British Journal of Psychology (2001), 92, 391–402 *Printed in Great Britain*

Female and male perceptions of female physical attractiveness in front-view and profile

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Two important cues to female physical attractiveness are body mass index (BMI) and shape. In front view, it seems that BMI may be more important than shape; however, is it true in profile where shape cues may be stronger? There is also the question of whether men and women have the same perception of female physical attractiveness. Some studies have suggested that they do not, but this runs contrary to mate selection theory. This predicts that women will have the same perception of female attractiveness as men do. This allows them to judge their own relative value, with respect to their peer group, and match this value with the value of a prospective mate. To clarify these issues we asked 40 male and 40 female undergraduates to rate a set of pictures of real women (50 in front-view and 50 in profile) for attractiveness. BMI was the primary predictor of attractiveness in both front and profile, and the putative visual cues to BMI showed a higher degree of view-invariance than shape cues such as the waist–hip ratio (WHR). Consistent with mate selection theory, there were no significant differences in the rating of attractiveness by male and female raters.

One of the most fundamental problems for any organism is mate selection. It is vitally important that we are sensitive to the physical cues that honestly signal that one individual is more desirable (i.e. fitter and with a better reproductive potential) than another, and use them to choose a partner who is most likely to enhance our chances of successful reproduction. In women, two potentially critical cues are shape and weight scaled for height (the body mass index or BMI, the units of which are $\mathrm{kg\,m^{-2}}$).

For shape in women, research has focused on the ratio of the width of the waist to the width of the hips (the waist–hip ratio, or WHR). A low WHR (i.e. a curvaceous body) is believed to correspond to the optimal fat distribution for high fertility (Wass, Waldenstrom, Rossner, & Hellberg, 1997; Zaadstra *et al.*, 1993), and so this shape should be highly attractive. This suggestion is supported by studies that have asked subjects to rate for attractiveness a set of line-drawn figures of women's bodies (Furnham, Tan, & McManus, 1997; Henss, 1995; Singh, 1993a,b, 1994a,b, 1995). The line-drawn figures are arranged in three series: underweight, normal and overweight. Within each series, the BMI of each of the four figures is supposed to be held constant, while WHR is varied by narrowing the waist. However, this is a false assumption. When the figures are modified by altering the width of the torso around the waist, this not only alters the

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WHR, but also the apparent BMI. As the value of the WHR rises, so does that of the apparent BMI, and so it is not possible to say whether changes in attractiveness ratings are made on the basis of WHR or body mass, or both (Tovée & Cornelissen, 1999; Tovée, Maisey, Emery, & Cornelissen, 1999). This error is duplicated in a recent paper by Henss (2000), who used photographs of women, and altered their WHR by thickening or narrowing their torsos, believing that this is only altered their WHR. However, by altering the torso width, this also altered their apparent body mass. So once again, the WHR and BMI were co-varied.

Another study noticed that Singh was modifying WHR by altering waist width (Tassinary & Hansen, 1998), but only picked up the fact that he was co-varying WHR with waist, not that there was also a change in apparent BMI. As a result, they produced a set of line-drawn figures in which they altered WHR either by waist width or by hip width, but still replicated the flaw in Singh's images, i.e. that they were co-varying WHR with BMI (Tovée & Cornelissen, 1999; Tovée *et al.*, 1999).

A multiple regression of the attractiveness ratings for images of real women (who independently vary in their WHR and body mass) suggests that although both shape and body mass are significant predictors of female attractiveness, weight scaled for height (i.e. BMI) is a far more important factor than WHR (Tovée, Reinhardt, Emery, & Cornelissen, 1998; Tovée *et al.*, 1999). It is not simply that this paradigm is not sensitive to shape cues, as when women are asked to rate male images in the same format and under the same experimental conditions, the primary determinant of male attractiveness is upper body shape (Maisey, Vale, Cornelissen, & Tovée, 1999). Another recent study has used real images of women, and this study also found that BMI is more strongly correlated with attractiveness than is WHR (Thornhill & Grammer, 1999).

