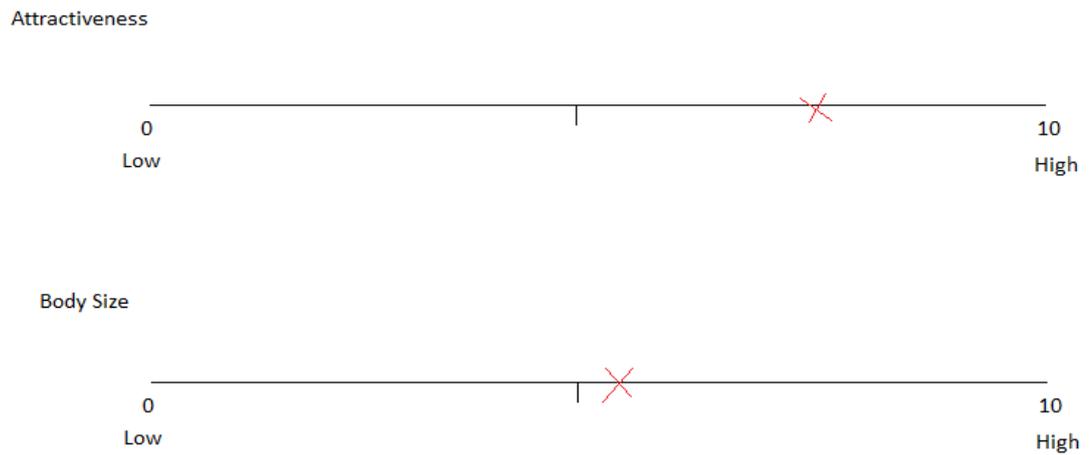
Figure 2.3. An example of the scale participants were presented with, ranging from low to high body size (0-10) and low to high attractiveness (0-10). The "x" represents how they were asked to mark their estimation of body size and attractiveness. The line used was 10cm long making it easier to measure each participant's responses during data analysis: e.g. in this example the participant's "x's" lie at 7.4cm and 5.3cm therefore showing an estimation of 7.4 on the attractiveness scale, and 5.3 on the body size scale.

The same images and general format was used for the Control sample, however these participants completed an online version of the study using Qualtrics online survey software. In this version, each body was presented on a separate screen shot with the two likert scales shown underneath it. Participants were required to click on an arrow to move to the next image. If participants missed a rating, Qualtrics was programmed to inform participants that they could not continue on to the next question until the current question had been answered (this ensured no participant could miss out a rating). All participants were given a Debrief on completion of the experiment to explain the full nature of the study. Data was exported from Qualtrics into Excel before further investigation. Participants with incomplete responses (where participants had stopped the questionnaire before the end) were deleted from any further participation in the study.

2.2.4. Data Analysis

A cubed polynomial regression (attractiveness ratings; see figure 2.4) and linear regression (body size ratings; see figure 2.5) were fitted to the data using Origin8, version 8E.
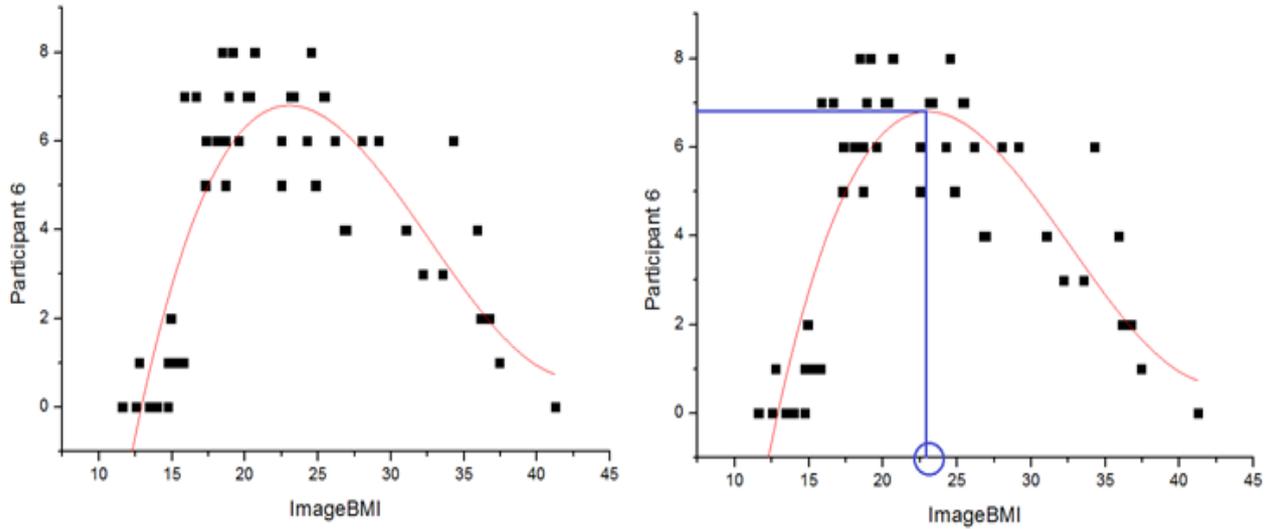
Figure 2.4. An example of the Image BMIs plotted against the average attractiveness ratings for, in this case, participant 6. The red line shows the 3rd order polynomial that was fitted to the graph in order to calculate the peak BMI. The blue line (right image) shows the BMI of the body that was rated as most attractive was 22.97 kg/m^2.
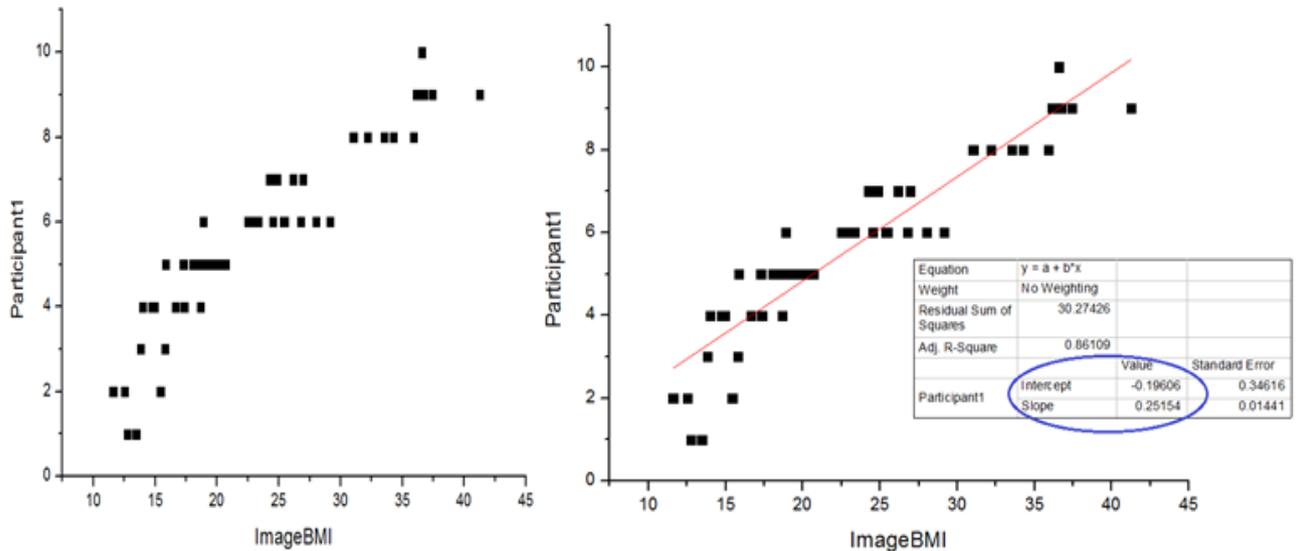
Figure 2.5. An example of how the Slopes and Intercepts for the linear fit of body size ratings against BMI of the images were obtained, i.e. in this case, for participant 1, there is a positive linear relationship with an intercept of -0.196 and a slope of 0.252.

This allowed peak attractiveness judgements and the slope and intercepts of body size ratings for each participant to be calculated. All subsequent data analysis was performed in SPSS version 21; Spearman's rho correlations and Cronbach's alpha reliability analysis were calculated to investigate sex differences, and a number of independent samples t-tests were performed to investigate differences between groups. Finally, G*Power (http://www.gpower.hhu.de/en.html) was used to calculate effect size and power of the sample. An alpha level of 0.05 was employed for all statistical analysis.

2.3. Results

As male and female body images were rated separately in 2 separate experiments for the experimental condition, these were kept separate for analysis. However, in order to make further analysis slightly simpler, it was necessary to combine the data of male and female participants to create just one group within each of the experimental groups. We therefore calculated 8 Spearman's rho correlations between male and female participants for both attractiveness and body size ratings and for both male and female body images (4 correlations for each group: attractiveness ratings of (1-female body images) and (2-male body images); body size ratings of (3- female body images) and (4- male body images)).

For group 1, a strong correlation was found between male and female participants' average attractiveness ratings for female bodies ($r = .864$) and male bodies ($r = .824$). To confirm the inter-rater reliability of the data, Cronbach's Alpha (α) calculations, testing to what extent people within a particular group are rating in the same way, were then calculated to ensure that combining male and female ratings into one group retained intra class homogeneity. Results showed an α value of .976 for female bodies and .965 for male bodies, suggesting uniformity in performance within the male and female participant groups (in group 1).

Further tests (independent samples t-tests) were then conducted to ensure that there was no significant difference between male (mean: 20.79; SD: 1.78) and female (mean: 21.19 SD: 1.19) attractiveness ratings in this group when rating female bodies or between male (mean: 22.78; SD: 2.62) and female (mean: 23.12; SD: 1.43) attractiveness ratings when rating male bodies. Results supported the previous findings of intra class homogeneity in that no significant difference was found between male and

female peak BMI scores when rating female bodies, [$t(44)$, t= .555, p= .582] (2 tailed), or when rating male bodies [$t(44)$, t= .478, p=.635] (2 tailed), suggesting all participants in this group were rating the bodies similarly for attractiveness.

When investigating body size ratings, another strong correlation was found between sexes in group 1 for their ratings of female images (r = 959), supported further by an α of .993, suggesting high uniformity in performance on the task in both male and female participants. This same pattern of results was found for their ratings of size of male bodies (r = .923), with Cronbach's alpha results (.984) again suggesting homogeneity in this data.

This analysis of sex homogeneity was then repeated for participants in Group 2.

For group 2, a strong correlation was found between male and female participants' average attractiveness ratings for both female (r = .959) and male (r = .887) bodies. To confirm the inter-rater reliability of the data, Cronbach's Alpha (α) were then calculated, with results showing an α value of .977 for female bodies and .964 for male bodies, suggesting uniformity in performance between male and female participants when rating bodies for attractiveness.

Further independent samples t-tests were conducted to ensure that there was no significant difference between male (mean: 20.22; SD: 0.61) and female (mean: 20.90; SD: 2.38) attractiveness ratings for female bodies, or male (mean: 22.82; SD: 2.13) and female (mean: 22.76; SD: 1.71) attractiveness ratings for male bodies. Results supported the previous findings of intra class homogeneity in that no significant difference was found between male and female peak BMI scores for female bodies [$t(48)$, t= .891, p= .377] (2 tailed) or male bodies [$t(48)$, t= -.094, p= .926] (2 tailed).

Another strong correlation was also found between male and female participants' average body size ratings for both female (r = .987) and male (r = .956) images. These correlations were again further supported by reliability analyses (female body α= .993; male body α= .979), suggesting high homogeneity between the ratings of each sex when rating these bodies for size.

This analysis of sex homogeneity was then repeated for participants in the control sample.

Four Spearman's rho correlations were calculated between male and female participants for both attractiveness and body size ratings and for both male and female body images (attractiveness ratings of (1-female body images) and (2-male body images); body size ratings of (3- female body images) and (4- male body images)).

Spearman's rho correlations revealed a strong significant correlation ($r = .944$) between male and female average attractiveness ratings of female body images and a slightly weaker correlation for male images ($r = .840$), suggesting both sexes were rating the images similarly. This was given further support by a Cronbach's α result of .984 for female images and .966 for male images. Independent samples t-tests confirmed no significant difference between male (mean: 19.79; SD: 1.05) and female (mean: 20.53; SD: 1.29) BMI peaks for female [$t(39)$, $t = -1.876$, $p > .05$] or male [$t(39)$, $t = -1.287$, $p > .05$] bodies, again lending further support to the idea that both sexes rated the images similarly, therefore allowing us to combine their ratings and treat them as one group.

A similar pattern of results was also found for control observers rating images for body size. A strong significant relationship was found between male and female body size ratings of female body images ($r = .991$) and male body images ($r = .969$). Cronbach's α values of .989 for female bodies and .967 for male bodies supports this finding of a strong relationship between the ratings of each sex, suggesting both were rating the male body images similarly for size.

For the rest of the analysis for this study (both experimental and control conditions) the ratings of male and female participants were combined as it appeared from these results that there was high uniformity in performance between the sexes and high intra-group correlations between ratings.

A one-way ANOVA was used to investigate any differences in attractiveness ratings (peak BMI values) and body size ratings (slopes and intercepts) between group 1, 2 and controls for firstly female body images, then male body images. Significant differences between groups were expected as a result of hunger, as those in group 2 (who were told they would have to wait a further 2 hours after the experiment finished until they could eat) would prefer a larger body compared to those in group 1 (who were told they could eat immediately after completing the study). This was due to the knowledge that they would not be eating soon therefore their psychological hunger

would increase. It was also predicted that significant differences would be found between both groups and the control sample, as the control sample would be less hungry and therefore prefer a thinner body than those who were hungry.

First, the data was plotted in scatterplots. To determine the type of relationship found between the BMI of the images and the judgements made, a hierarchical regression was performed. BMI was squared and cubed and entered into the regression model. If the 'R Square change' significantly increased with each additional index (e.g. BMI^2 and BMI^3), this is the relationship that was plotted, i.e. if both BMI and BMI^2 were significant, a squared function was plotted, however if all three indices were significant, a cubic function was plotted. However if the additional indices presented no significant increase, no further analysis was performed and a linear trend was used.
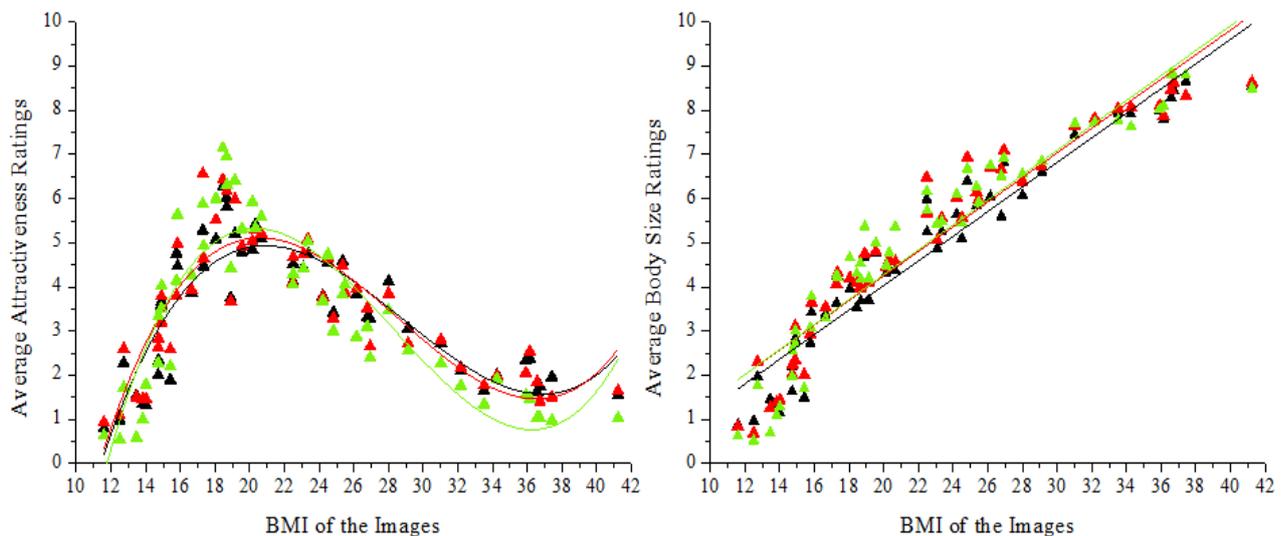
Figure 2.6. Comparing average attractiveness ratings (left) and average body size ratings (right) of female body images for participants in group 1 (black), group 2 (red) & controls (green). These are plotted against the BMI of the images in order for us to see which BMIs the 2 groups find most attractive and if participants can accurately rate the images for size.

When looking at the average attractiveness ratings of female bodies for the three groups in figure 2.6, a slight difference was evident. The peak for group 1 (black) appeared to be smaller than for group 2 (red), which was in turn smaller than for group 3 (green), therefore suggesting that those that were hungry (groups 1 and 2) found bodies of a lower BMI less attractive overall than those who were not hungry (control sample). Figure 2.6 showed that control participants rated bodies at the larger end of the BMI spectrum as less attractive than participants in the experimental groups.

49

When looking at body size ratings, on the right of figure 2.6, there appeared to be no significant difference between the gradients of the relationship between average body size ratings and BMI from each group. Group 1 (black) had a lower intercept than the other groups suggesting participants in this group may have rated images as consistently smaller than participants in group 2 (red) or the control group (green). The ratings for group 2 and the control sample (green) also appeared to be very similar, with a difference in the linear relationship almost imperceptible.
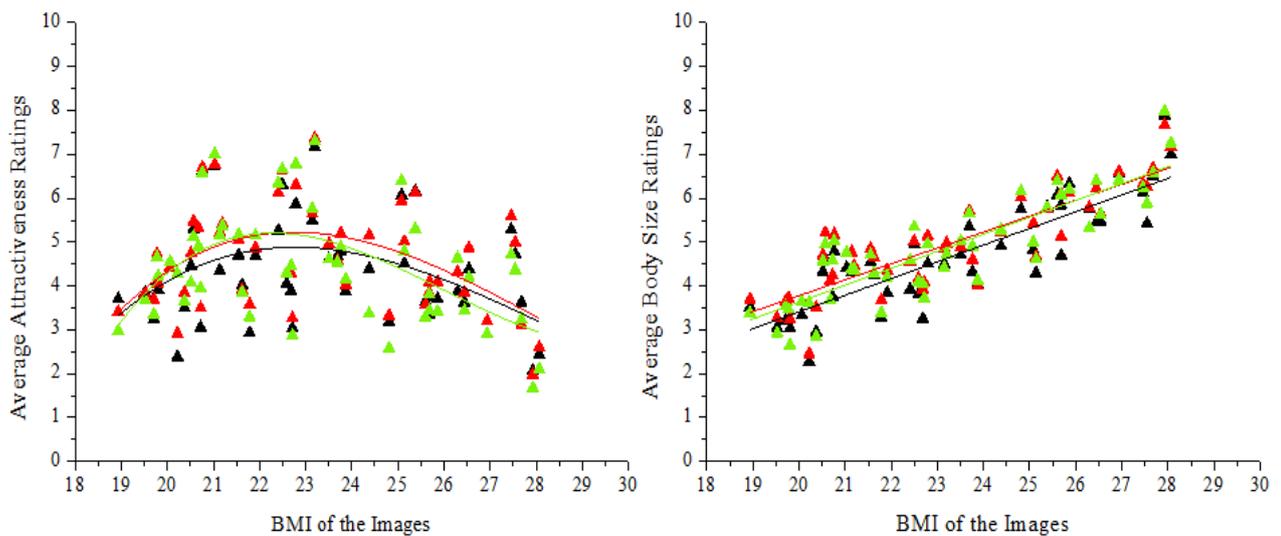
Figure 2.7. Comparing average attractiveness ratings (left) and average body size ratings (right) of male body images for participants in group 1 (black), group 2 (red) & controls (green). These are plotted against the BMI of the images in order for us to see which BMIs the 2 groups find most attractive and if participants can accurately rate the images for size.

In figure 2.7 there was a slight difference in pattern of ratings between groups. On the left, the average attractiveness ratings for group 1 were lower than for group 2, while the control group ratings started off at a similar level, but had a higher peak. In addition, the slope for the control group appeared to have a much steeper decline than for the other groups (whose ratings appeared to gradually reduce) as BMI of the images increased. Again, the control sample rated the higher BMI bodies as less attractive than the other groups.

On the right of figure 2.7 it is evident that there was a difference in body size ratings, especially between group 1 and 2. This difference was more evident when rating bodies at the lower end of the BMI spectrum, with participants in group 1 (black) rating lower BMI bodies as lower in size than group 2 (red). Control participants ratings

for bodies at the lower end of the spectrum appeared to fall between those of group 1 and 2, however again, the gradient for this relationship had a steeper incline for the control group, therefore suggesting these participants rated the heavier bodies as fatter than the other groups.

Further statistical analysis revealed if these small differences apparent in figures 2.6 and 2.7 were significant ones.

One-way ANOVAs calculated on the data for ratings of female bodies revealed no significant difference in Peak BMI values between group 1 (mean: 21.04; SD: 1.28), group 2 (mean: 20.76; SD: 2.16) and controls (mean: 20.71; SD: 1.66), $F(2,134) = 2.50$, $p= 0.09$. There was also no significant difference in slopes found between group 1 (mean: 0.35; SD: 0.10), group 2 (mean: 0.35; SD: 0.13), and controls (mean: 0.42; SD: 0.85), $F(2,134) = 0.31$, $p= 0.73$, or in intercepts (group 1 mean: -2.06, SD: 1.81; group 2 mean: -1.74; SD: 2.50; control group mean: -1.49, SD: 2.30) when rating bodies for size, $F(2,134) = 0.72$, $p= 0.49$.

Male body data analysed using the same method (one-way ANOVA) revealed a similar pattern, with no significant difference in peak BMI values between group 1 (mean: 23.07; *SD*: 1.63), group 2 (mean: 22.77; *SD*: 1.78) and controls (mean: 22.42; *SD*: 1.20), $F(2,134) = 1.86$, p= 0.16. There was also no significant difference in slopes found between group 1 (mean: 0.48; *SD*: 0.16), group 2 (mean: 0.45; *SD*: 0.24), and controls (mean: 0.39; *SD*: 0.23), $F(2,134) = 1.91$, $p= 0.15$, or in intercepts (group 1 mean: -5.32, *SD*: 3.47; group 2 mean: -4.38; *SD*: 5.27; control group mean: -4.26, *SD*: 5.52) when rating bodies for size, $F(2,134) = 0.66$, $p= 0.52$.

As this result was contradictory to what we had expected, G*Power (version 3.1) was used to complete a power calculation to investigate how many further participants would be needed in order for us to find a significant effect. Power analyses are important in helping to define the number of participants needed in order to find a significant effect. This is normally conducted before data collection occurs; therefore please see an explanation of why this did not take place in the limitations section of the discussion in this chapter (section 2.6.1). A priori statistical power analysis, with a set alpha level of .05 and power level of .95, was therefore used based on the results of the ANOVA calculated between the three groups. An effect size of 0.21 and critical *F*-value of 3.02 meant that 360 participants would be needed overall to find a significant effect of hunger on attractiveness ratings of female bodies.

The same calculation was performed for the male body image data, again based on the ANOVA between groups 1, 2 and controls. An effect size of 0.17 and critical *F*-value of 3.01 meant that a sample size of 525 participants would be needed to find a significant effect of hunger on BMI peaks for male body images.

To conclude a significant effect of group on body size intercepts, G*Power indicated that a sample size of 1,860 participants would be needed overall for the three groups when looking at female bodies, (effect size: 0.09; critical *F*-value: 3.00), and 2,103 participants in each group when looking at male bodies (effect size: 0.09; critical *F*-value: 3.00).

Furthermore, in order for a significant effect of group on body size slopes, G*Power indicated that 9,624 participants would be needed overall (groups 1, 2 and controls) when ratings female bodies (effect size: 0.04; critical *F*-value: 3.00) and 738 participants would be needed overall when rating male bodies (effect size: 0.15; critical *F*-value: 3.01).

Previous research (Swami, & Tovée, 2006) had found a significant effect of hunger on attractiveness judgements when male participants were rating female bodies, however the results presented here did not support this idea. Therefore this raised the question as to why this was the case. One possible explanation for this lack of effect was that hunger may not have been induced effectively.
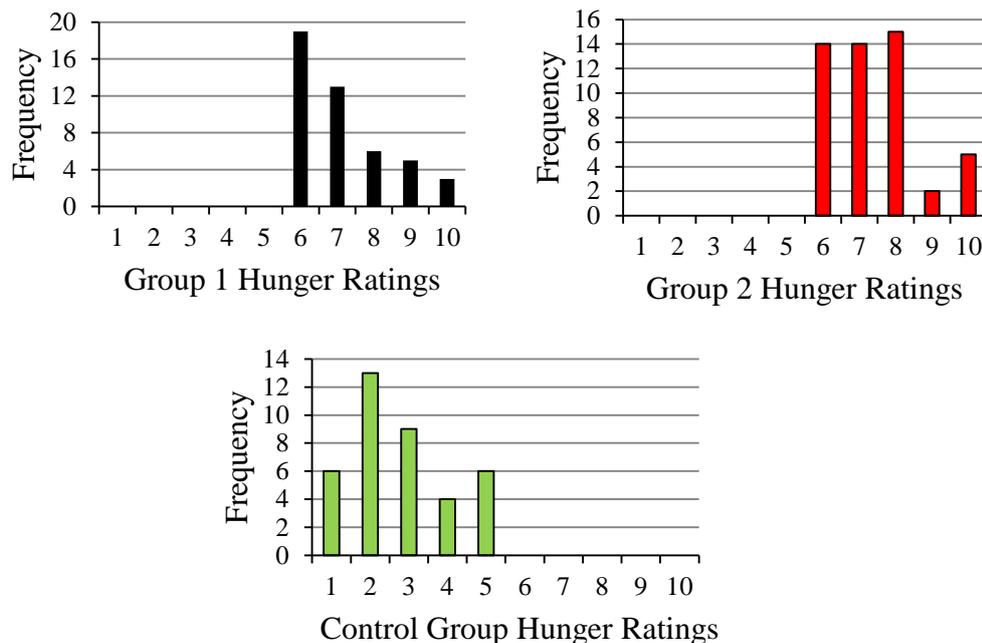
Figure 2.8. Frequency and distribution of hunger ratings of participants in the control group compared to those in groups 1 and 2.

In figure 2.8, the majority of participants in group 1 rated their hunger level as 6 or 7. There was an abnormal distribution of hunger ratings in participants in group 2, with the largest amount of participants rating their hunger as between 6, 7 or 8 out of 10, followed by a steep decline in the frequency of participants rating their hunger as 9 out of 10. This frequency then rose for those who stated their hunger was at a maximum level of 10 out of 10. While group 1 showed a gradual decline in frequency as hunger ratings increased (less people stated their hunger as 8, 9 or 10 out of 10), group 2 showed no pattern in ratings. From figure 2.8 it was difficult to see if there would be any significant difference in hunger ratings between groups 1 and 2.

In addition, hunger ratings for the control group clearly fell at the lower end of the scale, while hunger ratings for groups 1, and 2 lay at the higher end of the scale. The largest frequency was for a hunger rating of 2 out of a possible 10, followed shortly by the 2nd largest frequency for a rating of 3 out of 10.

Tests were therefore conducted to investigate if this difference in hunger between the control group and groups 1 and 2 was significant (one-way ANOVA). If there is a significant effect of hunger a significant difference in hunger ratings between the control sample and groups 1 and 2 would be expected. However, hunger levels between the two experimental groups should be similar, as all participants were required to fast.

Table 2.2. Descriptive statistics of the hunger ratings for group 1 and 2 compared to the control group

	Hunger	
	Mean	SD
Group 1	7.07	1.39
Group 2	7.32	1.27
Control Group	2.61	1.39

Results of this one-way ANOVA revealed a very strong significant difference between hunger ratings, $F(2,134) = 166.47$, $p < 0.001$. Post hoc tests (Tukey HSD) revealed this significant difference lay between the hunger ratings of the control group and groups 1 and 2, $p < 0.001$, suggesting hunger was induced effectively. However there was no significant difference found between hunger ratings of group 1 and 2 ($p= 0.66$).

2.4. Study 2: Physiological Effects of Hunger

2.4.1. Participants

There were no strict eligibility criteria for participation in this study, other than age between 18 and 30 as I wanted to investigate preferences for body size and attractiveness in the general population. As no psychological effects of hunger were found in the previous study in either males or females, a sample of both male and female participants were recruited again in order investigate evidence of a physiological effect of hunger in either sex.

69 participants (36 female and 33 male; mean age: 20.35 years, SD: 1.91, range: 18-26 years), all students at Newcastle University, were recruited for this experiment through social networking sites such as Facebook, and through the use of the undergraduate Research Participation Scheme run by the school of Psychology at Newcastle University (this involves adverts being sent by email to all first and second year undergraduates asking for volunteers). Participants were later split into two groups through random allocation (see procedure for definition of groups). 35 individuals were allocated to group 4 (19 female and 16 male; mean age: 20.34, SD: 2.24, range: 18-26 years), while 34 were allocated to group 5 (17 female and 17 male; mean age: 20.35, SD: 1.54, range: 19-26 years).

21 female participants (mean age: 19.43 years, SD: 0.81, range: 18-21 years), all students at Durham University, were also recruited as a control sample using adverts sent out to via the School of Psychology at Durham university.

Individuals who fasted on a regular basis (i.e.: for religious reasons), those with health problems such as diabetes, and those with dairy allergies were excluded from participation in this study. None of the subjects were aware of the true nature of the study until completion of the tasks.

2.4.2. Materials/Apparatus

High and low calorie yoghurt drinks (recipe taken from Zandstra and El-Deredy (2011)), with the exception of fat free vanilla "Yeo-Valley" yoghurt being used instead of natural yoghurt) were used in this study to differentiate between groups. The high calorie drink provided the consumer with 1069KJ (255 kcal) per 200ml serving, while the low calorie yoghurt drink only provided the consumer with 240 KJ (57kcal) per 200ml serving. These drinks were prepared in the mornings, 10 minutes prior to the

start of the experiment and kept refrigerated until participants arrived. Both drinks appeared similar in texture, taste and appearance and were consumed by participants from white, disposable, polystyrene cups. Qualtrics online survey software was used for the creation and completion of the questionnaires.

2.4.3. Procedure

On agreement to participate in the aforementioned study, both experimental and control participants were asked to fast for approximately 10 hours (from 8pm on the eve of the study until entering the lab the following day). Participants were also instructed to follow their normal dietary regime before the fasting began, avoiding eating excessively large amounts of food to make up for the imminent fasting, and also avoiding "tanking" (i.e. drinking large amounts of fluids). Fluids consumed during this 10hr fast were also restricted- water only.

On entering the laboratory the following morning, participants were asked to complete 2 online questionnaires, which started with them estimating their hunger (see figure below- 2.9) and providing some demographic info (as in the previous sample).

At the moment, on a scale of 0-10, how hungry are you feeling?
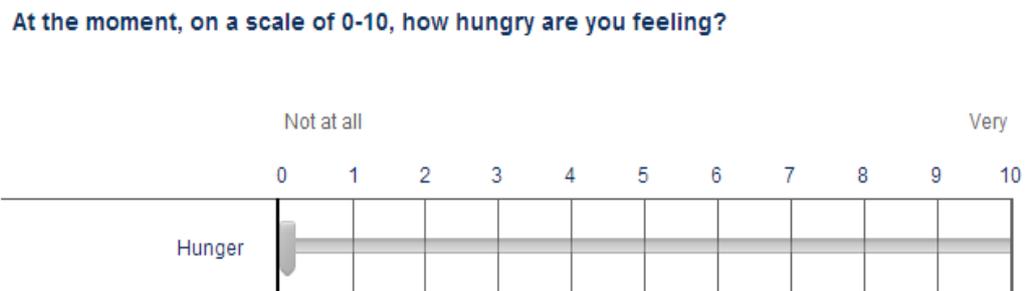
Figure 2.9. The sliding scale participants used to estimate their hunger levels in Qualtrics.

The first questionnaire showed 50 images of female bodies which the participants were required to rate for body size (low-high; 0-10) and attractiveness (low-high; 0-10), using sliding scales (see Figure 2.10 for an example of a question on the female body questionnaire). As soon as the first questionnaire was completed, they moved on to the second in which they were again required to rate 50 bodies (this time male) on scales from low to high body size and attractiveness (see Tovée et al. (1999) for details of all images).

Following this, participants in the experimental group were asked to consume either the low or high calorie drink (a note was taken as to who was given which), and were then asked to watch a television programme for approximately 25 minutes (in order for the drink to have an effect in the stomach). Control subjects also had a similar 25 minute break with the exception that nothing was consumed during this time. All participants, both experimental and control were then required to complete the 2 online questionnaires for a second and final time, after which they were given a Debrief on completion of the experiment to explain the full nature of the study.
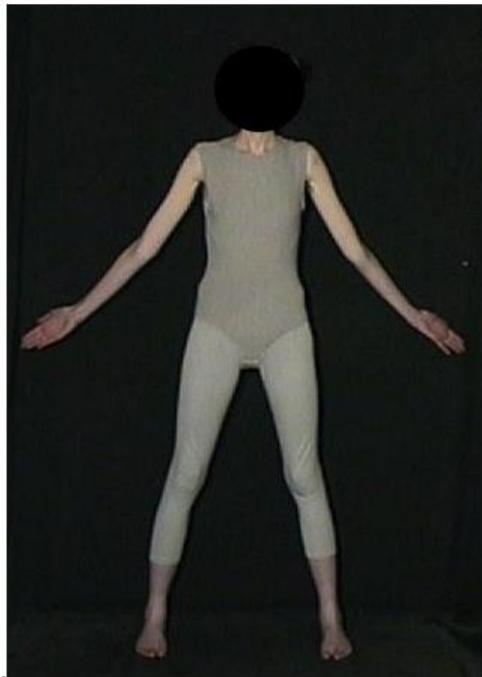
Figure 2.10. A screen shot of a question taken from the female body questionnaire on Qualtrics.com

2.4.4. Data Analysis

Origin8 was again used to calculate peak attractiveness judgements and body size slopes and intercepts for each participant. (See explanation and figures 2.4 and 2.5 in study 1 data analysis section for an example of this).

As this study involved a period of fasting designed to invoke a feeling of hunger in participants, those who reported a hunger level of below 5 (not hungry) were therefore removed from analysis as it was thought that their data may confound any effects of hunger that may be found in this sample. This reduced the experimental group sample size down from 69 participants to just 47 participants (24 in the low calorie group and 23 in the high calorie group). See table 2.3 for information about each group.

Table 2.3. The comparison of ages and numbers of each sex within each group.

	Low Calorie Group		High Calorie Group		Control Group
	Male	Female	Male	Female	Female
Number	11	13	13	10	21
Mean age (years)	19.64	19.92	20.15	19.40	19.43
SD	0.81	1.12	1.21	1.26	0.81
Age range (years)	19-21	18-21	18-22	18-21	18-21

2.5. Sample 2: Results

Again, male and female body images were rated separately in 2 separate experiments; therefore these were kept separate for analysis. However, in order to make further analysis slightly simpler, it was necessary to combine the data of male and female participants to create just one group within each of the experimental groups. 16 Spearman's rho correlations were therefore calculated between male and female participants in the experimental groups for both attractiveness and body size ratings and for both male and female body images for both pre and post conditions (8 correlations for each of the two groups (low and high calorie): attractiveness ratings of (1-female body images) and (2-male body images); body size ratings of (3- female body images) and (4- male body images) (x2- for both pre and post conditions) to investigate if both sexes were rating in a similar way.

2.5.1. Attractiveness

2.5.1.1. Female Bodies

A Spearman's rho correlation performed on the data for the low calorie group revealed a strong correlation between male and female participants' average attractiveness ratings for female bodies in both the pre (r = .947) and post (r = .947) ratings conditions. Cronbachs' Alpha calculations (α) resulted in an α value of .978 for pre-ratings and .979 for post ratings, suggesting uniformity in performance between male and female participants when rating female bodies in both the pre and post conditions (in the low calorie group). A further 2 tests (independent sample t-tests) were then conducted to ensure that there was no significant difference between pre male (mean: 20.86; SD: 0.82) and pre female (mean: 20.48; SD: 1.31) peak BMI values in this group and between post male (mean: 20.51; SD: 0.64) and post female (mean: 20.40; SD: 0.92) peak BMI values. Results supported the previous findings of intra class homogeneity in that no significant difference was found between pre male and female peak BMI scores, $t(23)$, $t= -.872$, $p= .392$ (2 tailed), or between post male and female peak BMI scores, $t(23)$, $t= -.337$, $p= .739$ (2 tailed).

This analysis of intra class homogeneity was then repeated for participants in the high calorie group.

A strong significant correlation was found between male and female pre attractiveness ratings (r = .954) and between male and female post attractiveness ratings (.949) for female body images (in the high calorie group). Combining the data for males and females, a Cronbach's α value of .973 was found for pre ratings and .976 for post ratings, which confirmed that the task had inter rater reliability as all participants appeared to rate the bodies in a similar pattern. T-tests were then conducted between male and female participants in the high calorie group (both pre and post ratings) to investigate any differences in peak BMI values between sexes. From the high correlation and high α level no difference between the sexes would be expected. Results confirmed this lack of significant difference between male (mean: 20.73; SD: 1.61) and female (mean: 20.51; SD: 0.93) pre ratings peaks, $t(23)$, $t= -.411$, $p= .685$, and male (mean: 20.37; SD: 1.21) and female (mean: 20.18; SD: 0.81) post ratings peaks, $t(23)$,

58

t= -.466, *p*= .646. This analysis would indicate that combining sex ratings of female bodies in the high calorie group would be acceptable for future analysis.

For the rest of this analysis ratings of male and female participants were combined when rating female bodies for attractiveness as these results suggested that there was high uniformity in performance between the sexes and high intra group correlations between ratings.

Before any analysis was carried out into further investigating the differences between the control and low and high calorie groups, it was necessary to investigate if there was any difference between pre and post ratings within each group. Significant differences between pre and post ratings were expected for the experimental groups, especially in the high calorie group as this was the group in which participants were given a high calorie/energy yoghurt drink which was designed to give them the sensation of satiety, however not for the control group. It was therefore expected that participants in the high calorie group would show a preference for a heavier body type pre rating compared to post rating (in line with previous research which suggest that hungry individuals prefer a heavier body).

It was also expected that there would be a significant effect of group on the pre and post ratings, with no significant difference between pre ratings for all three groups (as participants in all groups should be at an equal state of hunger) but a significant difference between post ratings for the high calorie and low calorie group and control, as those in the both the low calorie and control group would still be hungry and therefore prefer a larger body compared to those in the high calorie group (who's hunger levels should have been reduced after consuming the drink). This is due to the fact that there would be physiological differences in hunger levels between the two groups caused by the differences in the two yoghurt drink. In regards to the control sample, as no drink is to be provided at all, there should be no difference between participants' pre and post ratings. However if results show a difference between pre and post ratings, this may be used to explain the effects of hunger in the low calorie group as psychological rather than physiological, as any change in ratings may just be due to the idea that they have been given a drink rather than the actual feeling of their hunger being sated.
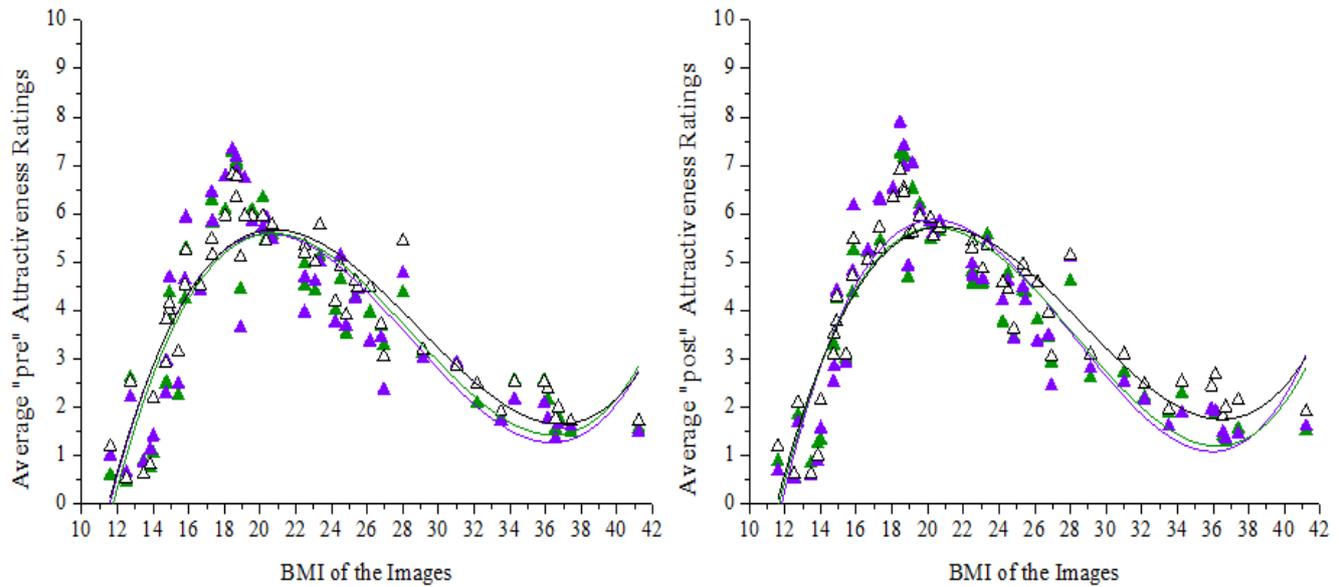
Figure 2.11. Average attractiveness ratings plotted against BMI of the images used (female bodies). Pre ratings are presented on the left, while Post ratings are presented on the right. Purple point/lines represent the high calorie group, green points/lines represent the low calorie group, and black points/lines represent the control group.

From figure 2.11 it was observed that ratings between groups were similar for both pre and post experimental ratings. For the "pre" experimental condition there appeared to be a larger difference between ratings for bodies at the larger end of the BMI scale, with the high calorie group appearing to find the heavier bodies slightly less attractive than participants in the low calorie group. In addition, participants in the control group appeared to find heavier bodies more attractive than either of the two experimental groups. For the "post" experimental condition, there appeared to be a slightly higher peak attractiveness rating for participants in the high calorie group, compared to those in the low calorie group, and again a pattern similar to that of the "pre" experimental ratings between low and high calorie groups for bodies at the larger end of the BMI spectrum was seen. Furthermore, during the "post-rating" condition, participants in the control group again appeared to rate bodies with BMIs of approximately 26-36 kg/m^2 as much more attractive than either of the two experimental groups; however opinions of all three groups appeared to converge when bodies became heavier than approx. 36 kg/m^2.
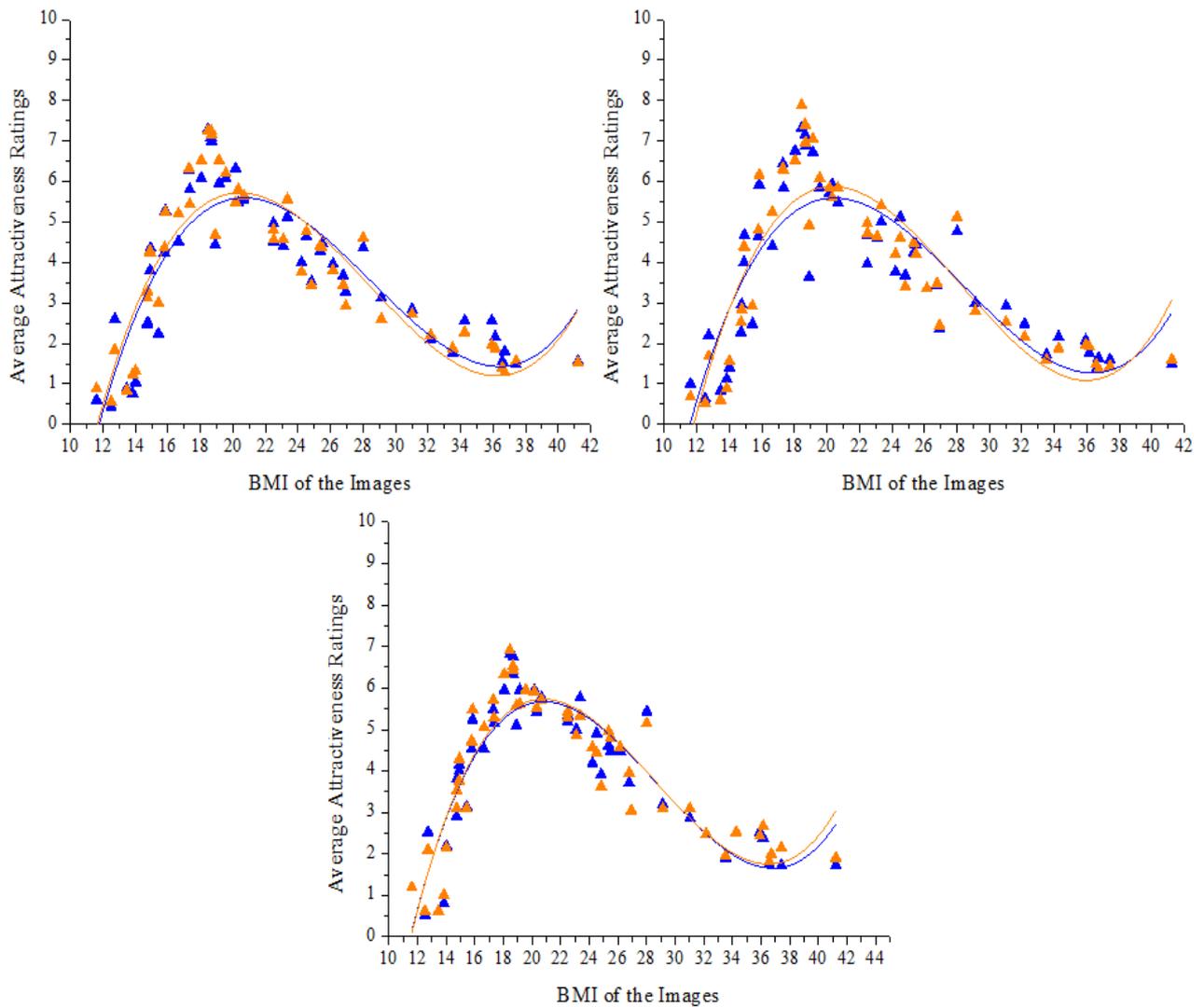
Figure 2.12. Comparing pre and post average attractiveness ratings within groups, plotted against BMI of the images (female bodies). Data for the low calorie group is presented on the left, high calorie group on the right, and the control group below. Pre experimental ratings are blue and post experimental ratings are presented in orange.

Data in figure 2.12 showed that for the low calorie group (left) there was a slight increase in peak attractiveness ratings between pre and post conditions (pre experimental peak of BMI 20.68 compared to post experimental peak of BMI 20.38). For the low calorie group, during the pre-rating phase (blue), a body size of BMI 26.47 was rated as least attractive, compared to the lowest attractiveness rating being assigned to a BMI of 26.17 (slightly smaller) for post experimental ratings. For the high calorie group (right) a similar pattern of results was found: a difference in peak attractiveness ratings between pre (BMI 20.53) and post (BMI 20.38) conditions and a difference in BMI between pre (36.22) and post (35.42) for the body assigned the lowest attractiveness rating. Data for the control sample follows a similar pattern; however in this group there appeared to be no difference in peak between pre and post ratings.

A Mixed design, repeated measures ANOVA was then performed on the attractiveness peaks of female bodies for both pre and post rating to investigate any within subject difference (pre and post) and any between subject differences (low and high calorie groups and control group).

Table 2.4. Descriptive statistics for the mixed design ANOVA calculated on the attractiveness ratings for the female bodies.

		Mean	SD
High Calorie (N= 23)	Pre	20.68	1.35
	Post	20.38	1.00
Low Calorie (N= 24)	Pre	20.71	1.09
	Post	20.43	0.77
Control (N= 21)	Pre	20.55	2.54
	Post	20.55	2.12

The ANOVA results for female bodies revealed a significant main effect of the time of rating (pre or post) on attractiveness ratings assigned to the female bodies, $F(1,65)= 4.10$, $p= .047$ ($r= .36$, showing a relatively small yield in effect size). However, there was no significant main effect of group (high or low calorie), $F(1,65)= .004$, $p =.996$. This lack of significant difference between groups is reflected in the yield of a very small effect size, $r=.02$.
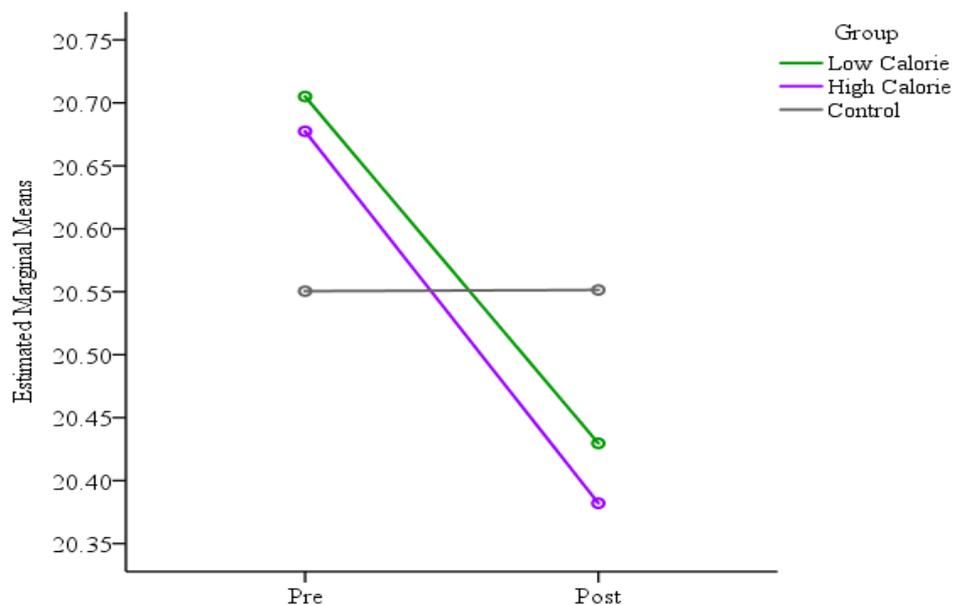
Figure 2.13. Interaction plot of attractiveness peaks for female bodies, comparing pre and post ratings for the low and high calorie and control groups.

There was also no significant interaction effect (see figure 2.13) found between any of the groups (low calorie, high calorie, or controls) when rating the bodies for attractiveness in the pre or post experimental condition, $F(2,65)= .999$, $p = .374$. Again, this interaction yielded a very small effect size (r= .01), as expected with a non-significant result.

2.5.1.2. Male Bodies

The correlation between the pre attractiveness ratings of male and female participants (r = .828) was not as strong as for post ratings (r = .904) in the low calorie group, however it was still a significant relationship. This therefore still suggested that male and female participants were rating the bodies in a similar manner. Cronbach's α performed on both the pre ratings (.943) and the post ratings (.954) confirmed this strong relationship. This was given even further support by an independent samples t-test which suggested no significant difference in the pre ratings peak BMI values of male (mean: 21.65; SD: 1.42) and female (mean: 22.28; SD: 0.77) participants, $t(23)$, t= 1.393, $p= .177$ (2 tailed), and no significant difference in the post rating pre BMI values of male (mean: 21.83; SD: 2.28) and female (mean: 22.07; SD: 0.84) participants, $t(23)$, t= .352, $p= .728$, when ratings male images.

A similar pattern of results was seen for ratings of male body images by participants in the high calorie group, with significant correlations found between male and female attractiveness ratings in both the pre (r = .764) and post (r = .821) conditions. The Cronbach's α result of .911 for pre ratings and .945 for post ratings also suggested (as all other Cronbach's results have) a high level of uniformity in performance between sexes on this task. A further independent samples t-test on this data again resulted in no significant difference in pre ratings peak BMI values, $t(23)$, t= -1.366, $p= .185$, between male (mean: 22.51; SD: 2.25) and female (mean: 21.49; SD: 1.29) participants, and no significant difference between males (mean: 21.53; SD: 1.49) and females (mean: 21.77; SD: 0.96) for post ratings peak BMI values, $t(23)$, t= .457, $p= .652$, showing that both sexes were rating the images similarly.

For the rest of the analysis for attractiveness ratings the ratings of male and female participants when rating male bodies for attractiveness were therefore combined as these results suggested that there was high uniformity in performance between the sexes and high intra group correlations between ratings.
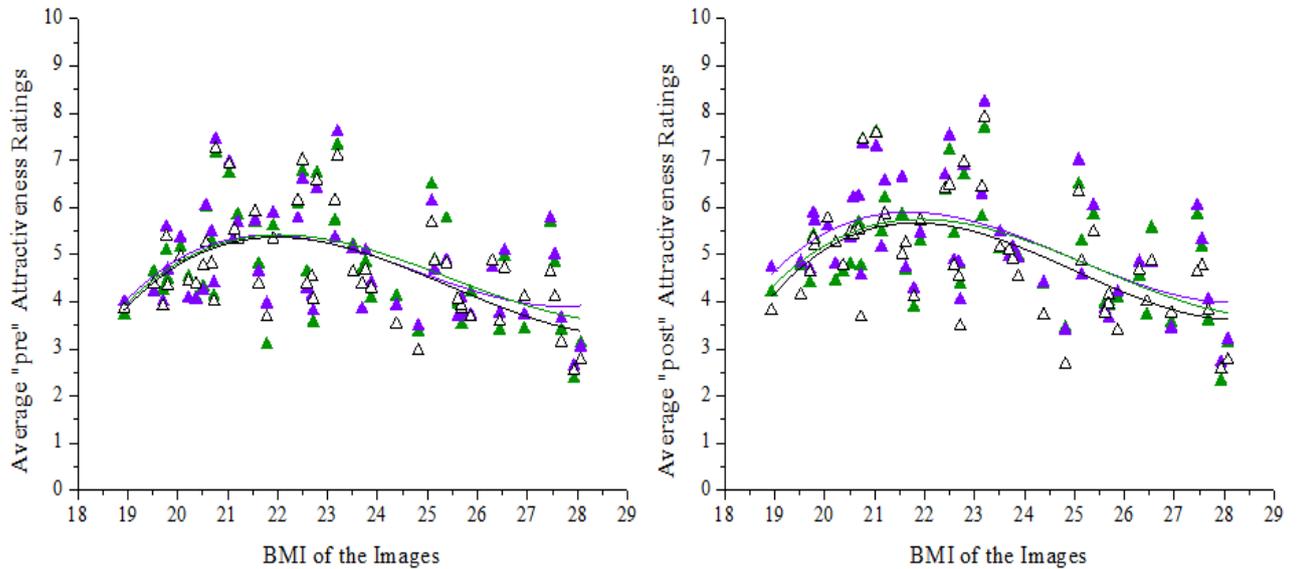
Figure 2.14. Average attractiveness ratings plotted against BMI of the images used (male bodies). Pre ratings are presented on the left, while Post ratings are presented on the right. Purple point/lines represent the high calorie group, green points/lines represent the low calorie group, and black points/lines represent the control group.

