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Waist-to-hip ratio and female attractiveness. Evidence from photographic stimuli and methodological considerations

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Abstract

There are a large number of empirical studies supporting the evolutionary psychological prediction that the waist-to-hip ratio (WHR) is an important attribute of female attractiveness. In contrast to previous research, which is almost exclusively based on line drawings, the present study used color photographs as stimuli. For each of six attractive females there were the original photographs and two digitally manipulated pictures, one depicting a lower and one depicting a higher WHR. In a between subjects design the pictures were rated by 180 males and 180 females. The ratings were done on 108 scales covering a broad range of personality factors. A factor analysis of these scales yielded seven factors. Only one of these factors was significantly affected by the WHR manipulation, namely Attractiveness. In accordance with evolutionary psychological expectations, a lower ratio was more attractive than a higher one. In addition to the empirical findings, some methodological issues are discussed. It is argued that, compared with face research, research on the human figure is in a poor state.

1. Introduction

Human beauty is one of the highest ranking topics in human life. To many it seems to be a great puzzle. Many lay people as well as social scientists believe that criteria of human beauty are solely culturally defined, rapidly changing in time and completely arbitrary. This view, however, has been seriously challenged by recent progress in evolutionary psychological

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conceptualizations and empirical evidence (Buss, 1994, 1995, 1999; Buss & Schmitt, 1993; Henss, 1992, 1998a; Kenrick, 1994; Symons, 1979, 1995). From an evolutionary perspective, physical attractiveness can be regarded as an indicator of mate value. From this vantage point it is to be expected that there are universally shared criteria of attractiveness which are honest cues to the target person's potential reproductive success. With regard to the human *face*, several such features have been identified (for literature reviews see Henss, 1992, 1998a; Symons, 1995; Zebrowitz, 1997). With regard to the attractiveness of the human *figure*, the picture seems less clear.

Recently, however, Singh (1993a,b, 1994a) has discovered a bodily feature which is both a cue to a female's reproductive potential and may be universally regarded attractive. While research on the human figure had almost exclusively concentrated on overall body weight, Singh drew attention to a variable that had been neglected in previous studies, namely the body fat distribution as measured by the waist-to-hip ratio (WHR). This parameter shows a conspicuous sexual dimorphism. Before puberty, the ratio is similar for boys and girls. After puberty, the pattern of fat distribution changes in a sex-typical manner. Women deposit a larger amount of fat peripherally and onto the lower body parts (buttocks and thighs). These morphological changes, which are under the control of female sex hormones, result in rounded feminine proportions that are characteristic of the *gynoid* fat distribution. Men, on the other hand, lose fat from their lower body parts and deposit fat intra-abdominally and on the upper body parts. These changes are controlled by male sex hormones which produce a male-typical body shape or *android* fat distribution. The difference between the gynoid and the android fat distribution engenders a typical sex difference: the waist-to-hip ratio of women is considerably lower than that of men. The distribution of WHRs in an adult population is bimodal and shows little overlap between the sexes. For healthy premenopausal women the ratio lies between 0.67–0.80; for healthy men it ranges from 0.85 to 0.95. After menopause, the female waist-to-hip ratio becomes similar to that of males. An essential key in Singh's evolutionary considerations is the fact that the waist-to-hip ratio is systematically related to a variety of life outcomes. He provided a long list of empirical evidence demonstrating that WHR is related to youthfulness, hormonal status, fecundity, and risk for major diseases, with a lower WHR being more favorable than a higher one (for literature review see Singh, 1993a). In evolutionary terms these findings suggest that a low waist-to-hip ratio is a reliable (albeit anything but perfect) indicator of a female's mate value. Therefore, one would expect that, over evolutionary time, men have developed special adaptations which make them sensitive to this parameter. Men should prefer mates with a sex typical WHR to women who display a more android fat distribution. That is, one would expect a negative correlation between WHR and female attractiveness. Of course, it is not to be expected that the relationship is strictly monotone. Beyond a certain point an extremely low WHR may appear grotesque and repelling. This often neglected aspect will be discussed in the final section.