The finding that BMI may be the primary determinant of female attractiveness is consistent with the fact that successful female fashion and glamour models all fall within a narrow BMI range (Tovée, Mason, Emery, McClusky, & Cohen-Tovée, 1997). It is well established that changes in BMI also have a strong impact on health (Manson *et al.*, 1995; Willet *et al.*, 1995) and reproductive potential (Frisch, 1988; Lake, Power, & Cole, 1997; Reid & Van Vugt, 1987; Wang, Davies & Norman, 2000). So a mate choice strategy based on BMI also favours reproductive success.

However, although these latter results suggest that the primary cue for attractiveness is BMI, the issue is far from clear-cut. All the studies have used images in front-view (Furnham *et al.*, 1997; Henss, 1995; Singh, 1993a, b, 1994a, b, 1995; Tovée *et al.*, 1998, 1999; Tovée, Emery, & Cohen-Tovee, 2000; Tovée, Tasker, & Benson, 2000). It can be argued that a more rigorous test of the importance of BMI over WHR comes from the perception of attractiveness in profile. The pattern of fat deposition in the lower body region across the thighs and buttocks is potentially more salient in profile, as is the size and shape of the bust. As a result, it might be suggested that body shape will be a better cue in profile and potentially more likely to influence perceptions of attractiveness. To address this possibility, this study reports ratings of attractiveness for images in profile and determines the relative importance of BMI and shape as predictors of attractiveness.

Additionally, to act as a good index of health and fertility, there must be some obvious and reliable visual guide to each subject's BMI. If one takes the area of the figure and divides by the path length of the perimeter (the perimeter–area ratio or BMI_{PAR}) one derives a figure that is correlated at better than .97 with BMI (Tovée *et al.*, 1999). Thus, for images seen in front-view, BMI_{PAR} would be a reliable measure of BMI. However, to be a reliable proxy for BMI it must be view-invariant, i.e. BMI_{PAR} must also be highly correlated with BMI when seen from any viewpoint. This should also be true of WHR if it is to serve as a reliable cue of fertility. The value of WHR used by Singh is derived from the distance across the waist and the distance *across* the hips of his line-drawings. However, the measures used to derive the WHR in the study of fertility predictors in artificial insemination is the distance *around* the waist and hips (Wass *et al.*, 1997; Zaadstra *et al.*, 1993). How well is the WHR seen in front-view (WHR_{front}), or in profile (WHR_{side}), correlated with this actual WHR? This, after all, is the measure directly correlated with fertility, and the rationale used for the importance of WHR in perceived attractiveness.

A further question is whether a gender difference exists in the perception of attractiveness. Mate selection theory predicts that women will have a very precise and accurate idea of what men find attractive (e.g. Buss, 1992). This allows them to judge their own relative value, with respect to their peer group, and match this value with the value of a prospective mate. So mate selection predicts that the ratings of the female images by men and women will not produce any gender differences. However, several studies have suggested a difference (e.g. Fallon & Rozin, 1985; Rozin & Fallon, 1988), while other studies have found no significant difference (e.g. Furnham *et al.* 1997; Henss, 1995). All these studies have used a comparatively small number of line-drawn figures of women, which limit observers in their choice of attractive image, and all the figures suffered from the co-variation problem discussed above. We therefore used a large set of real female pictures to explore whether there are significant systematic differences in the attractiveness ratings by male and female observers.

Method

Participants and procedure

We asked 40 male and 40 female undergraduates (mean age: 20 years, 8 months; SD 1 year, 4 months) to rate colour images of 50 real women in front and side-view. The mean age of the women in the images was 26 years, 8 months (SD 8 years, 3 months). To generate the images, consenting women were videoed standing in a set pose at a standard distance, wearing tight grey leotards and leggings in front and side-views. Images were then frame-grabbed and stored as 24-bit colour pictures (Fig. 1).