Ratings between groups were similar for both pre and post experimental ratings (figure 2.14). For the "post" experimental condition, there appeared to be a slightly higher peak attractiveness rating for participants in the high calorie group, compared to those in the low calorie group. In addition, in the "post" experimental condition the high calorie group appeared to rate bodies with the lowest BMIs as more attractive than participants in either the low calorie or control groups, while participants in the control group appeared to rate the bodies at the higher end of the BMI spectrum as much less attractive than participants in either of the other groups.
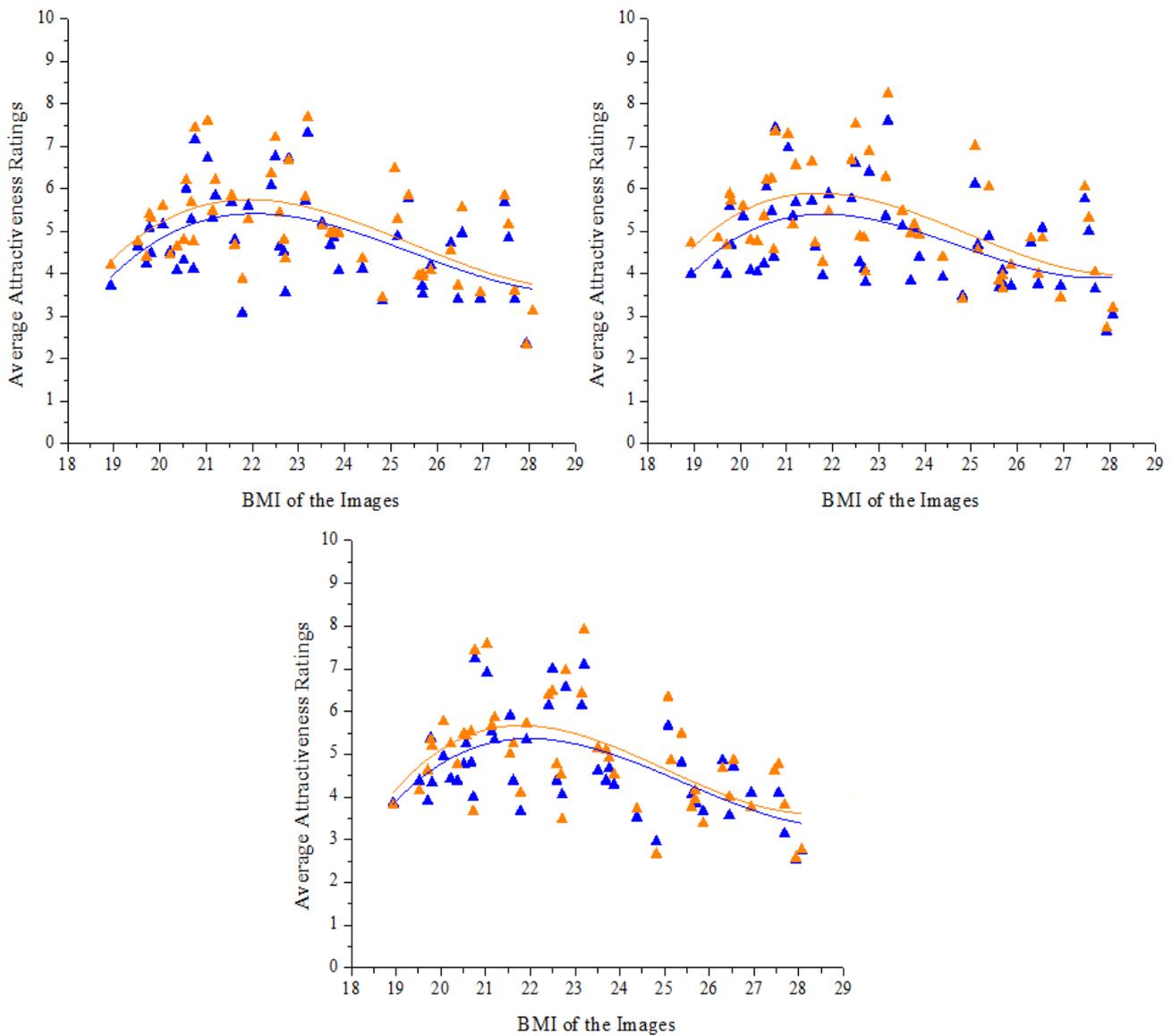
Figure 2.15. Comparing pre and post average attractiveness ratings within groups, plotted against BMI of the images (male bodies). Data for the low calorie group is presented on the left, high calorie on the right, and control below. Pre experimental ratings are blue and post experimental ratings are presented in orange.

From figure 2.15 there appeared to be a difference in attractiveness ratings between the pre and post experimental ratings for both the low calorie group and the high calorie group. The difference appears to be larger when the BMI of the bodies being rated is smaller, and seems to diminish as the BMI of the bodies becomes larger. This pattern of results was very similar for both the low and high calorie groups, but there appeared to be a greater difference in pre and post ratings in the high calorie group. For both groups, the average attractiveness for the pre experimental ratings was lower than for the post ratings, suggesting that after consuming their drinks, both groups rated bodies as more attractive overall.

A mixed-design repeated-measures ANOVA was then also calculated for this data to investigate if any effects seen in figures 2.14 and 2.15 were significant.

Table 2.5. Descriptive statistics for the mixed design ANOVA calculated on the attractiveness ratings for the male bodies.

		Mean	SD
High Calorie (N= 23)	Pre	21.97	1.92
	Post	21.76	1.23
Low Calorie (N= 24)	Pre	21.99	1.17
	Post	21.95	1.70
Control (N= 21)	Pre	22.15	1.70
	Post	21.85	1.33

However, when investigating the effects, the ANOVA results revealed no significant effect of the time of rating (pre and post) on attractiveness ratings, $F(1,65) = .778$, $p= .381$, and also no effect of group (low or high calorie), $F(2,65) = .074$, $p= .929$.

Figure 2.16. Interaction plot of the mixed design ANOVA of attractiveness ratings for male bodies, comparing pre and post ratings for the low/high calorie and control groups.

Figure 2.16 would suggest that there was a decline between pre experimental and post experimental ratings for attractiveness of male bodies in both the high calorie

group and control group, compared to a very small decline between pre and post for the low calorie group. In relation to the high calorie group this result was expected, as participants who were hungry (pre) should have rated bodies as more attractive than participants who were not hungry (post). It was also expected that this effect would be more evident in the high calorie group as their yoghurt drink contained more calories and sugar and therefore they would feel more sated than the low calorie group whose drink would not make them feel full. However, it was not predicted that there would be a decline in ratings from pre to post in the control condition as the participants were given no calories therefore should have remained hungry for the entire testing period.

Again, no significant interaction effect was found between low and high calorie and control groups when rating the male bodies for attractiveness in the pre or post experimental condition, $F(2,65) = .137$, $p= .872$. These were reflected in the small effect sizes calculated: $r= .06$ (pre or post), $r= .05$ (high or low calorie), $r= .13$ (interaction).

2.5.2. Body Size

2.5.2.1. *Female Bodies*

A strong significant correlation (Spearman's rho) was found between the ratings of male and female participants in the low calorie group (both pre [r = .987] and post [r = .986] rating) when rating female bodies for size. Cronbach's α values of .994 for both pre and post ratings again supported the correlation result with high uniformity in performance on this task evident between male and female observers.

A similar result was also found for participants in the high calorie group, with strong correlations found between both pre body size ratings (r = .979) and post body size ratings (r = .988). In support of this, α values of .988 for pre ratings and .994 for post ratings for the combined sexes also indicated uniformity in performance between sexes in the high calorie group when rating female bodies for size.

For the rest of the analysis for body size, ratings of female bodies (male and female participants) were therefore combined as it appeared from these results that there was high uniformity in performance between the sexes and high intra group correlations between ratings.
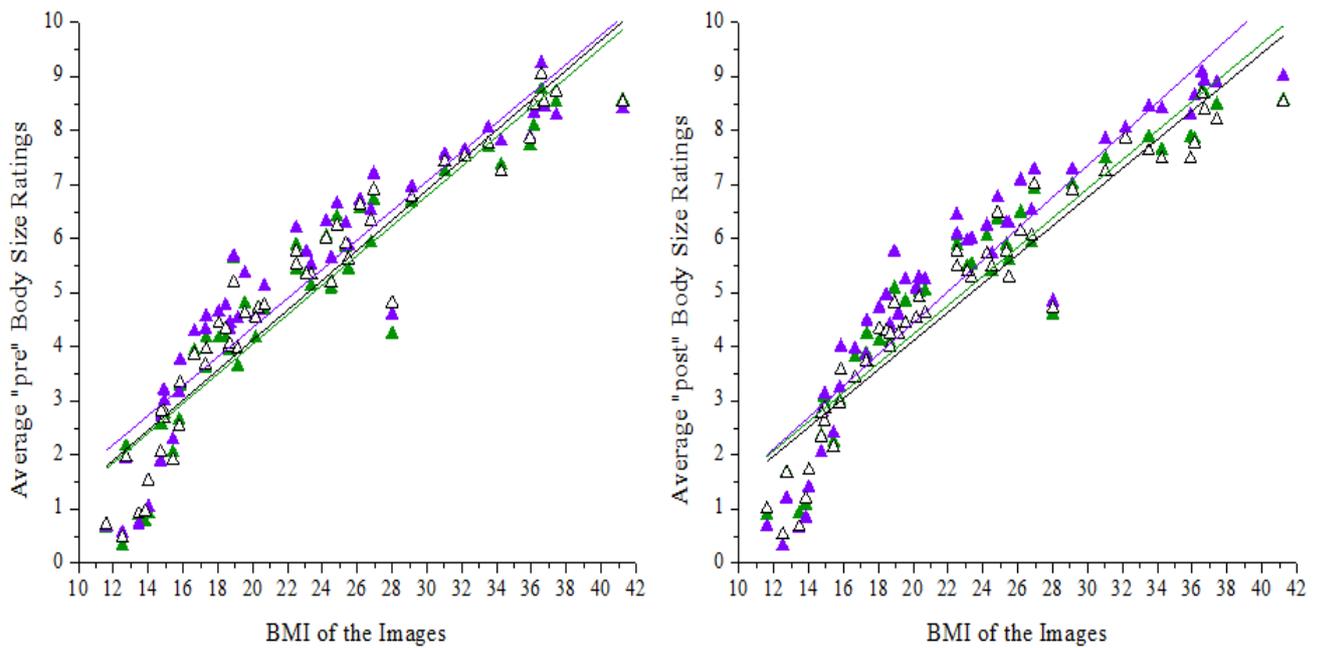
Figure 2.17. Average body size ratings plotted against BMI of the images used (female bodies). Pre ratings are presented on the left, while post ratings are presented on the right. Purple point/lines represent the high calorie group, green points/lines represent the low calorie group, and black points/lines represent the control group.

Figure 2.17 suggests that average body size ratings increased as BMI of the images increased, therefore suggesting that participants were accurately rating bodies for size. Linear fit of the data suggests that participants in the high calorie group (purple) were rating bodies higher than those in the low calorie group (green), as were participants in the control group (black). For pre rating, this difference between groups appeared constant across bodies of all BMIs, however for the post-ratings, the difference between high and low calorie groups gradually became larger as BMI of the images increased, suggesting that the low calorie group viewed larger BMIs as smaller than participants in the high calorie group. In addition, when rating bodies for the second time (post) participants in the control group appeared to rate the bodies as smaller in size than participants in both the experimental groups.
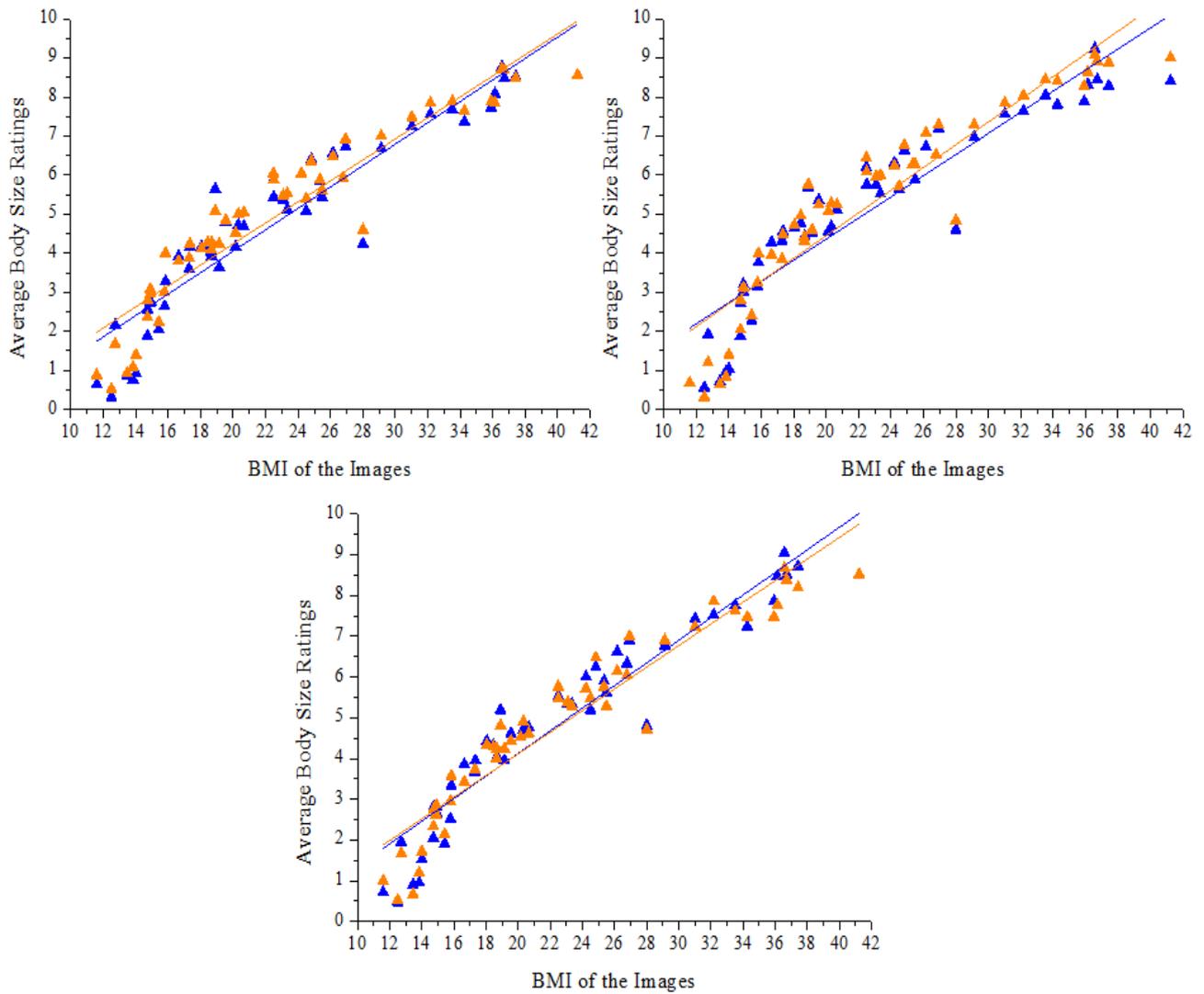
Figure 2.18. Comparing pre and post average body size ratings within groups, plotted against BMI of the images (female bodies). Data for the low calorie group is presented on the left, high calorie on the right, and control below. Pre experimental ratings are blue and post experimental ratings are presented in orange.

In figure 2.18 there is not much difference in average body size ratings between pre and post ratings for the low calorie group (left): the difference appears to be larger at images of a low BMI and becomes gradually less as BMI increases. The opposite pattern can be seen between pre and post ratings for both the high calorie group (right) and the control group (below), again with very little difference, but this time the difference in body size ratings for bodies at the lower end of the BMI spectrum is very small, and this difference appears to increase as the BMI of the images increases, suggesting a greater shift in preference post rating when the images are fatter.

A mixed-design repeated-measures ANOVA was then also calculated for both the slopes and the intercepts of this data to investigate any effects.

Table 2.6. Descriptive statistics for the mixed design ANOVA calculated on the body size slopes for the female bodies.

		Mean	SD
High Calorie (N= 23)	Pre	0.27	0.10
	Post	0.29	0.05
Low Calorie (N= 24)	Pre	0.27	0.05
	Post	0.27	0.05
Control (N= 21)	Pre	0.28	0.04
	Post	0.27	0.04

Data is table 2.6 would imply a lack of difference both between and within groups for body size slopes of female bodies, as all means were very similar (ranging from just 0.27 to 0.29) and variation around these means was minimal. When investigating these effects, the ANOVA results revealed no significant main effect of the time of rating (pre and post) on body size slopes, $F(1,65) = .193$, $p= .662$ ($r= .13$), and also no significant main effect of group (low, high calorie or controls), $F(2,65) = .135$, $p= .874$ ($r= .06$).
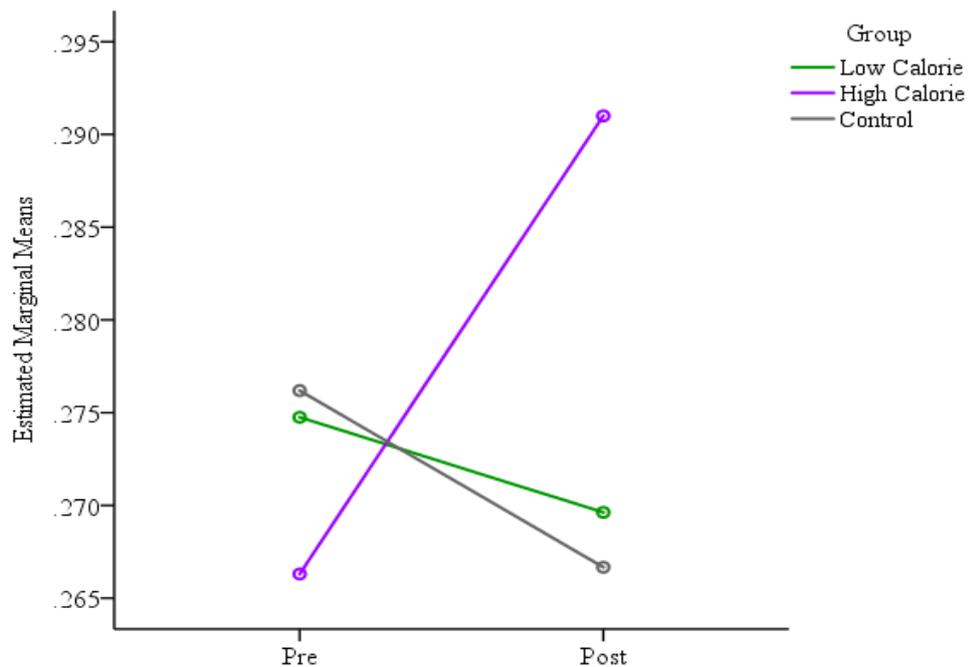
Figure 2.19. Interaction plot of the mixed design ANOVA of body size slopes for female bodies, comparing pre and post ratings for the low and high calorie groups.

Evidence from figure 2.19 suggests that in both the low calorie group and control group there was a slight decrease between pre and post body size slopes (slightly steeper decrease between pre to post rating for participants in the control group). However, for the high calorie group there was a large increase in slope between pre and post experimental conditions; although when looking at the y axis and table 2.6 it is clear that the increase was minimal (.27 to .29). However, ANOVA results found no significant interaction effect between pre and post conditions and low or high calorie groups, $F(2,65) = 2.00$, $p = .144$. The small effect size (r) of .20 also shows support for this lack of significant interaction.

This mixed design repeated-measures ANOVA was then repeated using the intercepts for body size ratings of the female bodies.

Table 2.7. Descriptive statistics for the mixed design ANOVA calculated on the body size intercepts for the female bodies.

		Mean	SD
High Calorie (N= 23)	Pre	-0.98	1.97
	Post	-1.42	1.19
Low Calorie (N= 24)	Pre	-1.46	1.13
	Post	-1.46	1.99
Control (N= 21)	Pre	-1.24	1.23
	Post	-1.20	1.12

In table 2.7 there appears to be no difference in mean body size intercepts between pre and post experimental ratings for participants in the low calorie group. For the high calorie group there is a difference between the pre and post body size intercept averages, however these are minimal (-0.98 to -1.42). These data are supported by the ANOVA results that reveal no significant main effect of time of rating (pre or post), $F(1,65) = .460$, $p = .500$ (effect size $r= .12$). There was also no significant main effect found for group (low/high calorie or control): $F(2,65) = .312$, $p = .733$ (effect size r= .10).
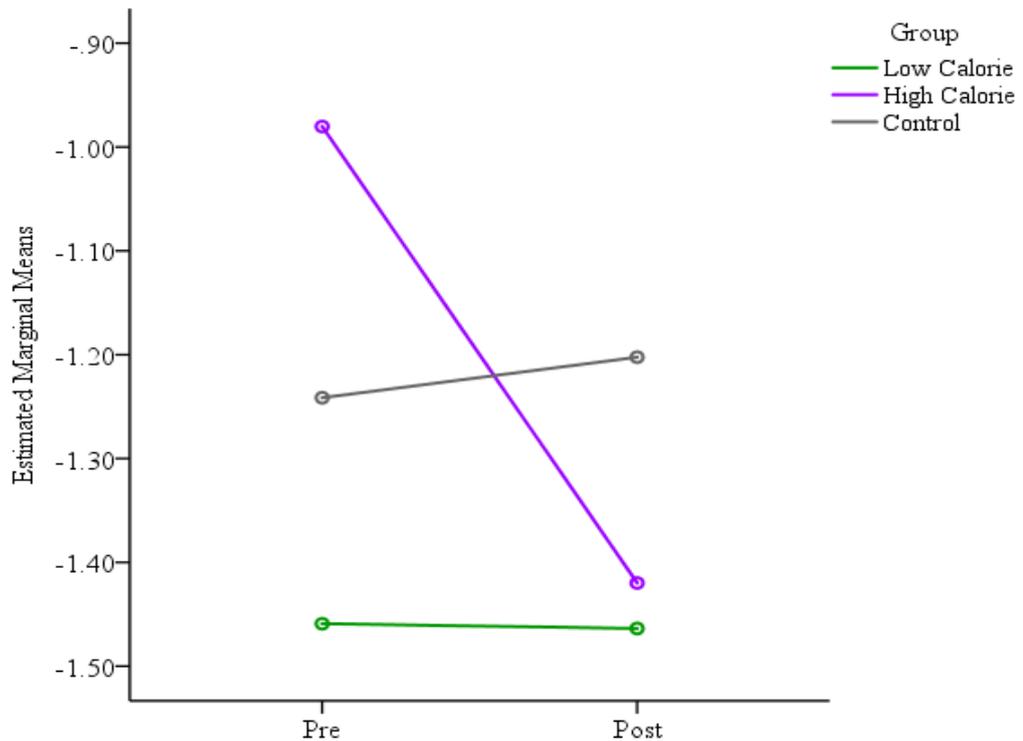
Figure 2.20. Interaction plot of the mixed design ANOVA of body size intercepts for female bodies, comparing pre and post ratings for the low and high calorie groups.

Looking at the data from figure 2.20 it would seem that there was no difference in body size intercepts for ratings in the pre experimental condition compared to the post for the low calorie group (something which was noticed earlier in table 2.7). Similarly, there appears to be only a slight difference in pre and post ratings for the control group, with just a small increase from pre to post being evident. However, for the high calorie group there appears to be a much larger difference in ratings between the conditions, with a much higher mean found for the pre experimental ratings than the post experimental ratings. The post experimental ratings for the low and high calorie groups appear to be very similar, while there was a large difference between the pre ratings of each group, with the high calorie group showing the highest mean for pre ratings, followed by the controls, then the low calorie group. Overall, there appears to be no relationship between the variables. This was given credibility by the lack of significant interaction effect found between time of rating and group, $F(2,65) = .5924$, $p =.556$ (comparisons here yield a very low effect size, $r= .12$).

2.5.2.2. Male Bodies

A correlation coefficient of .940 for pre body size ratings and .943 for post body size ratings, of participants in the low calorie group, again further reinforced the idea of a strong relationship between the ratings of male and female participants. Cronbach's Alpha performed on this data revealed α values of .977 (pre) and .975 (post), again supporting the idea that male and female observers were rating the images similarly. This would suggest that combining male and female participant data would be a logical progression in terms of future analysis.

For participants in the high calorie group, there was also a strong significant correlation between body size ratings of the two sexes (r = .949 for the pre ratings and r = .936 for the post ratings) shows a strong significant correlation between male and female body size ratings of male body images. This is further given support by a Cronbach's Alpha performed on the raw data, revealing strong, high α values of .961 (pre) and .966 (post) which again suggests the limited difference between the ratings of all participants in the high calorie group.
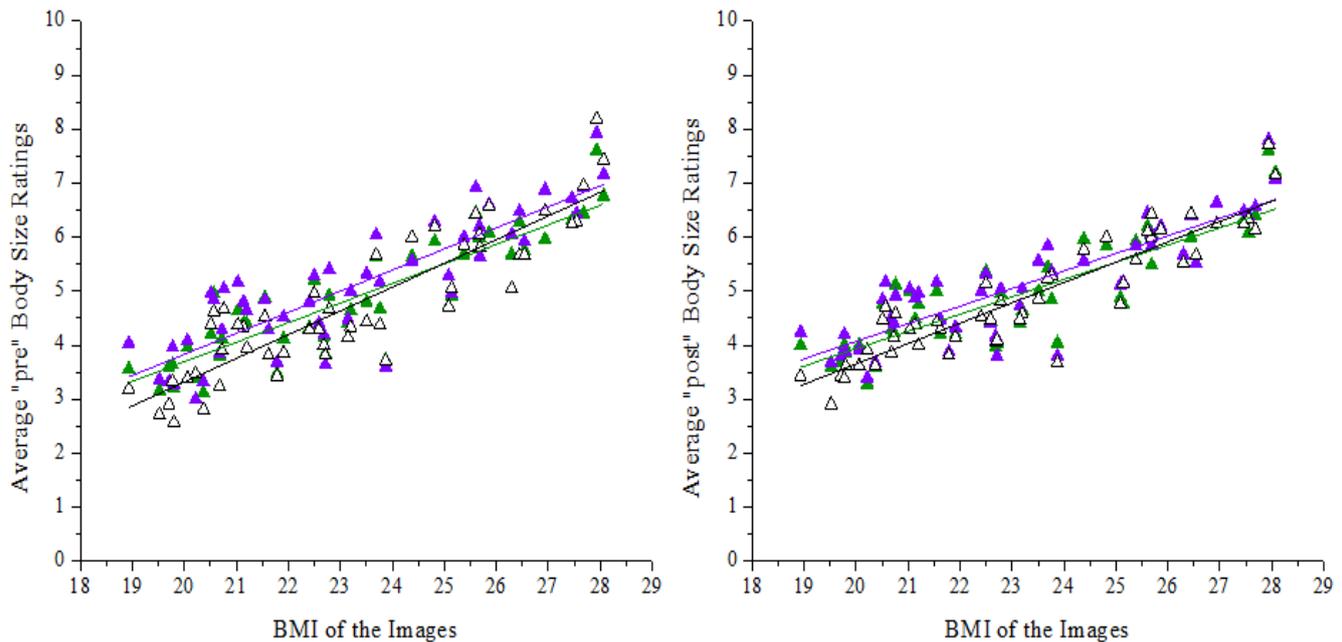
Figure 2.21 Average body size ratings plotted against BMI of the images used (male bodies). Pre ratings are presented on the left, while post ratings are presented on the right. Purple point/lines represent the high calorie group, green points/lines represent the low calorie group, and black points/lines represent the control group.

Figure 2.21 depicts the differences in pre ratings between groups and the differences in post ratings between groups. Overall there appears to be a general

positive linear relationship between average body size ratings and BMI of the images for both pre and post experimental conditions. On the left (pre ratings) there appears to be a larger difference in body size ratings between the groups, suggesting participants in the high calorie group (purple) rated bodies as larger overall than the low calorie group (green) and the control group (black). The difference between rating of the participants in the high and low calorie groups appears to become larger as the bodies increase in BMI, however, in direct contrast, the difference between the experimental groups and the control groups appears to decrease as BMI increases, with participants in the control group rating bodies of lower BMI as much smaller than participants in the other groups, while rating bodies of higher BMI more similarly to participants in the experimental groups. On the right (post ratings) there appears to be a similar difference between groups across bodies of all BMIs, with participants in the high calorie group again always rating bodies as slightly higher than participants in the low calorie group. Again, the graph in the right of figure 2.21 would suggest that participants in the control group also rated bodies of lower BMI as much smaller than their experimental group counterparts when rating the bodies for the second time.
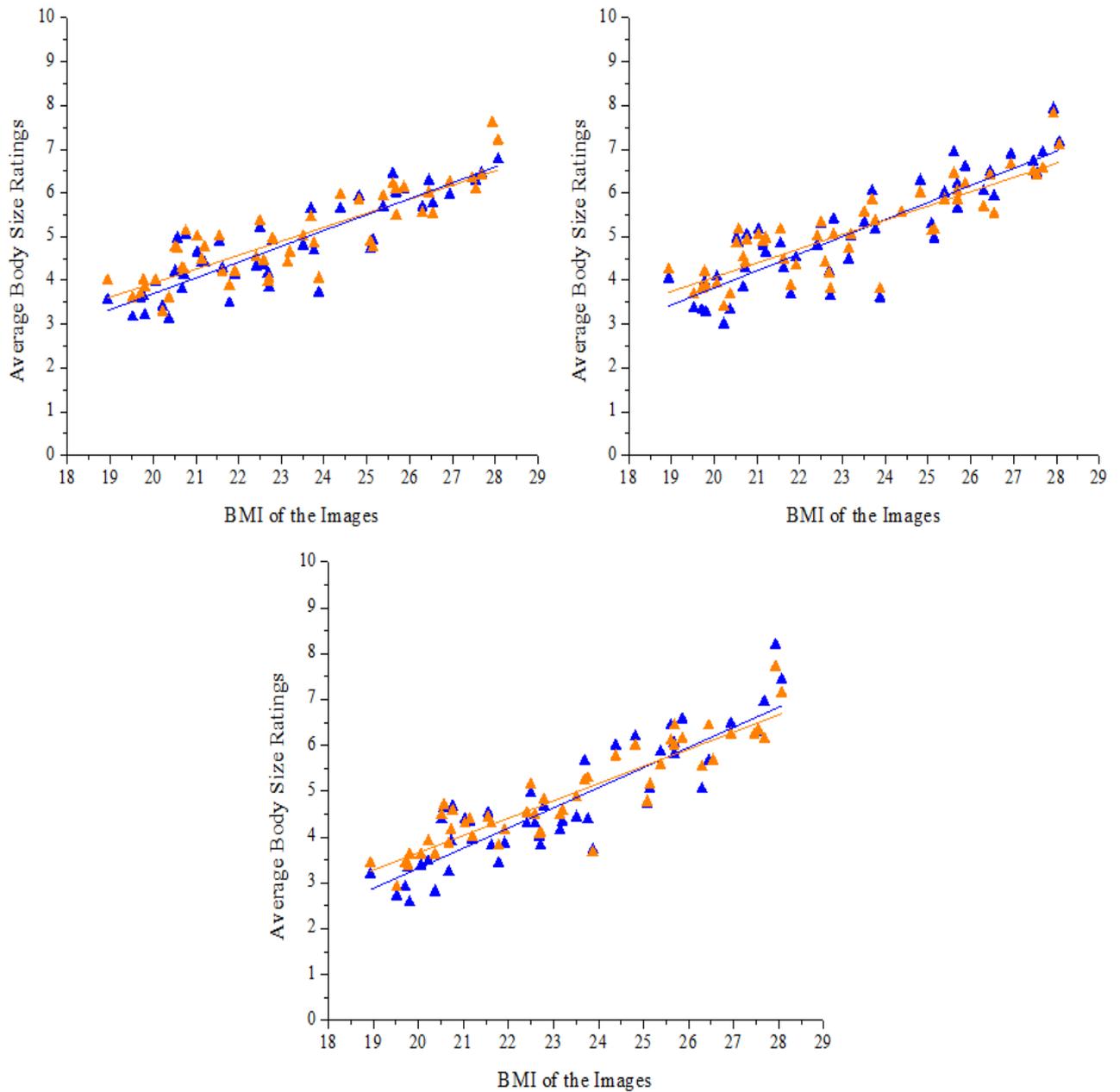
Figure 2.22. Comparing pre and post average body size ratings within groups, plotted against BMI of the images (male bodies). Data for the low calorie group is presented on the left, high calorie group on the right, and control below. Pre experimental ratings are blue and post experimental ratings are presented in orange.

Figure 2.22 shows a positive linear relationship between the variables, in that again, as BMI of the images increases participants' body size ratings increased. For male images, it appears that there was not much difference between pre and post ratings within each group. For both the low and high calorie groups, there was a slight difference in body size ratings for bodies at the lower end of the BMI spectrum, with pre ratings being lower than post ratings. However this difference diminished as bodies

became larger until the linear lines converged. For both the high calorie group and control group, there was an overlap in the pre and post regression lines at the larger end of the BMI spectrum: pre ratings started off as lower than the post ratings for bodies of a lower BMI, but then switched and became higher than the post ratings for bodies at the higher end of the BMI spectrum. This would suggest that during post-experimental rating, participants in both the high calorie and control group rated bodies of a larger BMI as smaller than they did during the pre-experimental phase.

Another mixed design repeated-measures ANOVA was therefore used to investigate if there was an effect of or an interaction between any of these variables for body size slopes and intercepts when looking at males bodies.

Table 2.8. Descriptive statistics for the mixed design ANOVA calculated on the body size slopes for the male bodies.

		Mean	SD
High Calorie (N= 23)	Pre	0.39	0.14
	Post	0.33	0.12
Low Calorie (N= 24)	Pre	0.36	0.10
	Post	0.32	0.09
Control (N= 21)	Pre	0.42	0.09
	Post	0.36	0.07

Data in table 2.8 shows that there was a slight decline in body size slopes between pre and post ratings within each group. However there would appear to be little difference between groups. ANOVA results for this data revealed a significant effect of time of rating (whether it was pre or post) on body size slopes for male bodies, $F(1,65) = 27.54$, $p < .001$ (with a moderate effect size of .54) There was however, no significant main effect of group (whether participants were in the high-, low- calorie group or control) on the body size slopes, $F(2,65) = 1.34$, $p = .268$. This insignificant comparison was supported by a very low effect size of $r = .10$.
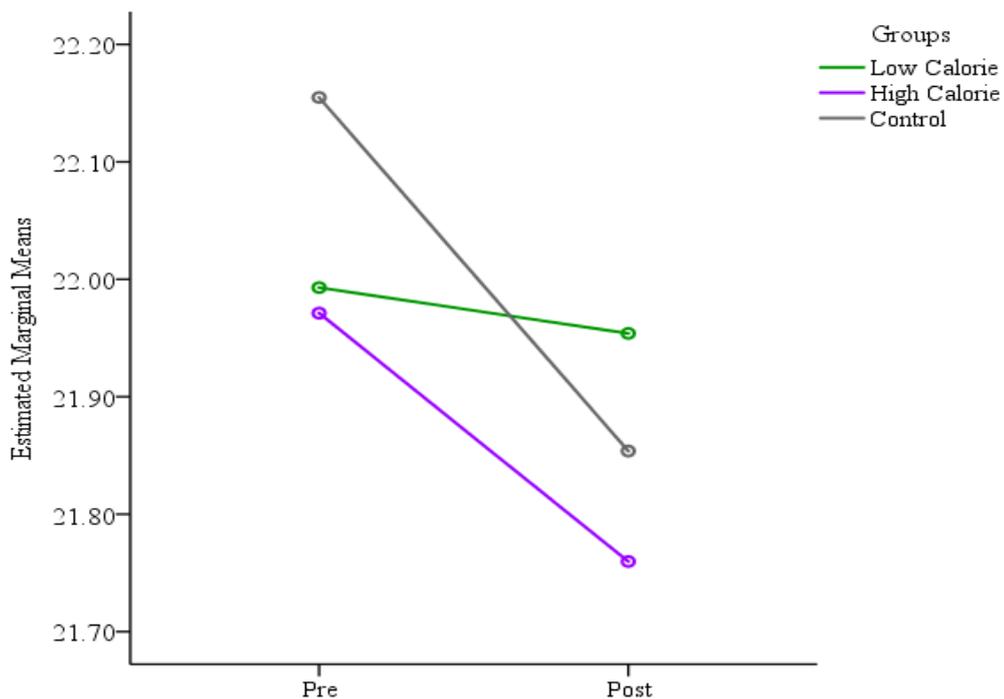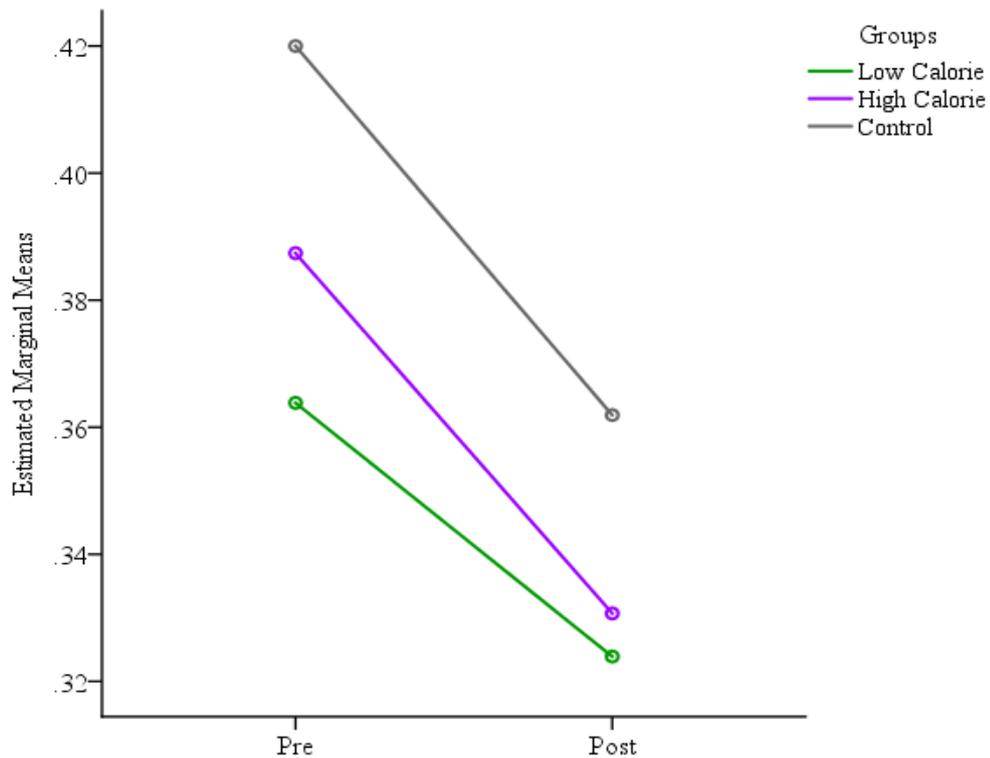
Figure 2.23. Interaction plot of the mixed design ANOVA of body size slopes for male bodies, comparing pre and post ratings for the low calorie, high calorie and control groups.

Figure 2.23 shows that there was a decline in body size slopes between pre and post body ratings for each group; however the body size slopes for the high calorie group appear to decrease at a slightly faster rate. When making comparisons between the groups, there was a larger difference between the low and high calorie groups in the pre experimental condition compared the post experimental condition. In addition, the control group means were higher than both the experimental conditions' for both pre and post ratings, and while slopes appeared to converge between the groups at post-rating, this was not the case for the control sample. Results suggest that this comparison of slopes between groups and the comparison of pre and post ratings within each group does not show a significant interaction, $F(2,65) = .363$, $p = .697$ (with a close effect size of $r = .07$).

This mixed design repeated-measures ANOVA was then repeated using the intercepts for body size ratings of the male bodies.

Table 2.9. Descriptive statistics for the mixed design ANOVA calculated on the body size intercepts for the male bodies.

		Mean	SD
High Calorie (N= 23)	Pre	-3.91	3.40
	Post	-2.54	2.86
Low Calorie (N= 24)	Pre	-3.62	2.47
	Post	-2.60	1.98
Control (N= 21)	Pre	-5.01	2.19
	Post	-3.54	1.67

Table 2.9 shows that there was a slight decrease in intercepts within each group between pre and post experimental ratings (more so for the control group than experimental groups), however when comparing the pre ratings between experimental groups and the post ratings between the experimental groups there was very little difference apparent. However, the standard deviations for these intercepts tell us that there was a much wider variation in intercepts around the mean. In addition, it is also clear from table 2.9 and figure 2.24 that the control group displayed much lower intercepts than the experimental groups and even though they increased with post-rating, this only just brought it in line with the other groups. ANOVA results for this data revealed a significant effect of time of ratings (pre or post) on the body size intercepts when looking at male bodies, $F(1,65) =28.43$, $p <.001$. However, there was no significant main effect of group (low or high calorie), $F(2,65) = 1.69$, $p = .192$. The significant effect of pre/post yields a moderately high effect size $(r= .49)$, while the non-significant effect of group results is a low effect size $(r= .02)$.
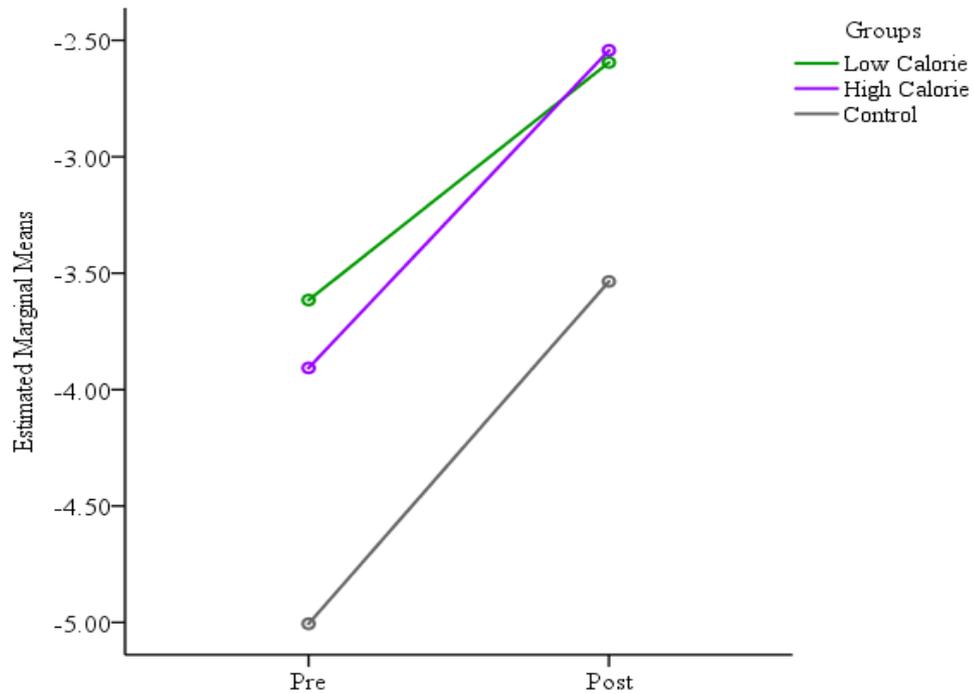
Figure 2.24. Interaction plot of body size intercepts for male bodies, comparing pre and post ratings for the low and high calorie groups and control group.

From figure 2.24 we can see that there is a relatively large difference between pre and post rating intercepts for both the low and high calorie groups, however the intercepts appear to increase more rapidly between pre and post rating for the high calorie group, compared to the low calorie group. When looking individually at the pre and post intercept conditions, we can see that there is a much larger difference between the low and high calorie groups for pre-ratings intercepts, compared to a much smaller difference between them for the post condition. In addition, there appears to be a small cross-over in groups for the post condition, with the high calorie group intercept becoming higher than that of the low calorie group.

The ANOVA data for the Interaction effect of these variables, suggests a non-significant relationship, $F(2,65) = .323$, $p = .725$. This comparison also yields a very small effect size ($r = .08$).

Finally, it was necessary to investigate if there was any effect of the yoghurt drink on hunger levels of the participants, as so far, data did not show any effect of group on ratings for body size or attractiveness.
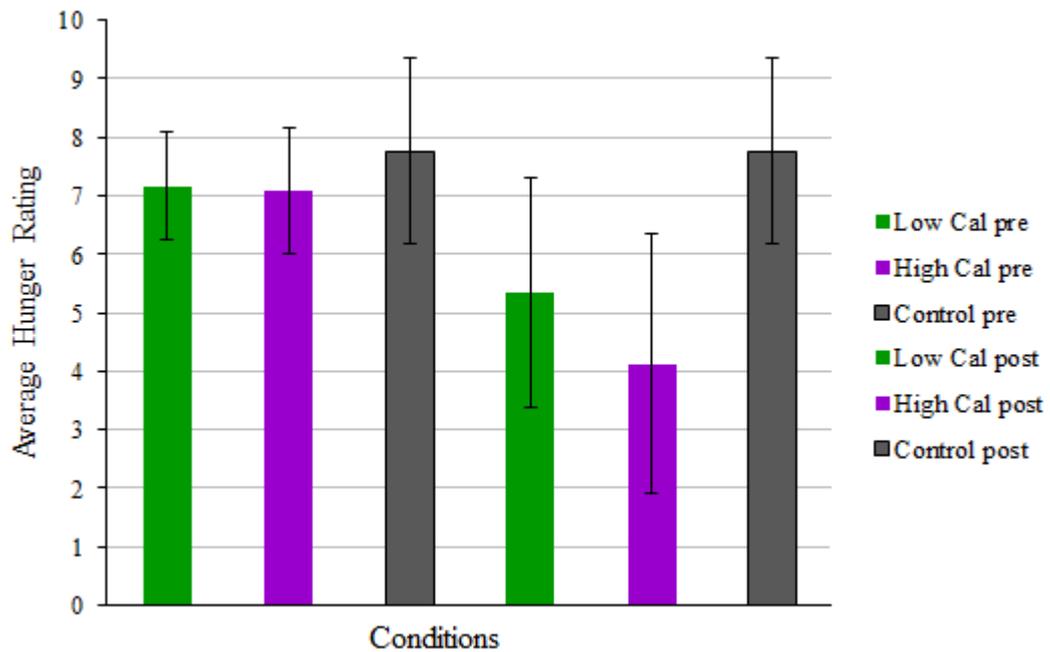
Figure 2.25. Pre and post average hunger ratings for each condition and each group; error bars represent ±1 standard deviation.

Figure 2.25 illustrates a decrease in hunger ratings between pre and post conditions for both experimental groups but not so for the control group. However, if there had been a significant effect of the yoghurt drink on the participants one would expect a significant difference in hunger ratings between the low and high calorie groups during the post-rating condition (as the high calorie group should feel satiated after their drink). However, an independent samples t-test revealed that there was no such significant difference between the low calorie (mean= 5.33, SD= 1.97) and high calorie (mean= 4.13, SD= 2.22) post-rating hunger scores, $t(45)$, $t = 1.97$, $p = .06$ (2-tailed).

2.6. Discussion

The objective of these studies was primarily to establish whether changes in body size preferences are determined by a psychological (resource scarcity) or a physiological (hunger) cue. Results from *study 1* found no significant difference in peak BMI or body size slopes/intercepts, suggesting that the significant difference in hunger between those who had fasted and those who had not had no resulting effect on their perception of size or preferences.

Results from *study 2*, a significant effect of time of rating (pre and post) on male and female bodies, but no effect of group, suggests that there was a difference between pre and post ratings for participants in all 3 groups, including controls. This would therefore suggest that any differences found were due to repeated exposure to the images rather than anything to do with hunger. This therefore makes it very difficult for us to make any firm conclusions about the effect of hunger on body image preferences from the results of *study 2*.

Previous research has demonstrated that hungry males find a larger female body more attractive than their satiated counterparts (Nelson, & Morrison, 2005; Swami, & Tovée, 2006), however this is not a finding replicated in the results presented in this chapter. The current studies suggest that changing body size preferences is more complex than previously thought.

These results can also be considered from an evolutionary perspective; it has been consistently found that males place far more emphasis on physical attractiveness when choosing a mate, whereas women tend to value qualities such as intelligence, social status and financial security (Buss, 2006). Therefore body size preferences for male bodies may not change as a consequence of resource scarcity (cued by hunger) as perceptions of male physical attractiveness may not be determined by an evolutionary cue. However, due to the results from the control sample in *study 2*, this cannot be stated as fact. In addition, it may be that male and female participants place differing levels of importance on particular bodily features, therefore creating differences in their perception of what is attractive (however Cronbach's alpha calculations on the data would suggest that this is not the case).

The present study used real images of males and females and was thus able to more sensitively evaluate body size preferences in comparison to studies which have used line drawings. These images are a much more realistic representation of real

bodies, and are thus likely to produce more valid ratings of attractiveness and body size. The results of the present research can also be easily compared to a number of previous studies which have used this same set of stimuli (Swami, & Tovée, 2006). Furthermore, the present studies used BMI as a measure of body size; this has been reliably shown to be the primary predictor of attractiveness ratings for female bodies, most likely because it is a good proxy of health and fertility (Frisch, 1987; Lake et al., 1997; Manson et al., 1995; Reid, & van Vugt, 1987; Swami, Neto, et al., 2007; Swami, & Tovée, 2005, 2006; Swami, & Tovée, 2007).

However research using similar stimuli to those used in the present studies, have considered BMI, WHR (waist-to-hip ratio) and WCR (waist-to-chest ratio) as contributors to male physical attractiveness and found that WCR is the primary predictor of attractiveness ratings of male bodies and accounts for the greatest variance within these ratings (Fan, Dai, Liu, & Wu, 2005; Fan et al., 2007; Maisey et al., 1999). Maisey et al. (1999) demonstrated that WCR was the primary determinant of male physical attractiveness and accounted for 56% of the variance in ratings, while BMI accounted for only 12.5%. Again this can be linked to evolutionary theory; as BMI is a reliable predictor of women's health, WCR is influenced by testosterone levels which may signal dominance, a trait often sought in men (Barber, 1995). It is therefore possible that BMI is not a reliable measure of male physical attractiveness ratings (Price, Pound, Dunn, Hopkins, & Kang, 2013; Swami, Smith, et al., 2007), as used here, and this could be cited as one reason there was no peak shift in attractiveness for male bodies.

However this study does not lend support to the idea of temporary affective states producing variation in body size preferences, and therefore does not support the variation found both across cultures and with varying SES (Swami, & Tovée, 2005, 2006). A wealth of research has shown cross-cultural differences in body size preferences and more recently empirical evidence indicates that these preferences are malleable; changing when observers move from one culture to another (Tovée et al., 2006); the same pattern has been observed within cultures, with varying SES (Swami, & Tovée, 2005). However, it may just be that in this study, hunger was not controlled for to a large enough extent, therefore this may not be an accurate representation of the effects of temporary affective states on body size preferences. Moreover, empirical tests of environmental security hypothesis (Pettijohn, & Tesser, 1999), which denotes that where an individual experiences insecurity they will choose a mate who will help them

to overcome this, have shown that body size preferences vary according to local historical economical contexts (Swami, Caprario, et al., 2006). One such study (Pettijohn, & Jungeberg, 2004) showed that males, who were hungry, preferred a larger female body to those who were satiated, a finding consistent with .

Even if the mechanism that determines body size preferences does have an evolutionary basis it will not occur outside of the social context and it therefore makes more sense to view these judgements in relation to individual resource scarcity(Swami, & Furnham, 2008; Swami, & Tovée, 2006). In order to do so, it is essential to consider the inter-play between individuals and their environments; specifically the culture in which they live. A central facet of Nelson and Morrison (2005) is the interaction between the individual and the collective; a core component of cultural psychology and in particular the theory of mutual constitution (Fiske, Kitayama, Markus, & Nisbett, 1998; Kim, & Markus, 1999; Kitayama, Markus, Matsumoto, & Norasakkunkit, 1997). According to this theory, psychological and socio-cultural mechanisms are placed in a feedback loop in which one inevitably constitutes the other(Swami, & Furnham, 2008). Thus in order to understand any psychological phenomenon like body size preferences it is essential to examine the 'collective reality' that underlies these preferences.

The collective reality is comprised of socio-culturally and historically rooted notions, values, institutions and social practices and it is upon these that attitudes and behaviours are formed. These notions are communicated to individuals via cultural specific practices like mass media publications, educational institutions and religious practices, thus shaping their preferences. Since these will be expressed in the social life of a culture, it has been proposed that they can be easily identified. In other words an individual's interactions with their environment will shape their psychological experience; consequently the values they are exposed to will become internalised and affect their judgements and preferences (Kim, & Markus, 1999).

This interaction between the individual and the collective reality explains why judgements of attractiveness vary according to SES, as judgements of attractiveness could be based on the individual assessment of resource scarcity (Swami, & Tovée, 2006). According to Nelson and Morrison (2005) theory, in environments where resources are scarce, it is probable the individual will lack resources themselves, and this is likely to be the case in low SES contexts. Consequently the affective and physiological states associated with this lack of resources provide implicit information that shapes the individuals preferences and behaviour. This idea is supported throughout

the literature since physiological states can have a direct effect on judgments in a variety of areas; affective states often serve to give us information about the environment, and feelings are widely acknowledged as influencing behaviour (Cacioppo et al., 1996; Nelson, & Morrison, 2005; Schwartz, 1990).

This may also explain why males and females were rating images in the same way, since individuals in the present studies would have been exposed to the same collective reality. In other words they are all living in the same social environment with the same socio-culturally and historically rooted notions and values, institutions and social practices such as educational institutions and the media. Therefore it is likely that they would consequently internalise similar attitudes and preferences, hence they rated similarly sized bodies as most attractive (Kim, & Markus, 1999). It is also plausible that males and females hold the same attractiveness judgements because one predicts the other; what males find attractive females then strive for in themselves, in order to attract these males, and vice versa.

2.6.1. Limitations

There were a number of limitations in these studies. Although asking participants to fast and then self-report their hunger on a scale of 0-10 was a more stringent approach to previous studies that used whether individuals were entering or leaving the dining hall to generate hungry and satiated participants (Nelson, & Morrison, 2005; Swami, & Tovée, 2006) it still had limitations. Firstly it was impossible to establish whether or not participants had fasted, and if they were initially hungry; individuals may have said they were hungry when they weren't since they knew they should have fasted. In order to try and control for this, participants were required to sign an honesty declaration stating that they had followed the fasting procedure, although this meant most participants dropped out before taking part if they hadn't fasted, without a more reliable measure of hunger it is not possible to ascertain that all participants had fasted. In order to overcome these limitations future studies should use a more reliable measure of whether or not participants had fasted, such as measuring blood glucose levels.

In addition, while there was a clear difference in hunger levels between the control and experimental conditions in *study 1*, suggesting hunger was effectively controlled for, there was no significant difference in hunger levels between groups within the experimental condition. It would therefore seem plausible to suggest that this

study did not adequately measure individual's perceptions of time until satiation (the difference between the groups). Participants were told at the end of the study they would either receive food or have to wait a further 2 hours to eat; however they also knew that they could leave the experimental setting during the time and so obtain food unobserved before they returned for final testing. This could have potentially accounted for the fact that no hunger difference was found for the two groups. Future research should therefore use a better method of manipulating participant's beliefs about future food availability. Furthermore it could be argued that waiting two hours is not representative of an unconditional waiting period, experienced by those in some cultures lacking in resources.

It is also acknowledged that a priori power calculations are the norm (Cohen, 1988); however, they were conducted post-experiment in this study. This was because the effect that I was testing had already been found in previous research (in male undergraduates) therefore I assumed that this would be the case for female undergraduates too in a similar size sample. In retrospect it would have been better to conduct this analysis prior to carrying out the study in order to investigate effect size and the number of participants I would need in advance to reach this effect.

2.6.2. Conclusion

In conclusion, the present research attempted to investigate the effects of hunger on body size preferences. However results were inconclusive as to whether hunger is determined by psychological or physiological cues, as no effects of hunger were found whatsoever, contradicting all previous research. It is therefore impossible to draw any conclusions about the influence of hunger on perception of body size from the results presented in this chapter. Further research would be needed in order to establish these effects, and as mentioned previously, we suggest a change in methodology as the key to establishing the true effect of hunger and the extent to which it can affect preferences for a particular body size.

Chapter 3: The effects of torso-length on perceptions of female body shape and weight

3.1. Introduction

A growing body of research has attempted to identify the physical characteristics that are considered attractive because they provide cues to fertility or our ability to successfully reproduce (Gangestad, & Simpson, 2000; Smith et al., 2007). In women's bodies, it is suggested that there are 2 important cues to this success: body shape (categorised by the waist-to-hip ratio (WHR), and weight scaled for height (BMI). However, more recently traits investigated in relation to reproductive success have also included breast size, height, body symmetry (fluctuating asymmetry or FA), leg-to-body ratio (LBR) and Androgyny Index (AI) (Frederick, Fessler, & Haselton, 2005; Frederick, Hadji-Michael, Furnham, & Swami, 2010; Frederick, & Haselton, 2007; Furnham et al., 2006; Salska et al., 2008; Swami, Einon, & Furnham, 2006, 2007; Swami, Jones, Einon, & Furnham, 2009; Swami, & Tovée, 2005).