To empirically test his hypotheses, Singh has developed a set of line drawings of female (and male) figures which systematically vary with respect to overall body weight (underweight, normal weight, overweight) and the waist-to-hip ratio. In an extensive series of experiments, he demonstrated that there is indeed a negative correlation between WHR and female attractiveness. Evidence comes from judges of both sexes, different age groups, and different

social classes, and it has been replicated in different countries like the USA, the island of Azore, Germany, Great Britain, Guinea-Bissau, Hong Kong, India, Indonesia (Furnham, Tan & McManus, 1997; Henss, 1995; Singh, 1993a,b, 1994a,b,c; Singh & Henss, submitted for publication; Singh & Luis, 1995, submitted for publication). It appears that Singh has discovered a morphological feature which is both a cue to female reproductive success and is universally regarded as attractive in women.

Recently, however, Tassinary and Hansen (1998) raised an important objection to the extant WHR research. They criticize the fact that research in this area has been almost exclusively restricted to the set of line drawings developed by Singh. This objection is indeed of great significance. One important reason which, however, is not discussed by Tassinary and Hansen is the following. There exists a large body of research on face perception that makes unmistakably clear that line drawings of faces (even if they are of high quality) may yield very different results than facial photographs from which they were derived (Leder, 1996). Given this evidence from face research, the ecological validity of line drawing studies, which are so dominant in the field of research on the human figure, is questionable. Despite the merit of Tassinary and Hansen's critique of the almost exclusive reliance on a single set of line drawings, their own approach can hardly be considered an improvement. Ironically, they also used a set of line drawings. Their stimuli, however, appear less appealing and less naturalistic than Singh's. Given the dubious quality of Tassinary and Hansen's stimuli (and methodological problems which will be discussed in the final section), their assertion to have provided 'a clear and unambiguous disconfirmation of the WHR hypothesis' (Tassinary & Hansen, 1998, p. 155) deserves little credit.

The present study was designed to overcome some shortcomings of prior research. To avoid potential pitfalls of line drawings, color photographs were used as stimuli. The pictures were digitally manipulated to yield a lower or a higher waist-to-hip ratio. The manipulated pictures as well as the original photographs were of high quality and very naturalistic (see Fig. 1).

In addition to the stimulus material, there is another major difference between the present study and prior research. Usually the participants of WHR studies are provided with the whole set of stimuli and are usually asked to rank order the figures with respect to different criteria. This procedure inevitably makes the manipulation of the WHR obvious to the subjects, and thus raises doubts about demand characteristics. To avoid such problems, the present study used a strictly between subjects design. That is, each participant judged a single stimulus. Thus, he or she was completely unaware of the central variable, i.e., WHR.

While most WHR research has concentrated on several aspects that are closely related to potential reproductive success, as for example, good health, youthful looks, physical attractiveness, sex appeal, desire for children, and capability for having children, the present investigation adopted a broader perspective. In addition to the aforementioned criteria it also considered the so called Big Five factors of personality description (Extraversion, Agreeableness, Conscientiousness, Emotional Stability, Intellect) as well as some aspects of mood. Thus, this study attempted to relate judgments of the human figure to recent developments in personality psychology (Henss, 1998a). In the present paper, however, the focus is on the relationship between WHR and attractiveness.

Another focus is on methodological issues which will be discussed in some detail. Overall, it will be argued that research on the human figure is in a rather poor state.