We obscured the heads of the women in our images, so that they could not be identified and facial attractiveness would not be a factor in subject's ratings. For our stimulus set, we drew 10 images of women from each of five BMI categories (Bray, 1978): emaciated (below 15), underweight (15–19), acceptable (20–24), overweight (25–30) and obese (above 30). The women in our study varied in WHR from 0.68 to 0.98. This range of BMI and WHR values represents the widest range available in our image library. In a previous study we examined the effect of varying the relative ranges of BMI and WHR for images in front-view. We found that BMI remained the primary predictor even when the range of BMI values was very narrow relative to the WHR range (Tovée *et al.*, 1999).

The set of front and side images were rated separately. Whether an individual subject rated the set of front-view images or the set of profile images first, was randomized between subjects. Within each image set, the individual images were presented in a randomized order, and subjects were presented with each entire set twice. The first run through was used to make subjects aware of the range of variability of body features represented in the images. This encouraged subjects to use the whole range of attractiveness ratings from 0 (least attractive) to 9 (most attractive). Only on the second run through were subjects asked to rate them.

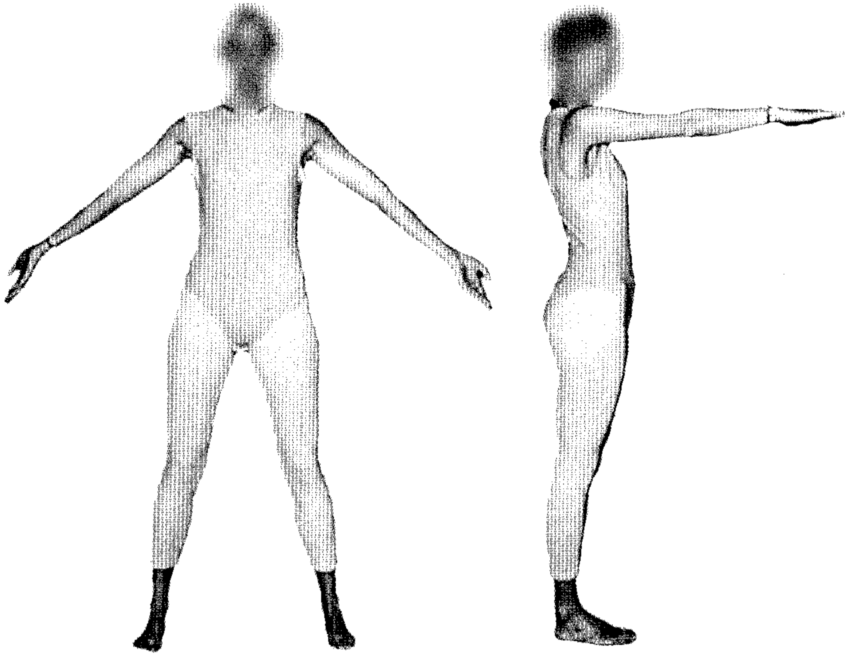

Figure 1. Examples of the female images used in these experiments in front and side view.

Results

Rating of attractiveness by men and woman

Figures 2(a) and 2(b) show plots of attractiveness rating as a function of BMI in front-view and profile for female (open circles) and male (solid circles) subjects. Figures 2(c) and 2(d) show the relationship between attractiveness and actual WHR. It is clear that the relationship between BMI and attractiveness is non-linear both in front-view and profile; small increases or decreases in BMI either side of the range 18–20 radically reduce attractiveness ratings. The data also suggest only a weak negative correlation of attractiveness with WHR; the attractiveness rating decreases as the value of WHR increases, reflecting an increasingly tubular body shape.

We first asked whether BMI or WHR explains more of the variance in subjects' attractiveness ratings. To deal with the non-linear relationship or attractiveness with BMI, we used polynomial multiple regression (see Altman, 1991). We followed Tovée *et al.* (1999) and permitted up to third-order terms for BMI in the model shown below. The model was run separately for male and female viewers, once each for front-view and profile:

$$\text{Model:} \quad y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + \mathrm{e}$$

Figure 2. Plots of attractiveness as a function of BMI for front-view (a) and profile (b), and for attractiveness as a function of WHR for front-view (c) and profile (d). Each point represents the average of the 40 attractiveness judgments. Regression lines are superimposed. The results from male raters are shown in filled circles. The results from female raters are shown in open circles.