For female body shape, research has mainly focused on WHR. Before puberty, both males and females have a WHR of approximately 1.0. At puberty, in females, this decreases to as low as 0.7, and subsequently rises again during menopause (Ley et al., 1992). A large WHR is related to a decrease in fertility, and this can be a result of conditions such as pregnancy, menopause or Polycystic Ovary Syndrome (PCOS) (Pirwany, Fleming, Sattar, Greer, & Wallace, 2001; Wass et al., 1997; Zaadstra et al., 1993). Other factors such as diabetes can also cause an increase in WHR (again correlated with a decrease in fertility).

As discussed previously, many studies have found that both male and female observers find a female WHR of 0.7 to be most attractive (Furnham, Lavancy, & McClelland, 2001; Furnham et al., 1997; Henss, 1995, 2000; Singh, 1993a, 1993b, 1994; Singh, & Luis, 1995; Singh, & Young, 1995), a preference that is evident across many countries, i.e. Cameroon- (Dixson, Dixson, Morgan, & Anderson, 2007); Germany- (Henss, 2000); China- (Dixson, Dixson, Li, & Anderson, 2007); the US and New Zealand- (Dixson, Dixson, Bishop, & Parish, 2010). This can be measured in two

different ways. The actual WHR is measured by the distance around a woman's waist divided by the distance around a woman's hips. Alternatively, another way to measure WHR when your only stimuli is a 2D image, is to measure the distance across the waist and divide it by the distance across the front of the hips. The important difference between these two measures is that actual WHR is correlated with fertility as slim waists and fat deposition on the hips and thighs are associated with increased levels of oestrogen and progesterone (Jasienska et al., 2004; Lipson, & Ellison, 1996; Wass et al., 1997), whereas WHR measured across the front of the body is just a visual cue to this. There is only a relatively weak correlation between actual WHR and its visual cue: 2D WHR (r= .60) compared with a correlation of .97 between BMI and its visual cues (Tovée, & Cornelissen, 2001). Confusion between these 2 measures may have led to an overestimation of the importance of the role of actual WHR in determining attractiveness judgements.

As it stands, current research suggests that a low WHR (a very curvy body) should be optimally attractive as this is an indicator of fertility (Wass et al., 1997; Zaadstra et al., 1993), something which has been reinforced by further studies using line drawings of female bodies, ranging in BMI and WHR, which are rated for attractiveness (Furnham et al., 1997; Henss, 1995; Singh, 1993a, 1993b, 1994). However, in these studies, when the bodies are modified by altering the width of the torso, it not only alters the waist but also the BMI, making it impossible to state whether the attractiveness ratings were made based on weight or shape of the bodies (Tovée, & Cornelissen, 1999).

Furnham et al. (2005) attempted to resolve this problem by increasing the size of the arms and legs as the waist width was decreased (in an effort to keep the weight constant). However, this resulted in an unrealistic representation of the body fat distribution in a female body (Garn, Sullivan, & Hawthorne, 1987). Eye movement data (George, Cornelissen, Hancock, Kiviniemi, & Tovée, 2011) also suggests that subjects only focus on the torso when making attractiveness judgements, therefore increasing the size of arms and legs will have little to no effect on perception of attractiveness. Alternative studies have further attempted to combat this problem by artificially increasing or decreasing torso width in photographs of real women instead of line drawings, however again this method was criticised due to the unrealistic nature of the images produced.

A study using Principle Component Analysis deliberately used body stimuli that clearly demonstrated an inverse correlation between BMI and WHR (images that get curvier as they increase in weight), with the rationale that if WHR was the most important predictor of attractiveness then the more curvaceous the image (with a higher BMI) the more attractive it would be judged, while the opposite would be found if BMI was the better predictor (Tovée et al., 2002). Subjects were asked to rate 60 front-view digital photos of real women, ranging in size across the BMI spectrum. Results suggested that the more curvaceous bodies (but higher BMI) were judged as least attractive- opposite to what would be expected if WHR was the most important predictor of attractiveness. This therefore provided support for the idea that judgements of attractiveness are based more on information about size than shape.

Following on from this, in the same study, Tovée et al. (2002) investigated if WHR was even an adequate measure of body shape. Waveform Analysis (Principle Component Analysis (PCA) and Independent Component Analysis (ICA)) was used to determine which components of the body are good predictors of attractiveness. The torso in each image was divided into 31 slices of equal thickness and a waveform was generated by plotting the width of each slice against its position on the body. Results suggested that components linked to body size were good predictors of attractiveness (strong correlations between BMI and attractiveness ratings), whereas those linked to shape were not (weak correlations found between attractiveness ratings and components relating to WHR and WCR).

This is given further support by the finding of a considerable overlap in WHRs of populations of normal and anorexic women (Tovée et al., 1997). Anorexic women suffer from Amenorrhea (Golden, & Carlson, 2008; Miller et al., 2005; Roberto et al., 2008), therefore have little or no fertility (Bulik et al., 1999; Frisch, 1996; James, 2001). It is therefore possible for someone with no fertility to have the same WHR as someone with normal fertility. This would suggest that WHR as a cue to attractiveness and therefore fertility and mate potential would be weak, and instead, BMI would be the better predictor of true attractiveness and mate quality. In two studies (Voracek, & Fisher, 2002, 2006) 577 consecutive issues of Playboy magazine were sampled from 1953-2001, analysing measurements of their centrefold models. From raw measurements they calculated BMI, WHR, BWR, BHR (bust-hip ratio) and AI (Androgyny Index), and concluded that all measures (excluding weight) showed a

significant temporal change, with BMI and BHR decreasing and WHR, BWR and AI increasing over the years. These results appear to show that neither WHR of BMI have remained stable over time, and in recent years centrefold bodies have become more androgynous and less curvaceous.

This is further supported by Voracek & Fisher who explain a difference between curvaceousness and androgyny as cues to female physical attractiveness. These differences can be seen most when comparing the types of models used in glamour magazines compared to those used on catwalks. Glamour models on the whole appear to be more curvaceous, with smaller waists in relation to fuller bust and hips, compared to catwalk models who appear more tubular/androgynous in shape. As WHR has long been said to be a proxy of female fertility, we would assume that WHR would be the best predictor of physical attractiveness. However, studies such as Kirchengast and Winkler (1996) who investigated perceived attractiveness in tribal people of Namibia, found that lighter weight women had significantly more reproductive success than larger females. In addition, Voracek and Fisher (2006) go further and suggest that women with low BMIs also display signs of attractiveness such as tissue firmness, "sexy gait", and gracious movements, all of which may signal increased sexual drive which in turn may lead to increased reproductive potential and success. It would therefore be adaptive for males to prefer these lower BMI females.

This BMI interpretation of "sexy gait" would seem to be countered by the results of Johnson and Tassinary (2005) which suggests that WHR is a significant cue when emphasised by walking. However, the Johnson & Tassinary stimuli not only look very unrealistic, but also repeat the co-variation of body mass with WHR. As a result, they fail to distinguish between BMI or WHR in the effect they report. In addition, research into WHR often assumes that this measure is independent of other body features. More recently, advances in this field have included studies that explore WHR's potential co-variation with BMI, but none have considered the fact that it may also be affected by torso length.

While leg length and LBR have been extensively studied, another anthropometric variable linked to these which appears to have been overlooked in this field is the contribution of torso length to the perception of body size, shape and attractiveness. A person's torso length will potentially affect the rate of change of curvature on the torso which may in turn alter the perception of WHR; i.e. will the same

WHR on a short versus long torso appear different? I suggest that WHR will be affected by the length across which it appears.

Supermodels are commonly thought to be less curvy because they are "thinner" and have a more "androgynous" look. However, this may not be the case. Studies (Tovée et al., 1997) have shown that on average, supermodels are 11cms taller than the average female but actually do have an hour glass figure (denoted by bust-to-hip ratio and WHR) therefore what may appear to be a tubular body shape may actually just be curves appearing over a longer surface area. People with the same waist-to-hip ratio can often have very different appearances because of the length of their torsos.
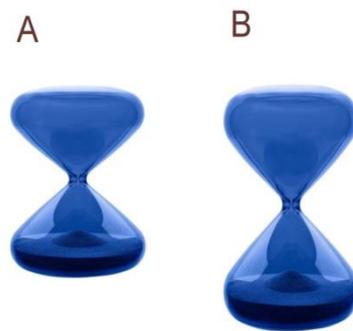
Figure 3.1. A schematic illustration of how a shorter hourglass (A) can appear curvier than a longer hourglass (B) although their circumferences are the same.

No research currently exists that specifically investigates the effects of torso length on the perception of curvaceousness of a body. The study reported in this chapter will investigate this by creating a series of bodies varying in torso length and waist width. Additionally, it will also investigate the effects differing body size may have on the estimation of curviness, i.e. will the adiposity of a torso influence its perceived curvaceousness? Moving on from the previous chapter, stimuli in this study will comprise of computer generated digital images as I thought that real photographs of female bodies would introduce to many different variables other than just differing torso length. Instead, using digital computer images will allow me to create a series of bodies increasing in equal increments of torso length, all with the same skin tone- effectively the same woman but with a variety of different torso lengths. This will allow me to better say that any effects are due to torso length over any other possible variable. Previous research that has used computer-generated manipulations of body shape to represent female body shape in the general population, i.e. Streeter & McBurney (2003) used stimuli that were very unrealistic, showing a lack of ecological validity. I therefore

took great care when making my images to ensure that they appeared ecologically valid in that torso length was not stretched too much or compressed too much to ensure that they were as accurate as they could be in representing a variety of different body shapes, i.e. WHR and BMI within the normal range for health and fertility: 0.6-0.8 for WHR (Singh, 2002) and 18.5-24.9 for BMI (NHS, 2014).

3.2. Study 1

3.2.1. Participants

As both male and females view bodies in the general population, it did not make sense to limit participants to a purely female sample. Instead, we recruited both males and females in order to investigate the effects of torso length. In addition, in chapter 2 it was shown that male and female participants rated bodies in a similar way (Cronbach's alpha) and no significant difference was found between the ratings of each sex (independent samples t-tests) therefore it was assumed that in this study, as we were not investigating sex differences in preferences for a particular torso, we could recruit both sexes as a combined sample as this would not affect the outcomes of the study as males and females would rate bodies similarly.

20 male (mean age: 28.10; SD: 6.69) and 26 female (mean age: 24.73; SD: 5.75) participants were recruited for this study through the use of social networking sites such as Facebook. This study was approved by the Faculty of Medical Sciences ethics committee at Newcastle University (00626/2013; 00626_1/2013).

3.2.2. Stimuli

The interactive 3D software modelling interface Daz3D Studio version 4.5 (from Daz3d.com) was used to create a series of 10 bodies differing in torso length.

This program allows the adjustment of photo-realistic female 3D models on a flat panel screen in order to modify different aspects of the body's features. The female model used was Victoria 5 (V5) from Daz3D wearing Hongyu's bikini for V5. The program allows the body to be rotated to allow a 360° view of the model, however for this study the body was fixed to face the viewer face-on as this was thought to show the curviness of the body/hourglass shape. Bodies were created using a set of graphic sliders which allow different aspects of individual body parts to be altered (using the Genesis Evolution Body Morphs add-on packages from Daz3D). When the slider is

91

adjusted, the model simultaneously changes, providing immediate visual feedback (see figure 3.2 for a screenshot of the programme used). In this study, only torso length is adjusted; the torso circumferences are unchanged.
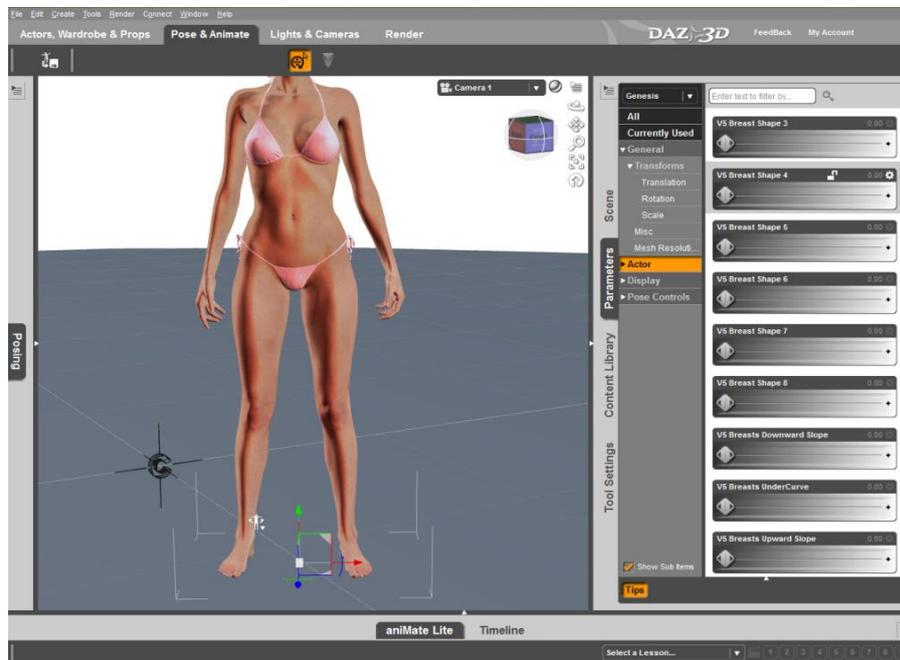
Figure 3.2. An example of the Daz3D version 4.5 interface, with an example of a female body created in the software package. Along the right of the picture are some of the 94 sliders which allowed different parts of the body to be independently altered.

10 bodies increasing in equal increments of torso length were created in order to generate a greater range of torso lengths and therefore a better effect. These bodies were again created using the "torso length" slider and then rendered as "jpeg" images at 310x330 pixels resolution, following which they were exported into Adobe Photoshop, where only the torso (from the neck to the pubis) was selected. These torso-only images were then re-saved as "jpeg" images and used as the stimuli. See figure 3.3 for examples of the bodies created. Qualtrics online survey software was used for the presentation and rating of the images.

Figure 3.3. An example of the torso-only images shown to participants (torso length increases from left to right).

3.2.3. Design

A within-subject repeated-measures design was implemented for this study as all participants were required to rate all 10 images on 3 scales (curviness, body size and attractiveness) twice, therefore meaning they made a total of 60 judgements- 3 ratings of 10 bodies x2. The independent variable was the images themselves and the varying torso length; while the dependent variable was the rating the participants gave each image on scales of attractiveness, body size and curviness.

3.2.4. Procedure

A link to the questionnaire was posted on Facebook with a request for male and female participants over the age of 18. Therefore by following the link to the questionnaire, people were giving their consent to participate. Having followed the link, participants were immediately given a written brief of what the questionnaire entailed and were informed that they were free to withdraw at any point if they became uncomfortable with the material or the questions that were being asked. Participants wanting to withdraw from the study were informed that to do so they simply had to close the browser page. Qualtrics was pre-programmed by the experimenter not to record incomplete surveys; therefore by closing the browser, participants could remove their answers from the database of responses.

Participants were firstly asked to provide us with demographic information (age, height, weight etc.), following which they were presented with the 20 bodies in a randomized order. Each body was shown on a separate screen, below which were the 3 rating scales in slider format (see figure 3.4).

Figure 3.4. A screenshot of an example question that participants were faced with.

Participants could take as long as they wanted to judge the bodies (this was not a reaction time task) following which they could slide the marker anywhere from 0-10 for attractiveness, body size, and then curviness. Participants pressed the arrow in the right hand corner of each screen to progress to the next image. Forced response was used so that participants could not accidentally miss out any responses. Again reaction time was not recorded. At the end of the questionnaire, participants were presented with an online explanation of the rationale behind the study and contact details for the experimenters should the participants had any further queries.

3.2.5. Data Analysis

As participants viewed the bodies in front-view only and not in 3D, it was decided that measurements around the 3D body would not be appropriate representations of what participants perceived. Therefore, measures of the waist, hips and chest as well as measures of torso and length were taken using pixel-ruler (http://pixel-ruler.en.softonic.com/), simply measuring the distance across the body (table 3.1).

Table 3.1. Measurements of each of the 10 bodies, taken using pixel-ruler. As the data shows, WHR and WCR remained constant as torso length increased; therefore any effects found would be due to torso length, instead of changing waist, chest or hip size.

Body	Torso Length (pixels)	WHR (pixels)	WCR (pixels)
1	299	0.58	0.64
2	302	0.58	0.64
3	305	0.58	0.64
4	308	0.58	0.64
5	311	0.58	0.64
6	314	0.58	0.64
7	317	0.58	0.64
8	320	0.58	0.64
9	323	0.58	0.64
10	326	0.58	0.64

Before the analysis took place, the data was plotted to show the pattern of the relationships. This was then followed by simple linear regression.

3.3. Results

3.3.1. Curviness

Preliminary analysis of homogeneity of variance between sexes was calculated through the use of a Spearman's rho correlation in order to make sure that analysing the data as a whole was a viable option, and a Cronbach's alpha calculation was performed to investigate reliability in ratings across all participants.

There was a strong significant correlation between male and female ratings, $r(18)= .841$, $p<0.0001$, suggesting both sexes were rating bodies similarly for curviness. A

Cronbach's α value of .920 was also found suggesting high intra-class homogeneity between sexes and high inter-rater reliability.
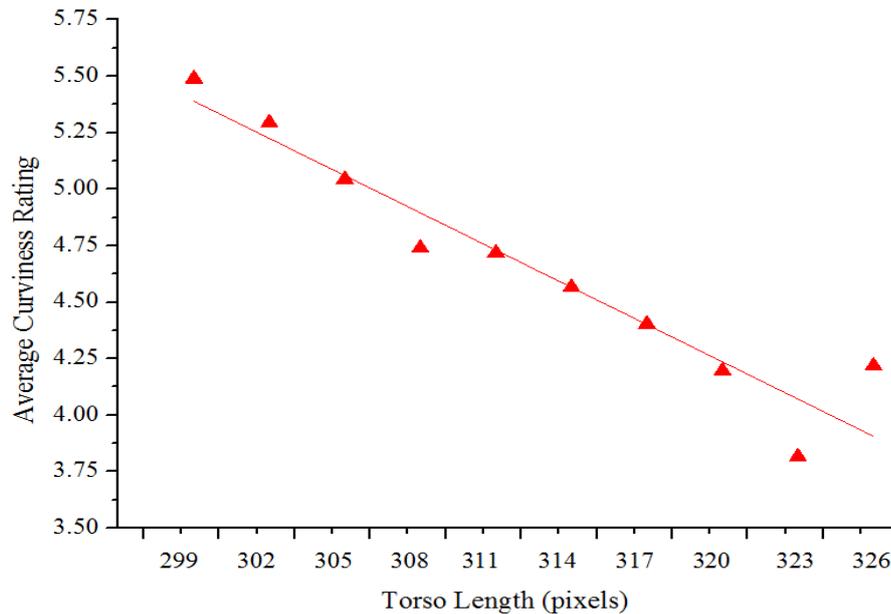
Figure 3.5. Linear plot depicting the effect of increasing torso length on perception of curviness of the bodies ($adj\ R^2$ =0.91).

Figure 3.5 clearly shows a strong negative linear relationship between these two variables. From this data it would be reasonable for us to infer that as torso length increased, bodies were seen as less curvy compared to bodies with a shorter torso which were seen as much more curvaceous. This is supported by an adjusted R^2 value of .91 suggesting a very strong relationship between torso length and perceived curvaceousness. However, the y axis shows that there is only a decrease in curviness rating from approximately 5.5 to 4, which is relatively small when the scale that was actually used ranged from 0-10.

A Simple Linear Regression was therefore carried out on the data (as there was no justification for using a non-linear term) to investigate whether Torso length was a good predictor of curviness ratings; from the visual representations in the data seen in figure 3.5 it was predicted that there would be a strong effect of torso length.

A substantial and statistically significant, negative correlation was found between TL and the outcome- average curviness ratings (-0.42, p = .002). A simple linear regression conducted produced a significant model to fit this curviness data.

Table 3.2. Model parameters for predicting average curviness ratings.

	B	S.E.	β	t
(constant)	13.41	2.73		4.91
TL	-0.23	0.01	-0.42	-3.19

The model in table 3.2 was found to be statistically significant, $F(1, 48) = 10.19$, $p < .05$, with torso length accounting for 17.5% of the variance in curviness judgements. This would therefore suggest that Torso Length is a strong, significant predictor of curviness.

3.3.2. Body Size

Again, preliminary analysis of homogeneity of variance between sexes was calculated through the use of a Spearman's rho correlation, and a Cronbach's alpha calculation was performed to investigate reliability in body size ratings across all participants.

There was a significant correlation between ratings, $r(18) = .743$, $p < 0.0001$, suggesting male and female participants were rating bodies similarly for body size. A Cronbach's α value of .881 was also found suggesting high intra-class homogeneity between sexes and high inter-rater reliability.
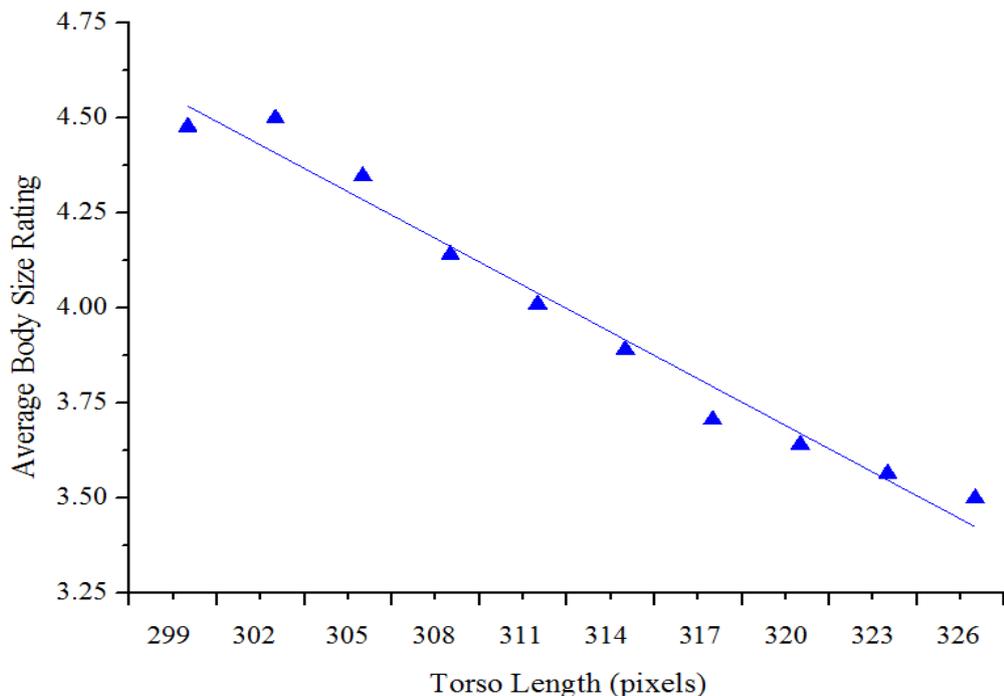
Figure 3.6. Linear plot depicting the effect of increasing torso length on participants' perception of overall body size of the images ($adj\ R^2 = 0.97$).

Figure 3.6 shows a strong linear relationship between length of the torso and perception of body size, supported by a very large adjusted R^2 value (.97). These data would suggest that as torso length increased, body size ratings decreased, therefore meaning that bodies with a longer torso are seen as thinner than those with a shorter torso. However, again ratings were only ranging from 3.5 to 4.5 on the scale of 0-10 which does not suggest much difference in body size rating across the torso lengths. This may be expected though as body size was actually kept constant and only torso length was altered.

Based on this linear relationship in figure 3.6, a Simple Linear Regression was carried out on the data to investigate torso length as a predictor of average body size ratings. However, a Pearson's correlation revealed no significant correlation between torso length and body size ratings, (-0.13, $p = 0.19$). A linear regression also produced no significant models to fit this data.

Table 3.3. Model parameters for predicting average body size ratings.

	B	S.E.	β	t
(constant)	8.84	5.30		1.67
TL	-0.02	0.02	-0.13	-0.90

The model in table 3.3 was not found to be statistically significant, $F(1, 48)$ =0.82, $p = 0.37$, with torso length accounting for only 0.02% of the variance in body size judgements. This would therefore suggest that Torso Length is not a good predictor of body size.

3.3.3. Attractiveness

Again, homogeneity of variance between sexes for attractiveness judgements was investigated through the use of a Spearman's rho correlation, and inter-rater reliability was investigated through the use of Cronbach's alpha.

There was a significant correlation between ratings, $r(18) = .609, p = 0.004$, suggesting that while this was not as significant a correlation as with the previous ratings, male and female participants were still rating bodies relatively similarly for attractiveness. A Cronbach's α value of .785 was also found suggesting high intra-class homogeneity between sexes and high inter-rater reliability.

Figure 3.7. Linear plot depicting the effect of increasing torso length on participants' perception of attractiveness ($adj\ R^2$ = -0.03).

The pattern of data in figure 3.7 suggested only a weak relationship between this variable and torso length. There was a slight positive linear relationship, with average attractiveness ratings increasing as torso length of the bodies increased, suggesting that participants had a preference for a slightly longer torso. This would support the results found for body size ratings as thinner bodies are normally viewed as more attractive, and here results showed that longer torsos were viewed as both thinner and more attractive. However, the adjusted R^2 of -0.03 suggests that this relationship between torso length and attractiveness was not a strong one.

Based on the relationship between the variables in figure 3.7, which appeared to be linear, there was no justification for using any non-linear terms, therefore a simple Linear Regression was again carried out on the data to investigate whether torso length was a good predictor of average attractiveness ratings.

No significant correlation was found between TL and average attractiveness ratings (-0.00, $p = 0.50$), supporting visual evidence in figure 3.7. Results from the simple linear regression again suggested no significant model to fit this attractiveness data.

Table 3.4. Model parameters for predicting average attractiveness ratings.

	B	S.E.	β	t
(constant)	5.68	4.35		1.31
TL	-6.80E-005	0.01	-0.00	-0.01

The model in table 3.4 was not found to be statistically significant, $F(1, 48) = 0.00$, $p = .99$, with TL accounting for only 0% of the variance in attractiveness ratings. This would suggest that TL was not a predictor of attractiveness ratings at all.

3.4. Study 2

3.4.1. Participants

Following on from the previous study, both males and females were again recruited to take part. 108 participants were recruited for this study: 56 females (mean age: 20.66; SD: 6.50; age range: 18-65) and 52 males (mean age: 21.58; SD: 6.62; age range: 18-56). Participants were recruited through the use of online social networking sites such as Facebook. This study was approved by the Faculty of Medical Sciences ethics committee at Newcastle University (00626/2013; 00626_1/2013).

3.4.2. Stimuli

Stimuli for this study were created using the interactive 3D software modelling interface Daz3D Studio version 4.5 (from Daz3d.com). Firstly, 5 bodies with different torso lengths (TLs) were created using the "torso length" slider. These bodies were identical to each other except for the torso length.

Figure 3.8. An example of the same sized body at 5 different torso lengths, created in Daz3D studio, increasing in Torso length from left (shortest) to right (longest).

Next, based on these five bodies two further manipulations were applied: the waist width and body size of the bodies were each varied at 5 levels on each of the 5 torso lengths using the waist width and body size dimension in Daz to produce a total of 50 bodies. Again, this stimulus set was created with ecological validity in mind. As these bodies were not real female bodies, we wanted to make sure that all the computer generated digital bodies appeared realistic so that any results found could be relatable to female bodies seen in everyday life. We therefore did not make bodies too slim, and did not make bodies too large. We also focused only on specific sliders in Daz3D Studio to not only keep the bodies increasing in equal increments, but also to ensure that they did not become too cartoon-like, but retained their validity in order to allow results to be as generalizable as possible (even though they were not real women's bodies). The bodies were then rendered in 24-bit colour at 755 by 826 pixels resolution. These bodies were rated online using the Qualtrics online software system (Qualtrics.com). Dimensions for each of these bodies, including BMI, WHR and Torso Length, can be found in Appendix C and D.

Figure 3.9. An example of bodies of the same torso length varying at 5 different waist widths, increasing in waist width from left to right (most to least defined hourglass shape).

3.4.3. Design

A within-subject repeated-measures design was implemented for this study as all participants were required to rate all 50 images on all 3 scales. The independent variable was the images themselves and the levels of waist width, body size and torso length; while the dependent variable was the rating the participants gave each image on scales of attractiveness, body size and curviness.

3.4.4. Procedure

A link to the questionnaire was posted on Facebook with a request for male and female participants over the age of 18. Participants were again informed that by following the link they were providing us with their consent to participate. On following the link, participants were immediately presented with a brief explanation of the aim of the study. Withdrawal procedures followed the same format as study 1.

Participants were firstly asked to provide us with demographic information (age, height, weight etc.), following which they were presented with the 50 bodies in a randomized order. Each body was shown on a separate screen, below which were the 3 rating scales in slider format. Participants could slide the marker anywhere from 0-10 for attractiveness, body size, and then curviness. Participants pressed the arrow in the right hand corner of each screen to progress to the next image. Forced response was used again and reaction time was again not recorded. At the end of the questionnaire, participants were presented with an online debrief with the purpose of explaining the full nature of the study and their involvement in it. Again, contact details for the experimenters were also provided in case the participants had any further questions.

Please rate the following bodies on a scale from low to high curvaceousness (0= straight up and down; 10= an hourglass shape), from low to high attractiveness, and from low to high body size.
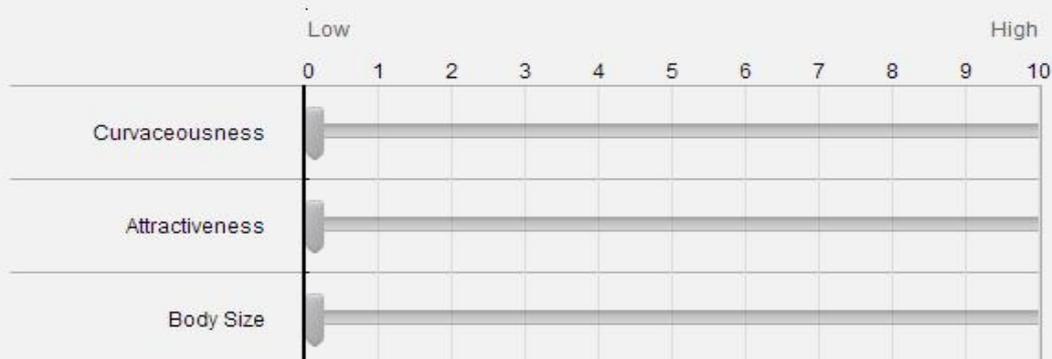
Figure 3.10. An example of the questions that participants were presented with.

3.4.5. Data Analysis

Before statistical analysis, the bodies were exported from Daz Studio in waveform format once clothing had been removed, and reopened in Daz 3D Studio Max (autodesk.com) so that the volume and weight of each body could be calculated. As in study 1, pixel-ruler (http://pixel-ruler.en.softonic.com/), was used to measure the distance across the body for waist, hips and chest, and also for leg and torso length. See Appendix C and D for measurements of all 50 bodies.

3.5. Results

3.5.1. Curviness

Preliminary analysis was conducted to investigate the similarity in ratings between male and female participants, using both a Spearman's Rho correlation and Cronbach's alpha reliability analysis. These calculations test for both within and between sex homogeneity.

There was a strong significant correlation between sexes, $r(48)= .880$, $p<0.001$, suggesting both sexes were rating the images similarly for curviness. A Cronbach's alpha calculation was performed on the combined raw data for males and females to investigate inter rater reliability within the study. An α value of .959 was found suggesting high intra class homogeneity, again reinforcing the inter- rater reliability for the amalgamated data.
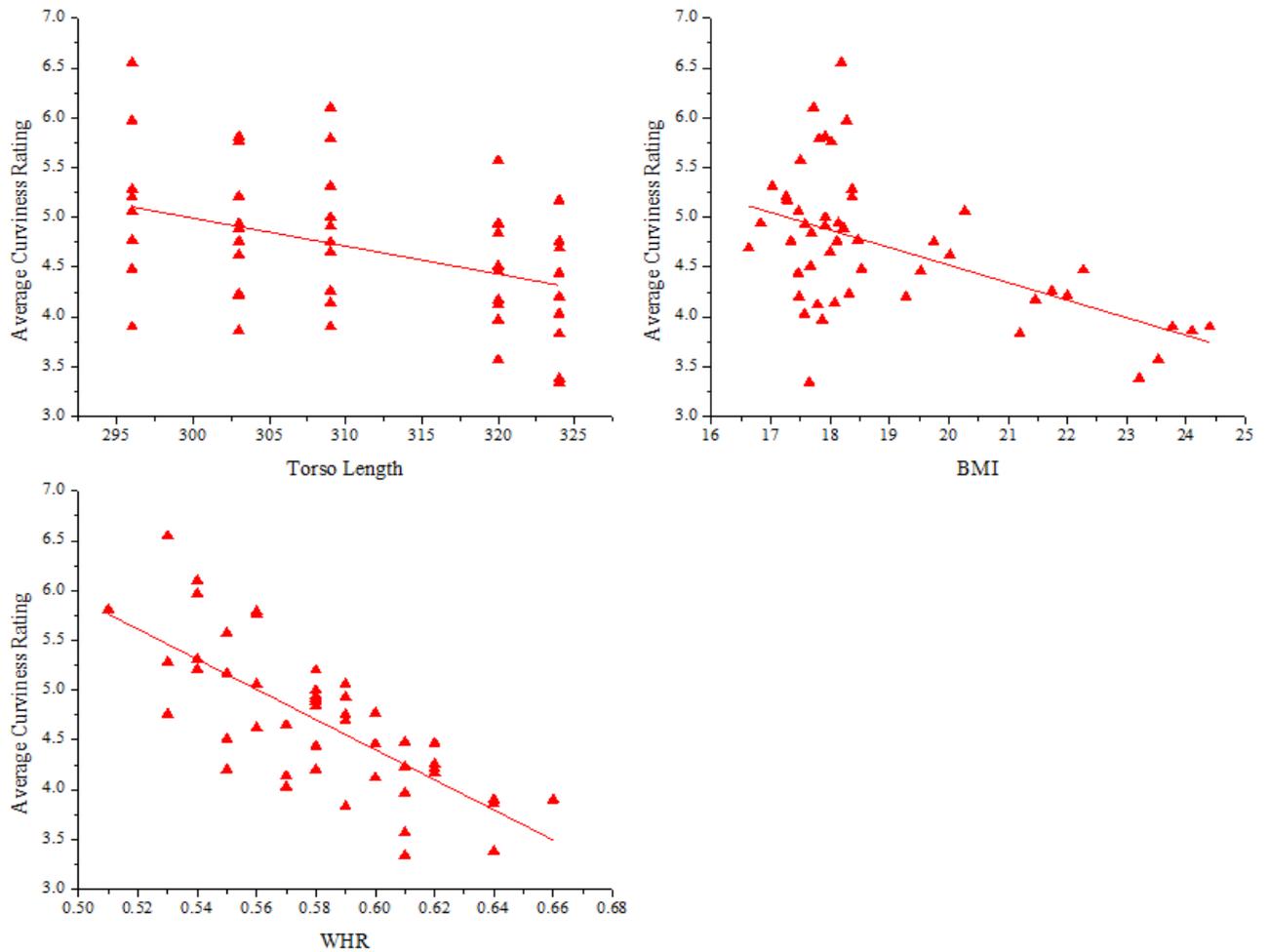
Figure 3.11. The relationship between the predictor variables of Torso Length (pixels), BMI and WHR of the bodies with average curviness ratings of each body made by the participants.

Figure 3.11 suggests that there was a linear relationship between each of the predictor variables (body measurements) and average curviness ratings. WHR appears to have the strongest negative relationship with ratings in that as WHR increased, curviness ratings decreased. A similar relationship was also found between both BMI and Torso Length and average curviness ratings, suggesting that the longer the torso and the larger the BMI, the less curvy the body appears.

Based on these linear relationships, a Hierarchical Linear Regression was carried out on the data to investigate which variable best predicted average curviness ratings; specifically- when bodies were also altered in both size and waist width, was torso length (TL) still a significant predictor of average curviness ratings (as it was in *study 1*)?

Table 3.5. The pattern of Pearson correlations for the predictor variables and outcome (average curviness rating).

	Avg. Rating	BMI	WHR
BMI	-0.53**	-	-
WHR	-0.71**	0.67**	-
TL	-0.42*	-0.16	0.06

*** = p< .001 ; * = p< .05*

A substantial and statistically significant, negative correlation was found between all predictor variables and average curviness ratings; especially BMI and WHR (table 3.5). In addition a strong significant correlation was also found between BMI and WHR, however this was to be expected as literature denotes that these two variables are highly correlated (Tovée et al., 2002). While it was acknowledged that collinearity between variables is usually a problem in regression analysis, for the purpose of this study (investigating the effects of torso-length as a new predictor), it was decided that this did not affect the reliability of the analysis as torso length was not found to be correlated with either BMI or WHR (table 3.5) therefore any effects of torso length that were found would be purely due to torso length alone, without BMI and WHR accounting for any aspect of torso length .

A hierarchical linear regression produced two significant models to fit this data (table 3.6).

Table 3.6. Model parameters for predicting average curviness ratings.

		B	S.E.	β	t
Model 1	*(constant)*	13.15	1.27		10.36
	BMI	-0.03	0.05	-0.09	-0.65
	WHR	-13.57	2.89	-0.65**	-4.70
Model 2	*(constant)*	21.38	2.00		10.72
	BMI	-0.08	0.04	-0.25*	-2.09
	WHR	-10.80	2.45	-0.52**	-4.42
	TL	-0.03	0.01	-0.43**	-4.84

*** = p< .001 ; * = p< .05*

Model 1 was found to be statistically significant, $F(2,47) = 24.20$, $p< .001$, with WHR + BMI accounting for 51% of the variance in curviness ratings (table 3.6 would

suggest that WHR not BMI was responsible for this significant effect). In addition, a second model incorporating the effects of Torso Length was also found to be statistically significant, $F(3,46) = 31.67$, $p < .001$, with BMI + WHR + TL accounting for 68% of the variance in curviness ratings. All three variables were found to significantly contribute to this model (table 3.6), with torso length predicting a further 17% of the variance in curviness ratings.

To create a measure that captures the rate at which the torso changes shape, the circumference of the waist relative to the bust and hips was considered relative to the torso length.

To do this we used the following formula:

$$rate\ of\ body\ curvature\ (RBC) = \frac{(b - w) + (h - w)}{TL}$$

NB b= Bust; w= Waist; h= Hips; TL= Torso Length.
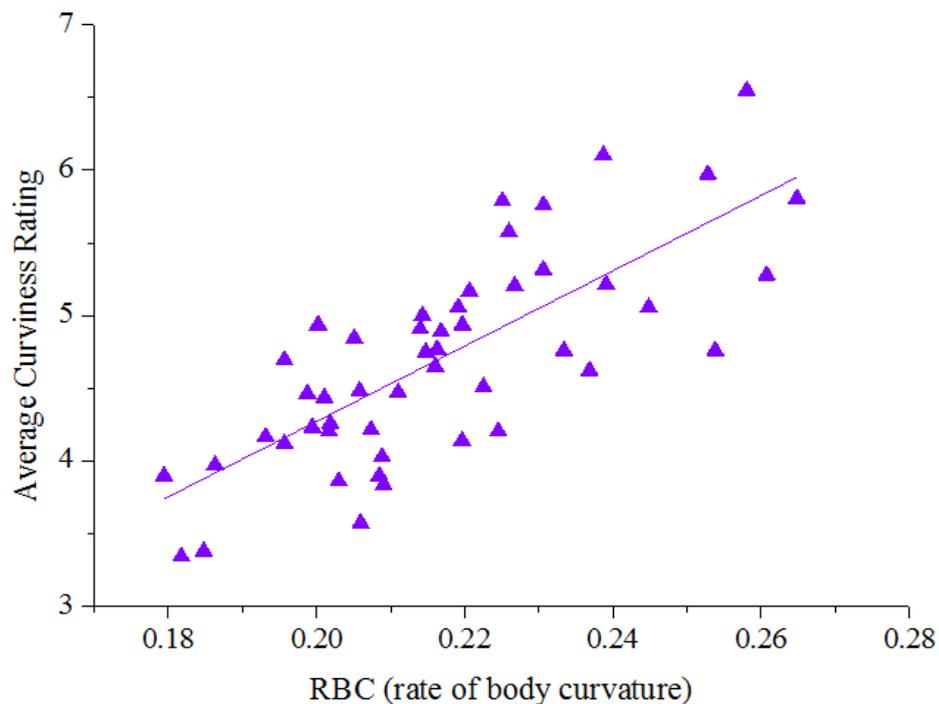
Figure 3.12. The relationship between the RBC and the outcome variable of average curviness rating.

Figure 3.12 suggests that there was a linear relationship between the RBC and average curviness ratings, with an adjusted r-square value of .56. Average curviness ratings appear to increase as the RBC increases.

Based on this linear relationship, a Hierarchical Linear Regression was carried out on the data to investigate whether the RBC better predicted the outcome of curviness than WHR or TL. We would expect that the RBC would encapsulate both WHR and TL therefore these two established variables would not add any significance to the model.

Table 3.7. The pattern of Pearson correlations for the predictor variables and outcome (average curviness rating).

	Avg. Rating	RBC	WHR	TL
RBC	.76**	-	-	-
WHR	-.71**	-.85**	-	
TL	-.42**	-.52**	.06	-

*** = p≤ .001*

A substantial and statistically significant, negative correlation was found between WHR and TL with average curviness ratings; however a significant positive correlation was found between the RBC and average curviness ratings (table 3.7). A hierarchical linear regression produced three significant models to fit this data (table 3.8).

Table 3.8. Model parameters for predicting average curviness ratings.

		B	S.E.	β	t
Model 1	*(constant)*	-0.91	0.71		-1.28
	RBC	25.89	3.25	0.76**	7.97
Model 2	*(constant)*	3.64	3.35		1.10
	RBC	18.72	6.09	0.55*	3.07
	WHR	-5.15	3.71	-0.25	-1.39
Model 3	*(constant)*	29.15	9.42		3.10
	RBC	-10.61	11.68	-0.31	-0.91
	WHR	-19.62	6.11	-0.94*	-3.21
	TL	-0.04	0.01	-0.52*	-2.87

*** = p< .001 ; * = p< .05*

Model 1 was found to be statistically significant, $F(1, 48) = 63.47$, $p< .001$, with the RBC accounting for 57% of the variance in curviness ratings. In addition, a second model incorporating the effects of WHR was also found to be statistically significant, $F(2, 47) = 33.31$, $p< .001$, with RBC + WHR accounting for 59% of the variance in curviness ratings, suggesting that WHR only accounted for 2% of the variance. Furthermore, a third model incorporating the effects of TL was also found to be statistically significant, $F(3, 46) = 28.37$, $p< .001$, with RBC + WHR + TL found to account for 65% of the variance in curviness ratings, suggesting that TL accounts for a further 6% .

Unfortunately this new measure does not seem to entirely capture all the variance predicted by WHR and TL. While it appeared to capture the majority of the variance predicted by WHR, it did not work so well for TL. Work still needs to be done to create a measure that captures both body curvature and the rate at which these curves appear.

3.5.2. Body Size

Similar preliminary analysis to the previous section was carried out to investigate the similarity in ratings between male and female participants.

There was a strong significant correlation between the average ratings for each sex, $r(48)= .979$, $p<0.001$, suggesting males and females were rating bodies similarly for size. A Cronbach's alpha calculation was again performed on the male and female ratings of body size to investigate inter rater reliability. An α value of .992 was found suggesting high intra-class homogeneity and inter-rater reliability.
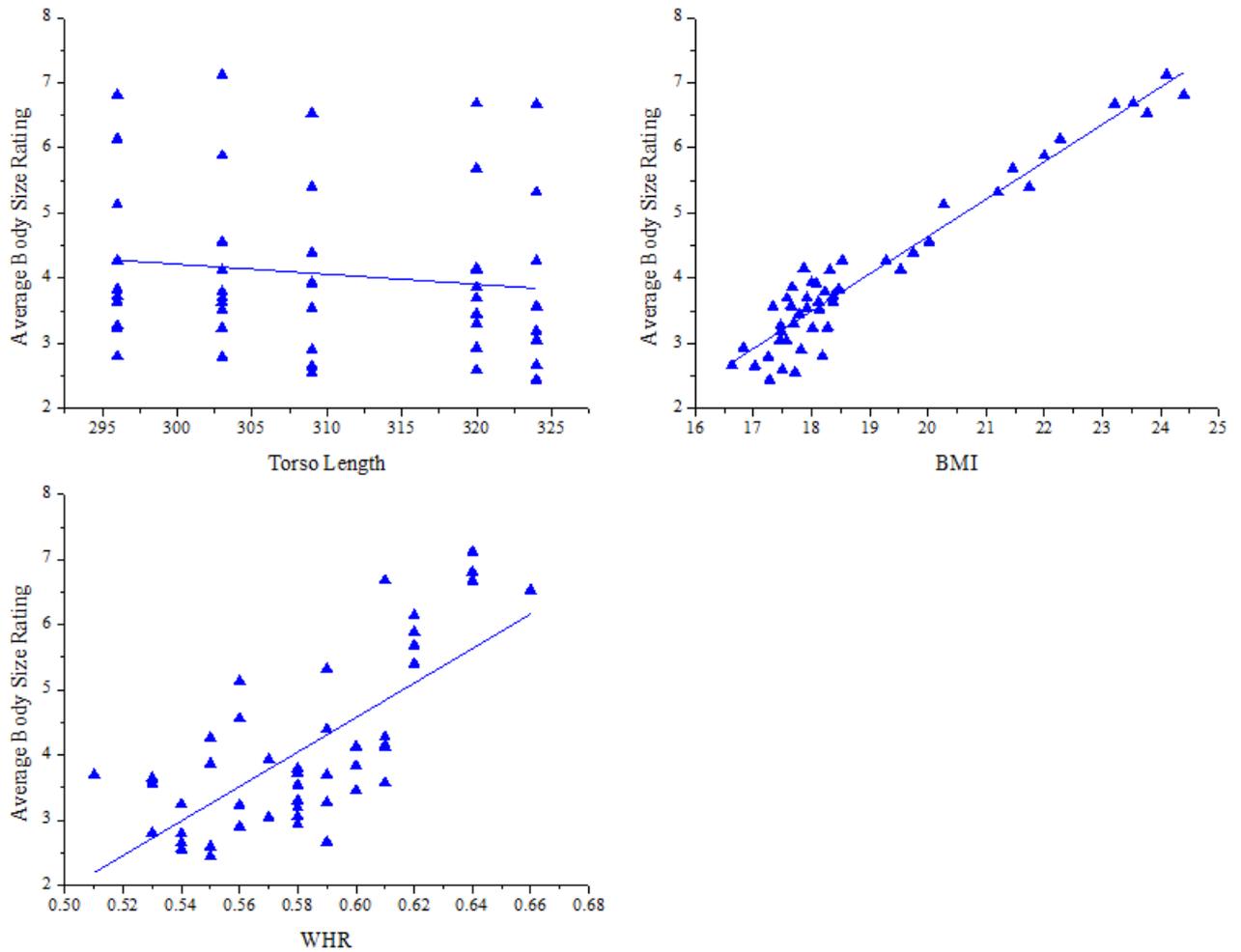
Figure 3.13. The relationship between the predictor variables of Torso Length, BMI and WHR with average body size ratings.

Figure 3.13 would suggest that the data for body size ratings has a linear relationship with the predictor variables. There is a clear, strong positive linear relationship between both BMI and WHR and average body size ratings, suggesting that participants were able to accurately rate bodies for size. However, there appears to be a much weaker relationship between torso length and body size, with evidence of a slight negative trend (as torso length increased, bodies were rated as thinner).

Based on these linear relationships, a Hierarchical Linear Regression was again carried out on the data to investigate which variable best predicted average body size ratings; specifically- when bodies were also altered in both size and waist-width, was torso length (TL) a significant predictor of average body size ratings?

110

Table 3.9. The pattern of Pearson correlations for the predictor variables and outcome (average body size rating).

	Avg. Rating	BMI	WHR
BMI	0.96**	-	-
WHR	0.71**	0.67**	-
TL	-0.13	-0.16	0.06

*** = p< .001*

A statistically significant, positive correlation was found between average body size ratings and BMI and WHR (table 3.9), supporting visual evidence in figure 3.13. In contrast, a negative correlation was found between average ratings and torso length; however this was a non-significant relationship, again showing support for the weak visual relationship depicted in figure 3.13. Results from the hierarchical linear regression suggested two significant models to fit this body-size data (table. 3.10).

Table 3.10. Model parameters for predicting average body size ratings.

		B	S.E.	β	t
Model 1	*(constant)*	-8.50	0.82		-10.42
	BMI	0.53	0.03	0.88**	17.68
	WHR	4.43	1.86	0.12*	2.39
Model 2	*(constant)*	-8.66	1.58		-5.50
	BMI	0.53	0.03	0.89**	16.86
	WHR	4.38	1.93	0.12*	2.27
	TL	0.00	0.01	0.01	0.12

*** = p< .001 ; * = p< .05*

Model 1 was found to be statistically significant, $F(2,47) = 341.56$, $p< .001$, with BMI + WHR accounting for 94% of the variance in body size ratings (table 3.10 would suggest that BMI was a more significant predictor of body size ratings than WHR). In addition, a second model incorporating the effects of Torso Length was also found to be statistically significant, $F(3,46) = 222.93$, $p< .001$, however the addition of TL in to the model did make any contribution to an explanation of the variance in body size ratings (table 3.10). BMI + WHR + TL also accounted for 94%, suggesting TL made no statistical improvement to the model, and therefore was not a significant predictor of body size ratings.

3.5.3. Attractiveness

Again, preliminary analysis of homogeneity of variance between groups was calculated through the use of a Spearman's rho correlation between average attractiveness ratings, and a Cronbach's alpha calculation to investigate reliability in ratings between all participants. There was a strong significant correlation between male and female ratings, $r(48)= .870$, $p<0.001$, suggesting both sexes were rating bodies similarly for attractiveness. A Cronbach's α value of .983 was also found suggesting high intra-class homogeneity between sexes and high inter-rater reliability.
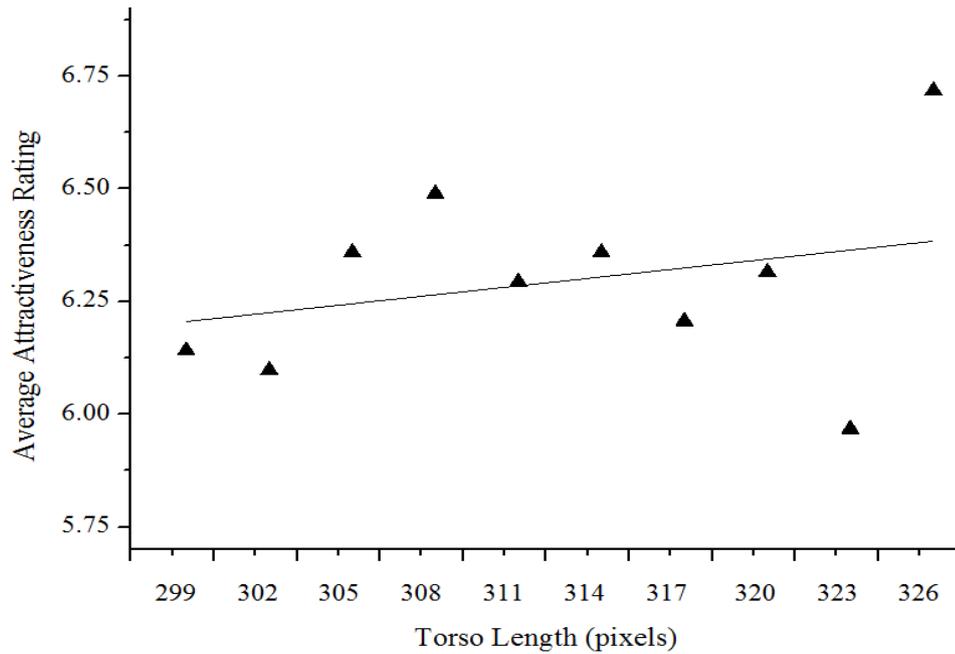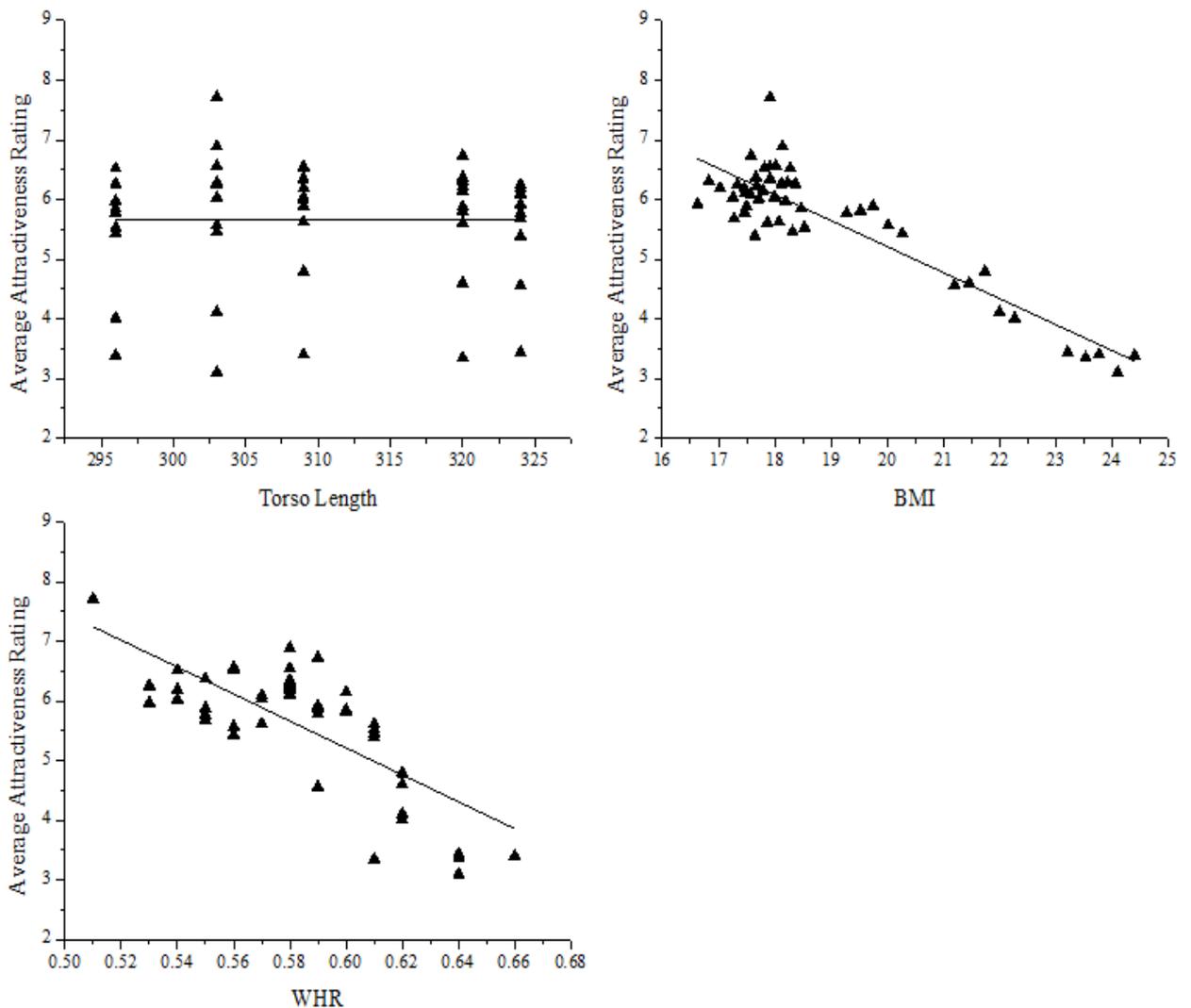

Figure 3.14. The relationship between the predictor variables of Torso Length, BMI and WHR with average curviness ratings.

Figure 3.14 depicts strong negative linear relationships between both WHR and BMI and average attractiveness ratings, in that as BMI and WHR increased, perception

of attractiveness decreased. However, there appears to be a limited relationship between torso length and attractiveness (relatively flat regression line). As it appears that there was little to no relationship between torso length and perceived attractiveness, it is quite clear that subsequent analysis will reflect this (with torso length predicting little to no variance in attractiveness judgements).