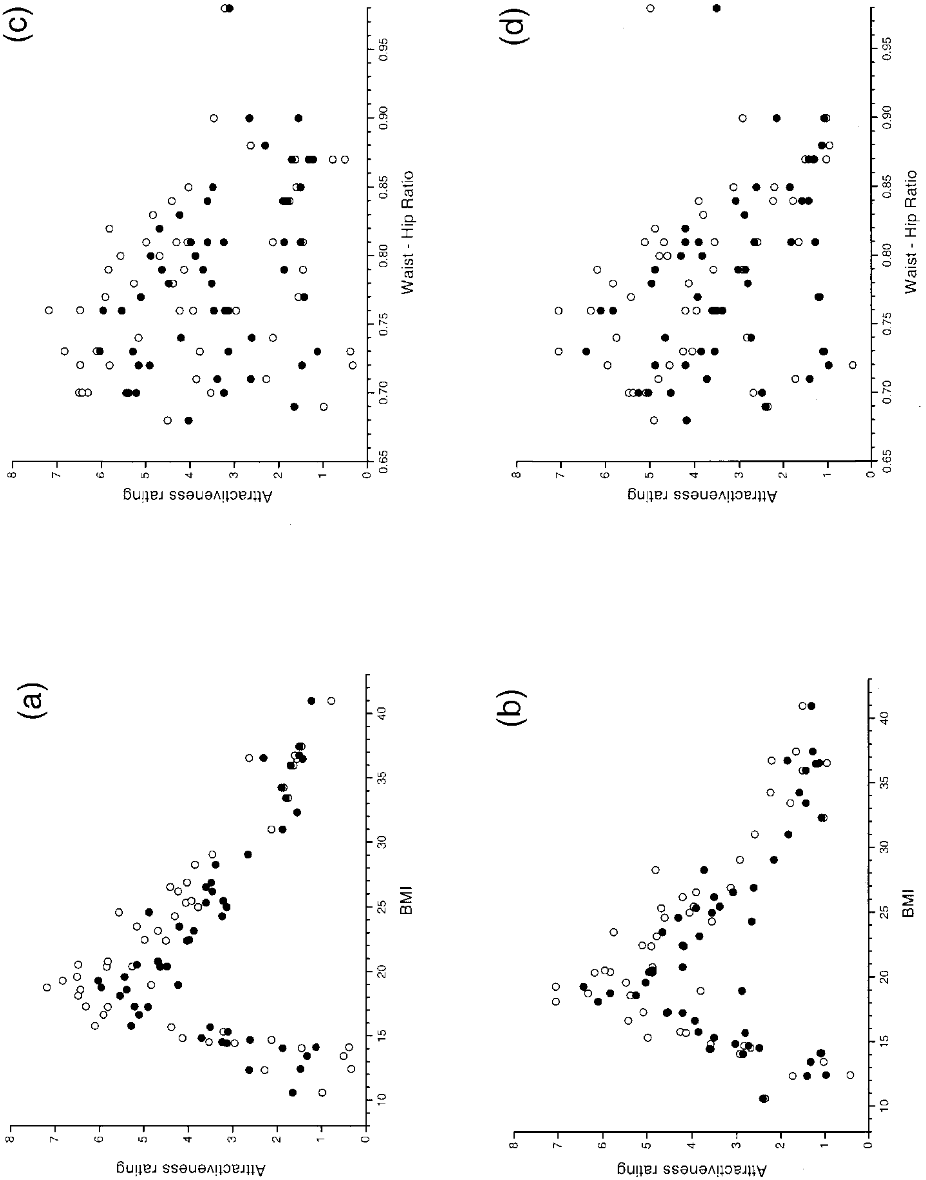
(a)
(b)
(c)
(d)
Attractiveness rating
BMI
Waist - Hip Ratio