Again, a Hierarchical Linear Regression was carried out on the data to investigate which variable best predicted average attractiveness ratings; however from the visual representations in the data seen in figure 3.14 it was predicted that there would be no effect of torso length found.

Table 3.11. The pattern of Pearson correlations for the predictor variables and outcome (average attractiveness rating).

	Avg. Rating	BMI	WHR
Avg. Rating	-	-	-
BMI	-0.90**	-	-
WHR	-0.74**	0.67**	-
TL	-0.00*	-0.16	0.06

*** = $p < .001$*

A substantial and statistically significant, negative correlation was found between BMI and WHR as well as between these predictor variables and the outcome-average attractiveness ratings (table 3.11). In addition, as expected, no correlation was found at all between average attractiveness ratings and length of the torso. As found previously with judgements of both curviness and body size, a hierarchical linear regression produced two significant models to fit this attractiveness data (table 3.12).

Table 3.12. Model parameters for predicting average attractiveness ratings.

		B	S.E.	β	t
Model 1	*(constant)*	16.78	1.04		16.15
	BMI	-0.36	0.04	-0.73**	-9.37
	WHR	-7.55	2.37	-0.25*	-3.19
Model 2	*(constant)*	19.88	1.93		10.28
	BMI	-0.38	0.04	-0.77**	-9.77
	WHR	-6.50	2.37	-0.22*	-2.75
	TL	-0.01	0.01	-0.11	-1.88

*** = $p < .001$; * = $p < .05$*

Model 1 was found to be statistically significant, $F(2,47) = 125.90$, $p < .001$, with BMI + WHR accounting for 84% of the variance in attractiveness ratings (table 3.12 would suggest that BMI was a better predictor of attractiveness judgements than WHR- a stronger significant result was evident). In addition, a second model incorporating the effects of Torso Length was also found to be statistically significant, $F(3,46) = 89.65$, $p < .001$, however again, Torso Length was found to account for only 1% of the variance in attractiveness judgements, therefore suggesting it is not a significant predictor of attractiveness judgements (as seen in table 3.12).

3.6. Discussion

3.6.1. Curviness

Overall results suggest a significant effect of torso length on the perception of curviness. Therefore bodies with the shortest torso length were judged as the curviest, while bodies at the longest torso length were judged as the least curvy. In bodies that varied in waist width or body size, perception of curviness also decreased as the length of the torso increased, however this effect appeared diluted by the effects of body size and shape.

Bodies of the same waist width were judged as increasingly less curvy as torso length increased. Therefore even though the waist-to-hip ratio was kept constant, the perception of these curves was altered by changing the *rate* of curvature along the torso. This would suggest that an hourglass figure is much more evident when the torso length is short and the rate of curvature change is higher curves appear over a much shorter area than when the torso length is long and the rate of curvature change is lower. This would imply that WHR is not as accurate a predictor of body shape as previous research would suggest (Singh, 1993a, 1993b, 1994; Singh, & Young, 1995), and would suggest that a more nuanced measure of lower torso shape is needed which takes rate of curvature into account.

An attempt was made to create a new variable that would combine the effects of WHR and TL as predictors of curviness and therefore show not only body shape but also the length over which curves appear. However, the variable created known as rate of body curvature (RBC) was not entirely successful in capturing both of these

previously established variables; therefore further work would be needed to develop a new measure that would take both overall body shape and length of torso into consideration.

3.6.2. Body Size

Results of judgements made about body size show a significant effect of torso length on the perception of size, with bodies at a shorter torso length being judged as fatter overall than those at a longer torso length. As expected, when more variables were introduced, any effects of torso length were again reduced by the overwhelming effects of BMI and WHR as cues to body size.

Bodies with the same waist width but with longer torsos were rated as thinner than those with shorter torso lengths. Therefore even though the waist-to-hip ratio was similar, bodies with longer torsos were perceived as being thinner than those with shorter torsos. Thus two bodies with the same waist width can be rated completely differently for size due to the curves being stretched out over a longer area (an idea that was postulated by Tovée et al. (1997). Similarly, the apparent slimness of fashion models may be accentuated because they are taller (on average 11cm taller-Tovée et al. (1997)) with longer torsos, their curves are more spread out, causing them to appear more tubular in body shape and less curvaceous than a shorter person with the same BMI. However, torso length has a relatively weak effect and the results suggest that it is likely to be over shadowed by the variation in size shape found in the general population.

3.6.3. Attractiveness

Results from both *study 1* and *study 2* indicate no relationship between torso length and attractiveness (although the general trend, albeit a weak one, in figure 3.7 would suggest that when torso length alone is provided as a cue, bodies become more attractive as torso length increases). Instead, results from *study 2* suggest that BMI and WHR are both strong and stable cues that are used above all other cues when making judgements about the attractiveness of others.

Research to date has postulated the idea that a longer Leg-to-Body ratio (LBR) is preferred (short torso in relation to longer legs) when making judgements of attractiveness, however our investigations yielded some interesting results in this area.

115

Initial investigations into LBR used classic line drawings of male and female bodies. Results from these studies suggested observers preferred a larger LBR in women (but not in men), therefore suggesting that longer legs and a shorter torso is considered the most attractive (Swami, Einon, et al., 2006). It was suggested (Swami, Einon, et al., 2007) that this preference for a larger LBR in women is potentially due to the portrayal of leg length and size in Western media (Western fashion and runway models are approximately 11cm taller than the average woman (Tovée et al., 1997), something which could be attributed to leg length). Swami, Einon, et al. (2006) also postulate the idea of a general dislike for low LBRs due to either a conscious or subconscious association between short legs and low Socio-Economic Status (SES) and poor health outcomes.

In a study investigating anthropometric variables related to attractiveness, Rilling, Kaufman, Smith, Patel, and Worthman (2009) found evidence for leg length as the most consistent positive predictor of attractiveness judgements, a factor that had been reported in previous literature (Fan et al., 2004). The origin of this preference for a particular leg length is relatively unknown; however leg length has gradually increased throughout human evolution. One theory to this, postulated by Isbell, Pruetz, Lewis, and Young (1998) and Pontzer (2007), is that long legs have become more attractive due to the idea that they enable more efficient movement, which in traditional hunter-gatherer society would have improved foraging ability. Leg length is also thought to be particularly sensitive to environmental influences during the prepubertal period (Gunnell, 2002; Gunnell et al., 1998).

In a study using silhouettes of males and females varying in leg length, Sorokowski and Pawlowski (2008) found that females with the shortest legs were judged as least attractive, and postulated the theory that this is likely to be a signal of an inability to spare any extra energy for leg growth during development whilst coping with adverse environmental conditions. This finding supported previous research that suggested that adverse life events during childhood or puberty would affect leg length more than trunk/torso growth (Wadsworth, Hardy, Paul, Marshall, & Cole, 2002). In this way, short legs would therefore act as an indicator of poor genetic quality or an inability to expand energy to other things when coping with stress during development (Sorokowski, & Pawlowski, 2008).

However, findings of Sorokowski and Pawlowski (2008) would seem to suggest there is an optimum leg length for attractiveness, with not only shorter legs being seen as unattractive, but also excessively long legs. Pyeritz (2000) suggests a link between excessively long legs and genetic disease such as Klinefelter or Marfan Syndromes. Another reason for the decrease in attractiveness judgements of legs after a certain length is that with increasing leg length comes shorter torso length. It is therefore hypothesized that this long leg length and therefore short torso length might result in an insufficient space for proper foetal development and therefore a reduction in chance of successful reproduction (Sorokowski, & Pawlowski, 2008). Smith et al. (2001) also highlight reduced lung functioning in those with shorter torsos, again supporting an adaptive preference for a particular leg length that will ensure genetic quality of offspring.

In this study, leg length was kept constant at 396 pixels, meaning any effects found should be directly related to torso length. However, as torso length increases, the LBR would also automatically decrease as a consequence of this constant leg length, therefore meaning that any bodies with a longer torso would automatically have a shorter LBR and those with a shorter torso would have a longer LBR.

We would therefore expect a shorter torso and therefore longer leg length-linked to higher genetic quality- to be judged as the most attractive body (Gunnell, 2002; Gunnell et al., 1998; Sorokowski, & Pawlowski, 2008; Wadsworth et al., 2002); however results here suggest that there was no effect of torso length (and therefore LBR) on judgements of attractiveness. It would seem that the LBR change in this study has little effect on perceived attractiveness, and instead suggests BMI as the best predictor of attractiveness, closely followed by WHR.

Results from this study would therefore seem to confirm previous evidence of WHR as a weaker cue to attractiveness and body size judgements than BMI (Freese, & Meland, 2002; Ketel et al., 2007; Power et al., 1997; Tovée, & Cornelissen, 1999; Tovée et al., 2002; Tovée et al., 1997), while suggesting torso length as a new anthropometric cue to perceived curviness and body size when no other visual cues are available.

3.6.4. Limitations

When making the stimuli for study 2 the aim was to create a comprehensive range of bodies to represent female body weight and shape. However, it may have been better to create bodies differing in only one measure rather than both torso length and body size or torso length and waist width at the same time as this obviously made it hard to know which of the measures was actually causing the difference in ratings. In future study, it may therefore be a good idea to vary the bodies in just one factor.

When making the stimuli for the second smaller study, it was necessary to create bodies increasing in equal increments of torso length. However, because we wanted to keep bodies as visually realistic as possible, the amount of bodies we could produce was limited, as bodies with too long or too short a torso appeared unrepresentative of a real female body. Therefore we were working within a very small range of possible bodies, which in turn made it difficult for participants to notice the very small differences between bodies. When presented with the shortest and longest torso lengths together, this would not have been an issue, but with bodies of similar torso lengths, participants may have found it difficult to notice whether there had been a change and therefore may have found it difficult to make judgements.

In addition, Daz was used to create the stimulus bodies in order to control for effects of skin and texture across all bodies, and so that varying size and shape etc. was completely under the experimenter's control. However, it may be more interesting in future research to use images of real women in order to investigate the effects of torso length in the real world. This would be carried out using a set of real bodies and seeing if torso length predicted curviness, body size or attractiveness- although in this case there would be lots of uncontrolled variables including body proportions, WHR and BMI, therefore making it a much more complex experiment.

Again, I acknowledge that power analysis is an important aspect of experimental design and would have allowed me to determine, prior to recruitment, how many participants would have been needed in order to find a significant effect of torso length on all 3 of the variables, however at the time of experiment this was overlooked. In future research, I aim to implement these power calculations before recruiting participants.

3.6.5. Conclusion

Overall, results from this study suggest torso length can be used as a reliable cue to both curviness and body size in the absence of any others. In addition, it can also be concluded that torso length can be accurately used as contributing cue to the perception of curviness, alongside both BMI and WHR. These results can be used to explain why supermodels or catwalk models appear to be more tubular than other women. As they are taller than the average woman, their torsos are longer, therefore making their curves appear stretched out over a larger distance. This therefore gives them the appearance of having tubular body shapes, when in actual fact; they often have hourglass figures (Tovée et al., 1997). In addition, the new measure of RBC outlined in this chapter goes some way to combining the effectiveness of torso length and WHR as predictors of curviness, however, more work would be needed in future to find a more reliable measure.

Chapter 4: Contraction Bias in Body Size Perception

4.1. Introduction

The diagnostic criteria for Anorexia Nervosa (AN), as specified by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5: American Psychiatric Association (2013)) includes weight loss and the maintenance of a weight that is significantly lower than a healthy body, intense fear of gaining weight, and body image disturbance.

One key symptom of AN is a pathological overestimation of body size compared to control subjects (Collins et al., 1987; Gardner, & Bokenkamp, 1996; Smeets, Smit, Panhuysen, & Ingleby, 1998; Steiger, Fraenkel, & Leichner, 1989; Tovée, Benson, Emery, Mason, & Cohen-Tovée, 2003; Tovée et al., 2000), with women with AN or Bulimia Nervosa (BN) consistently overestimating their own body size and having a markedly thinner ideal body size than control subjects (Williamson, Cubic, & Gleaves, 1993). Cash and Deagle (1997) suggest this disturbance in body size estimation is comprised of two components: Perceptual and Attitudinal/Cognitive. The perceptual component is described as the inability to accurately estimate body size. In Anorexic populations, this inability can be linked to the development and maintenance of their Eating Disorder (Slade, & Russell, 1973), as size is linked to perceived attractiveness and thin ideals (Cornelissen, Hancock, et al., 2009; Tovée et al., 2012). In contrast, the attitudinal component is described as a subject's dissatisfaction with and negative attitudes towards their own weight and shape (Cornelissen, Johns, & Tovée, 2013). Low self-esteem, high instances of depression, and the media's portrayal of a thin ideal are also all thought to contribute to Body Image Distubance (BID) in women (Ricciardelli, McCabe, Lillis, & Thomas, 2006).

Cash and Deagle (1997) suggest these perceptual and attitudinal components are independent of each other. Current treatment of AN focuses mainly on the attitudinal component, i.e. Cognitive Behavioural Therapy (CBT), tackling the thought processes behind the their dissatisfaction with their body. However, if there is a strong perceptual component of BID in Eating Disordered populations, this needs to be addressed in treatments and therapies.

Two possible theories providing an explanation for BID in ED groups compared to controls have been postulated in an attempt to account for this difference in body size

estimation between AN and control subjects (Cornelissen et al., 2013). The first is a dual channel model in which AN and controls have separate intercepts for estimated and actual BMI, with AN showing significantly greater overestimation. Earlier studies investigating this over-estimation of size in women have tended to overlook the influence of the observers' own BMI as a predictor of size estimation (Williamson et al., 1993). However, more recently a link has been found between these two variables (George et al., 2011); therefore body size overestimation could just be a secondary effect of a subject's own low BMI. This model would therefore seem to suggest that the overestimation of size is pathological for AN but not for controls.

However, an alternative theory for this discrepancy between AN and control subjects (the single channel model) proposes that both groups will estimate bodies along a similar slope and have the same intercept as variability in overestimation is said to be distributed continuously through the general population. This theory would suggest that body size judgements lie on a continuum from over to under estimation and that therefore, overestimation of body size is not a pathological trait in AN but is also present in the general population. Therefore any discrepancies found between AN and controls would be due to the part of this continuous distribution that is sampled. Therefore, if this pattern of overestimation does lie on a continuum, it would seem logical to believe that any individual with a low BMI, even those without an ED, would overestimate their body size. Therefore, distorted estimations of size should exist in all populations, not just those with EDs.

Cornelissen et al. (2013) presented evidence of this distortion being found in both ED and non ED populations. This suggests that there is a continuum of performance from over to under estimating body size, with AN sufferers displaying the behaviour found at one extreme of this continuum (significantly overestimating). In direct contrast to those with AN, obese subjects appear to under-estimate their own body size, occupying the other end of the continuum (Tovée et al., 2003; Tovée et al., 2000).

Cornelissen et al. (2013) suggest the perceptual mechanism behind this distorted self-image is Contraction Bias (CB). Contraction bias arises when one uses a standard reference or template for a particular kind of object (e.g., a fence post) against which to estimate the size of other examples of that object. The estimate is most accurate when a given example is of a similar size to the reference, but becomes increasingly inaccurate as the magnitude of the difference between the reference and the example increases.

When this happens, the observer estimates that the given example is more similar in size to the reference than it is in reality. As a result an example smaller in size than the reference will be over-estimated and an example larger will be under-estimated. The theory of CB postulates that everyone holds a mental reference for familiar stimuli, and that the effects of CB are most apparent when there are no concrete units of measurement with which to judge the stimuli, i.e. when estimating the size of a human body (Poulton, 1989).

In the case of bodies, this reference is proposed to be based on an average of all the bodies a subject has experienced over the course of their lives; with more emphasis being placed on the bodies that have been viewed most recently, i.e. the bodies of those around them and those in the media (Winkler, & Rhodes, 2005). When making judgements about body size, this average reference body is used as a comparison with people over- and under- estimating body size as they try to fit their size nearer to this average body (McCabe, Ricciardelli, Sitaram, & Mikhail, 2006). Winkler and Rhodes (2005) reported that showing very thin or very large bodies can shift this reference template in the short-term, altering participants' view of normal size. Support for this idea of CB when viewing bodies can be seen in a study by Smeets et al. (1998) who found that overweight people underestimated their own size, while normal or underweight participants overestimated their body size.

In the Cornelissen et al. (2013) study, when the participants' own body size was judged using an interactive body morphing program, the accuracy the estimation was predicted by a contraction bias explanation (a perceptual explanation). However, in a second study in which participants made a 2-alternative forced choice (2-AFC) judgement as to whether a body was thinner or fatter than themselves, results suggested that the accuracy of body size judgements were affected by the participants' scores on a set of psychometric scales (an attitudinal explanation). The latter finding may be affected by the use of the distorting video technique to simulate body weight change. This technique stretches a body in the horizontal axis to try and produce weight change, but also produces a range of cues to the degree of distortion and lacks biometric validity. A more recent study using the same paradigm but a more realistic fat simulation technique, suggests that contraction bias plays a significant role in these judgements Cornelissen et al (in press).

Evidence suggests that several psychopathologies comorbid with eating disorders are also evident in the general population. Self-esteem (how much we like ourselves and how much worth we place on ourselves) has been implicated in the development and maintenance of EDs (Button, SonugaBarke, Davies, & Thompson, 1996). A strong association has been repeatedly found between self-esteem and the incidence of EDs, with low self-esteem being said to be a vulnerability factor for EDs due to its correlation with body image dissatisfaction (Ben-Tovim, & Walker, 1991; Button, Loan, Davies, & SonugaBarke, 1997; Furnham, Badmin, & Sneade, 2002; Gual et al., 2002; van den Berg, Mond, Eisenberg, Ackard, & Neumark-Sztainer, 2010).

In addition, depression has also been commonly linked to EDs. In the media, thinness is portrayed as attractive, therefore high BMI will potentially result in body dissatisfaction as being overweight is not socially desirable. As appearance has become so central in Western culture, this body dissatisfaction may result in depression. In addition, body dissatisfaction often results in dieting, which in turn increases the chance of depression due to failures in dietary efforts. Therefore it has been suggested that body dissatisfaction mediates the relationship between weight, dieting and depression, while dieting mediates the relationship between body dissatisfaction and depression (Evans, Tovee, Boothroyd, & Drewett, 2013; Stice, Hayward, Cameron, Killen, & Taylor, 2000). It has been posited that the reason behind this link between depression and EDs is puberty, in that puberty changes young girls' bodies away from the thin ideal that they strive for, therefore resulting in poor body image, increased eating related risk factors, and higher levels of depression (Stice et al., 2000). It is therefore clear that depression and the incidence of EDs are very highly comorbid, but is depression also linked to the overestimation of body size?

A key factor of the contraction bias hypothesis and the mis-estimation of body size is that it is primarily perceptual and so should apply to judgements of other people's bodies as well as their own. To test these hypothesis participants will be asked to estimate the size of other women's bodies, as well as completing a set of psychometric scales to test the effect of attitudinal factors. Two experiments were conducted. In the first, participants rated body size using a Likert scale. In classical psychophysics literature, contraction bias is most clearly observed when participants try and quantify the magnitude of the stimulus being estimated. Poulton (1989) gives the example of trying to estimate the size of a fence post. So in a second experiment,

participants were asked to estimate the weight in Kg of a series of female bodies. A potential confound in this experiment is that although participants may be used to estimating the relative adiposity of a body (i.e. how fat someone is), they may be less practiced in estimating their actual weight. However, by comparing the results from both experiments it should be possible to determine the potential effect of contraction bias on body judgements.

4.2. Study 1

4.2.1. Participants

A sample of 80 females (mean age: 26.76 years; S.D.: 9.36; range: 18-50 years) were recruited for this study through the use of the undergraduate Research Participation Scheme run by the school of Psychology (adverts sent via email to all first and second year Psychology students asking for volunteers) and the Institute of Neuroscience Volunteers scheme (adverts sent out via email to anyone signed up as a volunteer- both staff and students across the whole university), both at Newcastle University. A female only sample was recruited for this study as here we were also investigating psychological state of participants and the interaction between their feelings about their own body and how this impacts on their perception of the bodies of other women. It therefore did not make sense to recruit male subjects, as it was not thought that viewing male bodies and rating them for size and weight would have a relationship with female psychological variables. Instead we were interested in the interplay between how a woman feels about herself in terms of self-perception and self-esteem, and whether this had any resulting effect on how she judges other women. Male subjects could be recruited in future research in order to investigate whether this relationship we hypothesis is also evident in them: would men's self-esteem and psyche also affect how they judge and view other men? However, in the first instance we decided to focus only on women as previous research does indicate that there is a relationship between body image dissatisfaction and self-esteem (van den Berg et al., 2010).

Participants' BMI ranged from 15.2- 32.3, with a mean of 22.40 kg/m² (within the "normal" BMI range of 20-25). In accordance with the International Classification of body weight in relation to BMI (WHO, 1995), calculated by kg/weight in m^2, 6 people were classed as underweight, 61 people were in the normal range, 12 people

were classed as overweight and 1 person was classed as obese. None of the participants reported they currently had or had a history of an eating disorder.

Data for 20 females who reported that they currently had or had a history of an eating disorder (mean age: 25.80 years; SD: 8.53; range: 18-46 years) were also taken from a previous study by George et al. (2011). These participants' BMIs ranged from 13.0- 26.0, with a mean of 19.0 kg/m^2. All of these participants reported they currently had or had a history of an eating disorder.

This study was approved by the Faculty of Medical Sciences ethics committee at Newcastle University (00611/2012; 00611_1/2013).

4.2.2. Stimuli

Stimuli used in this study were a set of 24-bit colour digital photographs of women wearing a standardized unsupportive flesh coloured vest and briefs (Smith et al., 2007). Descriptive statistics for these images can be seen below in table 4.1. Faces were blurred to remove any effects of facial cues.

Figure 4.1. An example of the 2D female bodies used as stimuli in this study.

Again, a change in stimuli from the previous chapter can be seen in this study. This is due to the fact that we were asking participants to not only judge size but also actual weight, and I thought that participants would find it easier to estimate weight of real bodies rather than computer generated bodies as these are the bodies that they are used to judging in terms of kilograms or stones in real life. While computer generated images are easier to control in terms of size and shape, it was thought that as they tend

to have a smoother and more even skin tone, while deposition of fat is in realistic areas, this has a different appearance to deposition of fat on a real woman as the texture of the skin is less realistic, i.e. computer generated bodies lack certain visual cues to fatness such as cellulite or dimpled skin. I therefore reverted back to the real women's' bodies for this study.

Table 4.1. Descriptive statistics for the 46 2D images used (Smith et al., 2007).

	Min	Max	Mean	S.D.
BMI	18.25	26.68	22.28	2.30
WHR	0.64	0.84	0.74	0.04
WCR	0.72	0.89	0.8	0.03

4.2.3. Materials

Copies of the Eating Disorder Beliefs Questionnaire (Cooper, CohenTovee, Todd, Wells, & Tovee, 1997), the 16 item- Body Shape Questionnaire (Evans, & Dolan, 1993), Beck's Depression Inventory (Beck et al., 1961) and Rosenberg's Self-Esteem Scale (Rosenberg, 1979) were used to assess attitudes towards eating and behaviours associated with Eating Disorders.

The *Eating Disorder Beliefs Questionnaire (EDBQ)* was developed as a multidimensional measure designed to assess the different types of core beliefs and assumptions held by those suffering from eating disorders. It consists of 4 subscales each designed to approach a different aspect of these assumptions: (i) Negative self-belief, (ii) weight and shape as a means to Acceptance by others, (iii) weight and shape as a means to Self-acceptance, and (iv) control over eating. In past studies (Cooper et al., 1997) Cronbach coefficient alphas were computed for each factor to assess their internal consistency. These values were: negative self-beliefs 0.93 (range 0.92- 0.93), acceptance by others 0.94 (range 0.93-0.94), self-acceptance 0.88 (range 0.85- 0.87), control over eating 0.86 (range 0.82- 0.87), suggesting that these subscales all have high reliability.

The 16-item version of the *Body Shape Concern Questionnaire (BSQ)* is designed to measure how concerned you are about your body shape and appearance-something that is typical of those with eating disorders. There are six response choices (never, rarely, sometimes, often, very often, and always) relating to how the person has been feeling over the past four weeks. Scores can range from 16 to 96, with

high/marked concerns categorised as those with scores over 66, while those with scores less than 38 were said to demonstrate no concerns. Scores of 38-51 show mild concern while a score of 52-66 shows moderate body shape concerns (Evans, & Dolan, 1993).

The *Beck Depression Inventory (BDI)* is a 21-item questionnaire designed to assess the severity of depression and was originally based on psychiatric observations of the attitudes and symptoms associated with depression. Past research found that for psychiatric populations, Cronbach's alpha ranged from 0.72 to 0.91, with a mean of 0.86. Within non-psychiatric samples, the mean alpha was 0.81; with a range of 0.73 to 0.92, again suggesting high reliability for this questionnaire (Osman, Kopper, Barrios, Gutierrez, & Bagge, 2004).

The *Rosenberg Self-Esteem Scale (RSE)* is a 10-item self-report scale where the participants are asked about general feelings about themselves and asked to tick the response closest to how the feel, with a choice of four responses (strongly agree, agree, disagree, strongly disagree). The highest total score is 30; however Rosenberg (1979) suggests scores of 15-25 are within the normal range, whilst scores below 15 suggest low self-esteem. Past research has found Cronbach's alpha ranging from .72 to .88 showing good reliability for this questionnaire (Gray-Little, Williams, & Hancock, 1997).

4.2.4. Design

A within-subject repeated-measures design was implemented for this study as all participants were required to rate images for body size. The independent variable was the images themselves; while the dependent variable was the rating the participants gave each image.

4.2.5. Procedure

Volunteers were first required to read an instruction sheet and give informed consent before participating in the study. They were then given copies of the BSQ, EDE-Q, EDBQ, BDI and RSE to complete before the experiment began. Participants were informed that if they became uncomfortable at any stage, they could take a break or withdraw completely from the study.

Participants were then asked to rate a series of 46 female bodies for body size on a Likert scale ranging from 0-99, with 0 representing an "emaciated" body and 99 representing an "obese" body (George et al., 2011).
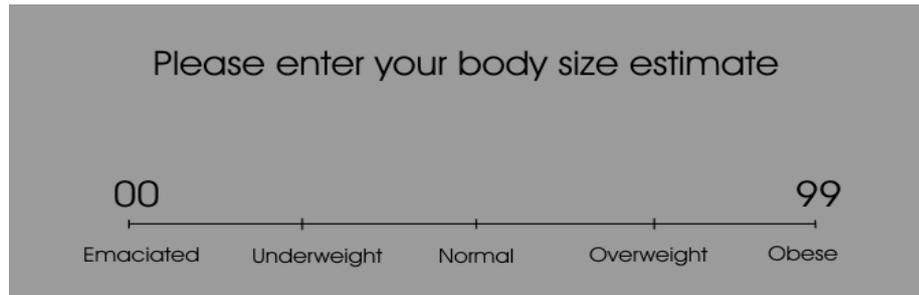
Figure 4.2. A screen shot of the rating scale for body size that participants were shown during the experiment.

Participants were asked to complete body size ratings for each of the 46 images. They were shown each image once. Images were shown in a randomised order which differed between participants.

E-Prime version 2.0 (http://www.pstnet.com) was used to create the experiment, and each trial comprised the following sequence: A black fixation cross appeared for a period of between 1,500 and 2,500 milliseconds (ms). The length of this interval was randomised to prevent participants predicting when the image would appear. Next, the target image (a body) appeared for a total of 2,000 ms. Following this, the observer was reminded of the rating scale from 0-99, and using the keyboard (pressing keys 0-9) they made their decision. A time limit was not implemented for this rating to take place, although participants were urged to make an instinctual choice to avoid over-thinking the decision. Immediately after the rating had been made, the fixation cross appeared and the next image was presented. This continued until all 46 images had been rated. On completion of this task, participants were given a debrief which outlined the aims and predictions of the study.
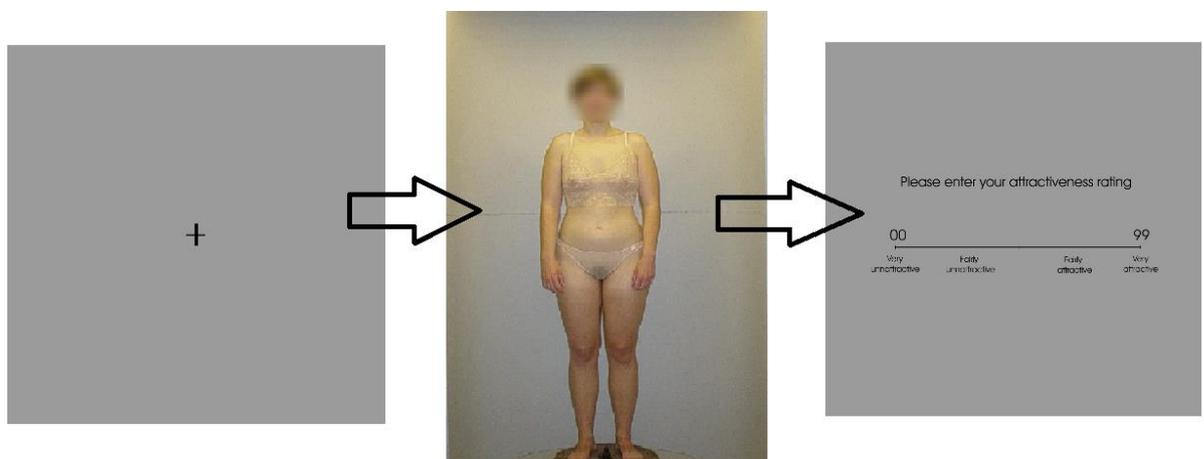
Figure 4.3. The sequence of events displayed in the E-Prime script: fixation cross, followed by 2D image, followed by ratings screen.

128

4.2.6. Data Analysis

Before statistical analysis of the data could commence, questionnaires were scored and participants' BMIs were calculated ($BMI = \frac{mass\ (kg)}{(height\ (m))^2}$).

The 16-item BSQ was scored by simply adding up the number circled for each of the 16 questions (1-6). The BDI was similarly scored by adding up each of the numbers entered for each of the 21 questions (0-3). The following table (4.2) shows what the scores mean:

Table 4.2. The classification system for scoring Beck's Depression Inventory. A persistent score of 17 or above indicates the individual may need professional treatment (Beck et al., 1961).

Classification	Total Score	Level of Depression
Low	1-10	These ups and downs are considered normal
	11-16	Mild mood disturbance
Moderate	17-20	Borderline clinical depression
	21-30	Moderate depression
Significant	31-40	Severe depression
	Over 40	Extreme depression

To score the RSE each was scored from 0-3; numbers were added to accumulate an overall score. For items 1, 2, 4, 6 and 7 an answer of "strongly agree" was scored as 3, "agree" as 2, "disagree" as 1, and "strongly disagree" as 0. Items 3,5,8, 9 and 10 were reversed in valence and thus so was the scoring, with "strongly agree" assigned a score of 0, "agree" a 1, "disagree" a 2, and "strongly disagree" a 3.

For the EDBQ, while there was a global score (the sum of all scores) there was also a score for each subscale: (i) Negative self-belief, (ii) Acceptance by others, (iii) Self-acceptance and (iv) Control over eating. Questions 1-10 loaded on to (i), questions 11-20 loaded onto (ii), questions 21-26 loaded onto (iii), and questions 26-32 loaded onto (iv). Questions in each subscale were added and divided by the number of questions that loaded on to that subscale. Those four numbers were then added and divided by the number of subscales (four) to create a global score.

SPSS statistics version 21 was used for all analysis with an alpha level set at 0.05. Correlation analysis was conducted to establish relationships between predictor

variables (observer BMI; questionnaire scores) and estimated weight. As the questionnaire results were highly correlated, a Principle Component Analysis (PCA) was conducted to reduce psychometric variables into fewer factors, and general linear mixed modelling (GLMM) was used to quantify the extent to which estimated body size could be accounted for in terms of the BMI of the women in the stimuli, the BMI of the Observers and the psychometric scores of the Observers. Estimated weight and the BMI of the images were converted to z-scores to facilitate direct comparison of the regression weights. Observer BMI was also centred and the latent variable for the psychometric scores was standardized.

4.3. Study 1 Results

Table 4.3. The means and standard deviations (SD) of the participants' questionnaire scores, and the reliability of these measures.

	N=110		
	Mean	SD	Cronbach (α)
Age (years)	27.24	9.06	
BMI	21.73	3.53	
Beck Depression Inventory (BDI) Max. score = 63	11.70	12.39	.893
Rosenberg Self Esteem (RSE) Max. score = 30	20.90	7.17	.939
Body Shape Questionnaire (BSQ) Max. score = 96	46.46	18.22	.981
Eating Disorder Beliefs Questionnaire (EDBQ) Max. score = 400	26.97	20.43	.977

Cronbach's α calculations performed on the raw data for the psychometric variables (table 4.3) revealed strong inter-rater reliability for each questionnaire, with these alpha levels consistent with the Cronbach's results from previous studies (see methods section 4.2.3).

Table 4.4. The pattern of Pearson correlations between all observer variables.

	Observer BMI	Observer Age	BSQ	RSE	BDI
Observer BMI	-	-	-	-	-
Observer Age	0.30**	-	-	-	-
BSQ	-0.11	-0.02	-	-	-
RSE	0.27**	0.20*	-0.45**	-	-
BDI	-0.41**	-0.04	0.60**	-0.51**	-
EDBQ	-0.48**	-0.08	0.75**	-0.50**	0.72**

$* = p<0.05; ** = p<0.01$

A substantial and statistically significant, positive correlation was found between estimated body size and the BMI of the women in the stimulus images ($r = 0.86$, $p<0.0001$) suggesting that participants were accurately able to estimate body size. Table 4.4 shows the pattern of Pearson correlations between the psychometric scores, age and BMI of the observers. Strong negative correlations were found between observer BMI and BDI score, observer BMI and EDBQ score, BSQ score and RSE, RSE score and both BDI and EDBQ score. While a strong positive correlation was found between observer BMI and observer age as well as with RSE score, observer age and RSE score, BSQ score with both BDI and EDBQ score, and BDI score with EDBQ score.

The aim was to model the relationship between estimated body size and observer BMI while controlling for the influence of AGE and the psychometric variables (RSE, BDI, BSQ and EDBQ). However, as table 4.4 shows, the latter were highly inter-correlated. Therefore, any attempt to model the relationship between estimated body size and these psychometric variables would be likely to be confounded by problems with collinearity between the variables. Therefore, a principal component factor analysis with rotation was carried out in order to identify the significant latent variables in the psychometric data. The factor scores from these variables were then used in all subsequent analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (which indicates the degree of diffusion in the pattern of correlations) was 0.76 suggesting an acceptable sample (Kaiser, 1974). One factor had Eigen values greater than Kaiser's criterion of 1 (i.e., 2.75) which explained 69% of the variance. The scree plot showed an inflexion, i.e., Cattel's criterion which also justified retaining just the one factor (Cattell, 1966). The residuals were all small, and the overall root mean

square off-diagonal residual was- 0.07, indicating that the factor structure explained most of the correlations. The factor loadings for RSE, BDI, BSQ and EDBQ were: - 0.67, 0.86, 0.86 and 0.91 respectively. This resulting variable represented a combination of the attitudes thought to contribute to body size disturbance: disturbed attitudes to eating, weight, and shape, and low self-esteem and depression.

General linear mixed modelling (GLMM) was used to quantify the extent to which estimated body size could be accounted for in terms of the BMI of the women in the stimuli, the BMI of the Observers and the psychometric scores of the Observers. Body size estimates and Image BMI were converted to z-scores to facilitate direct comparison of the regression weights. Observer BMI was centered and the latent variable for the psychometric scores was standardized. The following analysis strategy was pursued:

> 1) Start with an empty model which estimates the overall variance attributable to individual observers and to items
>
> 2) Extend this to a main effects model, which retains statistically significant random effects attributable to individual observers and to items
>
> 3) A final level model which extends the main effects model to include statistically significant interactions.
>
> The optimal model fitted was as follows:

$$\text{Level 1:} \quad y_{ti} = \beta_{0i} + \beta_{1i}(Img\_BMI_{ti})$$
$$+ W_t + e_{ti}(Obs\_BMI) + e_{ti}(Psych)$$
$$\text{Level 2:} \quad \beta_{0i} = \gamma_{00} + \gamma_{01}(Obs\_BMI_i) + \gamma_{02}(Psych_i) + U_{0i} \, ,$$
$$\beta_{1i} = \gamma_{10} + \gamma_{11}(Obs\_BMI_i)$$

NB Img_BMI = BMI of stimulus image, Obs_BMI = BMI of rater (centred),

Psych = Latent psychological variable (z-score)

Whereby y_{ti} was the z-score for the estimated body size for item $_t$, individual (rater) $_i$, γ_{00} and γ_{10} represented the fixed (main) effects of the intercept and image BMI respectively; γ_{01} and γ_{02} represented the fixed (main) effects of observer BMI and

psychometric score on the intercept respectively; γ_{11} represented the fixed effect of the two way interaction between image and observer BMI. W_t was random item (stimulus) effect, and the random intercept U_{0i} represented the individual intercept deviation after controlling for observer BMI and psychometric score. Finally e_{ti} represented the prediction error for level 1. This equated to three models based on maximum likelihood estimates. All results are displayed in table 4.5.

Table 4.5. Multilevel model parameters for predicting body size estimates

Parameter	Model 1		Model 2		Model 3	
	Est	SE	Est	SE	Est	SE
Fixed Effects						
Intercept (γ_{00})	-0.008	0.114	-0.007	0.063	-0.007	0.063
Image BMI (γ_{10})			0.634	0.056***	0.635	0.056***
Observer BMI (γ_{01})			-0.026	0.001*	-0.026	0.010*
Observer Psych (γ_{02})			0.110	0.036*	0.110	0.036*
Image by Observer BMI (γ_{11})					-0.010	0.002***
Variance Components						
Random item variance (W_t)	0.533	0.114***	0.139	0.030***	0.139	0.030***
Random intercept variance (U_{0i})	0.132	0.019***	0.102	0.015***	0.102	0.015***
Residual variance (e_{ti})	0.336	0.007***	0.336	0.007***	0.335	0.007***
Fit Statistics						
ML deviance (number of parameters)	9,110.2		9,023.0		9,005.4	
AIC	9,118.2		9,037.0		9,021.4	
BIC	9,144.2		9,082.5		9,073.3	

*$p < .05$, **$p<0.001$, ***$p < .001$

Model 1 was an intercept only (or empty) model, incorporating random variation at both the individual rater and item levels. By comparison with the empty model, both Models 2 and 3 represented successively significant reductions in log likelihood, indicating substantial improvements to model fit (results for the best fitting model are reported in full: Model: 3). It showed statistically significant main effects for image BMI [$F(1, 45.95) = 128.11$, $p = < .0001$], observer BMI [$F(1, 106.45) = 6.97$, $p = < .05$] and observer Psychometric score [$F(1, 106.45) = 9.38$, $p = < .05$].

As shown in table 4.5, observers' estimates of the body size of women increased as a function of increasing image BMI and increasing concern weight, body shape and eating, as well as reduced self-esteem. Consistent with contraction bias, the slope of this relationship was 0.74. Separate regression analysis confirmed that this was significantly

less than 1. By contrast, the effect of observer BMI was to reduce body size estimates. Model 3 also showed a statistically significant interaction between image BMI and and observer BMI [$F(1, 4747.22) = 17.67$, $p = < .0001$]. The nature of this effect is illustrated in figure 4.4. For low BMI stimulus, the BMI of the observer had little influence on body size estimates. Broadly speaking, all observers over-estimated the body size of low BMI images. However, as the BMI of observers increased, there was a much greater tendency for high BMI observers to under-estimate low BMI images than was the case for low BMI observers.
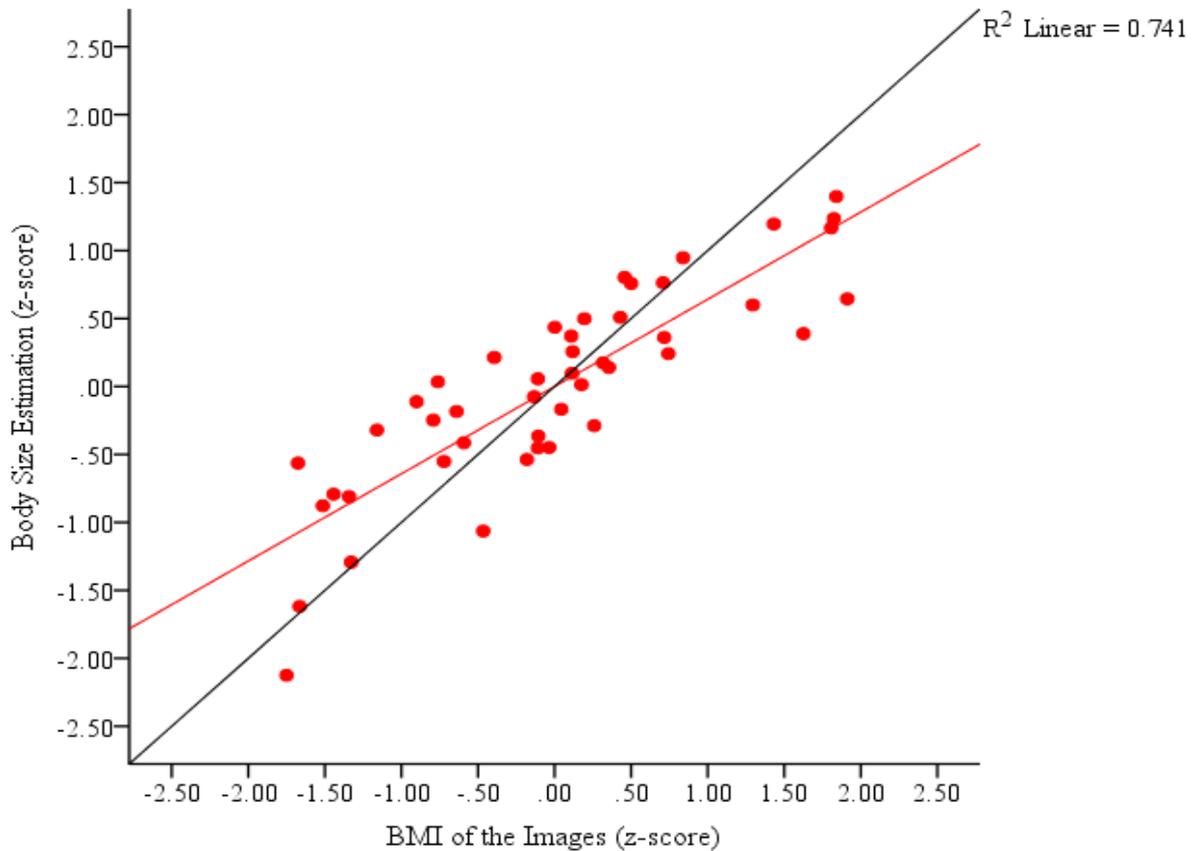
Figure 4.4. The actual BMI of the images plotted against estimated body size of the images (z scored data). Red line= linear regression line; Black line= reference line.

Figure 4.4 clearly shows a difference between the reference line that would occur should participants be able to estimate size, and the linear regression line fitted to the actual estimations. This suggests that participants overestimated the size of thinner bodies (lower BMI) and underestimated the size of fatter bodies (high BMI). The differences in slopes in this data that can be seen from figure 4.4 therefore indicate that there may have been contraction bias in this data.

The fitted data from model 3 of the GLMM (table 4.5) was then plotted in order to illustrate this evident overestimation of size but to also show the effect of observer BMI and observer psychometric score on their body size estimations.
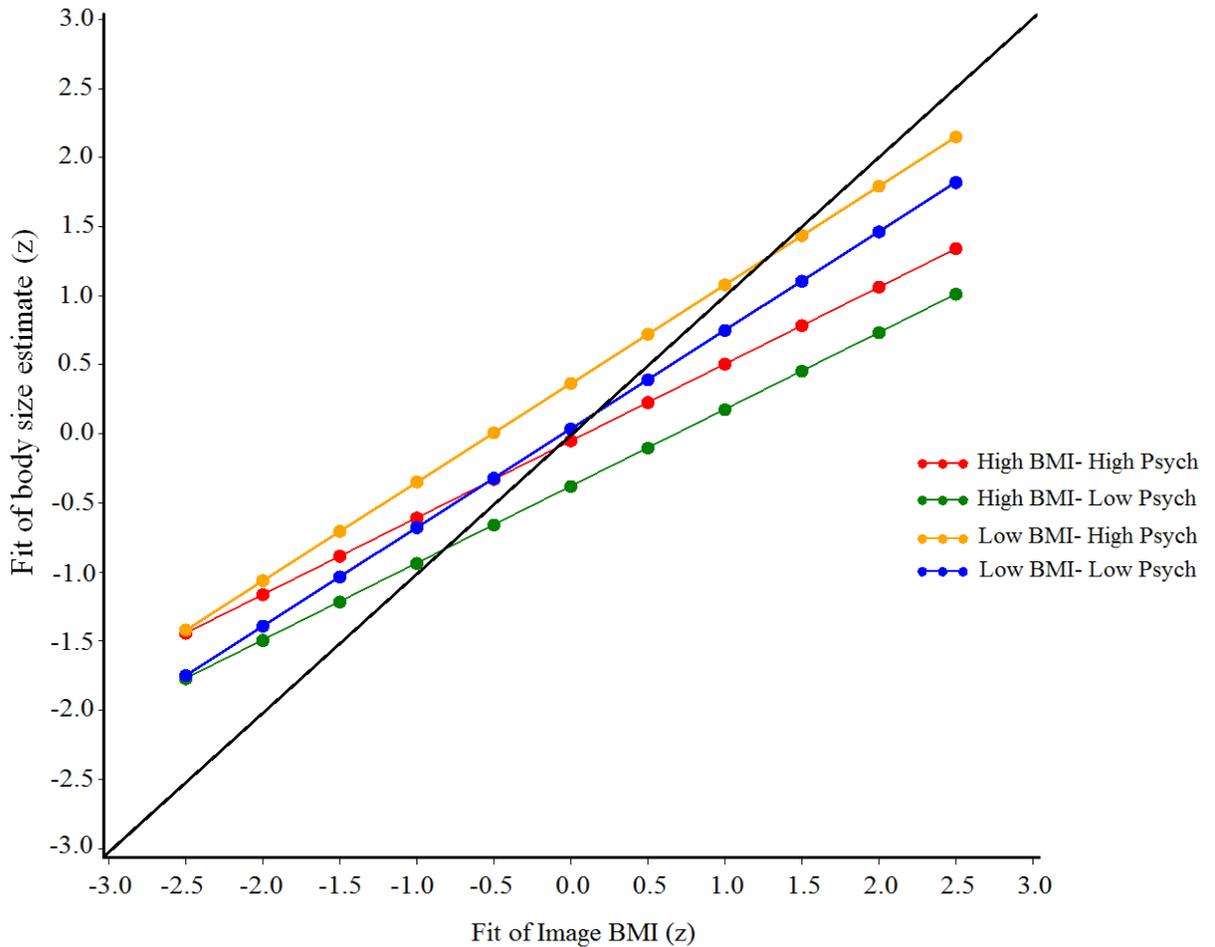
Figure 4.5. Fit of the body size estimations plotted against the BMI of the images. Four lines depict four groups of observers- those with low and high BMI and those with low and high psychometric scores. The black line represents the line of equality that would occur if participants were able to estimate body size perfectly.

The pattern of results in figure 4.5 would suggest that as the BMI of the images increased, estimations of size changed from overestimation to underestimation. It would also appear that there was an impact of observer BMI on body size estimates as body size increased (large difference between red and yellow lines (high and low BMI, high psych) and between green and blue lines (high and low BMI, low psych)). When judging bodies at the lower end of the BMI spectrum, it would appear that observer

135

BMI had less of an impact on estimation of size compared to psychometric scores-yellow and red lines were very close together, as were blue and green lines, when viewing bodies at the lower end of the BMI spectrum suggesting little difference in estimations between observers of low and high BMI, but instead more of an effect of psych score (red and green lines were far apart, as were yellow and blue).

The results of this study suggest that contraction bias applies not only to judgements of their own bodies, but also to bodies of other women. However, the judgement made in this study does not correspond to a "classical" contraction bias study, which would ask its participants to make a quantitative estimate of stimulus size (Poulton, 1989). Therefore to confirm the role of contraction bias in body estimation, a second study was carried out asking participants to estimate the weight of other women's bodies to determine whether the accuracy of judgments could be explained by contraction bias when making a quantitative estimation.

4.4. Study 2

4.4.1. Participants

A total of 80 female undergraduate participants (mean age: 24.40; SD: 7.60) were recruited for this study through the use of opportunity sampling fom both Newcastle and Northumbria schools of Psychology and through the ION volunteers scheme at the Institute of Neuroscience (Newcastle University). Participants' BMI ranged from 16.2-40.2, with a mean of 22.50 (within the "normal" BMI range of 20-25). In accordance with the International Classification of body weight in relation to BMI (WHO, 1995), calculated by kg/weight in m^2, 10 people were classed as underweight, 55 people were in the normal range, 13 people were classed as overweight and 2 people were classed as obese. None of the participants reported they currently had or had a history of an eating disorder.

4.4.2. Stimuli

130 digital photographs of female bodies (Tovée et al., 2003) were used as stimuli in this study. This image set was used instead of the set used in *study 1*, as it contained a wider range of BMI values than the Smith et al. set, and should allow any trend in mis-estimation of body size to be clearly identified. Females in the images used in the study varied in weight from 28.2kg to 104.9 kg. The females in the photographs

were front-facing, in a standard pose, presented against a fixed background and wore beige form-fitting leggings and leotards so that adiposity and deposition of fat could be seen to its true extent. As in *study 1*, faces were blurred to remove any effects of facial attractiveness and to protect anonymity.

4.4.3. Design

This study followed a within subject, repeated measures design, in order to establish evidence of contraction bias as an influence on the dependent variable (estimated body weight of the images shown).

4.4.4. Procedure

Participants were informed that if they became uncomfortable at any stage, they could take a break or withdraw completely from the study.

The computer-based task consisted of participants being presented with 130 images of female bodies. Each image was shown individually on a plain black background under which was a scale ranging from 30kg- 110 kg or 5st- 17st (see figure 4.6). Before the experiment began, participants were informed that they were going to be shown a series of bodies varying in adiposity which they were required to estimate for weight using either kilograms or stones (whichever they felt most comfortable with).

Following the completion of the task, participants were presented with a debrief sheet and were permitted to ask questions. This study took approximately 30 minutes to complete in total.

Figure 4.6. Participants were to move the black arrow along the scale (shown here at 14.5st) and click the weight they thought most represented the body above.

4.4.5. Data Analysis

SPSS statistics version 21 was used for all analysis with an alpha level set at 0.05. An ordinary least squares linear regression of the mean estimated weight for each image as a function of the actual weight in each image was used to investigate the amount of variance in estimations of weight accounted for by the actual weight of the images.

4.5. Study 2 Results
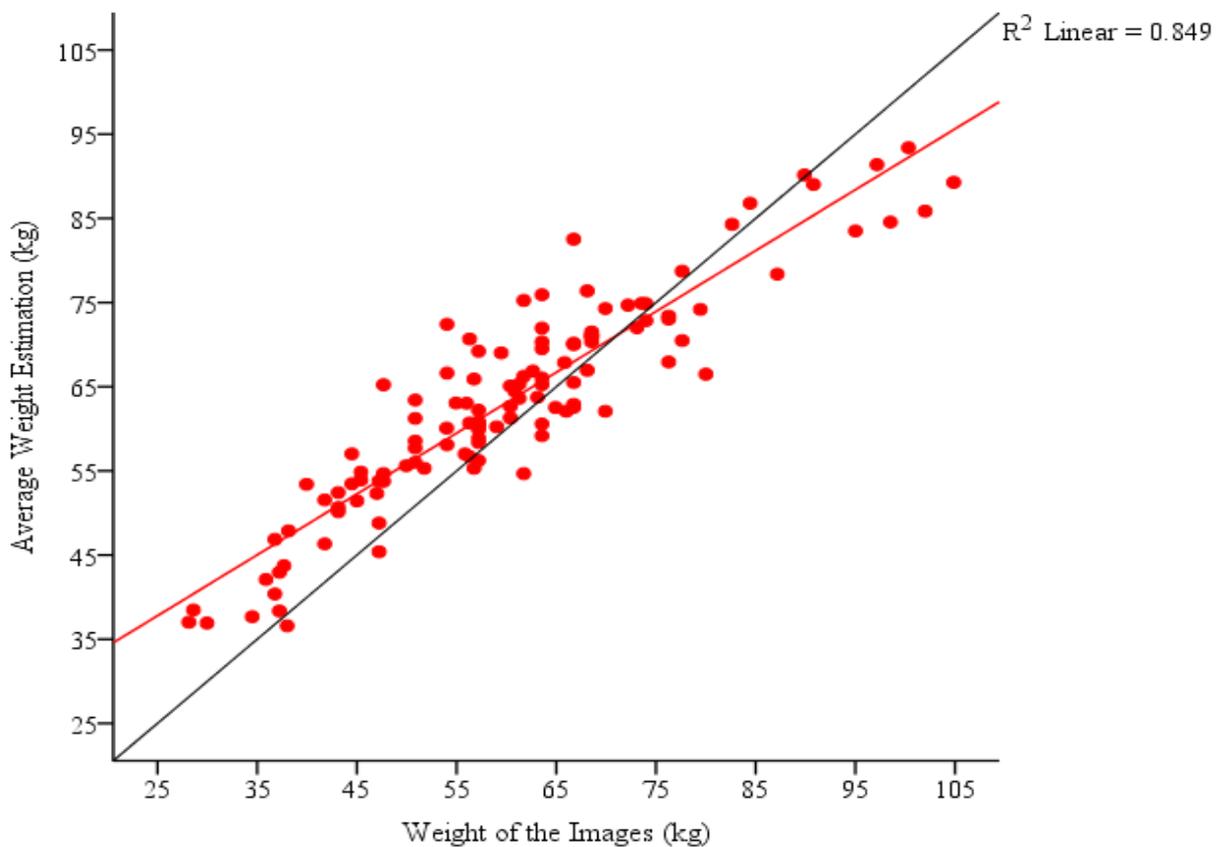
Figure 4.7. Scatterplot depicting the relationship between the actual weight of the images (kg) and the participants' estimations of weight (red line= linear regression line; black line= line of equality).

The line of equality in figure 4.7 represents what the graph should look like if participants were able to perfectly estimate the weight of others. As can be seen from figure 4.7 there is a distinct difference in the slopes of the regression and equality line. The data here would therefore seem to suggest that participants, on average,

overestimated the size of lighter bodies, while underestimating the size of heavier bodies, something which is consistent with the idea of Contraction Bias.

In order to investigate evidence of Contraction Bias here, the data was averaged at image level and a simple regression analysis was calculated in an attempt to see how much of the variance in judgements of weight was accounted for by actual weight of the bodies. An ordinary least squares regression of the mean estimated weight for each image as a function of the actual weight in each image was used. This model explained 85% of the variance in estimated weight. The overall model fit was statistically significant, $F(1,118) = 23.83$, $p<0.0001$. The regression parameters, $\beta_0 = 19.72$ [$t=11.28$, $p<0.0001$] and $\beta_1 = 0.72$ [$t= 25.77$, $p<0.0001$], showed a statistically significant, positive linear relationship between stimulus weight and estimated weight. However, the slope of this relationship was significantly less than 1, $F(1,118) = 97.46$, $p<0.0001$. Body weights lower than ~65kg were systematically overestimated, while body weights above ~65kg were systematically under-estimated.

Because the height of the women in the stimulus images had already been measured, it was possible to carry out an equivalent analysis of estimated BMI as a function of actual BMI. This model explained 82% of the variance in estimated BMI. The overall model fit was statistically significant, $F(1,118) = 527.08$, $p < .0001$. The regression parameters, $\beta_0 = 5.32$, $t= 6.68$, $p < .0001$, CI [3.74 – 6.90] and $\beta_1 = 0.81$, $t= 22.96$, $p < .0001$, CI [0.74 - 0.87], showed a statistically significant, positive linear relationship between stimulus weight and estimated weight. The slope of this relationship was also significantly less than 1, $F(1,118) = 30.91$, $p < .0001$. These data therefore demonstrate convincing evidence for contraction bias when female observers judge the body weight of other women.