Table 1. The total r^2 values for those explanatory variables which survived a stepwise fitting procedure applied to the four multiple regression models (i.e. separate models for male and female observers and for images in front and profile). In each case, BMI explained approximately 30 times more variance than WHR, suggesting that BMI is a considerably stronger determinant of body attractiveness than WHR

Image orientation	Viewer gender	Variable	Beta weight	Total r^2
Front	Female	WHR	−5.04	2.1%
		BMI	4.38	74.3%
		BMI^2	−0.16	
		BMI^3	0.0019	
	Male	WHR	−4.04	2.6%
		BMI	3.12	73.2%
		BMI^2	−0.12	
		BMI^3	0.0014	
Side	Female	Age	−0.039	2.5%
		BMI	3.77	73.4%
		BMI^2	−0.14	
		BMI^3	0.0016	
	Male	WHR	−3.91	3.4%
		BMI	3.07	70.6%
		BMI^2	−0.12	
		BMI^3	0.0013	

where: y = attractiveness rating (side or front view), a = intercept, x_1 = age of woman in image, x_2 = WHR, x_3 = BMI, $x_4 = BMI^2$, $x_5 = BMI^3$ and e = random error.

Table 1 shows the regression coefficients as well as total r^2 values for those explanatory variables which survived a stepwise fitting procedure applied to the four models. All the effects included in the table were significant at $p < .05$. In each case, BMI accounted for approximately 30 times more variance than WHR, suggesting that BMI is a considerably stronger determinant of body attractiveness than WHR.

Figure 2 shows that the images which both male and female viewers found most attractive appeared to have similar BMIs. To quantify this impression we fitted of both third-order polynomials for BMI to the attractiveness ratings made by all our male and female viewers. We then calculated the BMI at peak attractiveness for every viewer. In this way, we generated an estimate of optimal BMI for each subject. In front-view, the optimal BMI for male viewers was 19.2 (SD 1.4) and the optimal BMI for female viewers was 19.4 (SD 1.5). There was no significant difference between the optimal BMI of the two genders (t test, $t = -0.71, p = .48$). In side-view, the optimal BMI for male viewers was 20.1 (SD 1.6) and the optimal BMI for female viewers was 20.6 (SD 1.2). Again, there was no significant difference between the optimal BMI of the two genders (t test, $t(78) = 1.72, p = .09$). Contrary to Fallon and Rozin (Fallon & Rozin, 1985; Rozin & Fallon, 1988), this suggests that there are no systematic differences between the ratings made by the two sexes.

Cue invariance

The ratings of attractiveness in front-view and profile are also highly correlated. The Pearson correlation between the attractiveness ratings in front-view and profile for men is $r = .92$ and for women it is $r = .91$.

This high correlation suggests that subjects may have used the same cues when judging figures seen in front-view or profile. Thus, a critical test of the putative visual cues, such as BMI_{PAR} and WHR_{front}/WHR_{side}, is that they also should show view-invariance. To test this hypothesis we looked at how well correlated these putative visual cues are within the features they purport to represent under the two viewing conditions (e.g. BMI_{PAR} with BMI and WHR_{front} or WHR_{side} with WHR).

Two sets of putative visual cues have been suggested to signal physical attractiveness. The first set relates to BMI, and these are PAR and simple width estimation (Tovée *et al.*, 1998, 1999). For BMI_{PAR} there is a better than .95 correlation with BMI in both front-view and profile, and of course BMI_{PAR} in front-view and profile are correlated with each other ($r = .96$) (see Fig. 3).

Aside from BMI_{PAR}, we have previously shown that lower body width is also closely correlated with BMI (Tovée *et al.*, 1999). So, to obtain a simple index of BMI, an observer might simply estimate the width of a person's waist or hips. In the image set reported here, the waist and hip width are correlated with BMI in both front-view ($r = .96$ and .91, respectively) and in profile ($r = .96$ and .95, respectively), and the widths in front-view and profile were highly correlated with each other ($r = .91$ and .97, respectively).

The second set of putative cues to attractiveness is based on measures of WHR. The correlation between WHR_{front} (i.e. the distance across the waist divided by the distance across the hips in the 2-D image) and WHR is $r = .62$. The correlation between WHR_{side} seen in profile and WHR is $r = .43$. WHR_{front} and WHR_{side} in the image are only moderately correlated at $r = .32$ (see Fig. 3). Thus, the degree to which WHR_{front} or WHR_{side} are correlated with WHR and themselves is not as good as the correlation between BMI and its visual proxies (BMI_{PAR} and body width) seen in front-view and profile.

Discussion

Mate selection theory postulates that an individual will be able to judge not only the attractiveness of members of the opposite sex, but also that he or she will know their own attractiveness relative to other members of the same sex (e.g. Buss, 1992). This information allows a subject to concentrate on potential partners of the same attractiveness as him, or herself. This allows them to avoid an unsuccessful courtship of a more attractive partner than themselves (potentially wasteful in time and resources), or to avoid accepting a less attractive partner than themselves (with a potentially negative impact on future reproductive success). If this thoery is correct, there should be no gender difference in the perception of either female or male beauty, as both sexes should use the same selection criteria for estimating attractiveness in a particular gender (although the cues for male and female attractiveness may be different). Our data is consistent with this prediction. We could not find any systematic differences in the way that male observers rated the attractiveness of images compared to the female observers: the ratings can be

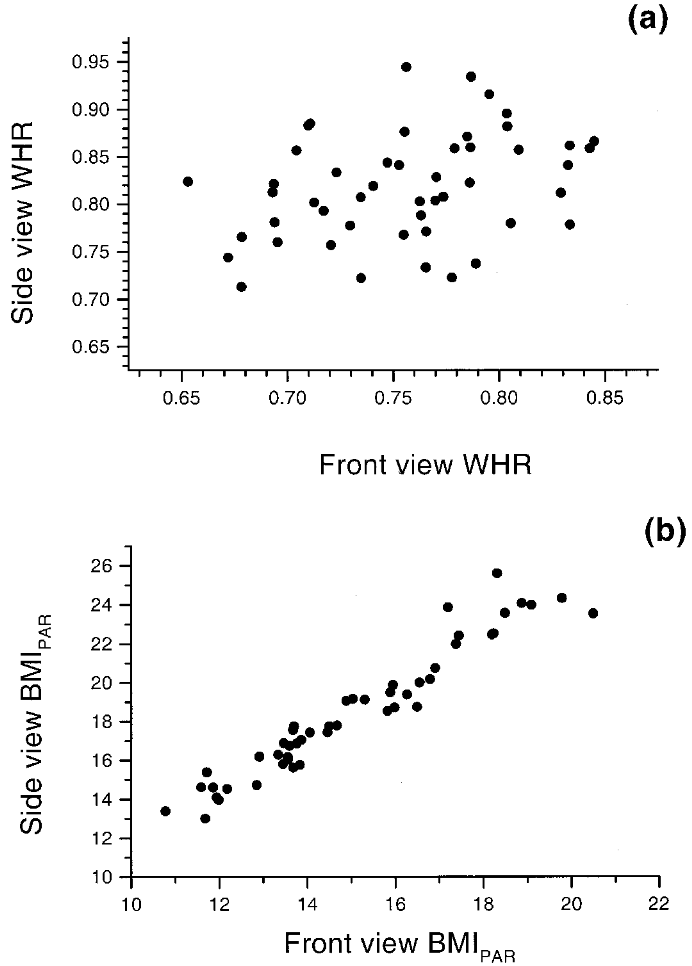

Figure 3. (a) Illustrates the correlation of side-view WHR with front-view WHR. If the viewpoints were highly correlated (i.e. this visual cue showed translation invariance) the points should form a straight line. They are actually only comparatively weakly correlated ($r = .32$), and the cue shows poor view-invariance. Judged on WHR, a number of bodies will change in their ranking relative to their peers depending on whether they are viewed in front-view or profile. (b) Illustrates the correlation of side-view WHR and front-view WHR. The two viewpoints are highly correlated ($r = .96$) and show good view-invariance.

explained by the sample multiple regression model, giving similar weightings for BMI and WHR. Furthermore, there is no convincing difference in the ideal BMI for female beauty preferred by both genders, and both genders prefer a curvaceous body (i.e. a low WHR).