4.6. Discussion

The results from both studies suggest that accuracy of body size estimation is proportional to the BMI of the body being judged. Participants overestimate the size of bodies at the lower end of the BMI spectrum, and under-estimate the size of bodies at the upper end of the spectrum. This pattern is shown not only by non-eating disordered participants but by women with AN as well, and is consistent with contraction bias

shaping the accuracy of estimation. This is important. A key prediction of a perceptual explanation of body misperception is that it should apply to all bodies, and not purely the observer's own body. This suggest that mis-estimation of body size is a general perceptual phenomenon and is not a specific behaviour found in women with AN and qualitatively from the behaviour found in control participants. Women with AN over-estimate their body size because their BMI is low not because they have AN, and non-eating disordered women of the same BMI would over-estimate to the same extent.

In experiment 2, female participants estimated the weight of women varying in their body mass. Their estimates clearly show contraction bias with bodies below 70Kg being increasingly over-estimated and bodies above 70Kg being increasingly under-estimated. For example, a woman who weighs 100kg will under-estimate her weight by ~10kg. A value of 70 kg is the average body weight for adult women in the UK (HSCIC, 2012), and its adoption as a reference value against which to judge other female bodies would be consistent with people's visual diet shaping their reference body so that it reflects the population norm. As the height and weight of the women in the photographs is known, it was possible to calculate both the actual BMI of the women in the photographs and the BMI of their bodies based on the participants' estimation of their weight. These data show the same pattern of contraction bias, with a BMI of 27 being the most accurately judged, again consistent with a reference template based on the average BMI for adult women in the UK (HSCIC, 2012).

Observers with larger BMIs were found to significantly underestimate the body size of larger individuals compared to observers with a smaller BMI, building on the evidence from studies which found that overweight individuals significantly underestimated their own body size (Tovée et al., 2003; Tovée et al., 2000). Our results therefore suggest that not only do overweight observers underestimate their own size but they also underestimate the size of others in the general population. In addition, all participants were found to significantly overestimate the body size of thinner bodies. This again shows support for previous literature (George et al., 2011) who also suggested that overestimation of size was a function of ones' own size.

A number of studies have suggested that over-weight and obese people under-estimate their BMI, and this has been explained in terms of an adaptation effect to a visual diet with a high proportion of heavier body types (Robinson, Webb, & Butler-Ajibade, 2012). That is to say, because we see lots of over-weight and obese people every day due to an increase in the proportion of people in the population with this

higher weight, we now regard that as a normal weight. However, the results reported here and in previous studies (Cornelissen et al., 2013; Tovée et al., 2003; Tovée et al., 2000), suggest that contraction bias would be a plausible alternative explanation. Contraction bias can also be used to explain the accuracy of judgements of own body size over a wide range of BMI values from emaciated to obese (Cornelissen et al., 2013) and can also explain the fact that previous studies have consistently shown that obese people under-estimate their size relative to normal weight people (Kuchler, & Variyam, 2003; Kuskowska-Wolk, Karlsson, Stolt, & Rossner, 1989; Maximova et al., 2008; Robinson, & Kirkham, 2014; Truesdale, & Stevens, 2008; Wetmore, & Mokdad, 2012).

Indeed, as a higher proportion of heavier bodies in an observers visual diet would shift the "internal body reference template" towards a higher BMI value, it would be expected that the increase in heavier bodies in the general population would improve the accuracy of heavy body estimation as it would reduce the difference in BMI of the template and the BMI of the body being estimated, thus reducing the contraction bias error. However, this also means that the "normal" size for a body is being recalibrated upwards. The weight and BMI values suggested for the internal template in experiment 2 place it in the middle of the over-weight BMI category, a result consistent with the finding from Winkler and Rhodes (2005) that the presentation of a sequence of larger bodies recalibrated their observer's judgement of what was a normal body size (upwards). Thus, a visual diet of high BMI bodies could lead people to believe that a higher BMI than is actually healthy is a normal and acceptable body size, and thus prevent them from undertaking weight control or reduction behaviours (Robinson, & Kirkham, 2014).

Although the pattern of over-estimation is predicted by contraction bias, the observer's own BMI and psychological state modulate the degree of mis-estimation. That is to say, increasing observer BMI and/or increasing psychological scores increase the estimated BMI of all of the bodies. If one considers the relationship between estimated body size and actual body size, contraction bias seems to alter the gradient of the relationship and the observer's own BMI and psychological factors move the function up or down the Y-axis.

The effect of BMI on the judgements may be linked to an adaptation effect. It could be argued that the body we see most often is own, and this may have an impact on our proposed internal reference template which we use to judge size. As mentioned above, repeated exposure to bodies of a particular size can shift what is regarded as a

normal body size (Winkler, & Rhodes, 2005), and if one is spending a lot of time looking at a thin body in the mirror this will impact on the reference template. Additionally, a person's BMI can be regarded as a proxy of the BMI of their social group, as people of a similar lifestyle and BMI tend to socialise together (Christakis, & Fowler, 2007). So for example, someone with a low BMI will see predominantly low BMI bodies in their social network, which will serve to adapt their internal reference template.

Alternatively, it may be that the participant's BMI is impacting not on the perceptual component of body size estimation, but on the psychological (attitudinal) component. The results from study 1 show that the psychological scores seem to be linked to a shift in the body size estimation which is independent of the perceptual factor (contraction bias). Cash and Deagle (1997) originally proposed that the psychological and perceptual components of body size estimation function largely independently. BMI is a significant predictor of psychological health and mood (Markowitz, Friedman, & Arent, 2008), and so BMI maybe having an impact through its influence on the participant's emotional state. For example, mood induction techniques can increase or decrease the accuracy of estimating the size of the same body (Cohen-Tovee, 1993). The results from these two studies are more consistent with the single-channel rather than the dual channel model proposed as a theory behind differences in estimation of size between AN and control subjects. This single channel model suggests that overestimation of size is not a pathological trait associated with AN, but that instead, body size judgements lie on a continuum with all populations having distorted perceptions of size to some extent (Bergström, Stenlund, & Svedjehäll, 2000) but some people have more marked distortions than others due to their psychological state.

Cultural and socio-economic factors may influence our judgement of bodies. For example, showing larger bodies in a positive light can increase the preference for larger bodies (Boothroyd et al., 2012). An example of this "visual valency" is the change in body preferences as people move between cultures. People living in rural KwaZulu Natal in South Africa prefer a much larger BMI (Tovée et al., 2006), but people from KwaZulu Natal moving to the UK shift their preferences towards a lower BMI. The average BMI of people in both regions is not significantly different, but in KwaZulu Natal a heavier body is associated with health and higher socioeconomic status whereas

in the UK the opposite is the case. Thus, it is the value placed a particular body size by a culture that seems to predict preferred body size.

4.6.1. Future Research

It would have been interesting to also recruit a large sub-clinical group of participants at both ends of the extreme BMI spectrum, in order to gain the greatest range of size estimations and psychological scores. In general, people tend to assume that people with larger BMIs are unhappy with their bodies, and those of a normal weight are conversely happy with their bodies. However, in this sample we had a range of people with different BMIs, some of whom were overweight and happy, some who were overweight and unhappy and a similar pattern for those who were underweight. Therefore it would be interesting in future to recruit four groups and investigate the differences in estimation of body size in those who are overweight (happy and unhappy with their body) and underweight (happy and unhappy with their body). This would give us a true representation of all possible combinations of psychological state and BMI.

In addition, a further factor not considered in this study also influencing the accuracy of body size judgements may be another well-established perceptual effect-Weber's Law. Weber's Law states that the just noticeable difference (JND) between two stimuli will be a constant proportion of their magnitude, leading to a constant Weber fraction over the stimulus range (i.e. $\Delta I / I = K$, where I = stimulus magnitude and K = constant). This means that, for bodies, it is easier to notice, for example, a one BMI unit difference between two bodies of a lower BMI than between two bodies at the higher end of the BMI spectrum. This could therefore make it much more difficult for overweight people to detect weight increase, and so subsequently reduce the probability of these people taking weight control measures.

In western countries there has been a dramatic rise in obesity levels with a concomitant pressure on public health resources (Ogden et al., 2006; Swinburn et al., 2011). A recent report from the McKinsey Global Institute put the costs of obesity to the world economy at £1.3 trillion, and the cost to the UK at £47 billion (Dobbs et al., 2014). Obesity can take up to 8 years off a person's life expectancy and can cause decades of ill health. A potential contributory factor to the rise in obesity levels is the failure of people to recognise their weight gain. It is thus an important additional factor to consider in body size judgments and should be investigated in future studies into the obesity epidemic we are facing today.

As mentioned in the limitations sections of previous studies in this thesis, a limitation of this study is the fact that a priori power analyses were not conducted in order to calculate the least number of participants needed to find an effect. In future studies, this will be implemented, but unfortunately this was overlooked when designing this study- instead a time frame was set for recruitment of participants and I recruited as many participants as I could during that time, giving me a sample of 80 undergraduate students. Instead, I looked at previous research and their sample sizes. Cornelissen et al. (2013) used 30 "normal" participants and 137 Anorexic subjects and found a significant effect of Contraction Bias, and while this is a larger number than my sample, I assumed that because they found such a strong effect, it would not matter if I was unable to match their numbers exactly). I therefore thought that 80 participants + 20 Anorexic subjects would be adequate (which it was in terms of showing a significant effect, although I acknowledge that I couldn't be completely sure that this would be the case before starting the study), however in terms of following a well-informed research design, I should have carried out power calculations before recruitment.

4.6.2. Conclusion

In conclusion, the evidence from this chapter suggests that there is a strong perceptual factor in the over-estimation of body size in women with AN and BN, which is true for estimates of any low BMI women. This over-estimation is modulated by psychological state, but will be ultimately based primarily on body size rather than psychological state. Therefore, in future, treatment for eating disorders that involve a significant overestimation of size should focus not only on the cognitive component of body image distortion, but should also take into account the idea that patients' attitudes to their own body shape, and their self-esteem is reinforced by their perceptual mis-perception of body size.

Chapter 5: The effects of perception training on the overestimation of body size and behavioural measures comorbid with Eating Disorders.

5.1. Introduction

Body image distortion (BID), a key symptom of Eating Disorders (EDs) and a feature of the diagnostic criteria for both Anorexia Nervosa and Bulimia Nervosa in both DSM-iv-R and DSM-5 (American Psychiatric Association, 1994, 2013), and this is also a key element of psychological models of this disorder (Fairburn, Shafran, & Cooper, 1999; Rosen, 1997). BID is said to be comprised of 2 components: a perceptual disturbance and a cognitive-evaluative dysfunction (Cash, & Brown, 1987; Cash, & Deagle, 1997; Gardner, & Boice, 2004; Gardner, & Bokenkamp, 1996; Skrzypek, Wehmeier, & Remschmidt, 2001).

Treatment for EDs that ignore BID altogether (Fairburn, 1991; Fairburn et al., 1991) have been found to have much lower levels of improvement in ED symptoms post treatment (Farrell, Shafran, & Lee, 2006). In a review of the literature, Shaw and Stice (2002) conclude that prevention and treatment interventions would be improved by placing more emphasis and focus on Body Image Distortion. This is given further support by studies using factor analysis to identify the most important psychological features of EDs: Gleaves, Williamson, and Barker (1993) identified body image disturbance as a main component of the psychopathology of Bulimia Nervosa, while Gleaves and Eberenz (1993) said the same about Anorexia Nervosa.

Much research suggests the core psychopathology of eating disorders is a disturbance in the cognitive component of BID- patients being overly concerned with weight and shape (Cash, & Deagle, 1997; Fairburn, & Harrison, 2003). Current treatment of EDs: Cognitive Behaviour Therapy (CBT), Interpersonal Psychotherapy (IPT), and Family Based Therapy (FBT), therefore focus solely on the cognitive component of BID.

However, those with EDs consistently over-estimate their own size, and the body size of others (Cornelissen et al., 2013; George et al., 2011; Tovée et al., 2000), something which was also found by Shafran and Fairburn (2002) who's results showed

a mean over estimation of body size of 17% in those with clinically diagnosed EDs, compared to a mean over estimation of just 6% in control subjects. More importantly, studies which have used signal detection theory to specifically separate out the perceptual from the cognitive component of BID, have found a significant effect of perceptual factors (Cornelissen et al., 2013) an effect confirmed by the results in the chapter addressing contraction bias (Chapter 4). Timerman, Scagliusi, and Cordas (2010) found that treatment such as CBT showed no significant reduction in the overestimation of body size and suggest that future treatment should be improved for perceptual aspects of body image distortion. If BID is a key factor in the development and maintenance of AN and BN, then it is important to address in treatment both its cognitive and perceptual components. Additionally improving the perceptual accuracy of body size estimation and the concept of what is a normal body size, may also improve cognitive concerns.

EDs are also said to be highly comorbid with a number of other psycho-pathologies (Lewinsohn, Striegel-Moore, & Seeley, 2000), with the closest links seen with high levels of depression and low self-esteem (Bettle, Bettle, Neumarker, & Neumarker, 2001; Noles, Cash, & Winstead, 1985; Webster, & Tiggemann, 2003). Many treatment strategies therefore aim to address these as secondary issues.

One technique found to have an effect on psychopathologies such as depression and even aggression is perception training or behaviour modification. Penton-Voak, Bate, Lewis, and Munafo (2012) conducted a study in which young adults with high levels of depressive symptoms were shown a series of faces with varying facial expressions (a continuum from happy to sad). Their aim was to increase the perception of happiness over sadness in those faces of ambiguous expression, and in turn, also decrease depressive symptoms and negative mood. Evidence for this reduction in depressive symptoms and improvement in mood was found, with the effect still being maintained 2 weeks after completion of the training. This suggests that targeting the perceptual component of a psychological condition can in turn affect the cognitive.

While in all previous chapters I have implemented a likert scale method of rating bodies, in this study I wanted to base my method on that of previous research in this area, and did not want to deviate from this method too much in order to maximise potential for comparison with other studies and increase the chances for replication.

This study will therefore use this technique of categorical rating, replacing the continuum of happy-sad faces with thin-fat bodies, with the aim of recruiting females with high concerns about their body (screened using the body shape questionnaire (BSQ)) who are known to overestimate body size, and training them to perceive bodies previously viewed as fat, as thin. A previous study has suggested that bodies are judged in a categorical manner (Tovée et al., 2012), and this training programme will attempt to shift the categorical boundary such that bodies previously judged as "fat" will now be judged as "thin".

This study uses a subclinical group of participants with high body size concerns rather than a group of participants with a formal eating disorder diagnosis from a clinician. However, some form of eating disordered behaviour is often found in a non-clinical population. For example, it has been reported that 1 in 4 women engage in abnormal weight control and eating practices (Forman-Hoffman, 2004). The use of a non-clinical group in this pilot experiment which was a test of concept (i.e. did the training alter body image perception and eating disordered concerns) was a necessary first step in the process that will lead to a clinical trial. These participants were required to take part in the training over several days as it was decided that it would be beneficial to test the effectiveness of the procedure before inviting women with AN to take part in what represents a significant effort on their part.

Subjects will complete a battery of questionnaires pre- and post- training with the aim of improving depression, self-esteem and body concerns as a secondary effect of the training. We hypothesise that training will have a significant effect on body size estimation as well as self-reported scores on the questionnaires used. We predict that body size over estimation will be significantly reduced from pre- to post- training as will scores on the BSQ showing improved body image perception. We also predict secondary effects of the training on the other self-reported questionnaires with reduced scores on the BDI, EDE-Q and EDBQ, and higher scores on the RSE to show improved self-esteem.

In order to find the optimal stimulus set for this training programme, it was necessary to first test judgements of different sets of body stimuli. 15 images would be needed for this study, therefore a range of different bodies were generated through a variety of different programmes and techniques: Daz3D studio (v. 4 and 4.5), Morpheus Photo Morpher, Poser (v. 6), AutoDesk 3D Studio Max, and Abrosoft FantaMorph (v. 5).

As the ratings in this study were changed from likert scales to categorical ratings of "thin" and "fat" we did not know what kind of stimuli to use. It was therefore necessary to carry out an investigation into which kind of stimuli would be easiest to rate in this manner. The following paragraphs will describe small pilot studies that were conducted in order to investigate which type of bodies would be best used, and what body sizes the general population thought were either categorically "thin" or categorically "fat".

5.2. Pilot Studies: Generating Stimuli

205 female participants (mean age: 24.52; SD: 9.24; range: 18-65 years) were recruited, through the use of social networking sites such as Facebook, to participate in 7 pilot studies. By following the link to the questionnaires online, females were giving their consent to participate. Having followed the link, participants were immediately given a written brief of what the questionnaire entailed and were informed that they were free to withdraw at any point if they became uncomfortable with the material or the questions that were being asked. Participants wanting to withdraw from the study were informed that to do so they simply had to close the browser page. Qualtrics was pre-programmed by the experimenter not to record incomplete surveys; therefore by closing the browser, participants could remove their answers from the database of responses.

These studies were approved by the Faculty of Medical Sciences ethics committee at Newcastle University (00620/2013).

5.2.1. Experimental Stimuli

The first step in this study was to establish a suitable set of bodies to be used in the training programme. A number of different stimuli options were tested for suitability (see Appendix E for a description of the different pilot studies that were carried out in order to test what type of body (artificial or real; 3D bodies, morphed or otherwise) would be easiest for participants to rate as categorically thin or fat). The final set of stimuli chosen for this study were based on the Daz Studio (Daz3D.com) Genesis series of 3D models, specifically the Victoria 5 model. The advantage of using artificial bodies is that features such as skin texture and body proportions are unchanged between bodies

in a sequence. To determine the range of body size change necessary to cover the perceptual range from thin to fat, a pilot experiment was carried out.

5.2.2. Participants

52 female participants (mean age: 21.65, SD: 4.04, age range: 18-46) were recruited for this pilot study through the use of the social networking website-Facebook. All participation was voluntary. See appendices C and D for information about participants who took part in the preliminary pilot studies.

5.2.3. Apparatus/Materials

Qualtrics online survey software was used for the creation and completion of the questionnaire.

The interactive 3D software modelling interface Daz3D Studio version 4.5 (from Daz3d.com) was used to create a series of 15 bodies ranging in adiposity. This program allows the adjustment of photo-realistic female 3D models on a flat panel screen in order to modify different aspects of the body's features. The female model used was "Victoria 5". The program allows the body to be rotated to allow a 360° view of the model, however for these pilots the body was fixed at an angle of 55° as this was thought to show the best deposition of fat in the model (allowing participants to see the bust size as well as the thigh and glutes size).

Bodies were created using 9 out of a set of over 100 graphic sliders which allow different aspects of individual body parts to be altered (using the Evolution Generation Body Morphs add-on package from Daz3D). The 9 graphic sliders used in this pilot study were: "heavy", "emaciated" and "thin" which alter the overall size and shape of the body, and "breast size", "breast natural", "breast small", "waist width", "stomach depth" and "sternum depth" which allow you to alter individual aspects of the body. When the slider is adjusted, the model simultaneously changes, providing immediate visual feedback.

Once these images had been created in Daz3D 4.5, they were rendered as Jpegs and uploaded into the online test webpage as stimuli.

Figure 5.1. An example of 4 of the 15 bodies created using Daz3D version 4.5 and used in this final pilot.

Anthropometric data from each body were calculated by exporting each body from Daz Studio in waveform format once clothing and hair had been removed (they are coded as individual 3D objects and would interfere with accurate measurement of the body's parameters), and reopening in 3ds Max (autodesk.com). The volume of the 3D body model was then calculated by the software, scaling the body volume relative to the body height entered by the experimenter. A height of 164cm was set for each body (the average height for adult women in the UK). Once the volume is known, it is possible to calculate the nominal weight of the 3D bodies by multiplying their volume by the density of the average young adult female body (1.04 g/cm^3). Next, 3ds Max was used to slice through the body at chosen points along its length to determine the circumference of the body at the bust, waist and hips. The software scales the circumferences (measured in cm) to the dimensions that the body would have if it were real. These were used to calculate the waist-hip ratio (WHR) and waist-chest ratio (WCR). See table 5.1 below for details of anthropometric measures.

Table 5.1. Anthropometric data for the 15 bodies created in Daz version 4.5.

	Volume (g/cm^3)	Height (cm)	Weight (kg)	WHR	WCR	BMI kg/m^2
Body 1	34111.83	164	35.48	0.496	0.639	13.19
Body 2	35465.71	164	36.88	0.498	0.643	13.71
Body 3	36864.69	164	38.34	0.505	0.647	14.25
Body 4	38309.27	164	39.84	0.504	0.651	14.81
Body 5	39799.90	164	41.39	0.495	0.654	15.39
Body 6	41336.05	164	42.99	0.492	0.658	15.98
Body 7	43635.01	164	45.38	0.496	0.663	16.87
Body 8	44544.80	164	46.33	0.491	0.665	17.22
Body 9	47279.82	164	49.17	0.507	0.685	18.28
Body 10	49635.82	164	51.62	0.527	0.701	19.19
Body 11	52553.43	164	54.66	0.542	0.719	20.32
Body 12	55062.26	164	57.26	0.563	0.733	21.29
Body 13	58165.74	164	60.49	0.571	0.748	22.49
Body 14	61371.17	164	63.83	0.578	0.762	23.73
Body 15	64120.65	164	66.69	0.584	0.773	24.79

5.2.4. Procedure

The experimented was encoded in an online software system called Qualtrics (Qualtrics.com). A link to the questionnaire was posted on Facebook with a request for female participants over the age of 18. By following the link to the questionnaire, the women were taken to have given their consent to participate. On the first page of the web paradigm, participants were shown a written brief of what the questionnaire entailed and were informed that they were free to withdraw at any point if they became uncomfortable with the material or the questions that were being asked. Participants wanting to withdraw from the study were informed that to do so they simply had to close the browser page. Qualtrics was pre-programmed by the experimenter not to record incomplete surveys; therefore by closing the browser, participants could remove their answers from the database of responses.

Participants were firstly asked to provide demographic information (age, height, weight etc.), following which they were presented with the short version (16 items) of the Body Shape Questionnaire (Evans, & Dolan, 1993) .

Using a two-alternative forced-choice task in which the bodies were presented in a randomized order one-by-one, participants were then asked if the bodies were either

"fat" or "thin". To record their answer, participants checked a box either next to the word "thin" or next to the word "fat". At the end of the experiment, participants were presented with an online debrief page with the purpose of explaining the full nature of the study and their involvement in it. Contact details for the experimenters were also provided in case the participants had any further questions.

Please look carefully at the following body, in your opinion is this body THIN or FAT?

○ Thin
○ Fat

Figure 5.2. A screenshot of a sample question in the questionnaire, showing participants a body and asking them to rate it as either thin or fat.

5.2.5. Data Analysis

A graph was plotted showing the relationship between the percentage of people who thought the body was fat and the calculated BMI of the body. It was expected that bodies that with a low BMI would be rated as "thin" 100% of the time, while bodies with high BMI would be rated as "fat" 100% of the time. Between these two, there would be a gradual increase in the probability of the body being judged "fat" as the

BMI of the bodies increased. A previous study has shown this categorical pattern of rating female bodies using both real bodies and DAZ generated bodies (Tovée et al., 2012).
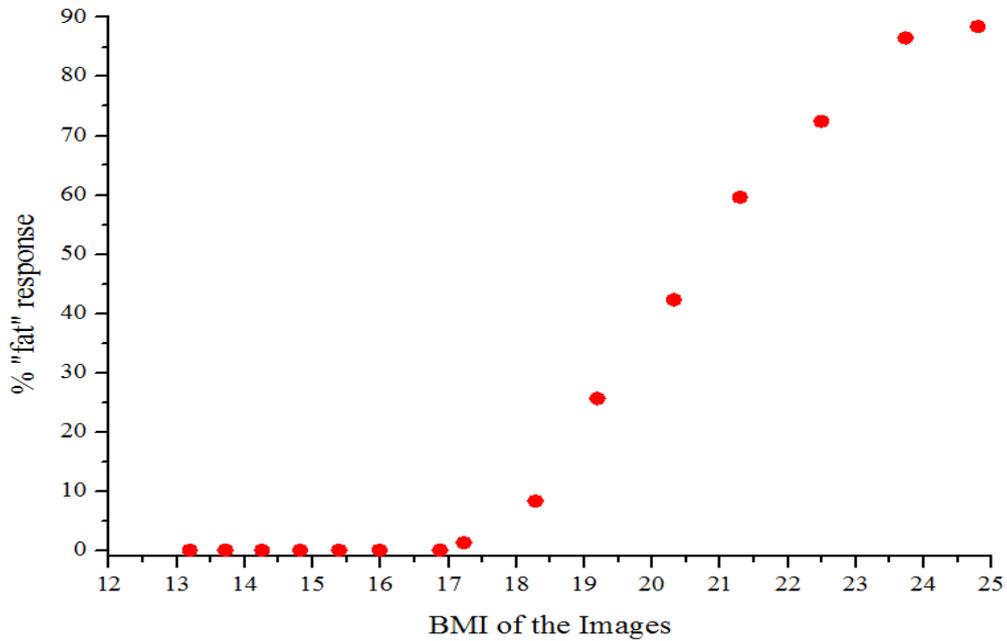
Figure 5.3. BMI of each image plotted again the % of people who thought that image was fat. At the lower end of the BMI range most people rated the body as fat 0% of the time, whereas the % of people rating the body as fat increases as the BMI of the bodies increase. This is the pattern we hoped for, however it may be necessary to remove some of the lower bodies from the questionnaire (as there are 7 bodies that are rated as fat 0% of the time) and instead create some more larger bodies with higher BMIs (as no bodies in this range have been rated as fat 100% of the time).

As none of the bodies at the higher end of the BMI spectrum were rated as fat 100% of the time (which is what would be expected if the body was unambiguously perceived as "fat") the decision was made to create 4 more bodies, extending the upper end of the BMI range.

Table 5.2. Anthropometric information for the 4 extra bodies created at the "fat" end of the scale.

	Volume (g/cm^3)	Height (cm)	Weight (kg)	WHR	WCR	BMI kg/m^2
Body 16	68643.87	164	71.39	0.583	0.748	26.54
Body 17	73772.1	164	76.72	0.594	0.768	28.53
Body 18	80369.85	164	83.58	0.602	0.786	31.08
Body 19	87051.49	164	90.53	0.604	0.795	33.66

153

The online paradigm (2-AFC task) was therefore repeated with the use of these 4 bodies of higher BMI (table 5.2), and the removal of the 4 bodies of the lowest BMIs. Again, participants rated bodies as either categorically "thin" or categorically "fat". Data was then plotted in graphical form to show the relationship between the percentage of people who thought each body was fat and the calculated BMI of each body (figure 5.4).
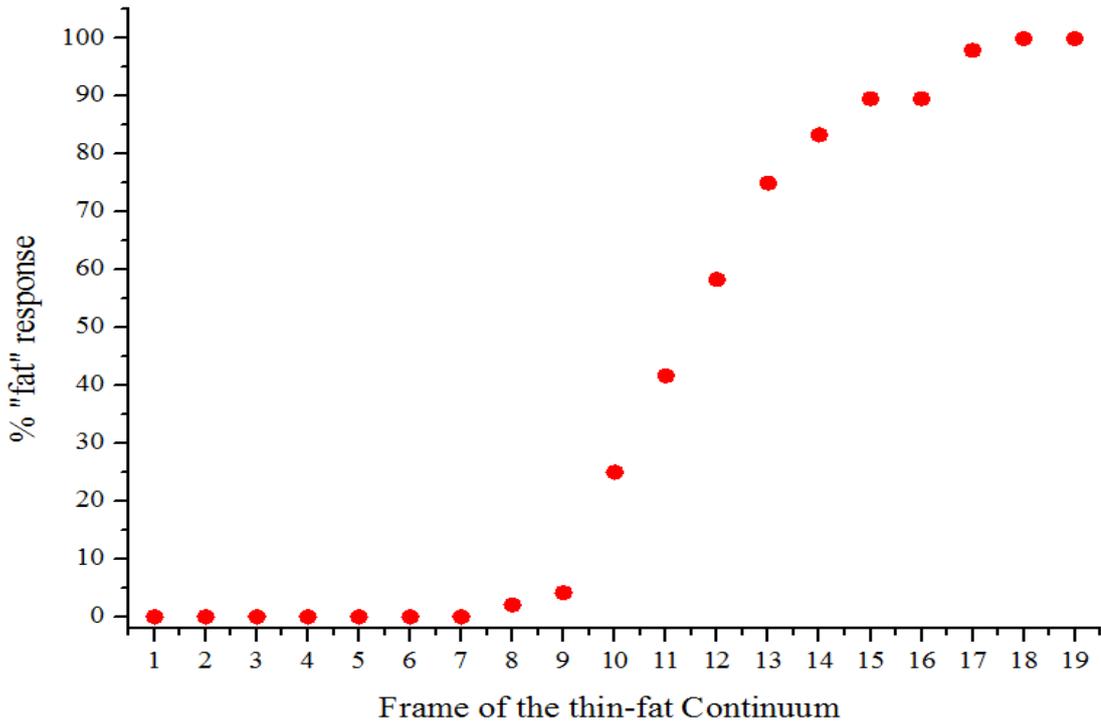
Figure 5.4. Bodies from 0- 19 (16- 19 being the extra 4 bodies added to the "fat" end of the scale) plotted against the % of people who thought each image was fat. At the lower end of the continuum where the BMI range is lowest most people rated the body as fat 0% of the time, whereas the % of people rating the body as fat increases as the continuum of the bodies, and therefore BMI, increases. This shows that adding the extra 4 bodies at the higher end of the continuum solved the problem of not all people rating body 15 as "fat" 100% of the time.

It was therefore decided that bodies 16-19 would be included in the thin-fat continuum for the perception training study as their adiposity levels were unambiguous, with participants rating them as "fat" 100% of the time, and bodies 1-4 would be removed as being unnecessary, as bodies 5-7 were already consistently rated as "thin" (see table 5.3 for details of the final 15 bodies chosen to be used as stimuli).

Table 5.3. Anthropometric information for the 15 bodies that were finally decided to be the best possible stimuli.

	Volume (g/cm^3)	Height (cm)	Weight (kg)	WHR	WCR	BMI kg/m^2
Body 1	39799.90	164	41.39	0.495	0.654	15.39
Body 2	41336.05	164	42.99	0.492	0.658	15.98
Body 3	43635.01	164	45.38	0.496	0.663	16.87
Body 4	44544.80	164	46.33	0.491	0.665	17.22
Body 5	47279.82	164	49.17	0.507	0.685	18.28
Body 6	49635.82	164	51.62	0.527	0.701	19.19
Body 7	52553.43	164	54.66	0.542	0.719	20.32
Body 8	55062.26	164	57.26	0.563	0.733	21.29
Body 9	58165.74	164	60.49	0.571	0.748	22.49
Body 10	61371.17	164	63.83	0.578	0.762	23.73
Body 11	64120.65	164	66.69	0.584	0.773	24.79
Body 12	68643.87	164	71.39	0.583	0.748	26.54
Body 13	73772.1	164	76.72	0.594	0.768	28.53
Body 14	80369.85	164	83.58	0.602	0.786	31.08
Body 15	87051.49	164	90.53	0.604	0.795	33.66

5.3. Perception Training Methods

5.3.1. Participants

20 female participants (mean age: 18.00 years; SD: 0.35), were recruited to the intervention condition, while 20 females (mean age: 24.70 years; SD: 7.83), were recruited to the control condition. All participants were recruited as part of a sub clinical sample for this study through the use of the School of Psychology research participation scheme (this involves adverts being sent via email to all first and second year Psychology students asking for volunteers) and the Institute of Neuroscience research volunteers (adverts sent out to anyone who is signed up to the scheme as a volunteer), at Newcastle University. Participants were allocated to the intervention or control condition on a first-come-first-served basis, with participants who responded the quickest to the adverts being allocated to the intervention condition, and then subsequent participants allocated to the control. Participants were unaware as to the nature of the study therefore were unaware there were any differing conditions.

Again, a female only sample was required in this study as we were again investigating the relationship between psychological state of the participant and their perception of their own body size. It would not make sense to recruit male participants to view female bodies or to have female participants rating male bodies. While we could have recruited a male sample to view male bodies in order to investigate the relationship between male psychological variables and their perception of male body size , as this was a proof of concept study we did not feel that we needed to do this yet.

Ethical approval was gained from the Faculty of Medical Sciences ethics committee at Newcastle University before recruitment (00620/2013).

5.3.2. Apparatus

Qualtrics online survey software was used to screen potential participants online using the 16- item Body Shape Questionnaire (BSQ) (Evans, & Dolan, 1993). This ensured a large number of potential participants could be screened relatively easily.

An E-Prime (version 2.0) script based on the experimental design used in the perception of facial expressions used by Penton-Voak, Bate, et al. (2012) was modified for use in this experiment. This program was used for the creation and completion of the task.

5.3.3. Materials

Copies of the Eating Disorder Examination Questionnaire (Fairburn, & Beglin, 1994), Eating Disorder Beliefs Questionnaire (Cooper et al., 1997),the 16 item- Body Shape Questionnaire (Evans, & Dolan, 1993), Beck's Depression Inventory (Beck et al., 1961) and Rosenberg's Self-Esteem Scale (Rosenberg, 1979) were combined in a booklet along with questions about age, height, weight, and torso measurements. The first questionnaire contains several subscales which assess level of restraint used during eating, and any concerns participants may have about eating, and their shape and weight. The second questionnaire contains subscales assessing negative self-beliefs, beliefs about social- and self- acceptance, and issues surrounding eating control, while the third questionnaire assesses any concerns about body shape and size. The fourth and fifth questionnaires assess depression levels and self-esteem issues (respectively).

5.3.4. Design

This study had a mixed subject design as all participants rated all stimuli, however there were 2 conditions: intervention and control.

5.3.5. Procedure

In order to gain a subclinical sample, potential participants were asked to provide their height and weight and to fill in the 16-item BSQ. This enabled us to calculate their BMI and BSQ score. Only those with high BSQ scores were eligible to participate in the training study. While the authors of the BSQ (Evans, & Dolan, 1993) indicate a cut off score of 66 is representative of an individual with high body shape concerns, for the purpose of increasing sample sizes, a cut off score of 60 was used in this study. 188 potential participants were asked to complete an online version of the 16-item BSQ. Of these 188 potential participants, only 40 had a high-enough BSQ score to be considered for participation in the subsequent study. Of these 40, all allocated to the intervention condition, only 27 responded to the request to take part further. In addition, there was a further drop-out of 7 participants, leaving only 20 participants to take part in the Intervention condition. 25 participants were allocated to the control condition, again with 5 participants failing to attend all 4 sessions, therefore being removed from data analysis.

5.3.5.1. Intervention and control condition

Participants were firstly asked to fill in a set of behavioural questionnaires. They were then randomly allocated to either the intervention or control conditions. The intervention and control conditions consisted of three phases: baseline, training and test.

In the baseline phase, participants were shown a series of 15 bodies ranging from underweight to overweight and were required to categorise them as either thin or fat (i.e. a 2-alternative forced choice)- (the "c" key was pressed if they perceived the body to be "thin" and the "m" key- "fat"). The bodies at the end of the sequence were very clearly either thin or fat, but the bodies in the middle of the sequence which were intermediate in their adiposity could be judged either way. The results from the baseline phase allowed the calculation of a categorical boundary/midpoint at which participants shifted from perceiving thinness to perceiving fatness in the body sequence (see Figure 5.5). This is done by calculating the number of "thin" responses as a proportion of the total number of trials.
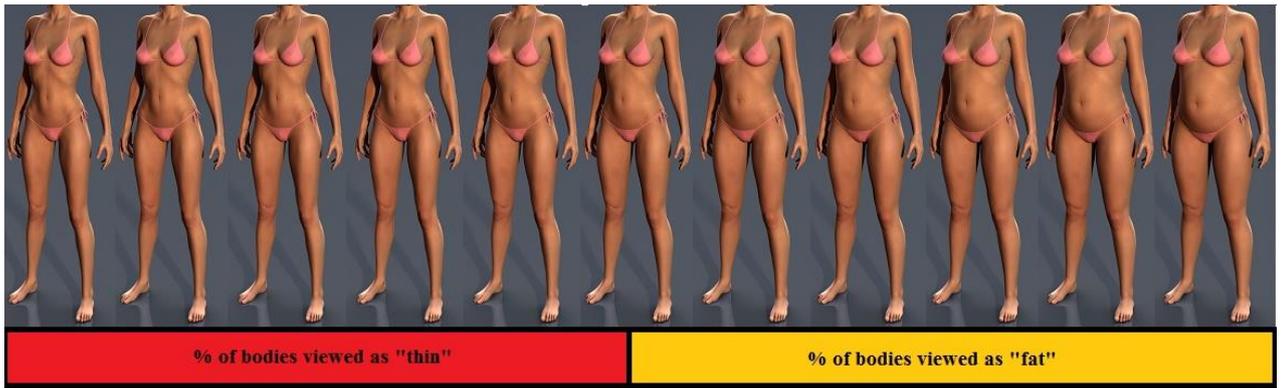
Figure 5.5. An example of the way we would expect a sample of participants with "normal" attitudes towards their bodies to rate the images.

Both the baseline and test conditions consisted of 45 trials, in which each of the 15 bodies was presented 3 times. The images were presented in a random order for 150 ms each. These were preceded by a fixation cross which was shown for approximately 1500-2500 ms (randomly jittered). The presentation of bodies was followed by a mask of visual noise which was shown for 150 ms, followed by a prompt screen (containing just a "?") which indicated that participants should make their judgement of "fat" or "thin". This procedure was repeated until all bodies had been rated 3 times each, allowing E-Prime to calculate an average judgement for each body in order to calculate the balance point/midpoint.
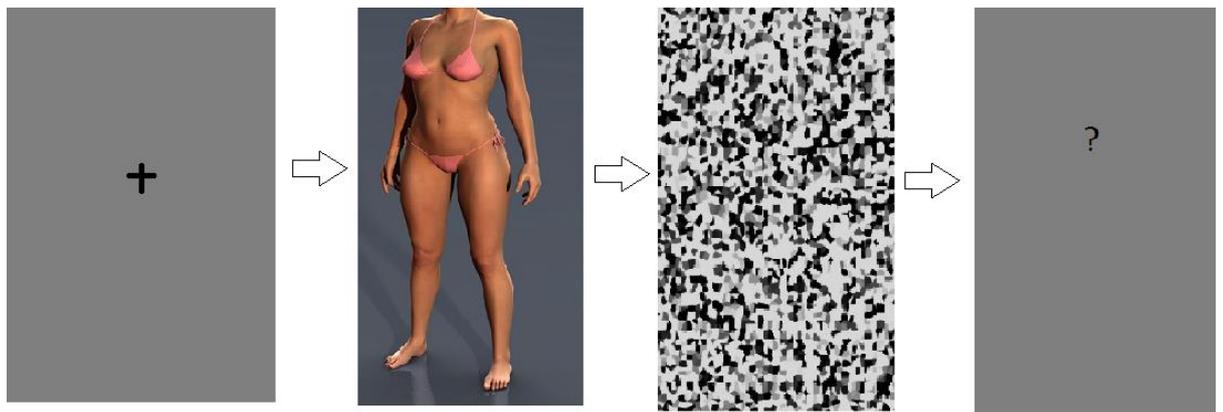
Figure 5.6. An example of the E-Prime procedure for each trial in the baseline procedure which allows E-Prime to calculate the balance point/midpoint for each participant.

This was then followed by a training phase that differed from the baseline procedure only in that feedback (i.e. 'correct' or 'incorrect') was provided. In the

158

intervention condition, feedback was provided based on a shifted categorical boundary, so that participants were trained to judge bodies near the categorical boundary that were previously judged as fat, as thin. The training phase was made up of a 6 blocks: 31 trials in each block. Bodies 1-2 and 14-15 are the bodies which are very likely to be classified as 'fat' or 'thin' and so these were only presented once in the training phase. Bodies 3-5 are considered to be slightly more ambiguously 'thin', and 11-13 are thought to be slightly more ambiguously 'fat' and were therefore presented twice. The remaining bodies, 6-10, were presented three times each as these bodies were considered to be the most ambiguous and hardest to categorise. Participants were given feedback of "Incorrect! That body was fat" or "Correct, that body was thin" after each response given.
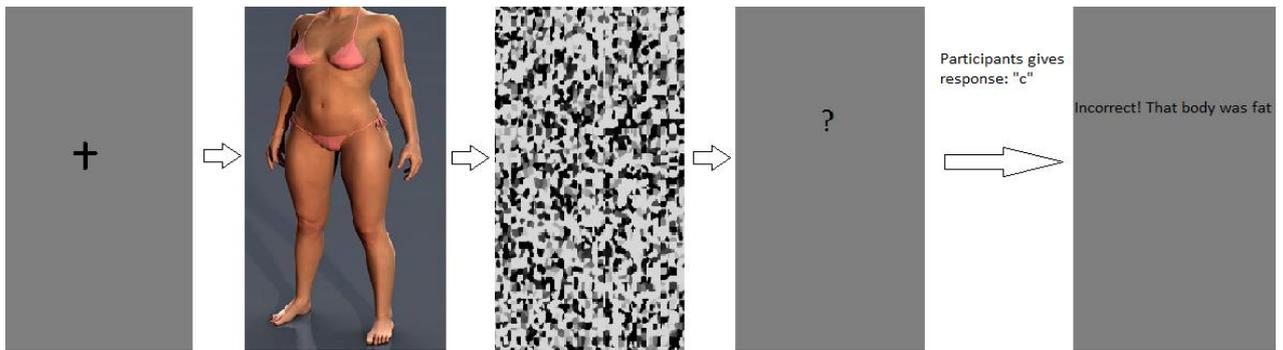
Figure 5.7. An example of the training phase procedure in E-Prime, showing feedback after participants' response.

Figure 5.8. An example of the way we expect people with high concerns about their body (who overestimate size) to rate bodies. We expect this population to view more bodies as "fat" than "thin" compared to a normal sample.

159

Effectively, the training programme is intended to shift the categorical boundary two bodies along the sequence.

By contrast, in the control condition the feedback was based on the categorical boundary calculated in the first phase (i.e. the feedback merely reinforced their existing categorical boundary), so that the judgement of intermediate bodies would not change.

After the training phase had been completed, participants' judgements were re-tested using the same test procedure as in the baseline phase, to determine whether the procedure had been successful in modifying the perception of intermediate or ambiguous bodies (i.e. had the training been successful and the categorical boundary changed). The participants were then required to fill in the questionnaire set again.

Participants were asked to complete the questionnaire pack 3 times in total: firstly before completing the experiment for the first time on day 1, then again after the 4th training session on day 4, and then again (just before completing the 2-AFC task) 2 weeks later. This latter test was to determine whether any improvements found in the scores of the training group were retained. (It is important that the improvements were not transient but were retained for a significant length of time if the training is to have a significant use as a therapeutic tool.)

This experiment tested the hypothesis that perception training would affect body size judgements in women with high body size concerns which in turn should also affect the participants' own body image and eating concerns. Therefore it was predicted that on completion of the 4 days of training, participants' body size judgements would be altered to perceive a heavier body as thin, where before it was considered fat. It is also predicted that this should have a positive effect on the participants' body image and eating concerns as demonstrated by the questionnaire scores- i.e.: Body Shape concerns would be reduced (BSQ).

5.3.6. Data Analysis
See data analysis section (4.2.6) for an example of how to calculate scores for each questionnaire.

5.4. Results

5.4.1. Training Data
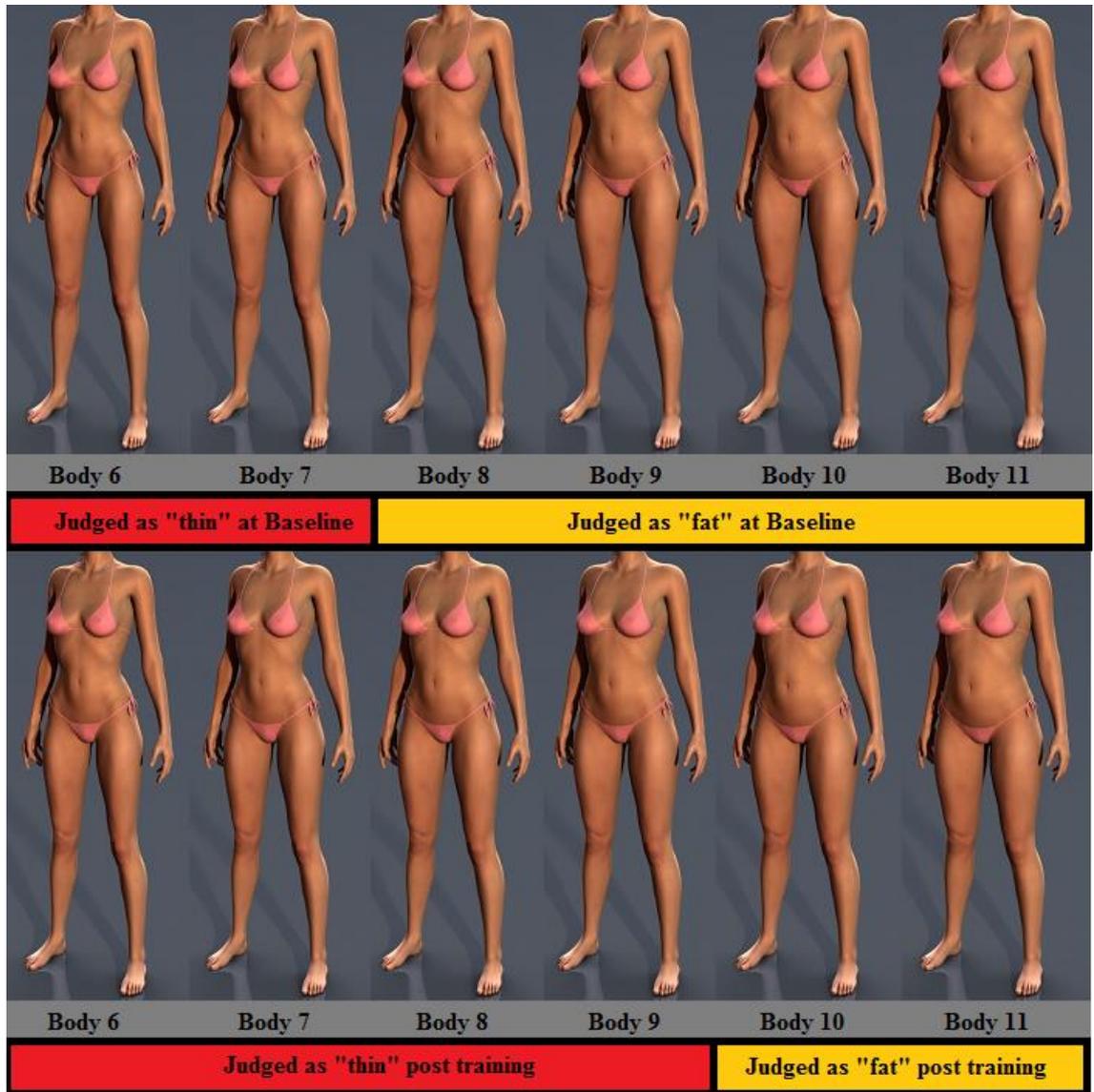
Figure 5.9. The balance point at which perception changed from viewing a body as thin to viewing the next body as fat (Intervention Condition). At baseline, the average threshold was 6.95 (showing that on average bodies 1-7 were viewed as "thin"). However, the average threshold rose to 9.00 post training showing that bodies 1-9 were perceived as thin following 4 days of training.

Figure 5.9 shows the difference in balance point at baseline and post training for participants in the Intervention condition. It is clear from this figure that on average, participants' overestimation of size was reduced following training with less bodies being perceived as fat.

161
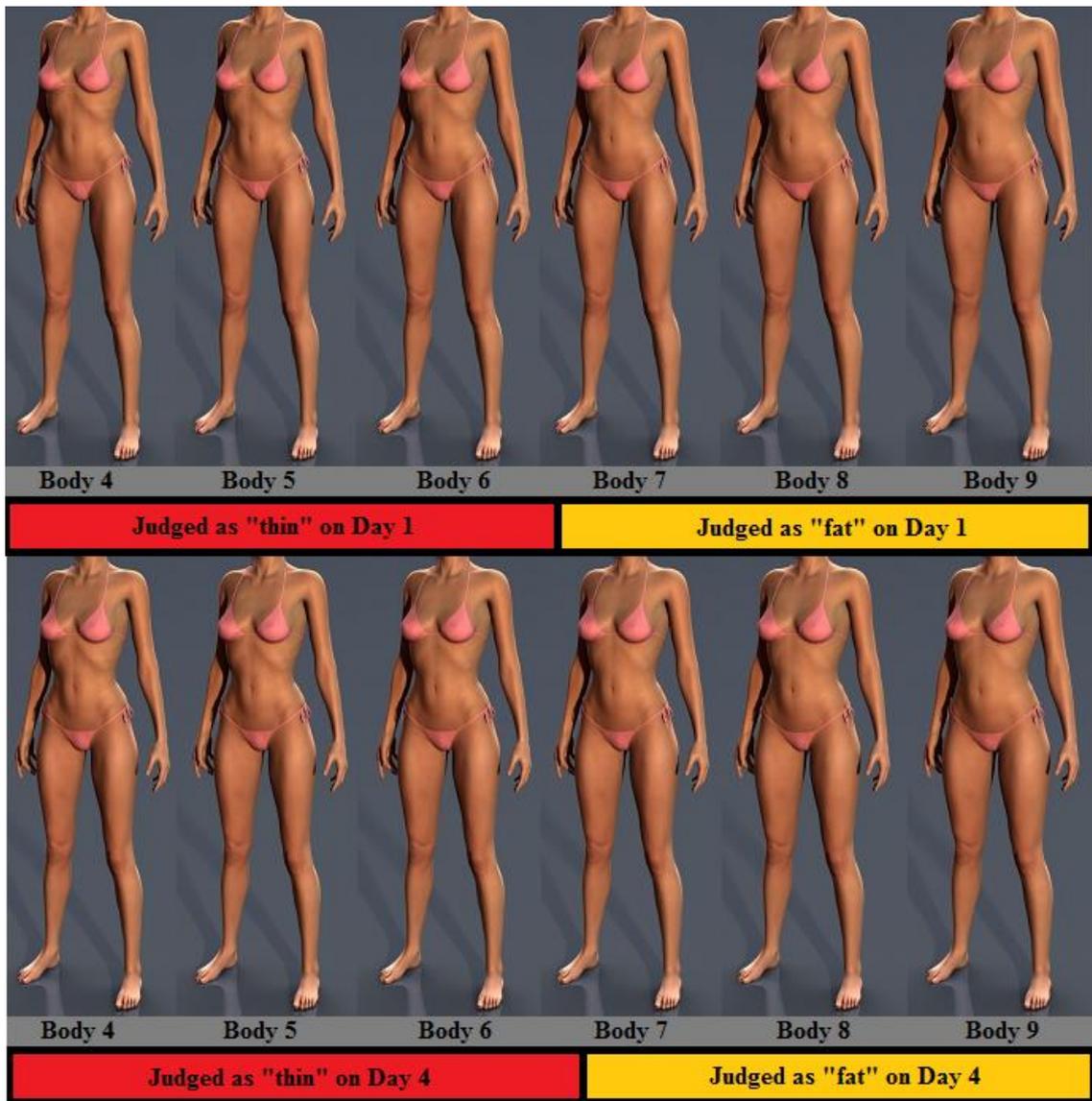
Figure 5.10. The balance point at which perception changed from viewing a body as thin to viewing the next body as fat (Control Condition). On day 1, the average threshold was 6.73. On day 4, this average threshold was 6.80.

Here (figure 5.10) the change in balance point from day 1 to 4 for the control condition was minimal, suggesting that participants perception of size was relatively unchanged (as they received no training), even after viewing the same bodies for 4 consecutive days.
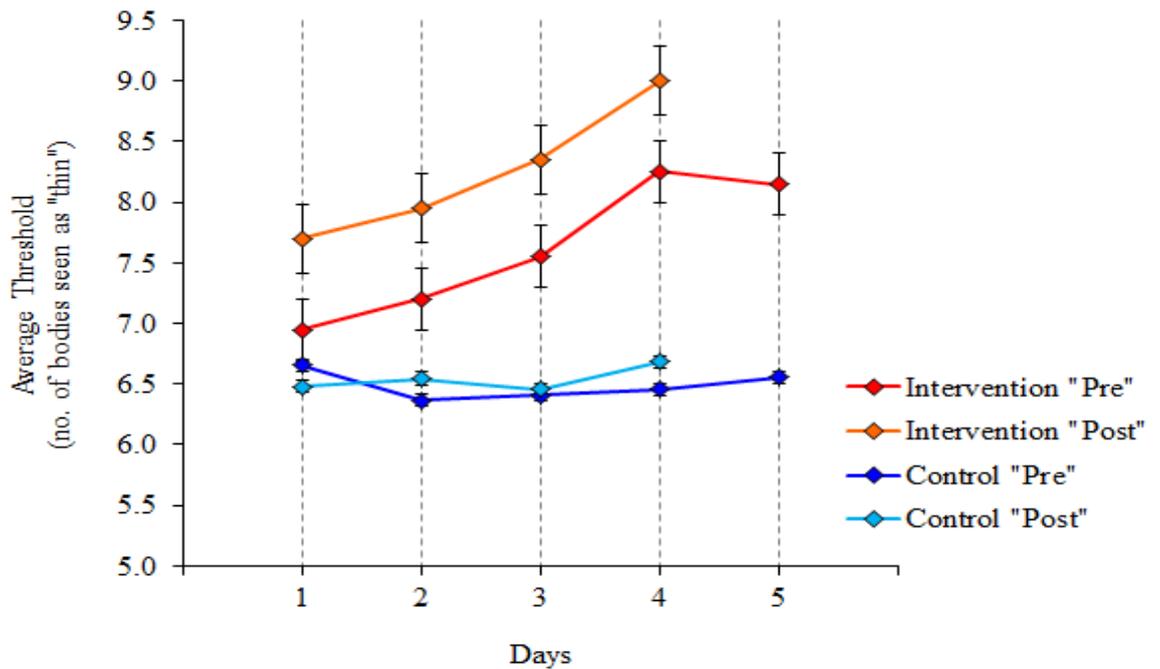
Figure 5.11. comparing the progression of average thresholds from day 1-5 between the intervention and control groups. Average thresholds for pre and post ratings are plotted on separate lines in order the show the difference between these ratings for each individual day. Average threshold is defined as the point at which the perception of body size changes from thin to fat.

It is visually clear from figure 5.11 that for subjects in the intervention condition, there appears to be a change in threshold between "pre training" on Day 1 and "post training" on Day 4, with this change being in the positive linear direction. There is variation in threshold each day, with the "pre" training thresholds lower than the "post" on each day, however overall the general trend is an increase in threshold, from 6.95 at pre-training day 1 (BMI of body 7 = 20.32 kg/m^2) to 9.00 at post-training day 4 (BMI of body 9 = 22.49 kg/m^2), to 8.15 at pre-training day 5 (BMI of body 8 = 21.29 kg/m^2). This therefore suggests that subjects perceived more bodies as "thin" post training. In contrast, there appears to be little difference in the average thresholds across the 5 days for subjects in the control condition with scores staying almost constant from 6.77 on day 1 to 6.72 on day 4, suggesting a relatively constant average threshold around body 7 which has a BMI value of 20.32 kg/m^2, however there is a slight decrease in threshold from 6.72 on day 4 to 6.65 on day 5, although again this is relatively constant (around a BMI of 20.32 kg/m^2).

In order to investigate the effects of the training programme (seen from figure 5.11) and any differences between the intervention and control condition, a General Linear Model using a repeated measures ANOVA was carried out on the average

163

threshold data for each group (control and intervention) across all four days of experimentation to test for both within and between subject effects.

Table 5.4. Descriptive statistics for the repeated measures ANOVA calculated on the pre and post ratings across all 4 days of experimentation for both the intervention and control groups.

	Groups	Mean	SD
Day 1 Pre	Intervention	6.95	1.90
	Control	6.73	1.54
Day 1 Post	Intervention	7.70	1.17
	Control	6.65	1.47
Day 2 Pre	Intervention	7.20	1.85
	Control	6.46	1.73
Day 2 Post	Intervention	7.95	1.85
	Control	6.69	1.62
Day 3 Pre	Intervention	7.55	1.96
	Control	6.58	1.45
Day 3 Post	Intervention	8.35	1.93
	Control	6.58	1.58
Day 4 Pre	Intervention	8.25	2.20
	Control	6.69	1.52
Day 4 Post	Intervention	9.00	1.95
	Control	6.81	1.63

When investigating the relationships depicted in figure 5.11 Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of Day, $\chi^2(5) = 16.17$, $p = <.001$, and the interaction between Day and Groups, $\chi^2(5) = 13.91$, $p = <.05$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of Sphericity ($\varepsilon = .84$ for the main effect of Day, and .86 for the interaction effect).

There was a significant main effect of Day (1-4) on average threshold, $F(2.51, 110.39) = 11.01$, $p <.001$. Contrasts revealed that the average threshold for day 4 was significantly higher than day 1, $F(1, 44) = 20.90$, $r = .57$, day 2, $F(1, 44) = 18.64$, $r = .55$, and day 3, $F(1, 44) = 22.92$, $r = .59$.

There was also a significant main effect of Test (pre or post) on the average threshold, $F(1, 44) = 30.78$, $p <.001$. Contrasts revealed that the average threshold was

significantly higher for post ratings than for pre ratings, F(1, 44) = 30.78, r = .64. There was also a significant between subject main effect of Group, indicating a difference in threshold between subjects in the Intervention and Control conditions, F(1, 44) = 6.97, p <.05.

There was no significant interaction effect found between Day and Test, F(2.57, 113.19) = 0.24, p =0.84. This indicates that the day did not have a different effect on the pre and post ratings. Instead this indicates that pre and post ratings were affected similarly for each day the task was completed.

However significant interactions were found between Day and Group, F(2.51, 110.39) = 8.33, p <.001, and Test and Group, F(1, 44) = 21.60, p <.001. Contrasts for the Day*Group interaction revealed that the threshold for day 4 was significantly higher than for days 1 [F(1, 44) = 17.50, r = .53], 2 [F(1, 44) = 9.58, r = .42] and 3 [F(1, 44) = 8.03, r =.39] for subjects in the Intervention condition compared to much lower in the Control condition (this is reinforced by the pattern of data depicted in the interaction plot in figure 5.12).
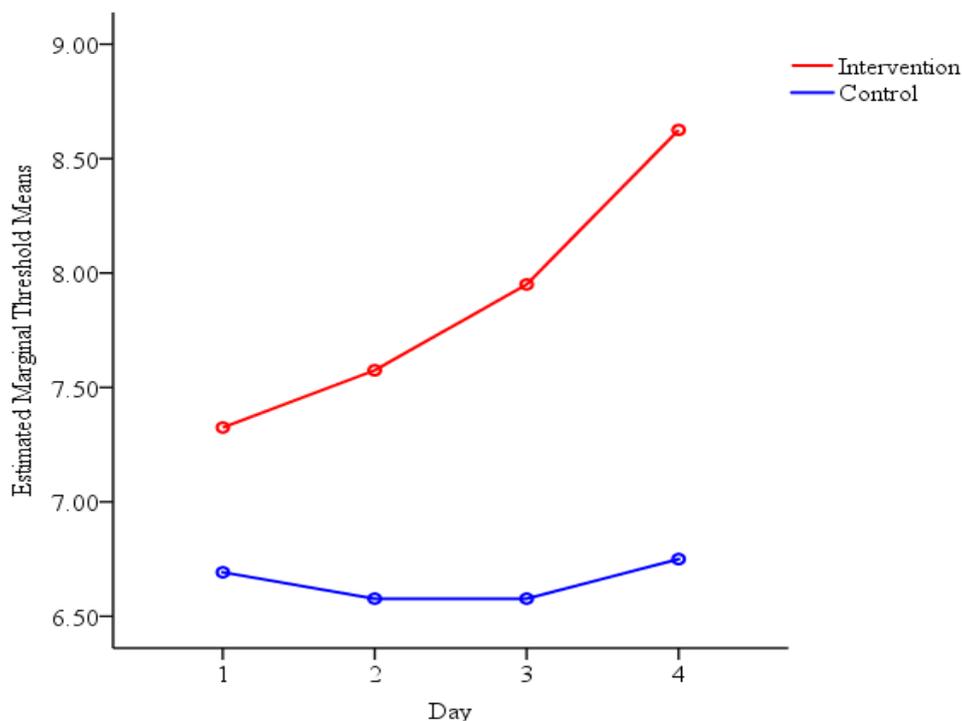
Figure 5.12. Comparing the progression of average thresholds between training days 1-4 between the intervention and control groups.

Over the 4 day period the average threshold in the intervention condition appeared to increase (figure 5.12) from 6.95 to 9.00 (originally approximately 7 of the 15 bodies were perceived as thin, whereas after training, this number increased to 9). In contrast, the average threshold for participants in the control condition appeared to stay relatively stable, starting slightly lower than the intervention condition threshold at pre-training on day 1 (6.47), and remaining between 6.27 and 6.53 across all four days. Again, this data suggests that there was a shift in the perception of body size in the desired direction in the intervention, compared to the control condition, which may also imply that any overestimation of size had been reduced.

In order to investigate if the main effects found were maintained at 2-week follow up, simple paired t-tests was carried out (one for the Intervention and one for the Control group) between the post training threshold on Day 4 (once training was complete) and the pre training threshold on Day 5 (before participants were subjected to the task again). Results revealed no significant difference between thresholds in either the Intervention [$t(19) = 2.04$, $p = .06$] or Control [$t(17) = -1.05$, $p = .31$] condition showing that perception did not change over the 2 week period.

5.4.2. Secondary Measures: Psychometric Variables

In addition to the effectiveness of the training programme itself, it was also necessary to investigate any differences in secondary measures following the implementation of training. Initially, it was thought that the Psychometric measures could be combined through the use of Principle Component Analysis in order to make subsequent analysis simpler, however a Pearson's Correlation revealed that not all of the Psychometric measures were correlated at 2-week follow up, therefore it was decided to investigate differences for each measure individually.
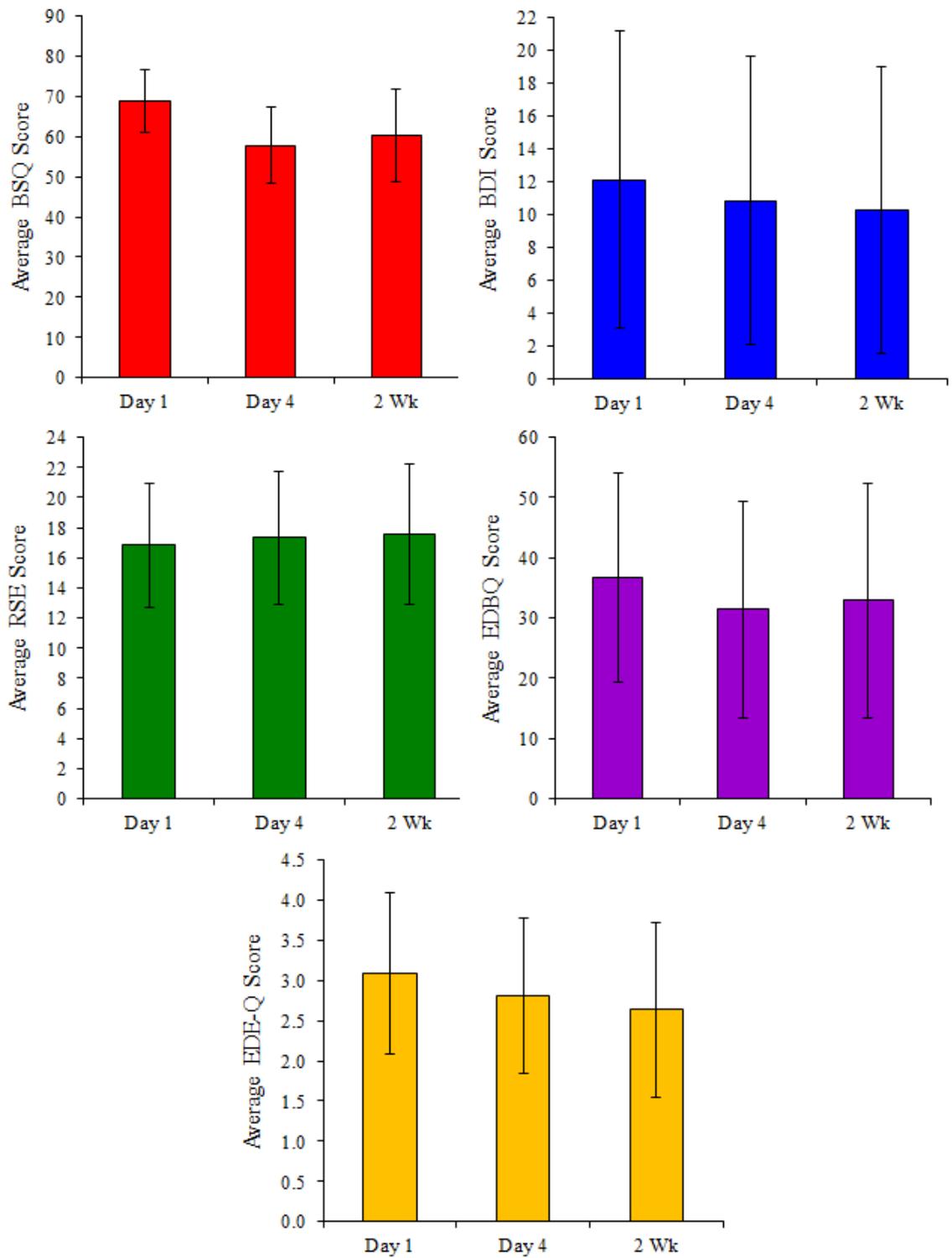
Figure 5.13. The change in scores from day 1, to day 4, to 2-week follow up for each psychometric measure (it was predicted that BSQ, BDI, EDBQ and EDE-Q scores would decrease over time from day 1 to day 4 as an effect of training, while RSE scores would increase, however it was also predicted that any effects would be maintained at 2-week follow up).

Cronbach's Alpha were calculated for each individual Psychometric measure for each day of testing (day 1, 4 and 5) in order to investigate inter-reliability of the questionnaires. These are presented in tables alongside the descriptive statistics of the questionnaire scores. The majority of α levels were high (except the day 1 RSE score [α =.587] for subjects in the control group), suggesting uniformity in performance for participants in each group across all days.

A general linear model was again fit using a repeated measure ANOVA for each Psychometric measure to investigate both within subject differences in scores from Day 1 (pre training) to Day 4 (post training) to Day 5 (2-week follow up), and any between subject differences in the Intervention and Control groups.

Table 5.5. Descriptive statistics for the BSQ scores of both the Intervention and Control groups from pre-training to 2-week follow up.

		BSQ		
		Mean	S.D.	Cronbach's α
Intervention	Day 1	68.20	7.25	.938
	Day 4	60.15	12.63	.931
	2 week	60.75	11.90	.936
Control	Day 1	47.30	16.32	.959
	Day 4	47.30	16.66	.948
	2 week	47.65	16.47	.913

Mauchly's test indicated that the assumption of sphericity had been violated for the main effect of BSQ score, $\chi^2(2) = 21.12$, $p = <.001$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of Sphericity ($\varepsilon = .697$).

There was a significant main effect of BSQ score, $F(1.39, 52.96) = 6.24$, $p <.05$, and a significant between subject effect of Group on BSQ scores, $F(1, 38) = 14.01$, $p <.001$. Contrasts revealed that the average BSQ score was significantly higher on day 1 than 2 week follow up (day 5), $F(1, 38) = 6.74$, $r = .39$. In addition, within subject contrasts also revealed no significant difference between BSQ scores on day 4 and at 2 week follow up, $F(1, 38) = 0.41$, $r = .10$ (something which we would expect as no training occurred at 2 week follow up).
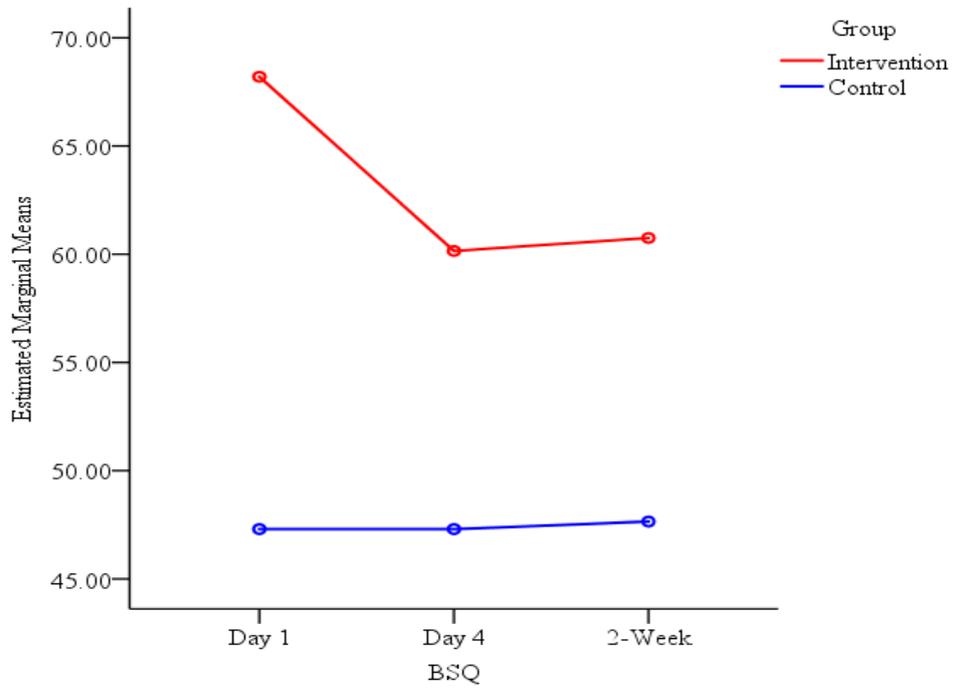
Figure 5.14. Interaction plot showing differences in estimated marginal means for BSQ scores between Intervention and Control group at each stage of testing.

As can be seen from figure 5.14, there was also a significant interaction effect between BSQ score and Group (intervention or control), $F(2, 76) = 6.76$, $p < .05$. Contrasts also revealed that this interaction was significant between BSQ scores on day 1 and at 2 week follow up, $F(1, 38) = 8.14$, $r = .42$. Figure 5.14 shows a very flat relationship between BSQ scores on day 1, day 4 and 2 week follow up for subjects in the control condition, suggesting similar scores throughout. In contrast, subjects in the intervention condition started off with much higher BSQ scores overall, but a strong decline in score can be seen between day 1 and day 4 for this group. This reduction then appears to be maintained (with only a slight increase evident) between day 4 and 2 week follow up.

Table 5.6. Descriptive statistics for the BDI scores of both the Intervention and Control groups from pre-training to 2-week follow up.

		BDI		
		Mean	S.D.	Cronbach's α
Intervention	Day 1	12.15	9.05	.854
	Day 4	10.85	8.76	.816
	2 week	10.25	8.74	.853
Control	Day 1	9.80	8.24	.810
	Day 4	9.00	7.47	.763
	2 week	8.95	7.07	.700

Mauchly's test again indicated that the assumption of sphericity had been violated for the main effect of BDI score, $\chi^2(2) = 17.32$, $p = <.001$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of Sphericity ($\varepsilon = .728$).

There was a significant main effect of BDI score, $F(1.46, 55.32) = 5.09$, $p < .05$, however, no significant between subject effect of Group on BDI scores was found, $F(1, 38) = 0.51$, $p = .48$. Contrasts revealed that the average BDI score was significantly higher on day 1 than 2 week follow up (day 5), $F(1, 38) = 6.06$, $r = .37$. In addition, within subject contrasts also revealed no significant difference between BDI scores on day 4 and at 2 week follow up, $F(1, 38) = 1.09$, $r = .17$ (something which we would expect as no training occurred at 2 week follow up).
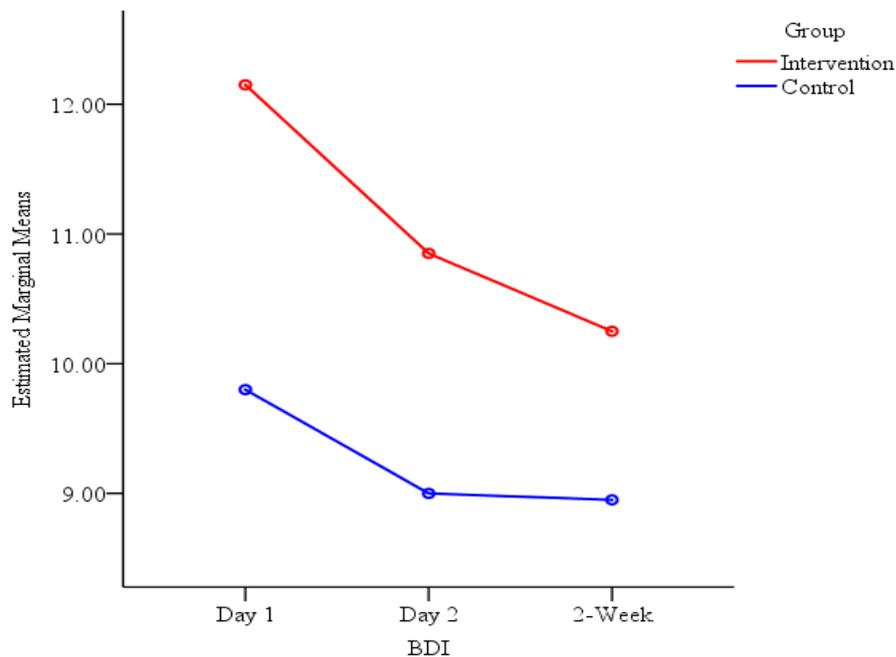
Figure 5.15. Interaction plot showing differences in estimated marginal means for BDI scores between Intervention and Control group at each stage of testing.

As can be seen from figure 5.15, there was also no significant interaction effect between BDI score and Group (intervention or control), $F(2, 76) = 0.68$, $p = .51$. Contrasts also revealed that this lack of interaction was between both day 1 and 4 [$F(1, 38) = 0.88$, $r = .15$] and day 4 and 2 week follow up [$F(1, 38) = 0.78$, $r = .14$]. Figure 5.15 shows a large difference in average BDI scores between the intervention and control conditions initially at day 1 of testing. There is then a sharp reduction in BDI score for subjects in the intervention condition from day 1 to day 4, and a similar (but less steep) reduction for subjects in the control condition. Scores at 2 week follow up appear to then decrease further for the intervention condition, but remain relatively

constant for the control condition. Overall, the pattern of BDI scores shown in figure 5.15 from day 1 to 2 week follow up is similar for both conditions, which may therefore explain why no significant main effect of BDI score was found.

Table 5.7. Descriptive statistics for the RSE scores of both the Intervention and Control groups from pre-training to 2-week follow up.

| | | RSE | | |
		Mean	S.D.	Cronbach's α
Intervention	Day 1	16.85	4.13	.886
	Day 4	17.35	4.42	.860
	2 week	17.60	4.66	.884
Control	Day 1	19.10	5.84	.587
	Day 4	17.95	5.65	.874
	2 week	18.65	6.03	.678

Mauchly's test again indicated that the assumption of sphericity had been violated for the main effect of RSE score, $\chi^2(2) = 6.35$, $p = <.05$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of Sphericity ($\varepsilon = .864$).

No significant main effects of RSE score [$F(1.73, 65.65) = 0.98$, $p = .37$] or Group (intervention or control) [$F(1, 38) = 0.67$, $p = .42$] were found. Contrasts revealed these lacks of significant effects were throughout all experimental phases (day 1, day 4 and 2 week follow up). In addition, there was also no interaction effect found between RSE score and Group, $F(2, 76) = 3.03$, $p = .06$ (figure 5.16).
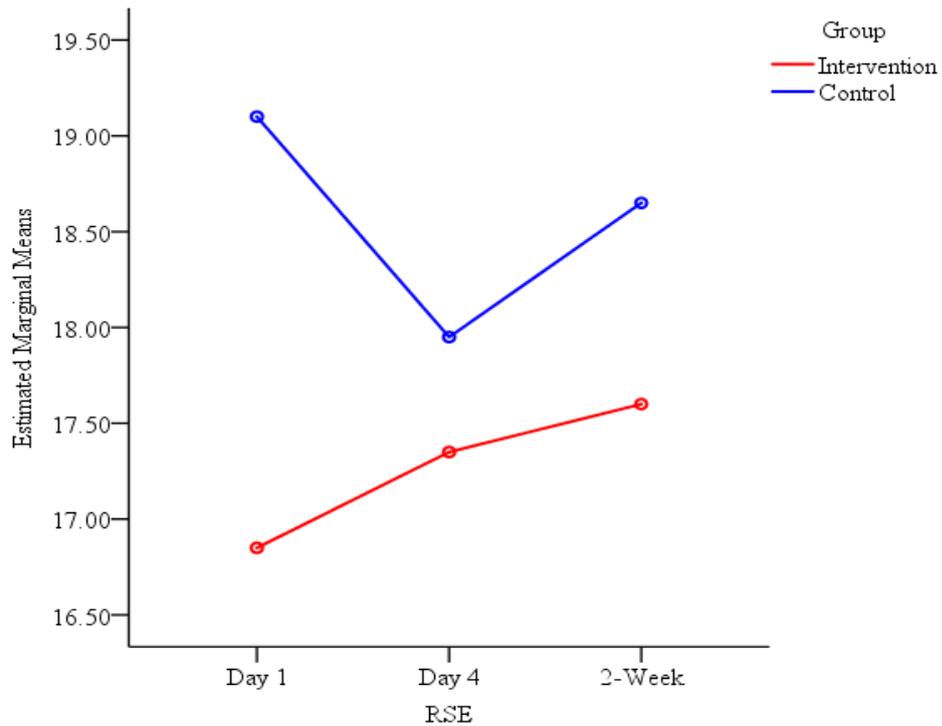
Figure 5.16. Interaction plot showing differences in estimated marginal means for RSE scores between Intervention and Control group at each stage of testing.

Figure 5.16 shows a contrasting effect from day 1 to day 4 on RSE scores between intervention and control conditions. While RSE scores for subjects in the control condition appear to reduce from day 1 to day 4, the scores for subjects in the intervention condition appear to increase. RSE scores for subjects in both conditions then appear to increase again from day 4 to 2 week follow up (although a more dramatic increase for the control condition than the intervention. This would seem to suggest that repeated exposure to bodies reduces self-esteem (day 1-4 in the control condition). However, when training is implemented, self-esteem increases gradually (although not significantly) and this higher self-esteem is maintained at 2 week follow up.

Table 5.8. Descriptive statistics for the EDBQ scores of both the Intervention and Control groups from pre-training to 2-week follow up.

		EDBQ		
		Mean	S.D.	Cronbach's α
Intervention	Day 1	36.83	17.38	.916
	Day 4	31.44	17.94	.954
	2 week	32.95	19.52	.901
Control	Day 1	24.69	17.35	.952
	Day 4	24.74	17.18	.934
	2 week	24.00	15.89	.902

Mauchly's test again indicated that the assumption of sphericity had been violated for the main effect of EDBQ score, $\chi^2(2) = 30.02$, $p = <.001$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of Sphericity ($\varepsilon = .643$).

There was a significant main effect of EDBQ score, $F(1.29, 48.85) = 3.64$, $p \leq .05$. Within subject contrasts, however, did not revealed any significant differences between any individual days of testing. However, no significant main effect of Group was found on EDBQ scores, $F(1, 38) = 2.92$, $p = .10$.

In addition, there was also a significant interaction effect between EDBQ score and the Group the subjects were in, $F(2, 76) = 3.25$, $p < .05$. This indicates a difference in changing EDBQ score between participants in the intervention condition compared to those in the control group (see figure 5.17).
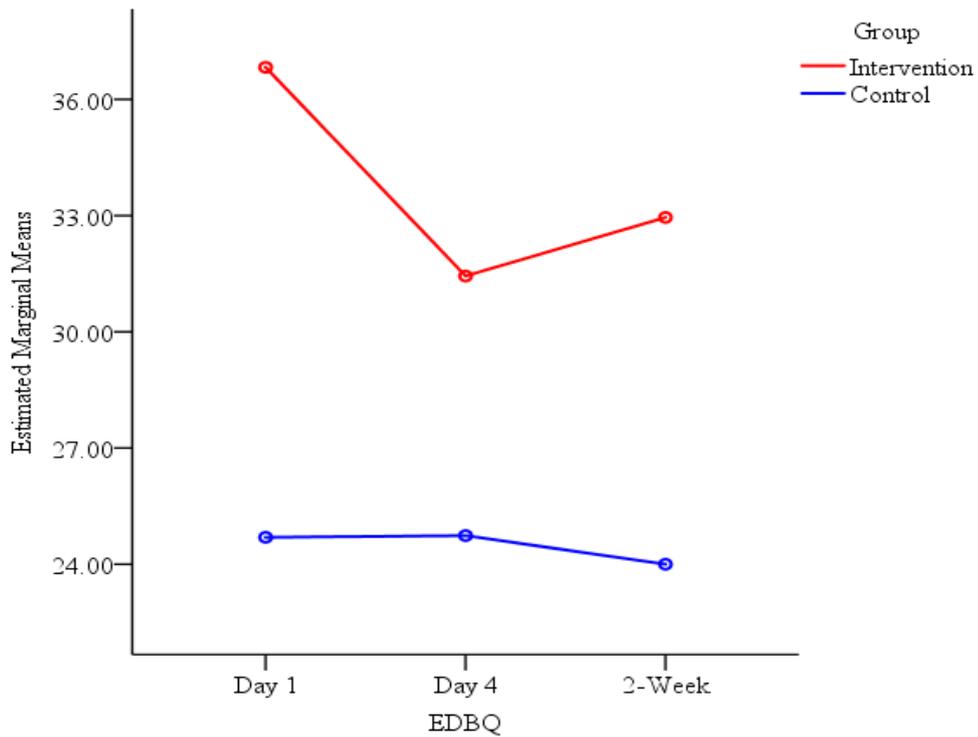
Figure 5.17. Interaction plot showing differences in estimated marginal means for EDBQ scores between Intervention and Control group at each stage of testing.

It is visually apparent from figure 5.17 that the difference in EDBQ from day 1 to day 4 is greater for subjects in the intervention condition compared to those in the control condition- a greater reduction in EDBQ score can be seen for the intervention condition. Instead, there appears to be a slight increase in EDBQ score from day 1 to day 4 for subjects in the control condition. However, this is reduced back down at 2 week follow up and may therefore just have been a reaction to repeated exposure to the questionnaire.

Table 5.9. Descriptive statistics for the EDE-Q scores of both the Intervention and Control groups from pre-training to 2-week follow up.

| | | EDE-Q | | |
		Mean	S.D.	Cronbach's α
Intervention	Day 1	3.09	1.01	.858
	Day 4	2.81	0.97	.865
	2 week	2.64	1.08	.916
Control	Day 1	1.91	1.23	.863
	Day 4	1.91	1.23	.836
	2 week	1.90	1.22	.839

174

Mauchly's test again indicated that the assumption of sphericity had been violated for the main effect of EDE-Q score, $\chi^2(2) = 15.64$, $p = <.001$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of Sphericity ($\varepsilon = .744$).

There was a significant main effect of EDE-Q score found, $F(1.49, 56.52) = 7.45$, $p < .05$, and also a significant between subject effect of Group, $F(1, 38) = 7.24$, $p < .05$. Contrasts revealed further that EDE-Q scores on day 1 were significantly higher than those at 2 week follow up [$F(1, 38) = 9.44$, $r = .45$] and that there was no significant difference between EDE-Q scores on day 4 and at 2 week follow up [$F(1, 38) = 2.68$, $r = .26$].

There was also a significant interaction effect between EDE-Q score and Group (intervention or control), $F(2, 76) = 6.87$, $p < .05$. Again, within subject contrasts revealed there was a difference in EDE-Q scores on day 1 and 5 for the intervention but not control condition [$F(1, 38) = 8.64$, $r = .43$], but no difference found between scores on day 4 and 5 [$F(1, 38) = 2.13$, $r = .23$] for both conditions.
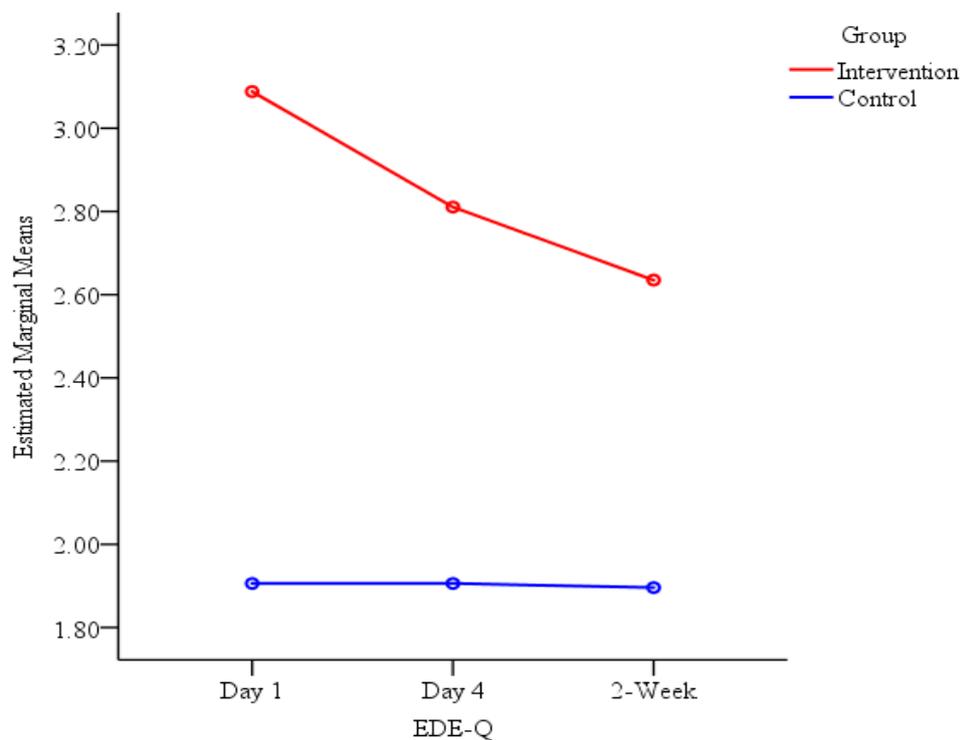
Figure 5.18. Interaction plot showing differences in estimated marginal means for EDBQ scores between the Intervention and Control group at each stage of testing.

Figure 5.18 immediately shows the difference in EDE-Q scores between the two experimental groups before any training began (day 1); subjects in the intervention group already had higher scores on the EDE-Q. However, following training these scores were reduced and reduced even further 2 weeks later, suggesting that the training was still having an effect. In contrast, the EDE-Q scores for subjects in the control condition appear to be relatively stable across training and at 2 week follow up, seen from the almost flat line.

5.5. Discussion

5.5.1. Perception of Size

Results from this study suggest that the perception training is effective when attempting to alter the categorical boundary for thin/fat perception, as there was an increase in the number of bodies perceived as thin from pre to post training (and therefore a reduction in the overestimation of size) in the intervention condition, whereas no such effect was found in the control condition. There was also no difference in the categorical boundary for thin/fat perception post training and also no difference 2 weeks after training, therefore suggesting that the effects of the training program were maintained and therefore potentially have longevity.

5.5.2. Secondary Effects

Results from the psychological aspects of this study suggest that perception training is also effective in reducing body image concerns of subjects who have marked concerns about their body (tested through the use of the BSQ), as there was a significant decrease in BSQ score from pre to post training. This effect was evident in only the intervention condition and not the control condition, therefore providing support for effects of perception training as a cause for this reduction. This result suggests that perception training would not only be a valuable tool for reducing the overestimation of body size in those with EDs, but would also help to improve the negative body image also evident in those with AN.

Results also suggest that another measure affected by the training program was the EDE-Q, as there was a significant decrease in EDE-Q score from pre to post training (an affect that was maintained at 2-week follow up). Again, results suggested this effect was evident only in the intervention condition, not control; therefore it would seem

logical to postulate that this reduction in eating disordered attitudes was also a secondary result of the training program. If this is in fact the case, this would make perception training a very important tool in the treatment of EDs, as not only does it appear to reduce BID in subjects, but it also affects behaviour associated with this, suggesting that subjects were less restrictive of their diets and became more satisfied with their bodies.

BDI scores were also reduced from pre to post training, however there was no difference in these effects between the intervention and control group, which may suggest that repeated viewing of bodies reduces negative mood regardless of training or it may be the effect of simply filling in the questionnaire multiple times.

Results suggested that self-esteem (as tested by the RSE) appeared to increase slightly from pre-post training for the intervention condition, however this was a non-significant effect. Furthermore, RSE scores of subjects in the control condition appeared to increase, therefore suggesting that repeated presentation of bodies alone may actually serve to reduce self-esteem (although this reduction was not permanent as self-esteem scores had increased at the time of 2-week follow up), or possibly more likely represent natural fluctuation in the scores when the same questionnaire was filled in repeatedly

Self-belief/the perception of others (tested through the EDBQ) also appeared to be unaffected by training. While an effect of EDBQ was found, in that there was a reduction in EDBQ score from pre to post training for subjects in the intervention condition, there was no actual significant effect of group, as this reduction in scores was transient. Similarly to the relationship found in other psychometric scores, it may be that in order to find a significant effect which can then be maintained, it may be necessary to implement a longer training program with concurrent follow up sessions.

An obvious flaw in the experiment is that the control group did not have the same questionnaire scores as the intervention group, particularly the BSQ. Thus it is possible that the lack of significant change in these scores are due to the fact that they are within the normal range for these measures already, rather than being at the high end of the scales. However, the relatively low proportion of women in the screening process who scored within the high concern range and the time constraints of the thesis made their inclusion necessary. Ideally, the lower BSQ scoring participants would be eliminated and their place taken by new recruits with higher BSQ scores. However, the

results from the intervention condition suggest that the thin-fat categorical boundary can indeed be altered by training and this shift is linked to an improvement in body image as measured by the BSQ. The results from the control group do suggest that repeatedly filling in the questionnaires does not have a significant impact on their questionnaire scores.

In addition, it is acknowledged that subjects in both the control and intervention groups should be matched on both Age and BMI in order to make them truly comparable. However, again due to time constraints and limitations in the availability of subjects with high BSQ scores, matching subjects based on both these factors became unrealistic and subjects were taken regardless of BMI or age (although all subjects were below 40). Unfortunately BMI can therefore not be removed as a variable, and could potentially have had a resulting effect on the outcome of this study. In future, all participants would be both age matched and of similar BMI in order to exclude these two factors as confounding variables.

Overall, results from this study suggest that perception training has the potential to be an effective tool when used to alter the estimation of body size in subjects with marked body image concerns. In addition, the training also has the secondary effect of improving negative body image and reducing eating-disordered behaviour. The evidence for this techniques effectiveness would be strengthened by a further study which randomly allocates high concern participants into an intervention or a control group and follows up the effect of training at a longer time interval than 2 weeks (a randomised controlled trial comparing the effectiveness of the intervention with a placebo). If this were successful, the next step would be to try a pilot study with women with Anorexia Nervosa for whom body image disturbance is a key diagnostic feature.

As current treatments focus mainly on the cognitive component of BID (i.e. CBT), with many failing to recognise the importance of perception (Timerman et al., 2010), it is suggested that perception training could potentially provide an invaluable solution to the problem of BID, and that this could be used alongside other treatments and therapies such as CBT, therefore treating all aspects of BID. However, it should be noted that I acknowledge that ED patients have concerns that have much deeper roots than our non-clinical sample; therefore a longer period of training would potentially be needed in order to truly alter patients' perception of size and subsequently their Eating Disordered beliefs and body shape concerns. In addition, to make this idea of a longer

training period in Eating Disordered patients a more viable option, future research should be conducted to investigate if this training programme could be implemented through the use of a downloadable app, therefore ensuring that patients were constantly reinforced every day for a specific period of time. I suggest this would allow the intervention to work at its full potential.

Again, in retrospect, power calculations should have been conducted a priori. However, due to the specific nature of the inclusion criteria for this study, I did not do this as I was conscious of focussing only on recruiting as many participants with high concerns about their body as possible. This alone was a challenging undertaking as not only did this reduce the amount of people available to take part in the study, but the length of the study (4 consecutive days with a follow up stage) meant that the chances of drop-out were also much higher. So while power calculations would have been effective in informing me of how many participants I would have needed in order to find an effect (i.e. it would have informed me about how many participants I would have need to recruit in order to find an effect on the RSE, BDI and EDBQ), I recruited all the participants available and was unable to recruit more. However, I do acknowledge that it would be useful to be able to present a number that would be needed in order to find an effect of training on the RSE, BDI and EDBQ, therefore allowing me to conclude whether perception training would actually ever be able to affect these outcome scores. Another reason for not calculating power a priori was the fact that this was a new intervention, therefore there was limited previous research on which to base my effect size calculations. I could have used information from a similar type of intervention in which depressed subjects received perception training (see introduction for this chapter), however we could not be certain that this intervention would have a similar effect on a completely different set of subjects when investigating a different research question.

5.5.3. Conclusion

In conclusion, the evidence from this chapter suggests that there is strong evidence for perception training as a useful tool in reducing the degree of BID found in women with marked concerns about their bodies, which in turn allows us to suggest that this could be an important therapeutic tool to treat body image disturbance found in those with EDs. Results from the previous chapter on the theory of Contraction Bias concluded that patients' attitudes to their own body shape, and their self-esteem is

reinforced by their judgement of their body size as being fatter than it actually is, emphasizing the importance of body judgements in the maintenance of EDs. Therefore, in future, treatment strategies designed to help those with EDs should not only focus on the cognitive component of body image disturbance, but should also be combined with perception training in order to tackle all possible components of the disorder in the hope of a more rounded method of treatment and a better outcome.

Chapter 6: General Discussion

6.1. How stable are body size preferences and judgements of attractiveness?

The evolutionary psychology view of female attractiveness suggests that attractiveness judgements are evolved psychological adaptations selected for their ability to provide cues to both health and fertility to potential mates (Tovée, & Cornelissen, 1999, 2001; Tovée et al., 2000; Tovée et al., 1998). Attractiveness is thought to be a "certificate" of health and fertility (Thornhill, & Grammer, 1999). In humans, male preferences have therefore been selected to favour females who display cues which honestly signal reproductive potential, and females therefore honestly signal their fecundity, again through visible qualities to potential mates (Smith et al., 2007). Much research has therefore focused on these cues to health and fertility, and in particular, how they can be measured.

However, this does not mean that there will be a fixed value for features such as BMI and WHR which result in judgements of high attractiveness across all cultures and environments. Although these features are important in judgements, the preferred value will depend on their environmental conditions; i.e. the preferences should be adaptive, shifting to local optimal values for an environment. A key question is how is this shift initiated? As discussed in Chapter 1 (section 1.8.1.) possible explanations put forward for reasons behind this shift include media influences ((Ahern et al., 2008; Thomsen et al., 2002; Tucci, & Peters, 2008; Wright, & Pritchard, 2009), stress (Pettijohn, & Tesser, 2005), culture (Furnham, & Alibhai, 1983; Swami, & Tovée, 2005) and resource scarcity ((Ember et al., 2005; Furnham, Moutafi, et al., 2002).

Research suggests that people in cultures in which resources such as food are scarce would prefer a larger body size as this would indicate greater access to food and therefore greater reproductive success, whereas a smaller body size would indicate limited access to food and possible malnutrition (Brown, & Konner, 1987; Furnham, Moutafi, et al., 2002). In Chapter 2 the question was therefore posed that if hunger could be responsible for differences in body size preferences, then would it be possible to invoke transient feelings of hunger in a western-based population, with the resulting effect of causing a change in body size preferences and attractiveness judgements (similar to preferences found in cultures where food is scarce)?

Although there may be a link between resource availability and body preferences (Swami, & Tovée, 2006), the precise nature of the link has been unclear. To explore this question, I carried out two sets of experiments to differentiate between psychological and physiological causes. In the first set I tested whether there was a difference in size or shape preferences between hungry participants who thought they were about to be fed and those who thought they would have to wait (i.e. this tests whether there is a psychological component to the body preference shift). The second set tested whether the calorie content of the food ingested is important in the judgement shift (i.e. this tests for physiological factors). In the event, there were no differences between the participants, which may be due to the student participants not having fasted as carefully as might have been hoped for. No mechanism was in place to control whether they did or did not fast during the pre-test period and this is a key weakness in the study.

However, shifts in preferences have been well documented in the literature, with marked differences found cross-culturally (Craig et al., 1996; Furnham, & Alibhai, 1983; Furnham, & Baguma, 1994; Furnham, Moutafi, et al., 2002; Marlowe, & Wetsman, 2001; Wetsman, & Marlowe, 1999; Wilkinson et al., 1994; Yu, & Shepard, 1998, 1999). This evidence shows that there is large variation in attitudes towards body shape and size (Brown, & Konner, 1987; Cassidy, 1991; Sobal, & Stunkard, 1989; Swami, & Furnham, 2008). From these studies it appears that in less developed countries a larger body ideal emerges, compared to a much smaller body preferred in developed, westernised countries (Swami, & Furnham, 2008). These shifts suggest that individuals are able to calibrate their preferences according to the environment; an idea that is consistent with an evolutionary perspective (Marlowe et al., 2005; Sugiyama, 2004; Swami, & Tovée, 2007). If this is the case then preferences should shift as we change environments, as differing BMIs will have differing health values depending on ecological conditions (Kopelman, 2000; Swami, & Furnham, 2008). Tovée et al. (2006) explored this idea by asking 4 different groups of observers, South African Zulus of low SES, Zulu migrants to Britain, Britons of Asian descent and British Caucasians, to rate images of real female bodies with varying BMI. Results indicated a large difference between the South African Zulus and both the British groups (who did not differ), with the former preferring women with a significantly higher BMI. The final group of Zulu migrants exhibited an intermediate preference that lay between the other two groups, supporting the idea of preferences for body size being adaptive.

182

Observers in rural South Africa are living in an environment that is economically deprived and lacks resources, with much of the population reporting going hungry (Swami, & Furnham, 2008). A higher body weight may therefore be found more attractive as it is seen as representing health, high status, affluence and access to resources (Clark et al., 1999; Mvo et al., 1999), whereas a thin body may reflect a lack of resources, in particular food (Brown, 1991; Treloar et al., 1999). Furthermore certain diseases associated with significant weight loss are prevalent in South Africa, such as AIDS, HIV and Tuberculosis, meaning smaller bodies may be interpreted as parasitic (Clark et al., 1999; Mvo et al., 1999; Swami, & Furnham, 2008).

Therefore, from an evolutionary psychology perspective, this difference in attractiveness in environments of low socioeconomic status (which lack resources) may be due to fatness being adapted as a cue to higher status and therefore increased availability of food. It would seem, therefore, that all preferences are a result of changing ecological conditions, with environmental changes causing a change in preference in order to reflect the most adaptive mate choice (Environmental Security Hypothesis (Pettijohn, & Tesser, 1999)).

6.2. Does WHR accurately capture variation in lower torso shape?

The theory of Quality Detection suggests attractiveness in females serves as a cue to males about their reproductive potential, health and fertility (Grammer et al., 2003). BMI is well documented in the literature as an indicator of female health (Manson et al., 1995; Willett et al., 1995) and reproductive potential (Frisch, 1987; Lake et al., 1997; Reid, & van Vugt, 1987), with Obesity linked to negative health outcomes such as cardiovascular disease (Conard et al., 2006; Ippoliti et al., 2013; Kenchaiah et al., 2002); and diabetes (Chan et al., 1994; Ford et al., 1997; Mokdad et al., 2001; Resnick et al., 2000). Manson et al. (1995) also suggests a BMI of over 24.9 will have a negative impact on fertility. Therefore, in relation to mate selection, it would make sense for a preference for a lower BMI to exist in a western setting.

However, as previously discussed, preferences differ cross-culturally in terms of BMI, with many cultures showing preferences for a larger (often overweight) BMI as this indicates access to resources. Therefore this would suggest that BMI signals different things in different cultures, depending on environmental pressures. If it is the case that ideals of attractiveness and body size are not actually stable, it could also be

the case that this is because BMI and WHR are only two of a range of different body features that may be important.

While there are also other variables that have been extensively studied as alternative cues to attractiveness, i.e. leg length and LBR, another anthropometric measure linked to these which appears to have been overlooked in this field is the contribution of torso length to the perception of body shape. In studies of LBR, relatively long legs are rated as most attractive, but in the images used in these studies the torso length is inversely correlated with leg length, so it may be shortening torso that is making the bodies more attractive and not longer legs. One way it might do this is to affect the perceived curvature of the torso, exaggerating the shape change. Tovée et al. (1997) found that on average, supermodels are 11cms taller than the average female but actually do have an hour glass figure (denoted by bust-to-hip ratio and WHR) therefore what may appear to be a tubular body shape may actually just be curves spread over a longer distance. The aim of chapter 3 was therefore to investigate changing torso length as a predictor of the perception of curvaceousness. The results suggested that torso length had a significant effect on perceived curviness and body size when no other cues were varied. Supermodels are usually of a similar BMI; therefore it may be that torso length as a modulator of perceived curviness may be the reason that they are seen as thinner than they actually are: as their curves and weight are stretched out over a longer torso length.

Although torso length modulates the perception of torso curvature, its impact on attractiveness is more limited. This is because curviness seems to be a weaker cue to attractiveness than other body features such as BMI, and as torso length is only modulating curviness its resultant impact on attractiveness will be correspondingly limited.

6.3. How accurate are our actual judgements of body size based on BMI, and can they be influenced by our own body size and cognitive state?

Evidence provided in the available literature to-date shows support for BMI as a better predictor of attractiveness, accounting for between 58-86% of the variance in attractiveness judgements, compared to just 0-30% explained by WHR (Swami, Knight, et al., 2007; Swami et al., 2008; Swami, Neto, et al., 2007; Swami, & Tovée, 2005; Swami, & Tovée, 2007; Tovée, & Cornelissen, 1999, 2001; Tovée et al., 2006).

More recently, Koscinski (2013) conducted a study in which digitally manipulated silhouettes of female bodies varying in both BMI and WHR were used as stimuli. Participants were first asked to estimate which images they thought were most attractive. They were then presented with pairs of images in which one of the pair deviated from the participants' ideal BMI and the other from their ideal WHR. In pairs in which deviations from the preferred BMI and WHR were equivalent, the silhouette altered for WHR was regarded as the most attractive, therefore suggesting that changing BMI away from the ideal had more of an effect on perceived attractiveness than changing the WHR. The extent of this effect was also found, with BMI being shown to be twice as important when making attractiveness judgements, compared to WHR, again suggesting BMI as the better predictor of attractiveness.

However, perception of body size denoted by BMI has been found to be distorted in a number of populations, most markedly in those with Eating Disorders who overestimate their own body size and the size of others (Collins et al., 1987; Gardner, & Bokenkamp, 1996; Smeets et al., 1998; Steiger et al., 1989; Tovée et al., 2003; Tovée et al., 2000). In Anorexic populations, this inability to estimate size accurately can be linked to the development and maintenance of their Eating Disorder (Slade, & Russell, 1973), due to the link with perceived attractiveness and thin ideals (Cornelissen, Hancock, et al., 2009; Tovée et al., 2012).

A number of studies have suggested that adaptation to a larger body size is shifting our perception of what is a normal body size (Robinson, & Kirkham, 2014). A similar effect may occur in women with AN, whose fixation on the ideal may be reinforced by the prolonged viewing of very thin bodies on pro-ana websites. However, an alternate viewpoint is that misjudgements of high and low weight bodies are due to contraction bias (Cornelissen et al., 2013). Contraction bias arises when one uses a standard reference or template for a particular kind of object (e.g., a fence post) against which to estimate the size of other examples of that object. The estimate is most accurate when a given example is of a similar size to the reference, but becomes increasingly inaccurate as the magnitude of the difference between the reference and the example increases. When this happens, the observer estimates that the given example is more similar in size to the reference than it is in reality. The effects of CB are said to be most apparent when there are no concrete units of measurement with which to judge the stimuli, i.e. when estimating the size of a human body (Poulton, 1989).

Overall, results from chapter 4 suggest there was a strong relationship between the estimated and the actual weight of the stimuli, with participants overestimating bodies of lower BMIs and underestimating bodies of higher BMIs. This therefore provides supporting evidence of Contraction Bias when estimating the body size. Furthermore, results suggest that contraction bias in body size estimation is modulated by observers own BMI and their psychological state. If the over-estimation of body size in women with AN arises as a secondary effect of estimating low weight bodies, rather than a qualitative difference between control and women with AN it undermines the inclusion of body image disturbance as one of the criteria for AN in the DSM-5 (American Psychiatric Association, 2013). Evidence from this chapter suggests that in the future, treatment for eating disorders that involve a significant overestimation of body size should focus not only on the cognitive component of body image distortion, but should also take into account the idea that patients' attitudes to their own body shape, and their self-esteem is reinforced by their perceptual mis-perception of body size.

If evolutionary theories, as presented in chapter 1, are correct, then eating disorders such as Anorexia Nervosa should not be present in society. One of the main cues to female attractiveness for males is body size- with a too large and too thin body negatively signalling reproductive success. However, women with Anorexia often suffer from amenorrhea, and therefore cannot reproduce. If evolutionary theory were correct in this instance, this drive for extreme thinness would not be in existence as women would not want to appear too thin and therefore signal a lack of reproductive potential to males. In my opinion, it therefore seems that while evolutionary theory was once true when life were simpler, I think in these times it is too simple an explanation. Anorexia is an increasingly common disease, therefore I believe that media influences have started to interact with evolution and that in fact Anorexia is a product of, amongst other things, repeated exposure to unhealthy and unrealistic ideals.

6.4. Can perception of body size be manipulated? Perception Training as a technique

A number studies suggest that body size preferences are malleable and vulnerable to external factors (Pettijohn, & Tesser, 1999; Swami, & Tovée, 2012; Winkler, & Rhodes, 2005). One such factor which has been found to affect body size preferences is a person's visual diet (Boothroyd et al., 2012).

This is supported by Tucci and Peters (2008) and Ahern et al. (2008) who found that when given magazines or shown websites that feature thin women, female participants tended to have increased negative feelings about their own bodies, including a drive for thinness. This is further reinforced by Gurari et al. (2006) who exposed participants to idealised images and found a resulting change in behaviour as well as attitudes: participants consuming less junk food and spending more time reading health related magazines than control subjects.

Thomsen (2002), in a study of 340 college-aged women, found that reading health and fitness magazines were directly linked to body shape concerns (Park, 2005; Thomsen et al., 2002). Body shape concerns are a key diagnostic feature of Anorexia and Bulimia Nervosa (DSM-5 (American Psychiatric Association, 2013)) therefore it would be logical to suggest that this increase in body shape concerns resulting from increased media exposure to a "thin ideal" may also cause an increase in the risk factors associated with the development of Eating Disorders. This idea is supported by Wright and Pritchard (2009) who stated that media images may be an important predictor of eating disordered behaviour in both adolescent men and women. Engeln-Maddox (2005) goes on to develop this further, suggesting that those who already have low self-esteem and issues surrounding body image will be more susceptible to media ideals as they will internalise these ideals.

Women with AN or BN have been found to have a markedly thinner ideal body size than control subjects (Williamson et al., 1993), possibly due to an internalisation of this "thin ideal" in their visual diet (Grabe et al., 2008). A second factor which is commonly found alongside this thinner ideal in AN and BN, is a consistent overestimation of their own body size.

Treatment for Eating Disorders to date focuses mainly on the cognitive component on body image disturbance, treating the attitudes and thought processes surrounding eating behaviours. However, as mentioned previously (Chapter 4) this distorted body image is said to have both a perceptual and cognitive component. Therefore it would make logical sense to attempt to treat both areas of disturbance in an attempt to rectify the discrepancies between Eating Disordered subjects and controls.

A treatment program found to be successful in reducing the perception of aggression and also depressive symptoms is that of Perception Training (also known as behaviour modification- (Penton-Voak, Bate, et al., 2012; Penton-Voak, Cooper, Roberts, Attwood, & Munafo, 2012)). This intervention aims to re-train subjects to

perceive things differently and involves positive and negative feedback to redefine the position of a categorical boundary for facial judgement.

In Chapter 5 this technique was therefore employed to redefine the thin/fat categorical boundary towards higher BMI bodies in subjects with marked concerns about their body, in an attempt to re-calibrate their body size judgements back into the normal range and also reduce other psychopathologies comorbid with Eating Disorders as secondary effects of the training.

Results showed a substantial effect of training in re-calibrating body fat judgements and also reducing eating disordered behaviours and body shape concerns (denoted by the EDE-Q and BSQ). It is therefore possible that this technique could be used to reduce body image disturbance in clinical subjects and therefore removing the effects of internalisation of the "thin ideal" portrayed in the media.

Treatment for eating disorders that involve body size concerns should therefore seek to employ this technique of perception training in an attempt to reduce body image disturbance, which would function alongside conventional CBT. This would potentially improve BID treatment and therefore improve treatment outcomes.

However, due to repeated exposure to this thin ideal, maintaining this reduction in overestimation of body size may be problematic, as the visual diet of the subjects will consistently have an effect.

In relation to this theory in the wider context of evolutionary psychology and the theory of innate preferences for a specific size and shape, study 5 actually shows that this may not be the case. If preferences were innate, it would not be possible to alter them so easily. I therefore believe that while preferences were originally related to ideas of fitness and choosing the best possible mate in order to ensure survival of yourself and your offspring, it now also seems to be the case that environment and other cues such as the media are interacting with this idea. I think that actually the environment in which we find ourselves and the people and values that we find ourselves surrounded by have a huge impact on our preferences for potential partners and therefore in turn, body size and shape. In western countries today, a preference for a thinner body is much more apparent, even though this may not be the most beneficial body size for reproduction. However, because we are constantly bombarded with images in the media of people that constitute the "perfect" body, our preferences have been manipulated and we have been, in a way, re-programmed to prefer this thinner body.

In addition, because there are such differences in the way people of different body sizes actually perceive size, this creates an even bigger problem. If preferences were determined by evolutionary processes, we would all have the same preferences for body size, however because people have distorted perception of size, we are all effectively seeing bodies differently, therefore we all have different preferences for size, based on our perception.

With the introduction of the media has come an increase in negative affect towards our bodies and constant comparisons made between ourselves and those depicted as "beautiful". This is shown perfectly by results from chapter 4 in which there was a significant interaction between people's own BMI, their psychological state and their estimations of body size/ weight. This therefore shows that the field of body image and body size preferences are more detailed than I first imagined. It is not simply that we all have an innate desire to meet the perfect mate and therefore portray ourselves in a way that would be "attractive" to the opposite sex, but instead there is interplay between this and the way we feel about our own bodies. Women who suffer from low self-esteem and are unhappy with their bodies etc appear to view the bodies of other women completely differently to women who are satisfied and happy in themselves. The media therefore appears to alter people's perceptions of what is attractive.

While this is only conjecture, it is my opinion that our own psychopathologies may potentially modulate this (although this is not based on fact), in that certain people will internalise ideas more and will be more affected by the fact that they cannot live up to the "thin ideal" portrayed by the media, while others will not be as affected. I also believe that this is in turn modulated by BMI. If your BMI does not fit in with the perfect body size shown on television, then this will undoubtedly affect your self-esteem and the way you feel about your own body. This in turn will affect how you perceive body size in general.

In summary, I believe that while evolutionary ideas such as fitness and sexual selection were once true, I think that in today's society media influence must also be taken into consideration. In my opinion, an interaction between evolutionary ideas and modern media influences appears to be the best explanation for mate preferences and preferences for a particular body size and shape.