Some previous studies have suggested that the ideal BMI for female attractiveness preferred by women is significantly lower than that preferred by men (Fallon & Rozin, 1985; Rozin & Fallon, 1988). In these studies, subjects were shown a sheet of paper on which were displayed nine line-drawn cartoon female figures (originally produced by Stunkard, Sorenson, & Schulsinger, 1980), which increase in apparent body mass across the page. The male and female subjects were asked a number of questions including which female figure they thought most attractive. A possible flaw in this experiment is the quality of the stimuli. First, the artistic quality of the line drawings is very poor. They do not give a good representation of a human body. We have used these figures in a previous study, and subjects have had difficulty in relating these figures to a corresponding real-life body shape (Parkinson, Tovée, & Cohen-Tovée, 1998). The figures are also of a poor quality scientifically, as they co-vary a number of features across the nine figures, including WHR_{front} and apparent BMI. Therefore, subjects may have judged attractiveness on a number of uncontrolled variables. Our failure to find any gender difference when using real images, both in front-view and profile – where both BMI and WHR are known – suggests that the gender difference reported by Fallon & Rozin may have been an artifact of their experimental stimuli.

Our results also suggest that there is no difference in the perception of female attractiveness between images seen in front-view and profile. The optimal BMI remains at about 19–20, and observers continue to prefer the lowest WHR. Additionally, the proportion of the variance accounted for by BMI and WHR remains the same despite the fact that shape cues (i.e. the bust and buttocks) are more salient in profile. This of course suggests that the cues used in judging attractiveness should also show this view-invariance, and if the putative cues such as BMI_{PAR} and WHR_{front} or WHR_{side} fail to show this invariance they are probably not the cues that are actually used.

Our results show that visual cues to BMI show good view-invariance. Both BMI_{PAR} and simple width measures remain a very good index of BMI in both front-view and profile. They also remain a good visual proxy even at the extremes of BMI (i.e. in the emaciated and very obese ranges). However, the absolute value of these cues for a body of a given BMI is slightly different in front-view and profile, although its relative value compared with other bodies remains the same. So although they show relative view-invariance, it does not show perfect invariance. Thus, to use this cue, a degree of learning would be involved. One would have to observe a number of bodies and determine how BMI_{PAR} and body width changed with changing view-point, to allow the calibration of a recognition system. However, this opportunity is available to us from birth, and we learn to utilize a whole set of visual cues to size invariance and for spatial judgments during childhood (e.g. Bedford, 1999).

WHR_{front} and WHR_{side} are correlated with WHR, but to a much lesser degree than visual cues to BMI are correlated with actual BMI. WHR_{front} and WHR_{side} are correlated, but to a markedly lesser degree than visual cues to BMI (Fig. 3). This suggests comparatively poor view-invariance. Judged on WHR, a number of bodies will change in their ranking relative to their peers depending on whether they are viewed in front-view or profile.

A case can be made for both BMI and WHR being important cues for female health and fertility. BMI can be very closely correlated with health and fertility (Brown, 1993; Frisch, 1988; Lake *et al.*, 1997; Manson *et al.*, 1995; Reid & Van Vugt, 1987). These studies suggest that the balance between the optimal BMI for health and fertility is struck at around a value of 18–19 which, in this study, is also the preferred BMI for attractiveness (for a detailed discussion of these issues see Tovée *et al.*, 1999). However, Hartz, Rupley and Rimm (1984) found that both BMI and WHR are positively related to irregularity in menstrual cycles, and WHR is an important predictor of conception in artificial insemination programmes (Wass *et al.*, 1997; Zaadstra *et al.*, 1993). So perhaps a more interesting question is why is WHR such a poor predictor of attractiveness relative to BMI?

The answer may come from the difficulty in accurately judging WHR. Comparing the potential utility of visual cues to BMI and WHR, it would seem that visual cues to BMI are more closely and accurately linked to actual BMI and show good view-invariance compared with the visual cues for WHR. If a physical feature has only a comparatively weak visual proxy, then it does not matter how good a predictor it is of health and fertility, it will play only a secondary role in sexual selection. This may be true of WHR, and could explain why it plays a subsidiary role to BMI, which has a more reliable visual proxy. However, it should be noted that we did not directly ask subjects to rate the images for fertility or health, although there is a strong correlation between the physical characteristics of the most attractive images and health and fertility (Brown, 1993; Frisch, 1988; Lake *et al.*, 1997; Manson *et al.*, 1995; Reid & Van Vugt, 1987). The results may have been different had we asked subjects to directly rate the images for health and fertility.

It should also be remembered that BMI and WHR may represent indicators of different aspects of female health and fitness. BMI may be a good indicator of general fitness and fertility, whereas WHR may be a more specific cue to fertility and pubertal status. However, this cue may be limited in its utility. For example, there is a considerable overlap in the WHR values of populations of normal women and anorexic patients (Tovée *et al.*, 1997). The latter are amenorrheic. So a woman with an effective fertility of zero can have the same WHR as a woman with normal fertility.

A number of recent studies have suggested that different ethnic groups may prefer different WHR values from those indicated by Western observers (e.g. Yu & Shepard, 1998, 1999; Wetsman & Marlowe, 1999). It has been suggested that these differences may be based on WHR acting as a predictor of child gender. It has been proposed that a high pre-conceptual Waist–Hip ratio (WHR) is a good predictor of male offspring, and so in cultures that value male children, an androgenous body shape may be judged as most attractive (Manning, Anderton & Washington, 1996; Manning, Trivers, Singh & Thornhill, 1999; Singh and Zambarano, 1997). The predictive value of WHR is based on studies measuring women who already have children and correlating their WHR with the proportion of existing male offspring. However, carrying a male child may alter WHR in a different way to carrying a female child, and a high WHR may be an effect rather than a cause of male offspring. To test the predictive power of pre-conceptual WHR and offspring gender, Tovée, Brown & Jacobs (2001) took WHR measures from 458 women who intended to become pregnant and then correlated with the gender of the subsequent child. They found no significant correlation.

An alternative explanation for the reported differences in body shape preferences may be based instead on BMI. These cross-cultural studies use the Singh images and the co-variation of WHR and BMI in these images means that the putative preference changes could be due to changes in BMI preferences rather than WHR (Tovée & Cornelissen, 1999). We would not necessarily expect the same ideal BMI for all racial groups and all environments. For example, epidemiological studies have suggested that different ethnic populations may have differing levels of risk for negative health consequences with changing body mass (e.g. Kopelman, 2000; McKeigue, Shah & Marmot, 1991). So there may be a different optimal BMI for health and longevity in different racial groups. As a consequence, we suggest that there will be a preferred optimal BMI for each ethnic group, which will balance environmental and health factors, but that this optimal BMI may differ between groups and environments.

In conclusion, we can say that men and women seem to have the same preferences for what constitutes female physical attractiveness. They seem to use the same visual cues, in the same order of importance, to judge attractiveness and this is not altered by changes in viewing angle. The visual cues to BMI (which seems to be the primary determinant of attractiveness) are more accurate and view-invariant than visual cues to WHR, which may be a factor in the relative importance of these two cues in determining physical attractiveness.

Acknowledgements

This research was funded by grants to Dr Tovée from the Strasser Foundation and Newcastle University.

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Received 7 September 1999; revised version received 20 April 2000