6.5. Future Directions

The training program outlined in Chapter 5 appears to show promise in those women who have high concerns about their bodies, albeit in those who do not currently have diagnosed eating disordered concerns, therefore the next step would be to recruit a clinical sample of women currently suffering from Anorexia Nervosa. It would be advantageous to conduct several trials in which a sample of AN patients were recruited and to investigate how much training would be necessary in order to create a change in BID that is maintainable.

The perception training could potentially provide an invaluable solution to the problem of the perceptual component of Body Image Distortion in women with Eating Disorders, and that this could be used alongside other treatments and therapies such as CBT, therefore creating a treatment programme that would tackle both components simultaneously. However, we do acknowledge that ED patients have mental health concerns that are much more severe than our non-clinical sample; therefore we suggest in future, any training put forward as a method of treatment for ED patients should implement a much longer period of training in order to change patients' perception of size and subsequently their Eating Disordered beliefs and body shape concerns. We also suggest that following this extended period of training, follow up appointments to reinforce the resulting change in body size perception would be needed for a much longer period of time, i.e. a follow up of 2 months, 6 months and 12 months later in order to ensure that any effects of the training are still evident.

In addition, to make this idea of a longer training period in Eating Disordered patients a more viable option, future research should be conducted to investigate if this training programme can be implemented through the use of a downloadable app, therefore ensuring that patients were constantly reinforced every day for a specific period of time. Allowing this programme to be available on a tablet, laptop or smart phone would make it much more accessible, therefore making it easier for AN patients to receive help without it interfering with their everyday lives. It would also be beneficial for reminder texts to be sent each day to patients from investigators/assistants in order to ensure that patients were keeping up with their training. Having this program working directly alongside patient's CBT sessions would provide a novel addition to current treatment regimes. We suggest this extension of the training period and the use

of downloadable apps to facilitate this extension would optimise the effectiveness of the intervention.

6.6. Summary

In this thesis I have described a method of investigating the mechanism linking resource scarcity (hunger) with differences in body size preferences. However, results proved inconclusive as to whether physiological (physical feeling of hunger) or psychological (beliefs about when hunger will be sated) factors are this driving mechanism.

I have investigated the effect of a new anthropometric variable (torso length), previously unstudied, that could be used to predict judgements of curviness, body size and attractiveness. This study revealed torso length to be a significant predictor of curviness and body size, but not attractiveness. This effect was diluted when BMI and WHR were introduced as alternative cues; however torso length did still provided a significant proportion of the variance in curviness judgements (but not body size or attractiveness judgements) when these alternative cues were present. This therefore indicates that when BMI and WHR are held constant, torso length may become a significant predictor of body size and curviness.

Investigating the phenomenon of Contraction Bias in the general population, I was able to show that observer BMI had a significant effect on body size estimation. I was also able to show that observers with low BMIs and high psychometric scores underestimated body size much more markedly than observers in the same BMI category but with low psychometric scores, therefore concluding that the effect of observer BMI on estimation of body size found in previous studies (George et al., 2011) is actually modulated by observer's own attitudes and feelings about their own body and their eating behaviours.

Finally, I was able to use the relatively new experimental paradigm of Perception Training, in an attempt to reduce overestimation of body size in observers with high body shape concerns. While the control sample used was not a true Control, results suggested a significant shift in the categorical boundary of the thin/fat perception in the intervention condition compared to the control condition. This also resulted in a reduction in body shape concerns and also dietary restrictive behaviours- an effect that was maintained at two week follow-up. This therefore provides support for the future

effectiveness of perception training as a tool for reducing body image disturbance in patients with Anorexia.

6.7. Conclusion

Perception of body size and preferences for a particular size are well documented in past and current literature. However, BMI and WHR as malleable and vulnerable cues to both health and fertility in potential mates cause preferences and perception to vary according to external influences such as ecological conditions, environments and cultures, suggesting that preferences for these features are adaptive. This thesis provides support for an evolutionary psychology explanation and also postulates new explanations for these differences in size perception and preferences in an attempt to contribute to and further advance the field of body image research.

References

Adams, K. F., Schatzkin, A., Harris, T. B., Kipnis, V., Mouw, T., Ballard-Barbash, R., . . . Leitzmann, M. F. (2006). Overweight, obesity, and mortality in a large prospective cohort of persons 50 to 71 years old. *New England Journal of Medicine, 355*(8), 763-778. doi: 10.1056/NEJMoa055643

Aeberli, I., Gut-Knabenhans, M., Kusche-Ammann, R. S., Molinari, L., & Zimmermann, M. B. (2011). Waist circumference and waist-to-height ratio percentiles in a nationally representative sample of 6-13 year old children in Switzerland. *Swiss Medical Weekly, 141*. doi: 10.4414/smw.2011.13227

Ahern, A. L., Bennett, K. M., & Hetherington, M. M. (2008). Internalization of the Ultra-Thin Ideal: Positive Implicit Associations with Underweight Fashion Models are Associated with Drive for Thinness in Young Women. *Eating Disorders: The Journal of Treatment & Prevention, 16*(4), 294-307.

American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders: Fourth Edition- Text Revised (DSM-IV-TR)*.

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders: Fifth Edition*.

Anderson, J. L., Crawford, C. B., Nadeau, J., & Lindberg, T. (1992). Was the Duchess of Windsor right- A cross-cultural review of the socioecology of ideals of female body shape *Ethology and Sociobiology, 13*(3), 197-227. doi: 10.1016/0162-3095(92)90033-z

Anderson, P. (2008). Reducing overweight and obesity: closing the gap between primary care and public health. *Family Practice, 25*, I10-I16. doi: 10.1093/fampra/cmn060

Barber, N. (1995). The evolutionary psychology of physical attractiveness: Sexual

    selection and human morphology. *Ethology and Sociobiology, 16*(5), 395-424.

    doi: 10.1016/0162-3095(95)00068-2

Baron, R. A., Markman, G. D., & Bollinger, M. (2006). Exporting social psychology:

    Effects of attractiveness on perceptions of entrepreneurs, their ideas for new

    products, and their financial success. *Journal of Applied Social Psychology,*

    36(2), 467-492.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory

    for measuring depression. *Archives of General Psychiatry, 4*, 561-571.

Becker, A. E., Burwell, R. A., Gilman, S. E., Herzog, D. B., & Hamburg, P. (2002).

    Eating behaviours and attitudes following prolonged exposure to television

    among ethnic Fijian adolescent girls. *British Journal of Psychiatry, 180*, 509-

    514. doi: 10.1192/bjp.180.6.509

Becker, A. E., Burwell, R. A., Navara, K., & Gilman, S. E. (2003). Binge eating and

    binge eating disorder in a small-scale, indigenous society: The view from Fiji.

    International Journal of Eating Disorders, 34(4), 423-431. doi:

    10.1002/eat.10225

Bell, B. T., Lawton, R., & Dittmar, H. (2007). The impact of thin models in music

    videos on adolescent girls' body dissatisfaction. *Body Image, 4*(2), 137-145. doi:

    10.1016/j.bodyim.2007.02.003

Ben-Tovim, D. I., & Walker, M. K. (1991). Women's body attitudes- A review of

    measurement techniques *International Journal of Eating Disorders, 10*(2), 155-

    167. doi: 10.1002/1098-108x(199103)10:2<155::aid-eat2260100204>3.0.co;2-7

Bergström, E., Stenlund, H., & Svedjehäll, B. (2000). Assessment of body perception among Swedish adolescents and young adults. *Journal of Adolescent Health, 26*(1), 70-75. doi: 10.1016/s1054-139x(99)00058-0

Bettle, N., Bettle, O., Neumarker, U., & Neumarker, K. J. (2001). Body image and self-esteem in adolescent ballet dancers. *Perceptual and Motor Skills, 93*(1), 297-309. doi: 10.2466/pms.93.4.297-309

Boothroyd, L. G., Tovée, M. J., & Pollet, T. V. (2012). Visual Diet versus Associative Learning as Mechanisms of Change in Body Size Preferences. *Plos One, 7*(11). doi: 10.1371/journal.pone.0048691

Borzekowski, D. L. G., Robinson, T. N., & Killen, J. D. (2000). Does the camera add 10 pounds? Media use, perceived importance of appearance, and weight concerns among teenage girls. *Journal of Adolescent Health, 26*(1), 36-41. doi: 10.1016/s1054-139x(99)00044-0

Boyatzis, C. J., Baloff, P., & Durieux, C. (1998). Effects of perceived attractiveness and academic success on early adolescent peer popularity. *Journal of Genetic Psychology, 159*(3), 337-344.

Brambilla, P., Bedogni, G., Heo, M., & Pietrobelli, A. (2013). Waist circumference-to-height ratio predicts adiposity better than body mass index in children and adolescents. *International Journal of Obesity, 37*(7), 943-946. doi: 10.1038/ijo.2013.32

Brown, P. J. (1991). Culture and the evolution of obesity. *Human nature (Hawthorne, N.Y.), 2*(1), 31-57. doi: 10.1007/bf02692180

Brown, P. J., & Konner, M. (1987). An Anthropological Perspective on Obesity *Annals of the New York Academy of Sciences, 499*, 29-46. doi: 10.1111/j.1749-6632.1987.tb36195.x

Bulik, C. M., Sullivan, P. F., Fear, J. L., Pickering, A., Dawn, A., & McCullin, M. (1999). Fertility and reproduction in women with anorexia nervosa: A controlled study. *Journal of Clinical Psychiatry, 60*(2), 130-135.

Buss, D. M. (1994). The Strategies of Human Mating. *American Scientist, 82*(3), 238-249.

Buss, D. M. (2006). Strategies of Human Mating. *Psychological Topics, 15*(2), 239-260.

Buss, D. M., & Barnes, M. (1986). Preferences in Human Mate Selection. *Journal of Personality and Social Psychology, 50*(3), 559-570. doi: 10.1037//0022-3514.50.3.559

Button, E. J., Loan, P., Davies, J., & SonugaBarke, E. J. S. (1997). Self-esteem, eating problems, and psychological well-being in a cohort of schoolgirls aged 15-16: A questionnaire and interview study. *International Journal of Eating Disorders, 21*(1), 39-47.

Button, E. J., SonugaBarke, E. J. S., Davies, J., & Thompson, M. (1996). A prospective study of self-esteem in the prediction of eating problems in adolescent schoolgirls: Questionnaire findings. *British Journal of Clinical Psychology, 35*, 193-203.

Cacioppo, J. T., Bernston, G. G., & Crites, S. L. (1996). Social neuroscience: Principles of psychophysical arousal and response. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 72-101). New York: Guilford.

Calle, E. E., Rodriguez, C., Walker-Thurmond, K., & Thun, M. J. (2003). Overweight, obesity, and mortality from cancer in a prospectively studied cohort of US adults. *New England Journal of Medicine, 348*(17), 1625-1638. doi: 10.1056/NEJMoa021423

Cash, T. F., & Brown, T. A. (1987). Body-image in Anorexia-nervosa and Bulimia-

    nervosa - A review of the literature *Behavior Modification, 11*(4), 487-521. doi:

    10.1177/01454455870114005

Cash, T. F., & Deagle, E. A. (1997). The nature and extent of body-image disturbances

    in anorexia nervosa and bulimia nervosa: A meta-analysis. *International Journal*

    of Eating Disorders, 22(2), 107-125. doi: 10.1002/(sici)1098-

    108x(199709)22:2<107::aid-eat1>3.3.co;2-y

Cassidy, C. M. (1991). The good body: when big is better. *Medical anthropology,*

    13(3), 181-213.

Cattell, R. B. (1966). The Scree Test for the Number of Factors. *Multivariate*

    Behavioural Research, 1(2), 245-276.

Chan, J. M., Rimm, E. B., Colditz, G. A., Stampfer, M. J., & Willett, W. C. (1994).

    Obesity, fat distribution, and weight-gain as risk-factors for clinical diabetes in

    men *Diabetes Care, 17*(9), 961-969. doi: 10.2337/diacare.17.9.961

Chan, Y. L., Leung, S. S. F., Lam, W. W. M., Peng, X. H., & Metreweli, C. (1998).

    Body fat estimation in children by magnetic resonance imaging, bioelectrical

    impedance, skinfold and body mass index: A pilot study. *Journal of Paediatrics*

    and Child Health, 34(1), 22-28. doi: 10.1046/j.1440-1754.1998.00147.x

Christakis, N. A., & Fowler, J. H. (2007). The spread of obesity in a large social

    network over 32 years. *New England Journal of Medicine, 357*(4), 370-379. doi:

    10.1056/NEJMsa066082

Clark, R. A., Niccolai, L., Kissinger, P. J., Peterson, Y., & Bouvier, V. (1999). Ethnic

    differences in body image attitudes and perceptions among women infected with

    human immunodeficiency virus. *Journal of the American Dietetic Association,*

    99(6), 735-737. doi: 10.1016/s0002-8223(99)00398-3

Cohen-Tovee, E. M. (1993). Depressed mood and concern with weight and shape in normal young women. *International Journal of Eating Disorders, 14*(2), 223-227. doi: 10.1002/1098-108x(199309)14:2<223::aid-eat2260140213>3.0.co;2-g

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences (2nd edition)* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Collins, J. K., Beumont, P. J. V., Touyz, S. W., Krass, J., Thompson, P., & Philips, T. (1987). Variability in body shape perception in Anorexic, Bulimic, Obese and Control subjects *International Journal of Eating Disorders, 6*(5), 633-638. doi: 10.1002/1098-108x(198709)6:5<633::aid-eat2260060506>3.0.co;2-u

Conard, M. W., Haddock, C. K., Poston, W. S. C., Havranek, E., McCullough, P., Spertus, J., & Cardiovascular Outcomes Res, C. (2006). Impact of obesity on the health status of heart failure patients. *Journal of Cardiac Failure, 12*(9), 700-706. doi: 10.1016/j.cardfail.2006.08.006

Conley, D., & McCabe, B. J. (2011). Body Mass Index and Physical Attractiveness: Evidence From a Combination Image-Alteration/List Experiment. *Sociological Methods & Research, 40*(1), 6-31. doi: 10.1177/0049124110390762

Cooper, M., CohenTovee, E., Todd, G., Wells, A., & Tovee, M. (1997). The eating disorder belief questionnaire: Preliminary development. *Behaviour Research and Therapy, 35*(4), 381-388. doi: 10.1016/s0005-7967(96)00115-5

Cornelissen, P. L., Hancock, P. J. B., Kiviniemi, V., George, H. R., & Tovée, M. J. (2009). 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), 417-428. doi: 10.1016/j.evolhumbehav.2009.04.003

Cornelissen, P. L., Johns, A., & Tovée, M. J. (2013). Body size over-estimation in

women with anorexia nervosa is not qualitatively different from female controls.

Body Image, 10(1), 103-111. doi: 10.1016/j.bodyim.2012.09.003

Cornelissen, P. L., Tovée, M. J., & Bateson, M. (2009). 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), 343-350. doi: 10.1016/j.jtbi.2008.09.041

Craig, P. L., Swinburn, B. A., MatengaSmith, T., Matangi, H., & Vaughan, G. (1996).

Do Polynesians still believe that big is beautiful? Comparison of body size

perceptions and preferences of Cook Islands, Maori and Australians. *New*

Zealand Medical Journal, 109(1023), 200-203.

Crossley, K. L., Cornelissen, P. L., & 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). doi: 10.1371/journal.pone.0050601

Derenne, J. L., & Beresin, E. V. (2006). Body image, media, and eating disorders.

Academic Psychiatry, 30(3), 257-261. doi: 10.1176/appi.ap.30.3.257

Deurenberg, P., Deurenberg-Yap, M., & Guricci, S. (2002). Asians are different from

Caucasians and from each other in their body mass index/body fat per cent

relationship. *Obesity Reviews, 3*(3), 141-146.

Dion, K. K. (1972). Physical attractiveness and evaluation of childrens transgressions

Journal of Personality and Social Psychology, 24(2), 207-&. doi:

10.1037/h0033372

Dion, K. L., & Dion, K. K. (1987). Belief in a just world and physical attractiveness

stereotyping *Journal of Personality and Social Psychology, 52*(4), 775-780. doi:

10.1037//0022-3514.52.4.775

Dixson, B. J., Dixson, A. F., Bishop, P. J., & Parish, A. (2010). Human Physique and

    Sexual Attractiveness in Men and Women: A New Zealand-US Comparative

    Study. *Archives of Sexual Behavior, 39*(3), 798-806. doi: 10.1007/s10508-008-

    9441-y

Dixson, B. J., Dixson, A. F., Li, B. G., & Anderson, M. J. (2007). Studies of human

    physique and sexual attractiveness: Sexual preferences of men and women in

    China. *American Journal of Human Biology, 19*(1), 88-95. doi:

    10.1002/ajhb.20584

Dixson, B. J., Dixson, A. F., Morgan, B., & Anderson, M. J. (2007). Human physique

    and sexual attractiveness: Sexual preferences of men and women in Bakossiland,

    Cameroon. *Archives of Sexual Behavior, 36*(3), 369-375. doi: 10.1007/s10508-

    006-9093-8

Dixson, B. J., Grimshaw, G. M., Linklater, W. L., & 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), 43-50. doi: 10.1007/s10508-009-

    9523-5

Dixson, B. J., Vasey, P. L., Sagata, K., Sibanda, N., Linklater, W. L., & 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), 1271-1279.

    doi: 10.1007/s10508-010-9680-6

Dobbs, R., Sawers, C., Thompson, F., Manyika, J., Woetzel, J., Child, P., . . . Spatharou,

    A. (2014). Overcoming obesity- An initial economic analysis. In M. a. Company

    (Ed.): McKinsey Global Institute- MGI.

Durnin, J., & Womersley, J. (1974). Body fat assessed from total-body density and its

    estimation from skinfold thickness- measurements on 481 men and women ages

from 16 to 72 years *British Journal of Nutrition, 32*(1), 77-97. doi: 10.1079/bjn19740060

Eagly, A. H., Makhijani, M. G., Ashmore, R. D., & Longo, L. C. (1991). What is beautiful is good, but - A meta-analytic review of research on the physical attractiveness stereotype *Psychological Bulletin, 110*(1), 109-128. doi: 10.1037/0033-2909.110.1.109

Ehtisham, S., Crabtree, N., Clark, P., Shaw, N., & Barrett, T. (2005). Ethnic differences in insulin resistance and body composition in United Kingdom adolescents. *Journal of Clinical Endocrinology & Metabolism, 90*(7), 3963-3969. doi: 10.1210/jc.2004-2001

Eisenkolbl, J., Kartasurya, M., & Widhalm, K. (2001). Underestimation of percentage fat mass measured by bioelectrical impedance analysis compared to dual energy X-ray absorptiometry method in obese children. *European Journal of Clinical Nutrition, 55*(6), 423-429. doi: 10.1038/sj.ejcn.1601184

Ember, C. R., Ember, M., Korotayev, A., & de Munck, V. (2005). Valuing thinness or fatness in women - Re evaluating the effect of resource scarcity. *Evolution and Human Behavior, 26*(3), 257-270. doi: 10.1016/j.evolhumbehav.2005.02.001

Engeln-Maddox, R. (2005). Cognitive responses to idealized media images of women: The relationship of social comparison and critical processing to body image disturbance in college women. *Journal of Social and Clinical Psychology, 24*(8), 1114-1138. doi: 10.1521/jscp.2005.24.8.1114

Evans, C., & Dolan, B. (1993). Body Shape Questionnaire- Derivation of shortened alternate forms *International Journal of Eating Disorders, 13*(3), 315-321. doi: 10.1002/1098-108x(199304)13:3<315::aid-eat2260130310>3.0.co;2-3

Evans, E. H., Tovee, M. J., Boothroyd, L. G., & Drewett, R. F. (2013). Body

dissatisfaction and disordered eating attitudes in 7- to 11-year-old girls: Testing

a sociocultural model. *Body Image, 10*(1), 8-15. doi:

10.1016/j.bodyim.2012.10.001

Fairburn, C. (1991). *The research on the treatment of Bulimia-Nervosa* (Vol. 968).

Fairburn, C. G., & Beglin, S. J. (1994). Assessment of Eating Disorders- Interview or

Self-report Questionnaire *International Journal of Eating Disorders, 16*(4), 363-

370.

Fairburn, C. G., & Harrison, P. J. (2003). Eating disorders. *Lancet, 361*(9355), 407-416.

doi: 10.1016/s0140-6736(03)12378-1

Fairburn, C. G., Jones, R., Peveler, R. C., Carr, S. J., Solomon, R. A., Oconnor, M. E., .

. . Hope, R. A. (1991). 3 Psychological treatments for Bulimia-Nervosa - A

comparative trial *Archives of General Psychiatry, 48*(5), 463-469.

Fairburn, C. G., Shafran, R., & Cooper, Z. (1999). A cognitive behavioural theory of

anorexia nervosa. *Behaviour Research and Therapy, 37*(1), 1-13. doi:

10.1016/s0005-7967(98)00102-8

Fan, J. T., Dai, W., Liu, F., & Wu, J. (2005). Visual perception of male body

attractiveness. *Proceedings of the Royal Society B-Biological Sciences,

272*(1560), 219-226. doi: 10.1098/rspb.2004.2922

Fan, J. T., Dai, W., Qian, X., Chau, K. P., & Liu, Q. (2007). Effects of shape parameters

on the attractiveness of a female body. *Perceptual and Motor Skills, 105*(1),

117-132. doi: 10.2466/pms.105.1.117-132

Fan, J. T., Liu, F., Wu, J., & Dai, W. (2004). Visual perception of female physical

attractiveness. *Proceedings of the Royal Society B-Biological Sciences,

271*(1537), 347-352. doi: 10.1098/rspb.2003.2613

Farrell, C., Shafran, R., & Lee, M. (2006). Empirically evaluated treatments for body image disturbance: A review. *European Eating Disorders Review, 14*(5), 289-300. doi: 10.1002/erv.693

Fernandez, S., & Pritchard, M. (2012). Relationships between self-esteem, media influence and drive for thinness. *Eating Behaviors, 13*(4), 321-325. doi: 10.1016/j.eatbeh.2012.05.004

Fiske, A. P., Kitayama, S., Markus, H. R., & Nisbett, R. E. (1998). The Cultural Matrix of Social Psychology. In D. T. Gilbert, S. T. Fiske & G. Lindzey (Eds.), *The Handbook of Social Psychology* (Vol. 2, pp. 915-981). New York: McGraw-Hill.

Flegal, K. M., Graubard, B. I., Williamson, D. F., & Gail, M. H. (2005). Excess deaths associated with underweight, overweight, and obesity. *Jama-Journal of the American Medical Association, 293*(15), 1861-1867. doi: 10.1001/jama.293.15.1861

Ford, C. S., & Beach, F. A. (1951). *Patterns of Sexual Behaviour*. New York: Harper & Brothers.

Ford, E. S., Williamson, D. F., & Liu, S. M. (1997). Weight change and diabetes incidence: Findings from a national cohort of US adults. *American Journal of Epidemiology, 146*(3), 214-222.

Forman-Hoffman, V. (2004). High prevalence of abnormal eating and weight control practices among U.S. high-school students. *Eating Behaviors, 5*(4), 325-336. doi: 10.1016/j.eatbeh.2004.04.003

Frederick, D. A., Fessler, D. M. T., & Haselton, M. G. (2005). Do representations of male muscularity differ in men's and women's magazines? *Body Image, 2*(1), 81-86. doi: 10.1016/j.bodyim.2004.12.002

Frederick, D. A., Hadji-Michael, M., Furnham, A., & 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), 51-55. doi: 10.1016/j.bodyim.2009.09.001

Frederick, D. A., & Haselton, M. G. (2007). Why is muscularity sexy? Tests of the fitness indicator hypothesis. *Personality and Social Psychology Bulletin, 33*(8), 1167-1183. doi: 10.1177/0146167207303022

Freese, J., & Meland, S. (2002). Seven Tenths Incorrect: Heterogeneity and Change in the Waist-to-Hip Ratios of Playboy Centerfold Models and Miss America Pageant Winners. *The Journal of Sex Research, 39*(2), 133-138.

Friedman, R. S., & Forster, J. (2000). The effects of approach and avoidance motor actions on the elements of creative insight. *Journal of Personality and Social Psychology, 79*(4), 477-492. doi: 10.1037//0022-3514.79.4.477

Frisch, R. E. (1987). Body-fat, menarche, fitness and fertility *Human Reproduction, 2*(6), 521-533.

Frisch, R. E. (1996). The right weight: Body fat, menarche, and fertility. *Nutrition, 12*(6), 452-453. doi: 10.1016/s0899-9007(97)85084-8

Furnham, A., & Alibhai, N. (1983). Cross-cultural differences in the perception of female body shapes *Psychological Medicine, 13*(4), 829-837.

Furnham, A., Badmin, N., & Sneade, I. (2002). Body image dissatisfaction: Gender differences in eating attitudes, self-esteem, and reasons for exercise. *Journal of Psychology, 136*(6), 581-596.

Furnham, A., & Baguma, P. (1994). Cross-cultural differences in the evaluation of male and female body shapes *International Journal of Eating Disorders, 15*(1), 81-89. doi: 10.1002/1098-108x(199401)15:1<81::aid-eat2260150110>3.0.co;2-d

Furnham, A., Lavancy, M., & McClelland, A. (2001). Waist to hip ratio and facial

    attractiveness: a pilot study. *Personality and Individual Differences, 30*(3), 491-

    502. doi: 10.1016/s0191-8869(00)00040-4

Furnham, A., McClelland, A., & Omer, L. (2003). A cross cultural comparison of

    ratings of perceived fucundity and sexual attractiveness as a function of body

    weight and waist-to-hip ratio. *Psychology, Health and Medicine, 8*, 219-230.

Furnham, A., Moutafi, J., & Baguma, P. (2002). A cross-cultural study on the role of

    weight and waist-to-hip ratio on female attractiveness. *Personality and*

    Individual Differences, 32(4), 729-745. doi: 10.1016/s0191-8869(01)00073-3

Furnham, A., Petrides, K. V., & Constantinides, A. (2005). The effects of body mass

    index and waist-to-hip ratio on ratings of female attractiveness, fecundity, and

    health. *Personality and Individual Differences, 38*(8), 1823-1834. doi:

    10.1016/j.paid.2004.11.011

Furnham, A., Swami, V., & Shah, K. (2006). Body weight, waist-to-hip ratio and breast

    size correlates of ratings of attractiveness and health. *Personality and Individual*

    Differences, 41(3), 443-454. doi: 10.1016/j.paid.2006.02.007

Furnham, A., Tan, T., & McManus, C. (1997). Waist-to-hip ratio and preferences for

    body shape: A replication and extension. *Personality and Individual Differences,*

    22(4), 539-549. doi: 10.1016/s0191-8869(96)00241-3

Gallagher, D., Visser, M., Sepulveda, D., Pierson, R. N., Harris, T., & Heymsfield, S. B.

    (1996). How useful is body mass index for comparison of body fatness across

    age, sex, and ethnic groups? *American Journal of Epidemiology, 143*(3), 228-

    239.

Gangestad, S. W., & Simpson, J. A. (2000). The evolution of human mating: Trade-offs and strategic pluralism. *Behavioral and Brain Sciences, 23*(4), 573-+. doi: 10.1017/s0140525x0000337x

Gardner, R. M., & Boice, R. (2004). A computer program for measuring body size distortion and body dissatisfaction. *Behavior Research Methods Instruments & Computers, 36*(1), 89-95. doi: 10.3758/bf03195553

Gardner, R. M., & Bokenkamp, E. D. (1996). The role of sensory and nonsensory factors in body size estimations of eating disorder subjects. *Journal of Clinical Psychology, 52*(1), 3-15. doi: 10.1002/(sici)1097-4679(199601)52:1<3::aid-jclp1>3.3.co;2-l

Garn, S. M., Sullivan, T. V., & Hawthorne, V. M. (1987). Differential rates of fat change relative to weight change at different body sites. *International Journal of Obesity, 11*(5), 519-525.

Garner, D. M., & Garfinkel, P. E. (1980). Sociocultural factors in the development of Anorexia-Nervosa *Psychological Medicine, 10*(4), 647-656.

George, H. R., Cornelissen, P. L., Hancock, P. J. B., Kiviniemi, V. V., & Tovée, M. J. (2011). Differences in eye-movement patterns between anorexic and control observers when judging body size and attractiveness. *British Journal of Psychology, 102*, 340-354. doi: 10.1348/000712610x52429

Gleaves, D. H., & Eberenz, K. (1993). The psychopathology of Anorexia-Nervosa - A factor-analytic investigation *Journal of Psychopathology and Behavioral Assessment, 15*(2), 141-152. doi: 10.1007/bf00960614

Gleaves, D. H., Williamson, D. A., & Barker, S. E. (1993). Confirmatory factor-analysis of a multidimensional model of Bulimia-Nervosa. *Journal of Abnormal Psychology, 102*(1), 173-176. doi: 10.1037//0021-843x.102.1.173

206

Golden, N. H., & Carlson, J. L. (2008). The pathophysiology of amenorrhea in the adolescent. In C. M. Gordon, C. Welt, R. W. Rebar, P. J. A. Hillard, M. M. Matzuk & L. M. Nelson (Eds.), *Menstrual Cycle and Adolescent Health* (Vol. 1135, pp. 163-178).

Grabe, S., Ward, M. L., & Hyde, S. J. (2008). Role of the media in body image concerns among women: A meta-analysis of experimental and correlational studies. *Psychological Bulletin, 134*(3), 460-476. doi: 10.1037/0033-2909.134.3.460

Grammer, K., Fink, B., Moller, A. P., & Thornhill, R. (2003). Darwinian aesthetics: sexual selection and the biology of beauty. *Biological Reviews, 78*(3), 385-407. doi: 10.1017/s1464793102006085

Gray-Little, B., Williams, V. S. L., & Hancock, T. D. (1997). An item response theory analysis of the Rosenberg self-esteem scale. *Personality and Social Psychology Bulletin, 23*(5), 443-451. doi: 10.1177/0146167297235001

Greenberg, B. S., Eastin, M., Hofschire, L., Lachlan, K., & Brownell, K. D. (2003). Portrayals of overweight and obese individuals on commercial television. *American Journal of Public Health, 93*(8), 1342-1348. doi: 10.2105/ajph.93.8.1342

Grinspoon, S., Thomas, E., Pitts, S., Gross, E., Mickley, D., Miller, K., . . . Klibanski, A. (2000). Prevalence and predictive factors for regional osteopenia in women with anorexia nervosa. *Annals of Internal Medicine, 133*(10), 790-794.

Gual, P., Perez-Gaspar, M., Martinez-Gonzalez, M. A., Lahortiga, F., de Irala-Estevez, J., & Cervera-Enguix, S. (2002). Self-esteem, personality, and eating disorders: Baseline assessment of a prospective population-based cohort. *International Journal of Eating Disorders, 31*(3), 261-273. doi: 10.1002/eat.10040

Gunnell, D. (2002). Commentary: Can adult anthropometry be used as a 'biomarker' for prenatal and childhood exposures? *International Journal of Epidemiology, 31*(2), 390-394. doi: 10.1093/ije/31.2.390

Gunnell, D. J., Davey-Smith, G., Frankel, S., Nanchahal, K., Braddon, F. E. M., Pemberton, J., & Peters, T. J. (1998). Childhood leg length and adult mortality: follow up of the Carnegie (Boyd Orr) Survey of Diet and Health in Pre-war Britain. *Journal of Epidemiology and Community Health, 52*(3), 142-152.

Gurari, I., Hetts, J. J., & Strube, M. J. (2006). Beauty in the "I" of the beholder: Effects of idealized media portrayals on implicit self-image. *Basic and Applied Social Psychology, 28*(3), 273-282. doi: 10.1207/s15324834basp2803_6

Hall, L. F., & Neubert, A. G. (2005). Obesity and pregnancy. *Obstetrical & Gynecological Survey, 60*(4), 253-260. doi: 10.1097/01.ogx.0000158509.04154.9e

Henss, R. (1995). Waist-to-hip ratio and attractiveness - Replication and Extension *Personality and Individual Differences, 19*(4), 479-488. doi: 10.1016/0191-8869(95)00093-l

Henss, R. (2000). Waist-to-hip ratio and female attractiveness. Evidence from photographic stimuli and methodological considerations. *Personality and Individual Differences, 28*(3), 501-513. doi: 10.1016/s0191-8869(99)00115-4

Herbozo, S., Tantleff-Dunn, S., Gokee-Larose, J., & Thompson, J. K. (2004). Beauty and thinness messages in children's media: a content analysis. *Eating disorders, 12*(1), 21-34.

HSCIC, H. a. S. C. I. C. N.-. (2012). Health Survey for England.

Huxley, R. R., & Jacobs, D. R. (2011). Size still matters ... but not in the way we once thought. *Lancet, 377*(9771), 1051-1052. doi: 10.1016/s0140-6736(11)60239-0

Ippoliti, F., Canitano, N., & Businaro, R. (2013). Stress and Obesity as Risk Factors in
    Cardiovascular Diseases: A Neuroimmune Perspective. *Journal of*
    Neuroimmune Pharmacology, 8(1), 212-226. doi: 10.1007/s11481-012-9432-6

Isbell, L. A., Pruetz, J. D., Lewis, M., & Young, T. P. (1998). Locomotor activity
    differences between sympatric patas monkeys (Erythrocebus patas) and vervet
    monkeys (Cercopithecus aethiops): Implications for the evolution of long
    hindlimb length in Homo. *American Journal of Physical Anthropology, 105*(2),
    199-207. doi: 10.1002/(sici)1096-8644(199802)105:2<199::aid-ajpa7>3.0.co;2-
    q

Jackson, A. S., Stanforth, P. R., Gagnon, J., Rankinen, T., Leon, A. S., Rao, D. C., . . .
    Wilmore, J. H. (2002). The effect of sex, age and race on estimating percentage
    body fat from body mass index: The Heritage Family Study. *International*
    Journal of Obesity, 26(6), 789-796. doi: 10.1038/sj.ijo.0802006

James, D. C. (2001). Eating disorders, fertility, and pregnancy: Relationships and
    complications. *Journal of Perinatal & Neonatal Nursing, 15*(2), 36-48.

Jasienska, G., Ziomkiewicz, A., Ellison, P. T., Lipson, S. F., & Thune, I. (2004). Large
    breasts and narrow waists indicate high reproductive potential in women.
    Proceedings of the Royal Society B-Biological Sciences, 271(1545), 1213-1217.
    doi: 10.1098/rspb.2004.2712

Johnson, K. L., & Tassinary, L. G. (2005). Perceiving sex directly and indirectly -
    Meaning in motion and morphology. *Psychological Science, 16*(11), 890-897.
    doi: 10.1111/j.1467-9280.2005.01633.x

Jokela, M. (2009). Physical attractiveness and reproductive success in humans: evidence
    from the late 20th century United States. *Evolution and Human Behavior, 30*(5),
    342-350. doi: 10.1016/j.evolhumbehav.2009.03.006

Kahn, H. S., Imperatore, G., & Cheng, Y. L. J. (2005). A population-based comparison of BMI percentiles and waist-to-height ratio for identifying cardiovascular risk in youth. *Journal of Pediatrics, 146*(4), 482-488. doi: 10.1016/j.jpeds.2004.12.028

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika, 39*(1), 31-36.

Kelishadi, R., Gheiratmand, R., Ardalan, G., Adeli, K., Gouya, M. M., Razaghi, E. M., . . . Riazi, M. M. (2007). Association of anthropometric indices with cardiovascular disease risk factors among children and adolescents: CASPIAN Study. *International Journal of Cardiology, 117*(3), 340-348. doi: 10.1016/j.ijcard.2006.06.012

Kenchaiah, S., Evans, J. C., Levy, D., Wilson, P. W. F., Benjamin, E. J., Larson, M. G., . . . Vasan, R. S. (2002). Obesity and the risk of heart failure. *New England Journal of Medicine, 347*(5), 305-313. doi: 10.1056/NEJMoa020245

Kenealy, P., Frude, N., & Shaw, W. (1988). Influence of childrens physical attractiveness on teacher expectations *Journal of Social Psychology, 128*(3), 373-383.

Ketel, I. J. G., Volman, M. N. M., Seidell, J. C., Stehouwer, C. D. A., Twisk, J. W., & Lambalk, C. B. (2007). Superiority of skinfold measurements and waist over waist-to-hip ratio for determination of body fat distribution in a population-based cohort of Caucasian Dutch adults. *European Journal of Endocrinology, 156*(6), 655-661. doi: 10.1053/eje-06-0730

Kim, H., & Markus, H. R. (1999). Deviance or uniqueness, harmony or conformity? A cultural analysis. *Journal of Personality and Social Psychology, 77*(4), 785-800. doi: 10.1037/0022-3514.77.4.785

Kirchengast, S., & Winkler, E. M. (1996). Differential fertility and body build in !Kung San and Kavango females from northern Namibia. *Journal of Biosocial Science, 28*(2), 193-210.

Kitayama, S., Markus, H. R., Matsumoto, H., & Norasakkunkit, V. (1997). Individual and collective processes in the construction of the self: Self-enhancement in the United States and self-criticism in Japan. *Journal of Personality and Social Psychology, 72*(6), 1245-1267. doi: 10.1037/0022-3514.72.6.1245

Kohrt, W. M. (1995). Body composition by DXA: tried and true? *Medicine and Science in Sports and Exercise, 27*, 1349-1353.

Kohrt, W. M. (1998). Preliminary evidence that DEXA provides an accurate assessment of body composition. *Journal of Applied Physiology, 84*(1), 372-377.

Kopelman, P. G. (2000). Obesity as a medical problem. *Nature, 404*(6778), 635-643.

Koscinski, K. (2013). Attractiveness of womens body: body mass index, waist-hip ratio, and their relative importance. *Behavioral Ecology, 24*(4), 914-925. doi: 10.1093/beheco/art016

Kuchler, F., & Variyam, J. N. (2003). Mistakes were made: misperception as a barrier to reducing overweight. *International Journal of Obesity, 27*(7), 856-861. doi: 10.1080/sj.ijo.0802293

Kuk, J. L., Lee, S., Heymsfield, S. B., & Ross, R. (2005). Waist circumference and abdominal adipose tissue distribution: influence of age and sex. *American Journal of Clinical Nutrition, 81*(6), 1330-1334.

Kuskowska-Wolk, A., Karlsson, P., Stolt, M., & Rossner, S. (1989). The predictive-validity of body mass index based on self reported weight and height *International Journal of Obesity, 13*(4), 441-453.

Kvist, H., Chowdhury, B., Grangard, U., Tylen, U., & Sjostrom, L. (1988). Total and
visceral adipose-tissue volumes derived from measurements with computed-
tomotography in adult men and women - Predictive equations *American Journal
of Clinical Nutrition, 48*(6), 1351-1361.

Lake, J. K., Power, C., & 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),
432-438. doi: 10.1038/sj.ijo.0800424

Langlois, J. H., Kalakanis, L., Rubenstein, A. J., Larson, A., Hallam, M., & Smoot, M.
(2000). Maxims or myths of beauty? A meta-analytic and theoretical review.
Psychological Bulletin, 126(3), 390-423. doi: 10.1037/0033-2909.126.3.390

Langlois, J. H., Ritter, J. M., Casey, R. J., & Sawin, D. B. (1995). Infant attractiveness
predicts maternal behaviors and attitudes *Developmental Psychology, 31*(3),
464-472. doi: 10.1037/0012-1649.31.3.464

Leahy, S., O'Neill, C., Sohun, R., & Jakeman, P. (2012). A comparison of dual energy
X-ray absorptiometry and bioelectrical impedance analysis to measure total and
segmental body composition in healthy young adults. *European Journal of
Applied Physiology, 112*(2), 589-595. doi: 10.1007/s00421-011-2010-4

Lee, S., & 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*(3), 317-327. doi:
10.1002/(sici)1098-108x(200004)27:3<317::aid-eat9>3.3.co;2-u

Lemieux, S., Prudhomme, D., Bouchard, C., Tremblay, A., & Despres, J. P. (1993).
Sex-differences in the relation of visceral adipose-tissue accumulation to total-
body fatness *American Journal of Clinical Nutrition, 58*(4), 463-467.

Lewinsohn, P. M., Striegel-Moore, R. H., & Seeley, J. R. (2000). Epidemiology and

    natural course of eating disorders in young women from adolescence to young

    adulthood. *Journal of the American Academy of Child and Adolescent*

    Psychiatry, 39(10), 1284-1292. doi: 10.1097/00004583-200010000-00016

Ley, C. J., Lees, B., & Stevenson, J. C. (1992). Sex-associated and menopause-

    associated changes in body-fat distribution *American Journal of Clinical*

    Nutrition, 55(5), 950-954.

Lipson, S. F., & Ellison, P. T. (1996). Comparison of salivary steroid profiles in

    naturally occurring conception and non-conception cycles. *Human*

    Reproduction, 11(10), 2090-2096.

Liu, A. L., Byrne, N. M., Kagawa, M., Ma, G. S., Kijboonchoo, K., Nasreddine, L., . . .

    Hills, A. P. (2011). Ethnic differences in body fat distribution among Asian pre-

    pubertal children: A cross-sectional multicenter study. *Bmc Public Health, 11*.

    doi: 10.1186/1471-2458-11-500

Lohman, T. G., Caballero, B., Himes, J. H., Davis, C. E., Stewart, D., Houtkooper, L., .

    . . Stephenson, L. (2000). Estimation of body fat from anthropometry and

    bioelectrical impedance in Native American children. *International Journal of*

    Obesity, 24(8), 982-988. doi: 10.1038/sj.ijo.0801318

Maisey, D. S., Vale, E. L. E., Cornelissen, P. L., & Tovée, M. J. (1999). Characteristics

    of male attractiveness for women. *Lancet, 353*(9163), 1500-1500. doi:

    10.1016/s0140-6736(99)00438-9

Manning, J. T., Trivers, R. L., Singh, D., & Thornhill, R. (1999). The mystery of female

    beauty. *Nature, 399*(6733), 214-215. doi: 10.1038/20341

Manson, J. E., Willett, W. C., Stampfer, M. J., Colditz, G. A., Hunter, D. J., Hankinson,

    S. E., . . . Speizer, F. E. (1995). Body-weight and mortality among women *New*

England Journal of Medicine, 333(11), 677-685. doi: 10.1056/nejm199509143331101

Markey, C. N., Tinsley, B. J., Ericksen, A. J., Ozer, D. J., & Markey, P. M. (2002). Preadolescents' perceptions of females' body size and shape: Evolutionary and social learning perspectives. *Journal of Youth and Adolescence, 31*(2), 137-146. doi: 10.1023/a:1014022010577

Markowitz, S., Friedman, M. A., & Arent, S. M. (2008). Understanding the relation between obesity and depression: Causal mechanisms and implications for treatment. *Clinical Psychology-Science and Practice, 15*(1), 1-20. doi: 10.1111/j.1468-2850.2008.00106.x

Marlowe, F. W., Apicella, C., & Reed, D. (2005). Men's preferences for women's profile waist-to-hip ratio in two societies. *Evolution and Human Behavior, 26*(6), 458-468. doi: 10.1016/j.evolhumbehav.2005.07.005

Marlowe, F. W., & Wetsman, A. (2001). Preferred waist-to-hip ratio and ecology. *Personality and Individual Differences, 30*(3), 481-489. doi: 10.1016/s0191-8869(00)00039-8

Marti, B., Tuomilehto, J., Salomaa, V., Kartovaara, L., Korhonen, H. J., & Pietinen, P. (1991). Body-fat distribution in the Finnish population- Environmental determinants and predictive power for cardiovascular risk factor levels *Journal of Epidemiology and Community Health, 45*(2), 131-137. doi: 10.1136/jech.45.2.131

Maximova, K., McGrath, J. J., Barnett, T., O'Loughlin, J., Paradis, G., & Lambert, M. (2008). Do you see what I see? Weight status misperception and exposure to obesity among children and adolescents. *International Journal of Obesity, 32*(6), 1008-1015. doi: 10.1038/ijo.2008.15

Mazur, A. (1986). U.S. trends in feminine beauty and overadaptation. *Journal of Sex Research, 22*(3), 281-303.

McCabe, M. P., Ricciardelli, L. A., Sitaram, G., & Mikhail, K. (2006). Accuracy of body size estimation: Role of biopsychosocial variables. *Body Image, 3*(2), 163-171. doi: 10.1016/j.bodyim.2006.01.004

McCarthy, H. D., & Ashwell, M. (2006). A study of central fatness using waist-to-height ratios in UK children and adolescents over two decades supports the simple message - 'keep your waist circumference to less than half your height'. *International Journal of Obesity, 30*(6), 988-992. doi: 10.1038/sj.ijo.0803226

Miller, K. K., Grinspoon, S. K., Ciampa, J., Hier, J., Herzog, D., & Klibanski, A. (2005). Medical findings in outpatients with anorexia nervosa. *Archives of Internal Medicine, 165*(5), 561-566. doi: 10.1001/archinte.165.5.561

Mischner, I. H. S., van Schie, H. T., Wigboldus, D. H. J., van Baaren, R. B., & Engels, R. (2013). Thinking big: The effect of sexually objectifying music videos on bodily self-perception in young women. *Body Image, 10*(1), 26-34. doi: 10.1016/j.bodyim.2012.08.004

Mokdad, A. H., Bowman, B. A., Ford, E. S., Vinicor, F., Marks, J. S., & Koplan, J. P. (2001). The continuing epidemics of obesity and diabetes in the United States. *Jama-Journal of the American Medical Association, 286*(10), 1195-1200. doi: 10.1001/jama.286.10.1195

Mutz, D. C. (1998). *Impersonal influence: How perceptions of mass collectives affect political attitudes*. New York: Cambridge University Press.

Mvo, Z., Dick, J., & Steyn, K. (1999). Perceptions of overweight African women about acceptable body size of women and children. *Curationis, 22*(2), 27-31.

Nelson, L. D., & Morrison, E. L. (2005). The symptoms of resource scarcity - Judgments of food and finances influence preferences for potential partners. *Psychological Science, 16*(2), 167-173. doi: 10.1111/j.0956-7976.2005.00798.x

Nelson, L. D., Pettijohn, T. E., & Galak, J. (2007). Mate preferece in social cognitive context: When environmental and personal change leads to predictable cross-cultural variation. *The Body Beautiful: Evolutionary and Sociocultural perspectives.* . New York: Palgrave Macmillan.

Nelson, M. E., Fiatarone, M. A., Layne, J. E., Trice, I., Economos, C. D., Fielding, R. A., . . . Evans, W. J. (1996). Analysis of body-composition techniques and models for detecting change in soft tissue with strength training. *American Journal of Clinical Nutrition, 63*(5), 678-686.

NHS. (2014). Live well: What's your BMI? . *Your Health, Your Choice.* Retrieved 25 Sept, 2015, from

http://www.nhs.uk/LiveWell/loseweight/Pages/BodyMassIndex.aspx

Nielsen, S., Guo, Z., Johnson, M. C., Hensrud, D. D., & Jensen, M. D. (2004). Splanchnic lipolysis in human obesity. *The Journal of Clinical Investigation, 113*(11), 1582-1588.

Noles, S. W., Cash, T. F., & Winstead, B. A. (1985). Body-image, physical attractiveness, and depression *Journal of Consulting and Clinical Psychology, 53*(1), 88-94. doi: 10.1037//0022-006x.53.1.88

Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *Jama-Journal of the American Medical Association, 295*(13), 1549-1555. doi: 10.1001/jama.295.13.1549

Osman, A., Kopper, B. A., Barrios, F., Gutierrez, P. M., & Bagge, C. L. (2004).
Reliability and validity of the Beck Depression Inventory-II with adolescent
psychiatric inpatients. *Psychological Assessment, 16*(2), 120-132. doi:
10.1037/1040-3590.16.2.120

Park, B. (1986). A method for studying the development of impressions of real people
Journal of Personality and Social Psychology, 51(5), 907-917. doi:
10.1037//0022-3514.51.5.907

Park, S. Y. (2005). The influence of presumed media influence on women's desire to be
thin. *Communication Research, 32*(5), 594-614. doi:
10.1177/0093650505279350

Pasquali, R. (2006). Obesity, fat distribution and infertility. *Maturitas, 54*(4), 363-371.
doi: 10.1016/j.maturitas.2006.04.018

Penton-Voak, I. S., Bate, H., Lewis, G., & Munafo, M. R. (2012). Effects of emotion
perception training on mood in undergraduate students: randomised controlled
trial. *British Journal of Psychiatry, 201*(1), 71-72. doi:
10.1192/bjp.bp.111.107086

Penton-Voak, I. S., Cooper, R. M., Roberts, R. E., Attwood, A. S., & Munafo, M. R.
(2012). Effects of acute alcohol consumption on the perception of eye gaze
direction. *Journal of Psychopharmacology, 26*(2), 254-261. doi:
10.1177/0269881110385599

Pettijohn, T. E., & Tesser, A. (1999). Popularity in Environmental Context: Facial
Feature Assessment of American Movie Actresses. *Media Psychology, 1*(3),
229-247.

Pettijohn, T. E., & Tesser, A. (2005). Threat and social choice: When eye size matters. *Journal of Social Psychology, 145*(5), 547-570. doi: 10.3200/socp.145.5.547-570

Pettijohn, T. F., & Jungeberg, B. J. (2004). Playboy Playmate curves: Changes in facial and body feature preferences across social and economic conditions. *Personality and Social Psychology Bulletin, 30*(9), 1186-1197. doi: 10.1177/0146167204264078

Pirwany, I. R., Fleming, R., Sattar, N., Greer, I. A., & Wallace, A. M. (2001). Circulating leptin concentrations and ovarian function in polycystic ovary syndrome. *European Journal of Endocrinology, 145*(3), 289-294. doi: 10.1530/eje.0.1450289

Pontzer, H. (2007). Effective limb length and the scaling of locomotor cost in terrestrial animals. *Journal of Experimental Biology, 210*(10), 1752-1761. doi: 10.1242/jeb.002246

Posavac, H. D., Posavac, S. S., & Posavac, E. J. (1998). Exposure to media images of female attractiveness and concern with body weight among young women. *Sex Roles, 38*(3-4), 187-201. doi: 10.1023/a:1018729015490

Poulton, E. C. (1989). Uncertain size of exponent when judging without familiar units *Behavioral and Brain Sciences, 12*(2), 286-288.

Power, C., Lake, J. K., & Cole, T. J. (1997). Measurement and long-term health risks of child and adolescent fatness. *International Journal of Obesity, 21*(7), 507-526. doi: 10.1038/sj.ijo.0800454

Power, M. L., & Schulkin, J. (2008). Sex differences in fat storage, fat metabolism, and the health risks from obesity: possible evolutionary origins. *British Journal of Nutrition, 99*(5), 931-940. doi: 10.1017/s0007114507853347

Price, M. E., Pound, N., Dunn, J., Hopkins, S., & Kang, J. S. (2013). Body Shape

Preferences: Associations with Rater Body Shape and Sociosexuality. *Plos One,

8*(1). doi: 10.1371/journal.pone.0052532

Puhl, R. M., & Boland, F. J. (2001). Predicting female physical attractiveness: Waist-to-

hip ratio versus thinness. *Psychology, Evolution & Gender, 3*(1), 27-46.

Pyeritz, R. E. (2000). The Marfan syndrome. *Annual Review of Medicine, 51*, 481-510.

doi: 10.1146/annurev.med.51.1.481

Rankinen, T., Kim, S. Y., Perusse, L., Despres, J. P., & Bouchard, C. (1999). The

prediction of abdominal visceral fat level from body composition and

anthropometry: ROC analysis. *International Journal of Obesity, 23*(8), 801-809.

doi: 10.1038/sj.ijo.0800929

Reid, R. L., & van Vugt, D. A. (1987). Weight-related changes in reproductive function.

Fertility and Sterility, 48(6), 905-913.

Resnick, H. E., Valsania, P., Halter, J. B., & Lin, X. H. (2000). Relation of weight gain

and weight loss on subsequent diabetes risk in overweight adults. *Journal of

Epidemiology and Community Health, 54*(8), 596-602. doi:

10.1136/jech.54.8.596

Ricciardelli, L. A., McCabe, M. P., Lillis, J., & Thomas, K. (2006). A longitudinal

investigation of the development of weight and muscle concerns among

preadolescent boys. *Journal of Youth and Adolescence, 35*(2), 177-187. doi:

10.1007/s10964-005-9004-7

Rilling, J. K., Kaufman, T. L., Smith, E. O., Patel, R., & Worthman, C. M. (2009).

Abdominal depth and waist circumference as influential determinants of human

female attractiveness. *Evolution and Human Behavior, 30*(1), 21-31. doi:

10.1016/j.evolhumbehav.2008.08.007

Rivadeneyra, R., Ward, L. M., & Gordon, M. (2007). Distorted reflections: Media exposure and Latino adolescents' conceptions of self. *Media Psychology, 9*(2), 261-290.

Roberto, C. A., Steinglass, J., Mayer, L. E. S., Attia, E., & Walsh, B. T. (2008). The clinical significance criterion for of amenorrhea as a diagnostic anorexia nervosa. *International Journal of Eating Disorders, 41*(6), 559-563. doi: 10.1002/eat.20534

Robinson, E., & Kirkham, T. C. (2014). Is he a healthy weight? Exposure to obesity changes perception of the weight status of others. *International Journal of Obesity, 38*(5), 663-667. doi: 10.1038/ijo.2013.154

Robinson, S. A., Webb, J. B., & Butler-Ajibade, P. T. (2012). Body Image and Modifiable Weight Control Behaviors Among Black Females: A Review of the Literature. *Obesity, 20*(2), 241-252. doi: 10.1038/oby.2011.54

Romero-Corral, A., Somers, V. K., Sierra-Johnson, J., Thomas, R. J., Collazo-Clavell, M. L., Korinek, J., . . . Lopez-Jimenez, F. (2008). Accuracy of body mass index in diagnosing obesity in the adult general population. *International Journal of Obesity, 32*(6), 959-966. doi: 10.1038/ijo.2008.11

Rosen, A. (1997). Crisis management in the community. *Medical Journal of Australia, 167*(11-12), 633-638.

Rosenberg, M. (1979). *Conceiving the Self* (Eds. ed.). New York: Basic Books.

Rush, E. C., Freitas, I., & Plank, L. D. (2009). Body size, body composition and fat distribution: comparative analysis of European, Maori, Pacific Island and Asian Indian adults. *British Journal of Nutrition, 102*(4), 632-641. doi: 10.1017/s0007114508207221

Salska, I., Frederick, D. A., Pawlowski, B., Reilly, A. H., Laird, K. T., & Rudd, N. A. (2008). Conditional mate preferences: Factors influencing preferences for height. *Personality and Individual Differences, 44*(1), 203-215. doi: 10.1016/j.paid.2007.08.008

Savva, S. C., Tornaritis, M., Savva, M. E., Kourides, Y., Panagi, A., Silikiotou, N., . . . Kafatos, A. (2000). Waist circumference and waist-to-height ratio are better predictors of cardiovascular disease risk factors in children than body mass index. *International Journal of Obesity, 24*(11), 1453-1458. doi: 10.1038/sj.ijo.0801401

Schwartz, N. (1990). Feelings as information: Informational and motivational functions of affective states. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behaviour* (Vol. 2, pp. 527-561). New York: Guilford Press.

Sell, A., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C., & 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*, 575-584.

Shafran, R., & Fairburn, C. G. (2002). A new ecologically valid method to assess body size estimation and body size dissatisfaction. *International Journal of Eating Disorders, 32*(4), 458-465. doi: 10.1002/eat.10097

Shah, N. R., & Braverman, E. R. (2012). Measuring Adiposity in Patients: The Utility of Body Mass Index (BMI), Percent Body Fat, and Leptin. *Plos One, 7*(4). doi: 10.1371/journal.pone.0033308

Shaw, H., & Stice, E. (2002). Body image, eating disorders, and obesity in youth: Assessment, prevention, and treatment. *Contemporary Psychology-Apa Review of Books, 47*(5), 519-520.

Singh, D. (1993a). Adaptive significance of female physical attractiveness- role of waist-to-hip ratio. *Journal of Personality and Social Psychology, 65*(2), 293-307. doi: 10.1037/0022-3514.65.2.293

Singh, D. (1993b). Body shape and women's attractiveness- the critical role of waist- to-hip ratio *Human Nature-an Interdisciplinary Biosocial Perspective, 4*(3), 297-321. doi: 10.1007/bf02692203

Singh, D. (1994). Ideal female body shape- Role of body weight and waist-to-hip ratio. *International Journal of Eating Disorders, 16*(3), 283-288. doi: 10.1002/1098-108x(199411)16:3<283::aid-eat2260160309>3.0.co;2-q

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*, 81-91.

Singh, D., Dixson, B. J., Jessop, T. S., Morgan, B., & Dixson, A. F. (2010). Cross-cultural consensus for waist-hip ratio and women's attractiveness. *Evolution and Human Behavior, 31*(3), 176-181. doi: 10.1016/j.evolhumbehav.2009.09.001

Singh, D., & Luis, S. (1995). Ethnic and gender consensus for the effect of waist-to-hip ratio on judgment of women's attractiveness *Human Nature-an Interdisciplinary Biosocial Perspective, 6*(1), 51-65. doi: 10.1007/bf02734135

Singh, D., & Singh, D. (2011). Shape and Significance of Feminine Beauty: An Evolutionary Perspective. *Sex Roles, 64*(9-10), 723-731. doi: 10.1007/s11199-011-9938-z

Singh, D., & 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), 483-507. doi: 10.1016/0162-3095(95)00074-7

Skrzypek, S., Wehmeier, P. M., & Remschmidt, H. (2001). Body image assessment using body size estimation in recent studies on anorexia nervosa. A brief review. *European Child & Adolescent Psychiatry, 10*(4), 215-221.

Slade, P. D., & Russell, G. F. M. (1973). Awareness of body dimensions in Anorexia Nervosa: cross- sectional and longitudinal studies *Psychological Medicine, 3*(2), 188-199.

Smeets, M. A. M., Smit, F., Panhuysen, G. E. M., & Ingleby, J. D. (1998). Body perception index: Benefits, pitfalls, ideas. *Journal of Psychosomatic Research, 44*(3-4), 457-464. doi: 10.1016/s0022-3999(97)00142-6

Smith, G. D., Greenwood, R., Gunnell, D., Sweetnam, P., Yarnell, J., & Elwood, P. (2001). Leg length, insulin resistance, and coronary heart disease risk: The Caerphilly Study. *Journal of Epidemiology and Community Health, 55*(12), 867-872.

Smith, K. L., Tovée, M. J., Hancock, P. J. B., Bateson, M., Cox, M. A. A., & Cornelissen, P. L. (2007). 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), 927-953. doi: 10.1080/13506280601029515

Sobal, J., & Stunkard, A. J. (1989). Socioeconomic-status and Obesity- A review of the literature *Psychological Bulletin, 105*(2), 260-275. doi: 10.1037/0033-2909.105.2.260

Sorokowski, P., & Pawlowski, B. (2008). Adaptive preferences for leg length in a

    potential partner. *Evolution and Human Behavior, 29*(2), 86-91. doi:

    10.1016/j.evolhumbehav.2007.09.002

Steiger, H., Fraenkel, L., & Leichner, P. P. (1989). Relationship of body-image

    distortion to sex-role identifications, irrational cognitions, and body-weight in

    eating-disordered females. *Journal of Clinical Psychology, 45*(1), 61-65. doi:

    10.1002/1097-4679(198901)45:1<61::aid-jclp2270450108>3.0.co;2-d

Stepper, S., & Strack, F. (1993). Proprioceptive determinants of Emotional and

    Nonemotional feelings. *Journal of Personality and Social Psychology, 64*(2),

    211-220. doi: 10.1037//0022-3514.64.2.211

Stice, E., Hayward, C., Cameron, R. P., Killen, J. D., & Taylor, C. B. (2000). Body-

    image and eating disturbances predict onset of depression among female

    adolescents: A longitudinal study [Press release]

Stice, E., & Shaw, H. E. (1994). Adverse-effects of the media portrayed thin-ideal on

    women and linkages to Bulimia symptomology. *Journal of Social and Clinical*

    Psychology, 13(3), 288-308. doi: 10.1521/jscp.1994.13.3.288

Streeter, S. A., & McBurney, D. H. (2003). Waist-hip ratio and attractiveness- New

    evidence and a critique of "a critical test". *Evolution and Human Behavior,*

    24(2), 88-98.

Sugiyama, L. S. (2004). Is beauty in the context-sensitive adaptations of the beholder?

    Shiwiar use of waist-to-hip ratio in assessments of female mate value. *Evolution*

    and Human Behavior, 25(1), 51-62. doi: 10.1016/s1090-5138(03)00083-7

Swami, V., Antonakopoulos, N., Tovée, M. J., & Furnham, A. (2006). A critical test of

    the waist-to-hip ratio hypothesis of women's physical attractiveness in Britain

    and Greece. *Sex Roles, 54*(3-4), 201-211. doi: 10.1007/s11199-006-9338-3

Swami, V., Caprario, C., Tovée, M. J., & Furnham, A. (2006). Female physical

attractiveness in Britain and Japan: A cross-cultural study. *European Journal of

Personality, 20*(1), 69-81. doi: 10.1002/per.568

Swami, V., Einon, D., & Furnham, A. (2006). The leg-to-body ratio as a human

aesthetic criterion. *Body Image, 3*(4), 317-323. doi:

10.1016/j.bodyim.2006.08.003

Swami, V., Einon, D., & Furnham, A. (2007). Cultural significance of leg-to-body ratio

preferences? Evidence from Britain and rural Malaysia. *Asian Journal of Social

Psychology, 10*(4), 265-269. doi: 10.1111/j.1467-839X.2007.00235.x

Swami, V., Frederick, D. A., Aavik, T., Alcalay, L., Allik, J., Anderson, D., . . . Zivcic-

Becirevic, I. (2009). The Attractive Female Body Weight and Female Body

Dissatisfaction in 26 Countries Across 10 Wold Regions: Results of the

International Body Project 1. *Personality and Social Psychology Bulletin, 36*(3),

309-325.

Swami, V., & Furnham, A. (2008). *The Psychology of Physical Attraction*. East Sussex:

Routledge.

Swami, V., Henderson, G., Custance, D., & Tovée, M. J. (2011). A Cross-Cultural

Investigation of Men's Judgments of Female Body Weight in Britain and

Indonesia. *Journal of Cross-Cultural Psychology, 42*(1), 140-145. doi:

10.1177/0022022110383319

Swami, V., Jones, J., Einon, D., & Furnham, A. (2009). Men's preferences for women's

profile waist-to-hip ratio, breast size, and ethnic group in Britain and South

Africa. *British Journal of Psychology, 100*, 313-325. doi:

10.1348/000712608x329525

225

Swami, V., Knight, D., Tovée, M. J., Davies, P., & Furnham, A. (2007). Preferences for female body size in Britain and the South Pacific. *Body Image, 4*(2), 219-223. doi: 10.1016/j.bodyim.2007.01.002

Swami, V., Miller, R., Furnham, A., Penke, L., & Tovée, M. J. (2008). The influence of men's sexual strategies on perceptions of women's bodily attractiveness, health and fertility. *Personality and Individual Differences, 44*(1), 98-107. doi: 10.1016/j.paid.2007.07.017

Swami, V., Neto, F., Tovée, M. J., & Furnham, A. (2007). Preferences for female body weight and shape in three European countries. *European Psychologist, 12*(3), 220-228. doi: 10.1027/1016-9040.12.3.220

Swami, V., Poulogianni, K., & Furnham, A. (2006). The influence of resource availability on preferences for human body weight and non-human objects. *Journal of Articles in Support of the Null Hypothesis, 4*(1), 17-28.

Swami, V., Smith, J., Tsiokris, A., Georgiades, C., Sangareau, Y., Tovée, M. J., & Furnham, A. (2007). Male physical attractiveness in Britain and Greece: A cross-cultural study. *Journal of Social Psychology, 147*(1), 15-26. doi: 10.3200/socp.147.1.15-26

Swami, V., & Tovée, M. J. (2005). Female physical attractiveness in Britain and Malaysia: A cross-cultural study. *Body Image 2*, 115-128.

Swami, V., & Tovée, M. J. (2006). Does hunger influence judgments of female physical attractiveness? *British Journal of Psychology, 97*, 353-363. doi: 10.1348/000712605x80713

Swami, V., & 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*(4), 391-396. doi: 10.1016/j.bodyim.2007.07.002

226

Swami, V., & Tovée, M. J. (2012). The Impact of Psychological Stress on Men's Judgements of Female Body Size. *Plos One, 7*(8). doi: 10.1371/journal.pone.0042593

Swami, V., & Tovée, M. J. (2013). Resource Security Impacts Men's Female Breast Size Preferences. *Plos One, 8*(3). doi: 10.1371/journal.pone.0057623

Swami, V., Tovée, M. J., & Furnham, A. (2009). Does financial security influence judgments of female physical attractiveness? *The Journal of Socio-Economics, 37*, 1363-1370.

Swinburn, B. A., Sacks, G., Hall, K. D., McPherson, K., Finegood, D. T., Moodie, M. L., & Gortmaker, S. L. (2011). Obesity 1. The global obesity pandemic: shaped by global drivers and local environments. *Lancet, 378*(9793), 804-814.

Symons, D. (1995). Beauty is in the Adaptations of the Beholder: The Evolutionary Psychology of Human Female Sexual Attractiveness In P. R. Abramson & S. D. Pinkerton (Eds.), *Sexual Nature Sexual Culture* (pp. 80-121). Chicago: The University of Chicago Press.

Taylor, R. W., Keil, D., Gold, E. J., Williams, S. M., & Goulding, A. (1998). Body mass index, waist girth, and waist-to-hip ratio as indexes of total and regional adiposity in women: evaluation using receiver operating characteristic curves. *American Journal of Clinical Nutrition, 67*(1), 44-49.

Thompson, D. L., Thompson, W. R., Prestridge, T. J., Bailey, J. G., Bean, M. H., Brown, S. P., & McDaniel, J. B. (1991). Effects of hydration and dehydration on body composition analysis: a comparative study of bioelectric impedance analysis and hydrodensitometry. *Journal of Sports Medicine and Physical Fitness, 31*(4), 565-570.

Thomsen, S. R., McCoy, J. K., Gustafson, R. L., & Williams, M. (2002). Motivations
for reading beauty and fashion magazines and anorexic risk in college-age
women. *Media Psychology, 4*(2), 113-135. doi: 10.1207/s1532785xmep0402_01

Thomsen, S. T. (2002). Health and beauty magazine reading and body shape concerns
among a group of college women. *Journalism & Mass Communication
Quarterly, 79*(4), 988-1007.

Thornhill, R., & Grammer, K. (1999). The body and face of woman: One ornament that
signals quality? *Evolution and Human Behavior, 20*(2), 105-120. doi:
10.1016/s1090-5138(98)00044-0

Tiggemann, M., & Pickering, A. S. (1996). Role of television in adolescent women's
body dissatisfaction and drive for thinness. *International Journal of Eating
Disorders, 20*(2), 199-203. doi: 10.1002/(sici)1098-108x(199609)20:2<199::aid-
eat11>3.0.co;2-z

Tiggemann, M., & Slater, A. (2004). Thin ideals in music television: A source of social
comparison and body dissatisfaction. *International Journal of Eating Disorders,
35*(1), 48-58. doi: 10.1002/eat.10214

Timerman, F., Scagliusi, F. B., & Cordas, T. A. (2010). Longitudinal assessment of
body image disturbances in patients with bulimia nervosa submitted to
multidisciplinary treatment. *Revista De Psiquiatria Clinica, 37*(3), 113-117. doi:
10.1590/s0101-60832010000300004

Tovée, M. J. (2012). Anthropometry. *Encyclopedia of Body Image and Human
Appearance, 1*, 23-29.

Tovée, M. J., Benson, P. J., Emery, J. L., Mason, S. M., & 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*, 501-516. doi: 10.1348/000712603322503060

Tovée, M. J., & Cornelissen, P. L. (1999). The mystery of female beauty. *Nature, 399*(6733), 215-216. doi: 10.1038/20345

Tovée, M. J., & Cornelissen, P. L. (2001). Female and male perceptions of female physical attractiveness in front-view and profile. *British Journal of Psychology, 92*, 391-402. doi: 10.1348/000712601162257

Tovée, M. J., Edmonds, L., & Vuong, Q. C. (2012). Categorical perception of human female physical attractiveness and health. *Evolution and Human Behavior, 33*(2), 85-93. doi: 10.1016/j.evolhumbehav.2011.05.008

Tovée, M. J., Emery, J. L., & Cohen-Tovée, 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), 1987-1997.

Tovée, M. J., Hancock, P. J. B., Mahmoodi, S., Singleton, B. R. R., & Cornelissen, P. L. (2002). Human female attractiveness: waveform analysis of body shape. *Proceedings of the Royal Society B-Biological Sciences, 269*(1506), 2205-2213. doi: 10.1098/rspb.2002.2133

Tovée, M. J., Maisey, D. S., Emery, J. L., & Cornelissen, P. L. (1999). Visual cues to female physical attractiveness. *Proceedings of the Royal Society B-Biological Sciences, 266*(1415), 211-218.

Tovée, M. J., Mason, S. M., Emery, J. L., McCluskey, S. E., & Cohen-Tovée, E. M. (1997). Supermodels: stick insects or hourglasses? *Lancet, 350*(9089), 1474-1475. doi: 10.1016/s0140-6736(05)64238-9

Tovée, M. J., Reinhardt, S., Emery, J. L., & Cornelissen, P. L. (1998). Optimum body-mass index and maximum sexual attractiveness. *Lancet, 352*(9127), 548-548. doi: 10.1016/s0140-6736(05)79257-6

Tovée, M. J., Swami, V., Furnham, A., & Mangalparsad, R. (2006). Changing perceptions of attractiveness as observers are exposed to a different culture. *Evolution and Human Behavior, 27*(6), 443-456. doi: 10.1016/j.evolhumbehav.2006.05.004

Treloar, C., Porteous, J., Hassan, F., Kasniyah, N., Lakshmanudu, M., Sama, M., . . . Heller, R. F. (1999). The cross cultural context of obesity: an INCLEN multicentre collaborative study. *Health & Place, 5*(4), 279-286. doi: 10.1016/s1353-8292(99)00018-0

Truesdale, K. P., & Stevens, J. (2008). Do the obese know they are obese? *North Carolina medical journal, 69*(3), 188-194.

Tucci, S., & Peters, J. (2008). Media influences on body satisfaction in female students. *Psicothema, 20*(4), 521-524.

van den Berg, P. A., Mond, J., Eisenberg, M., Ackard, D., & Neumark-Sztainer, D. (2010). The Link Between Body Dissatisfaction and Self-Esteem in Adolescents: Similarities Across Gender, Age, Weight Status, Race/Ethnicity, and Socioeconomic Status. *Journal of Adolescent Health, 47*(3), 290-296. doi: 10.1016/j.jadohealth.2010.02.004

Voracek, M., & Fisher, M. L. (2002). Shapely centrefolds? Temporal change in body measures: trend analysis. *British Medical Journal, 325*(7378), 1447-1448. doi: 10.1136/bmj.325.7378.1447

Voracek, M., & Fisher, M. L. (2006). Success is all in the measures: Androgenousness, curvaceousness, and starring frequencies in adult media actresses. *Archives of Sexual Behavior, 35*(3), 297-304. doi: 10.1007/s10508-006-9021-y

Wadsworth, M. E. J., Hardy, R. J., Paul, A. A., Marshall, S. F., & Cole, T. J. (2002). Leg and trunk length at 43 years in relation to childhood health, diet and family circumstances; evidence from the 1946 national birth cohort. *International Journal of Epidemiology, 31*(2), 383-390. doi: 10.1093/ije/31.2.383

Wagner, D. R., & Heyward, V. H. (1999). Techniques of body composition assessment: A review of laboratory and field methods. *Research Quarterly for Exercise and Sport, 70*(2), 135-149.

Waldenstrom, U., Wass, P., Rossner, S., & Hellberg, D. (1997). Women with a high waist:hip ratio have lower pregnancy rates with NF. *Human Reproduction, 12*, R120-R120.

Wang, J. X., Davies, M., & Norman, R. J. (2000). Body mass and probability of pregnancy during assisted reproduction treatment: retrospective study. *British Medical Journal, 321*(7272), 1320-1321. doi: 10.1136/bmj.321.7272.1320

Wass, P., Waldenstrom, U., Rossner, S., & Hellberg, D. (1997). An android body fat distribution in females impairs the pregnancy rate of in-vitro fertilization-embryo transfer. *Human Reproduction, 12*(9), 2057-2060. doi: 10.1093/humrep/12.9.2057

Watts, K., Naylor, L. H., Davis, E. A., Jones, T. W., Beeson, B., Bettenay, F., . . . Green, D. J. (2006). Do skinfolds accurately assess changes in body fat in obese children and adolescents? *Medicine and Science in Sports and Exercise, 38*(3), 439-444.

Webster, J., & Tiggemann, M. (2003). The relationship between women's body satisfaction and self-image across the life span: The role of cognitive control. *Journal of Genetic Psychology, 164*(2), 241-252.

Weeden, J., & Sabini, J. (2005). Physical attractiveness and health in western societies: A review. *Psychological Bulletin, 131*(5), 635-653. doi: 10.1037/0033-2909.131.5.635

Wetmore, C. M., & Mokdad, A. H. (2012). In denial: Misperceptions of weight change among adults in the United States. *Preventive Medicine, 55*(2), 93-100. doi: 10.1016/j.ypmed.2012.04.019

Wetsman, A., & Marlowe, F. W. (1999). How universal are preferences for female waist-to-hip ratios? Evidence from the Hadza of Tanzania. *Evolution and Human Behavior, 20*(4), 219-228. doi: 10.1016/s1090-5138(99)00007-0

WHO, W. H. O.-. (1995). The World Health Report 1995: Bridging the Gaps. Geneva.

Wickramasinghe, V. P., Lamabadusuriay, S. P., Cleghorn, G. J., & Davies, P. S. (2008). Use of skin-fold thickness in Sri Lankan children: Comparison of several prediction equations. *Indian Journal of Pediatrics, 75*(12), 1237-1242. doi: 10.1007/s12098-008-0227-y

Wiederman, M. W., & Dubois, S. L. (1998). Evolution and sex differences in preferences for short-term mates: Results from a policy capturing study. *Evolution and Human Behavior, 19*(3), 153-170. doi: 10.1016/s1090-5138(98)00006-3

Wilkinson, J. Y., Ben-Tovim, D. I., & Walker, M. K. (1994). An insight into the personal and cultural significance of weight and shape in large Samoan women. *International Journal of Obesity, 18*(9), 602-606.

Willett, 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. *Jama-Journal of the American Medical Association, 273*(6), 461-465. doi: 10.1001/jama.273.6.461

Williamson, D. A., Cubic, B. A., & Gleaves, D. H. (1993). Equivalence of body-image disturbances in Anorexia and Bulimia Nervosa *Journal of Abnormal Psychology, 102*(1), 177-180. doi: 10.1037//0021-843x.102.1.177

Winkler, C., & Rhodes, G. (2005). Perceptual adaptation affects attractiveness of female bodies. *British Journal of Psychology, 96*, 141-154. doi: 10.1348/000712605x36343

Wright, A., & Pritchard, M. E. (2009). An examination of the relation of gender, mass media influence, and loneliness to disordered eating among college students. *Eating and Weight Disorders-Studies on Anorexia Bulimia and Obesity, 14*(2-3), E144-E147.

Yu, D. W., & Shepard, G. H. (1998). Is beauty in the eye of the beholder? *Nature, 396*(6709), 321-322. doi: 10.1038/24512

Yu, D. W., & Shepard, G. H. (1999). The mystery of female beauty - Reply. *Nature, 399*(6733), 216-216. doi: 10.1038/20348

Zaadstra, B. M., Seidell, J. C., Vannoord, P. A. H., Tevelde, E. R., Habbema, J. D. F., Vrieswijk, B., & Karbaat, J. (1993). Fat and Female Fecundity - Prospective - Study of effect of body-fat distribution on conception rates. . *British Medical Journal, 306*(6876), 484-487.

Zahavi, A. (1975). Mate Selection - Selection for a Handicap. *Journal of Theoretical Biology, 53*(1), 205-214. doi: 10.1016/0022-5193(75)90111-3

Zandstra, E. H., & El-Deredy, W. (2011). Effects of energy conditioning on food preferences and choice. *Appetite, 57*(1), 45-49. doi: 10.1016/j.appet.2011.03.007

Appendices

Age _____

Gender   Male/Female

Estimated Height _____

Estimated Weight _____

Are you currently dieting?   Yes/ No

If so, how long have you been dieting for? (weeks) _____

Estimate your average calorie intake per day _____

At this moment in time, on a scale of 0-10, how hungry are you?
(Please mark an "x" on the line below, 0= not hungry at all, 10= extremely hungry).

0   10

          _____

       You will now be shown a series of 50 female bodies followed by a series of 50 male bodies. You will only be shown each body for a short period of time (approximately 5 seconds) therefore please make sure you pay attention at all times. You will be given a short break in which to rest after each 25 bodies.

       After viewing the body for 5 seconds you will be given a further 5 seconds in which to record your rating for that body if you have not already done so. You are asked to make a rating from 0-10 on two scales: attractiveness and body size. 0 represents a thinner body or a less attractive body, while 10 represents a larger body or a less attractive body. Your ratings can differ on both of these scales for each body.

pto.

FEMALE BODIES

Please mark your estimations of body size and attractiveness on the lines below with a cross (0= low body size and attractiveness, 10= high body size and attractiveness).

IMAGE 1
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 2
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 3
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 4
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 5
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 6

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 7

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 8

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 9

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 10

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 11

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 12

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 13

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 14

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 15

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 16

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 17

Body Size

0 _____ 10

Attractiveness

0 _____ 10

IMAGE 18

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 19

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 20

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 21

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 22

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 23

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 24

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 25

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 26

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 27

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 28

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 29

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 30
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 31
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 32
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 33
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 34
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 35
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 36

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 37

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 38

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 39

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 40

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 41

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 42

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 43

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 44

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 45

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 46

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 47

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 48

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 49

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 50

Body Size

0   10

_____

Attractiveness

0   10

_____

MALE BODIES

Please mark your estimations of body size and attractiveness on the lines below with a cross (0= low body size and attractiveness, 10= high body size and attractiveness).

IMAGE 1
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 2
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 3
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 4
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 5
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 6
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 7
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 8
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 9
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 10
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 11
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 12
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 13
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 14
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 15
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 16
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 17
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 18
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 19
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 20
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 21
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 22
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 23
Body Size
0   10

_____

Attractiveness
0   10

_____

IMAGE 24

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 25

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 26

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 27

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 28

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 29

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 30

Body Size

0
10

_____

Attractiveness

0
10

_____

IMAGE 31

Body Size

0
10

_____

Attractiveness

0
10

_____

IMAGE 32

Body Size

0
10

_____

Attractiveness

0
10

_____

IMAGE 33

Body Size

0
10

_____

Attractiveness

0
10

_____

IMAGE 34

Body Size

0
10

_____

Attractiveness

0
10

_____

IMAGE 35

Body Size

0
10

_____

Attractiveness

0
10

_____

IMAGE 36

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 37

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 38

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 39

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 40

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 41

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 42

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 43

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 44

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 45

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 46

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 47

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 48

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 49

Body Size

0   10

_____

Attractiveness

0   10

_____

IMAGE 50

Body Size

0   10

_____

Attractiveness

0   10

_____

Appendix B

Honesty Declaration

The purpose of this document is to establish whether or not you have followed the protocol for fasting outlined in the instructions given to you on advertisement of this study. The protocol was as follows:

1. No food to be consumed after 8pm last night until you completed the study this morning.

2. The only liquid to be consumed: water (specifically no alcohol).

3. No tanking up on water (drinking a larger amount than usual in order to feel full) as a substitute for lack food.

Your response here will in no way affect the way you are treated following participation in this study. However, if you cannot honestly sign this form, please let the experimenter know now, and your participation can be rearranged for an alternative date when you have adhered to the procedures necessary for participation.

I _____ honestly declare that, to my knowledge, I have followed the exact protocol stated above.

Participant Signature:

_____

Researcher Signature:

_____

Appendix C

Measurements of the bodies manipulated in waist width- 5 different waist widths at each of the 5 torso lengths.

Manipulation	Torso Length (pixels)	Height (cm)	Weight (kg)	Waist (cm)	Hips (cm)	BMI	WHR
WW	296	164	49.17	57.59	106.52	18.19	0.53
WW	296	164	49.68	60.83	102.19	18.28	0.54
WW	296	164	49.42	59.25	102.11	18.37	0.58
WW	296	164	48.92	55.86	104.62	18.47	0.60
WW	296	164	49.84	62.34	102.24	18.53	0.61
WW	303	164	48.20	55.45	108.49	17.92	0.51
WW	303	164	48.74	58.81	111.72	18.02	0.56
WW	303	164	49.28	61.88	101.32	18.12	0.53
WW	303	164	48.48	57.17	101.39	18.23	0.58
WW	303	164	49.03	60.39	103.76	18.32	0.61
WW	309	164	48.19	58.38	100.60	17.72	0.54
WW	309	164	48.42	59.95	104.30	17.82	0.56
WW	309	164	47.93	56.75	100.66	17.92	0.58
WW	309	164	47.65	55.04	101.52	18.00	0.57
WW	309	164	48.63	61.43	108.47	18.08	0.57
WW	320	164	47.28	56.33	95.07	17.50	0.55
WW	320	164	47.07	54.64	99.76	17.58	0.59
WW	320	164	47.85	59.51	99.78	17.69	0.58
WW	320	164	48.07	60.99	99.82	17.79	0.60
WW	320	164	47.59	57.96	99.68	17.87	0.61
WW	324	164	46.65	55.93	106.37	17.28	0.55
WW	324	164	46.48	54.25	98.68	17.34	0.53
WW	324	164	47.48	60.55	98.72	17.46	0.58
WW	324	164	47.26	59.08	104.49	17.57	0.57
WW	324	164	46.97	57.54	98.95	17.65	0.61

Appendix D

Measurements for the bodies that were manipulated in size- 5 different body sizes at each of the 5 torso lengths.

Manipulation	Torso Length (pixels)	Height (cm)	Weight (kg)	Waist (cm)	Hips (cm)	BMI	WHR
BS	296	164	46.98	57.71	98.63	17.47	0.62
BS	296	164	59.91	70.29	112.64	18.37	0.62
BS	296	164	49.42	59.25	112.17	20.27	0.64
BS	296	164	54.52	64.81	115.10	22.27	0.66
BS	296	164	65.63	75.59	118.82	24.40	0.68
BS	303	164	48.79	58.81	101.27	17.26	0.62
BS	303	164	59.17	69.77	112.48	18.14	0.62
BS	303	164	64.82	75.03	118.16	20.02	0.64
BS	303	164	46.41	57.29	105.74	22.00	0.66
BS	303	164	53.84	64.34	114.03	24.10	0.68
BS	309	164	63.93	74.48	112.37	17.03	0.62
BS	309	164	58.46	69.26	111.58	17.92	0.62
BS	309	164	48.19	58.38	100.50	19.75	0.64
BS	309	164	53.11	63.87	108.34	21.74	0.66
BS	309	164	45.81	56.88	104.43	23.77	0.68
BS	320	164	47.52	57.96	105.65	16.83	0.62
BS	320	164	52.52	63.40	105.13	17.67	0.62
BS	320	164	63.28	73.93	121.58	19.53	0.64
BS	320	164	45.27	56.46	96.77	21.46	0.66
BS	320	164	57.73	68.75	110.63	23.53	0.68
BS	324	164	62.44	73.39	115.16	16.63	0.62
BS	324	164	51.86	62.94	113.94	17.48	0.62
BS	324	164	44.72	56.06	95.80	19.28	0.64
BS	324	164	47.00	57.54	99.09	21.20	0.66
BS	324	164	57.03	68.26	116.13	23.21	0.68

Appendix E

Perception Training Pilot Studies: Generating Stimuli

205 female participants (mean age: 24.52; SD: 9.24; range: 18-65 years) were recruited, through the use of social networking sites such as Facebook, to participate in 7 pilot studies. By following the link to the questionnaires online, females were giving their consent to participate. Having followed the link, participants were immediately given a written brief of what the questionnaire entailed and were informed that they were free to withdraw at any point if they became uncomfortable with the material or the questions that were being asked. Participants wanting to withdraw from the study were informed that to do so they simply had to close the browser page. Qualtrics was pre-programmed by the experimenter not to record incomplete surveys; therefore by closing the browser, participants could remove their answers from the database of responses.

These studies were approved by the Faculty of Medical Sciences ethics committee at Newcastle University (00620/2013).

1. Daz3D Bodies

Participants

24 females (mean age: 24.13; SD: 9.23; range: 19-65 years) participated in the first pilot using Daz3D studio, and 30 females (mean age: 25.77; SD: 9.45; range: 19-53 years) participated in the second pilot. All participation was voluntary.

Materials/Apparatus

The interactive 3D software modelling interface Daz3D Studio version 3.1 (from Daz3d.com) was used to create a series of 24 bodies ranging in size and shape. This program allows the adjustment of photo-realistic female 3D models on a flat panel screen in order to modify different aspects of the body's features. The female model used was "Victoria 4.2". The program allows the body to be rotated to allow a 360° view of the model, however for these pilots the body was fixed at an angle of 55° as this was thought to show the best deposition of fat in the model (allowing participants to see the bust size as well as the thigh and glutes size). Bodies were created using a set of 94 graphic sliders which allow different aspects of individual body parts to 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.
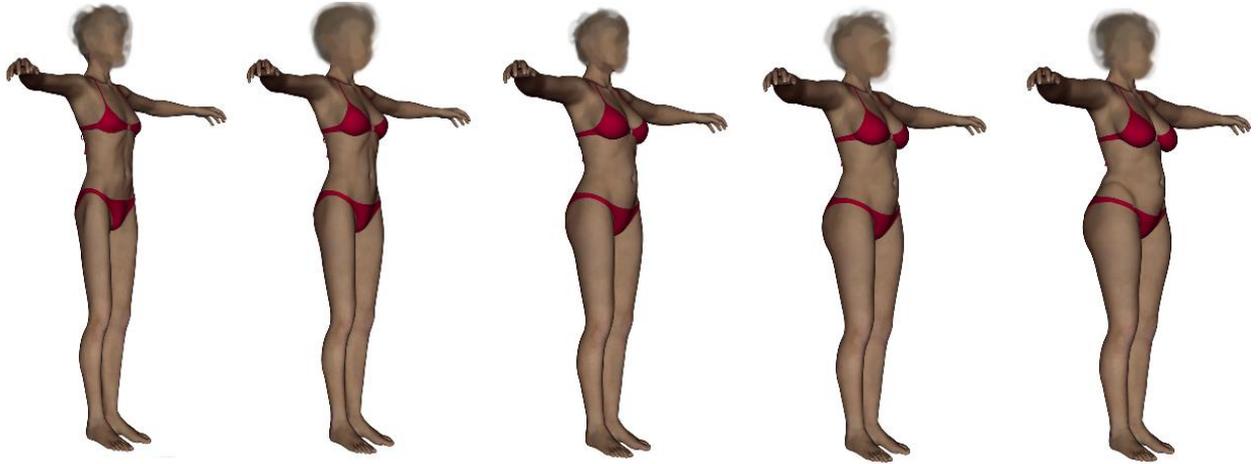

Figure 1. An example of some of the bodies created in Daz3D, shown at a 55 $^{\circ}$ angle with their faces blurred.

Once 24 bodies had been created for the first Daz3D pilot, these were rendered as "jpeg" images and used as stimuli for the first pilot study. Qualtrics online survey software was used for the creation and completion of the questionnaire.

Data Analysis

The 3D models were exported from Daz Studio in waveform format once clothing had been removed, and reopened in Daz 3D Studio Max (autodesk.com). The volume of the 3D body model was then calculated by the software, scaling the body volume relative to the body height entered by the experimenter. Once the volume is known, it is possible to calculate the nominal weight of the 3D bodies by multiplying their volume by the density of the average young adult female body (1.04 g/cm^3).

Once the volumes were calculated for each model, graphs were plotted showing the relationship between the percentage of people who thought the body was fat and the actual volume of the model. We would expect to find that bodies that with a lower volume would be rated as "thin" 100% of the time, while bodies with larger volumes that were obviously fat would be rated as "fat" 100% of the time. Between these two, it would be harder to say if a body was fat or thin, therefore we would expect to see a variation in ratings for ambiguous bodies.
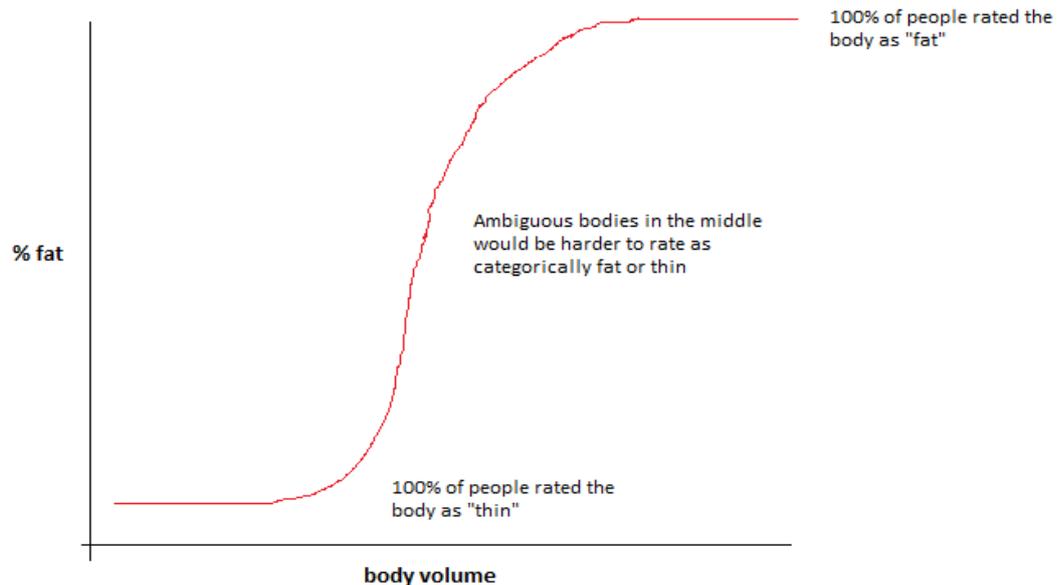

Figure 2. An example of the shape we expect to find when looking at the effect body volume has on people's ratings of whether it is categorically "fat" or "thin".

Procedure

A link to the questionnaire was posted on Facebook with a request for female participants over the age of 18. Therefore by following the link to the questionnaire, females were giving their consent to participate. Having followed the link, participants were immediately given a written brief of what the questionnaire entailed and were informed that they were free to withdraw at any point if they became uncomfortable with the material or the questions that were being asked. Participants wanting to withdraw from the study were informed that to do so they simply had to close the browser page. Qualtrics was pre-programmed by the experimenter not to record incomplete surveys; therefore by closing the browser, participants could remove their answers from the database of responses.

Participants were firstly asked to provide us with demographic information (age, height, weight etc.), following which they were presented with the short version of the Body Shape Questionnaire (16 questions).

Using a two-alternative forced-choice task, in which the 24 Daz3D images were presented one-by-one in a randomized order, participants were asked to state if the bodies were either "fat" or "thin" by checking a box.

At the end of the questionnaire, participants were presented with an online debrief with the purpose of explaining the full nature of the study and their involvement in it. Contact details for the experimenters were also provided in case the participants had any further questions.

Results

Daz3D Body Pilot 1

Figure 3. The relationship between the volume of the body and the percentage of people who thought that particular body was fat for the first Daz3D pilot.

Because there were large gaps between points on the graph (ie: where there was a large leap in the percentage of people who thought those bodies were fat, and where there was a gap between the body volumes), especially between a volume of 39.846 and 43.564 and between a volume of 47.307 and 49.739, a second Daz3D pilot was

conducted, with more bodies created which would fill in the gaps for the missing body volumes seen in Figure 3.

A new graph was then plotted on completion of this second Daz3D pilot study (see figure 4).

*Daz3D Body Pilot **2***
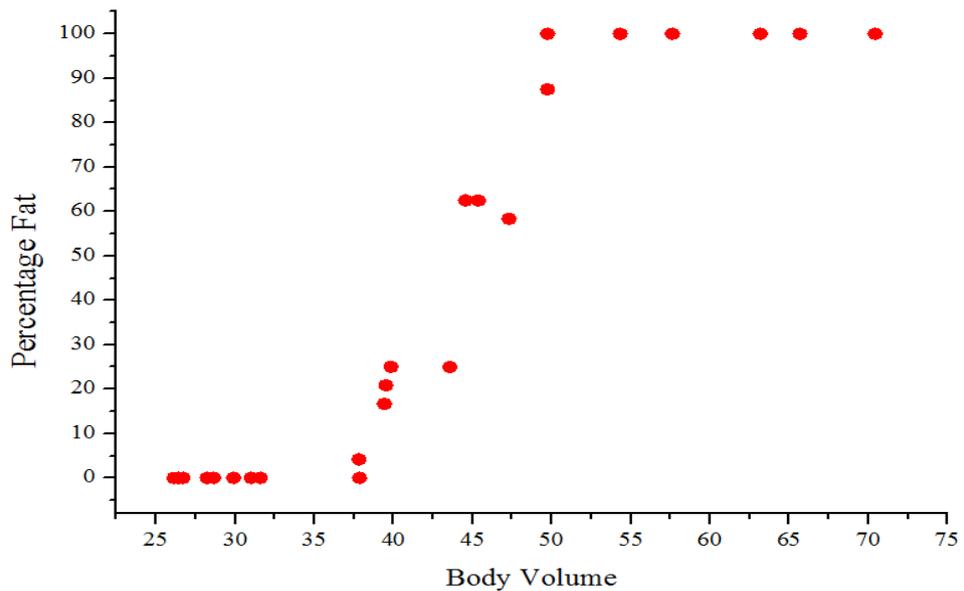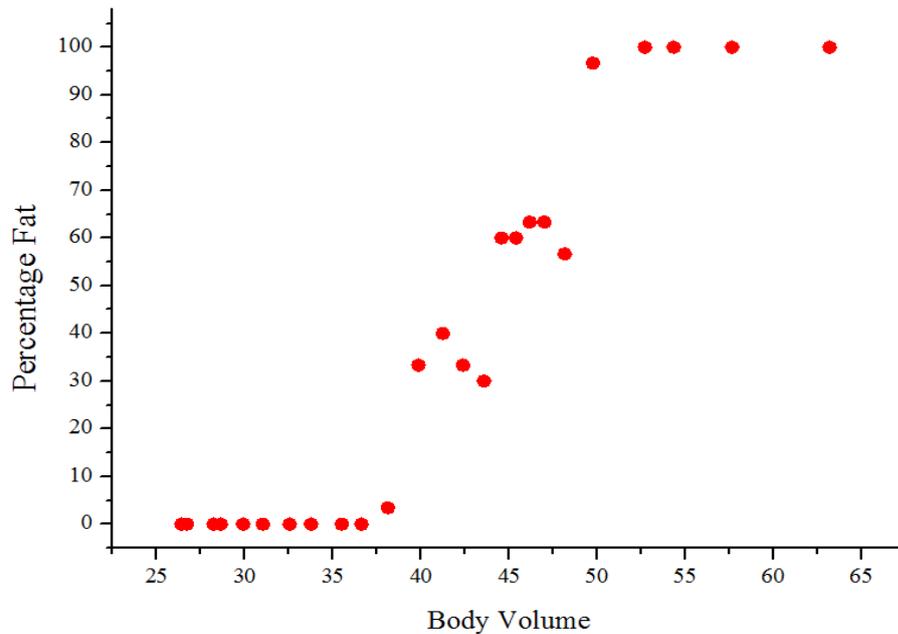

Figure 4. The relationship between the volume of the body and the percentage of people who thought that particular body was fat for the amended Daz3D pilot.

Unfortunately, the spread of the data shown in figure 4 was no better than that depicted in figure 3 therefore it was decided that these bodies were not accurate enough in representing a wide variety of realistic body sizes and shapes and could not be used as stimuli.

2. Real Bodies

Participants

27 females (mean age: 22.26; SD: 6.03; range: 18-52 years) participated in the first of two pilots using real female bodies as its stimuli. In the second, 22 females (mean age: 25.41; SD: 11.05; range: 19-65 years) participated. All participation was voluntary.

For the first of these pilots, photographed images of 24 real women were used as stimuli. Again these ranged in size and shape with 2 bodies falling in the emaciated BMI category($< 16\text{kg/m}^2$), 3 in the underweight category (16-18.5kg/m^2), 14 in the normal category (18.5-24.9kg/m^2), 3 in the overweight category (25-30kg/m^2), and 2 bodies falling in the obese BMI category ($>30\text{kg/m}^2$).

Figure 5. An example of the real female bodies used, ranging in body size and shape from an underweight BMI to an obese BMI.

For the second of these pilots, the number of images used was increased to 35. However, the range of body sizes was decreased here with all 35 bodies falling in the "normal" BMI category (as results from the first real body pilot showed that there was much discrepancy between the percentage of participants who thought bodies around a normal BMI were fat; we would have expected to see a linear increase in the percentage of people who rated the bodies of increasing BMIs as fat, however there were several large gaps in the percentage fat data around the normal BMI mark. We therefore hoped that by increasing the number of "normal" BMI bodies the gaps would reduce).

Figure 6. An example of the bodies used in the second real body pilot. All bodies in this pilot were in the "normal BMI" category (18.5-24.9kg/m^2).

Again, Qualtrics online survey software was used for the creation and completion of both of these questionnaires.

Procedure

A link to the questionnaire on Qualtrics.com was posted on Facebook with a request for female participants over the age of 18. Therefore by following the link to the questionnaire, females were giving their consent to participate. Having followed the link, participants were immediately given a written brief of what the questionnaire entailed and were informed that they were free to withdraw at any point if they became uncomfortable with the material or the questions that were being asked. Participants wanting to withdraw from the study were informed that to do so they simply had to close the browser page. Qualtrics was pre-programmed by the experimenter not to record incomplete surveys; therefore by closing the browser, participants could remove their answers from the database of responses.

Participants were firstly asked to provide us with demographic information (age, height, weight etc.), following which they were presented with the short version of the Body Shape Questionnaire (16 questions).

Using a two-alternative forced-choice task, participants were then asked if a series of randomized female bodies ranging in body size and shape (Tovée et al., 1999) were either "fat" or "thin". Images were presented one-by one and participants made their answer by checking a box either next to the word "thin" or the word "fat".

At the end of the questionnaire, participants were presented with an online debrief with the purpose of explaining the full nature of the study and their involvement in it. Contact details for the experimenters were also provided in case the participants had any further questions.

Results

Real Body Pilot

Figure 7. The relationship between the BMI of the body and the percentage of people who thought that particular body was fat for the first Real Body pilot.
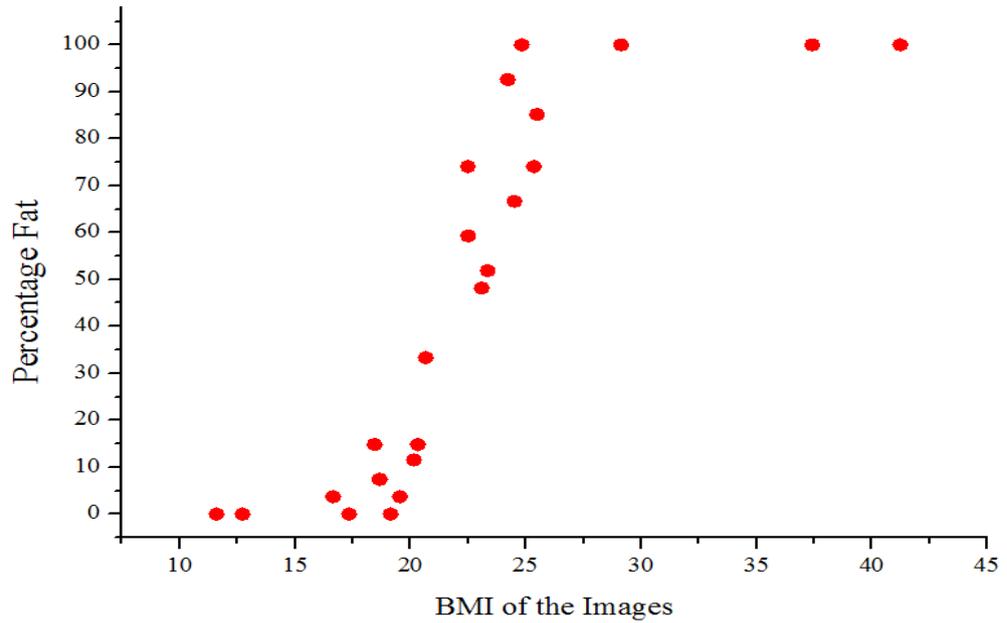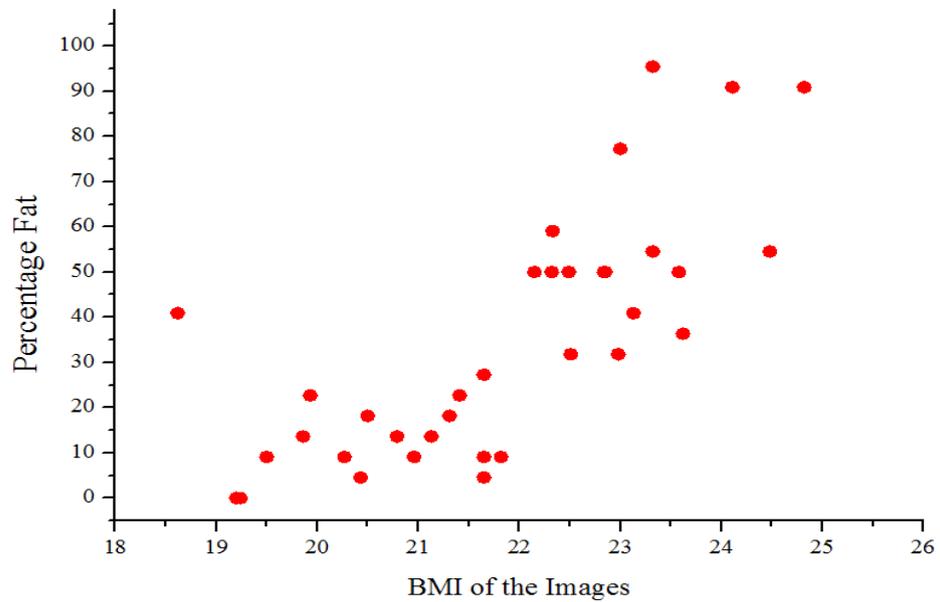
Real Body Pilot 2

Figure 8. The relationship between the BMI of the body and the percentage of people who thought that particular body was fat for the amended Real Body pilot.

As it can clearly be observed from figure 7 and 8 the distribution of ratings is far from what we wanted from this pilot, with no plateau at either the low BMI or high

BMI extremes- we would expect all participants to view the bodies with the lowest BMIs as fat 0% of the time, and the bodies with the highest BMIs as fat 100% of the time. However, figure 7 and 8 suggests this was not the case. These bodies were therefore rejected in search of a better set of stimuli.

3. Daz3D Body Morphs

Participants

     25 females (mean age: 25.76; SD: 11.7; range: 18-65 years) participated in a further pilot involving the use of Daz3D studio morphed bodies. All participation was voluntary.

Materials/Apparatus

     The models were created using Poser 6 software (Smith Micro Graphics, http://graphics.smithmicro.com/go/poser). The female body used as a template was "Victoria" version 4.0, taken from Daz3D studio. The bodies were dressed in the standard skin from the Victoria 4.0 Basic Wear clothing package. Body shape was altered using the shape morphs available in Daz, and two bodies were produced (one thinner and one fatter).

Figure 9. The two original bodies created in Daz3D from which the continuum of other bodies in between was produced.

To produce a continuum of different body sizes ranging between the two bodies created in Daz3D, we morphed the 3D geometry of the bodies in 3D Studio Max (AutoDesk, http://usa.autodesk.com). The original thin body was designated as body size 0 (0%) and the original fat body was designated as body size 100 (100%). 24 bodies were then generated at 4% steps along the morphed continuum between body 0 and 100, making a total of 26 bodies. An obvious concern, as highlighted in previous research (Tovée et al., 2012), is that these bodies will not change shape and size in an anthropometrically valid way. However the shape/ volume of the 3D models can be measured and compared to similar anthropometric measures from real female bodies. Analysis by Tovée, Edmonds & Vuong (2012), amongst others, has shown that morphing between body models results in shape and size changes that are very similar to the shape and size changes seen in real female bodies.

All body models were rendered at 55° angle viewpoint as 24-bit colour JPEGS and were 480 pixels in width and 680 pixels in height. Faces were blurred out so that facial cues to body size could not be used when making the judgements.

Qualtrics online survey software was used for the creation and completion of the questionnaire.

Data Analysis

All bodies were imported into Daz 3D Studio Max (autodesk.com). The volume of the 3D body model was then calculated by the software, scaling the body volume relative to the body height entered by the experimenter. Once the volume is known, it is possible to calculate the nominal weight of the 3D bodies by multiplying their volume by the density of the average young adult female body (1.04 g/cm^3).

Once the volumes were calculated for each model, graphs were plotted showing the relationship between the percentage of people who thought the body was fat and the actual volume of the model.

Procedure

A link to the questionnaire was posted on Facebook with a request for female participants over the age of 18. Therefore by following the link to the questionnaire, females were giving their consent to participate. Having followed the link, participants were immediately given a written brief of what the questionnaire entailed and were

informed that they were free to withdraw at any point if they became uncomfortable with the material or the questions that were being asked. Participants wanting to withdraw from the study were informed that to do so they simply had to close the browser page. Qualtrics was pre-programmed by the experimenter not to record incomplete surveys; therefore by closing the browser, participants could remove their answers from the database of responses.

Participants were firstly asked to provide us with demographic information (age, height, weight etc.), following which they were presented with the short version of the Body Shape Questionnaire (16 questions).

Using a two-alternative forced-choice task, participants were asked if the bodies were either "fat" or "thin". The Daz3D bodies were presented in a randomized order one-by-one, and to make their decision participants were required to check a box either next to the word "thin" or next to the word "fat".

At the end of the questionnaire, participants were presented with an online debrief with the purpose of explaining the full nature of the study and their involvement in it. Contact details for the experimenters were also provided in case the participants had any further questions.

Results

Figure 10. The relationship between the volume of the body and the percentage of people who thought that particular body was fat for the morphed Daz3D pilot.

Figure 10 shows a relatively linear relationship between body volume and the percentage of bodies that were viewed as fat, however there was not a plateau of ratings of bodies at the lower end of the volume scale as we would have liked (the thinnest bodies should be regarded by everyone as categorically thin). Therefore it was decided that another pilot study should be carried out, instead using a set of images that were more realistic, i.e. using real female bodies instead of Daz3D creations.

4. Real Body Morphs

Participants

25 females (mean age: 25.04; SD: 10.34; range: 20-65 years) participated in a further pilot involving the use of morphed real bodies created using Abrosoft FantaMorph Version 5. All participation was voluntary.

Materials/Apparatus

The idea for this study was to create a sequence of intermediate images, which when put together with the two original images, shows the transition from one image to the other. The 2 original images chosen for this study were image 2 (overweight BMI) and image 12 (underweight BMI) from (Crossley, Cornelissen, & Tovée, 2012). These were chosen as they were two of the smallest and largest BMIs but were of similar height which made the morphing more realistic. To create the morphs, "key dots" were placed on important aspects of each the first image. These then appeared on the corresponding points on the second image forming "partner dots". As our second image was much larger than the first, when a dot was placed for example on the smallest part of the waist on image 12, its partner dot might appear on the centre of the stomach of image 2, as the stomach area was much larger in this image (see the green "key dots" in figure 11). Therefore it was important to move the dot on the second image to the same place as the first image.

Figure 11. An example of placing "key dots" on the images to create corresponding points which enables the smaller image to morph accurately to the larger image.

This process of placing key dots on the first image and moving them to the corresponding place on the second image was repeated until all major elements of the morphing image were covered (the more key dots the better the alignment of the images, therefore the better the morph).

Figure 12. Example of the two images after all key dots were placed on all major elements of the morphing image.

FantaMorph typically creates a movie, morphing from one image to the other. However for this experiment we required 26 still images. Therefore in the "preview movie" window below the two images, the "preview" slider was paused at 4% intervals, therefore creating movie "stills". These frames were then exported as Jpegs.

Figure 13. An example of the still morphed frames taken at 4% intervals. See red circles for 4% and 8%.

Again, Qualtrics online survey software was used for the creation and completion of the questionnaire.

Procedure

A link to the questionnaire was posted on Facebook with a request for female participants over the age of 18. Therefore by following the link to the questionnaire, females were giving their consent to participate. Having followed the link, participants were immediately given a written brief of what the questionnaire entailed and were informed that they were free to withdraw at any point if they became uncomfortable with the material or the questions that were being asked. Participants wanting to withdraw from the study were informed that to do so they simply had to close the browser page. Qualtrics was pre-programmed by the experimenter not to record incomplete surveys; therefore by closing the browser, participants could remove their answers from the database of responses.

Participants were firstly asked to provide us with demographic information (age, height, weight etc.), following which they were presented with the short version of the Body Shape Questionnaire (16 questions).

Using a two-alternative forced-choice task in which the frames were presented in a randomized order one-by-one, participants were then asked if the bodies were either "fat" or "thin". To state their answer, participants were required to check a box either next to the word "thin" or next to the word "fat".

271

At the end of the questionnaire, participants were presented with an online debrief with the purpose of explaining the full nature of the study and their involvement in it. Contact details for the experimenters were also provided in case the participants had any further questions.
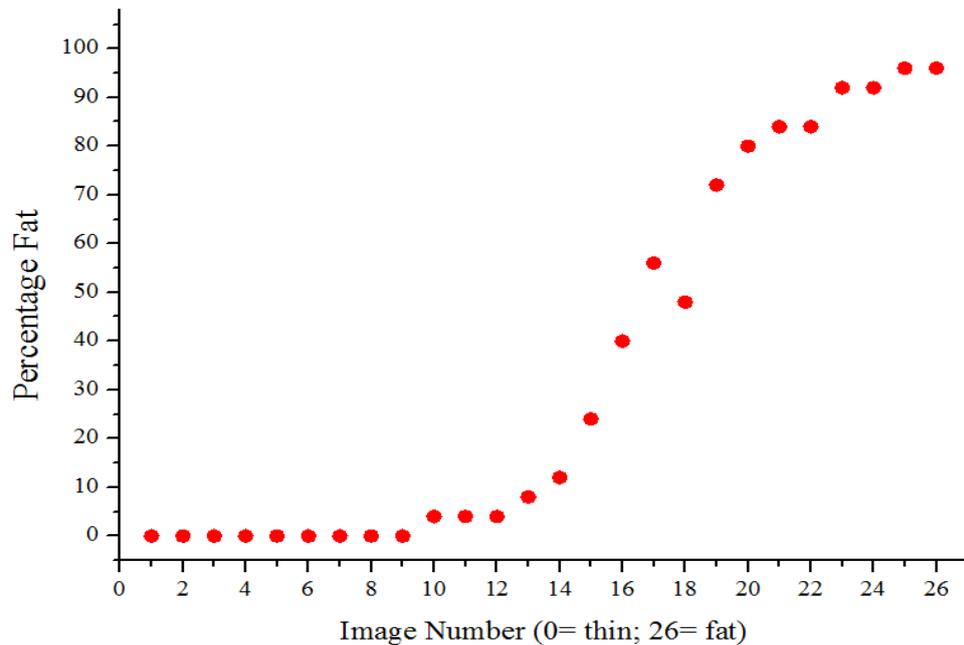
Results

Figure 14. The relationship between the volume of the body and the percentage of people who thought that particular body was fat for the morphed Daz3D pilot.

While figure 14 showed the best curve so far, it was decided that these images were not realistic enough to show increasing adiposity in women. A new version of Daz3D was then subsequently released (version 4.5) which enabled a set of much more realistic body sizes and shapes to be created. To test this a 7th and final pilot experiment was conducted, again asking participants to rate 15 bodies (3 times each) as either categorically fat or categorically thin. This pilot is presented within Chapter 5.