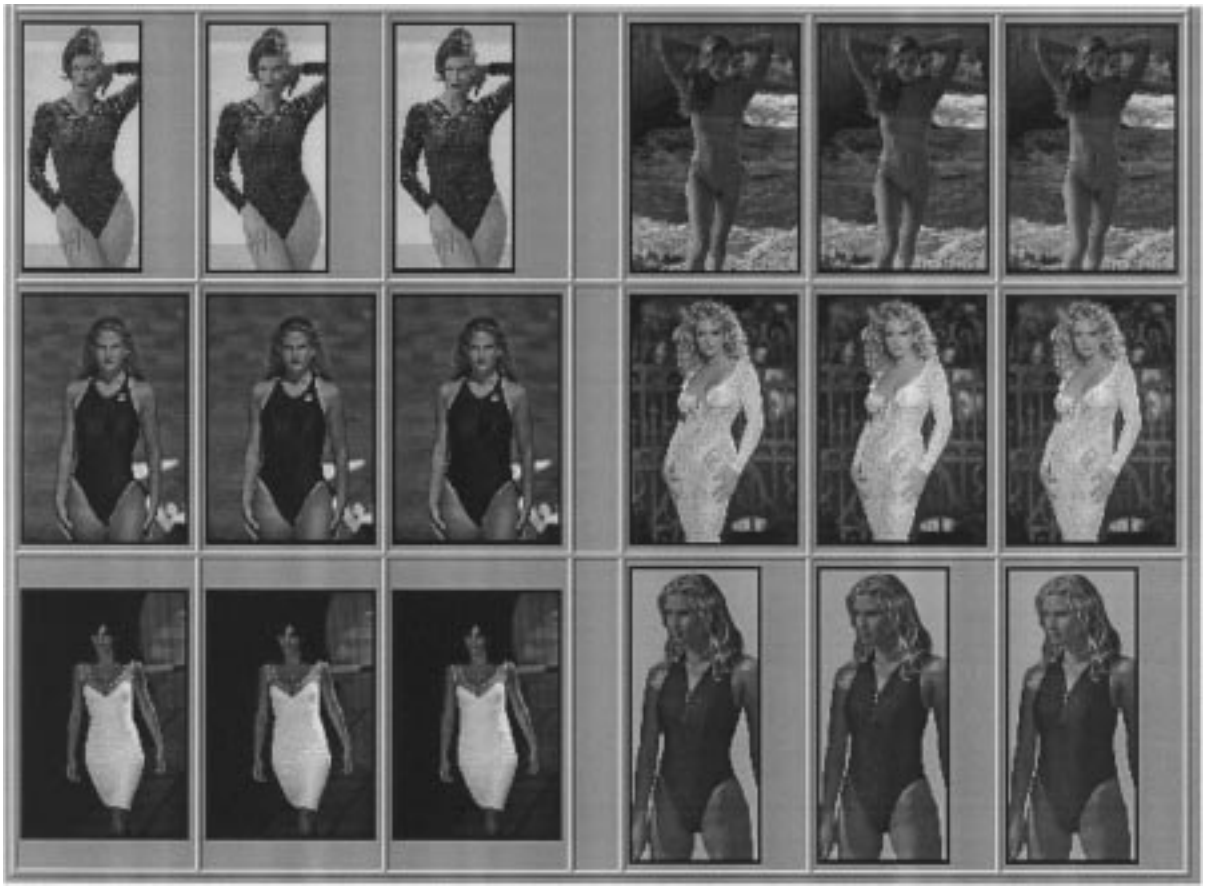

Fig. 1. Stimulus figures.

2. Method

2.1. Stimulus material

The stimulus material was created from color photographs of six attractive women. Two of the original pictures were taken from fashion catalogues and scanned into a computer; four pictures were downloaded from the Internet. From each photograph two versions of waist-to-hip ratio were created by morphing techniques. In one picture the waist was tightened, in the other one it was widened. Thus, for each stimulus person there was the original photograph, and two manipulated pictures, one displaying a smaller and the other one displaying a higher waist-to-hip ratio. The complete set of pictures is shown in Fig. 1[1].

It is important to note that the amount of manipulation of the waist-to-hip ratio was somewhat different for the different stimulus persons. Based on enlarged versions of the

[1] The pictures are downloadable from the Internet. For instructions contact the author.

Table 1
Waist-to-hip ratios

	Stimulus person					
	1	2	3	4	5	6
Smaller	0.74	0.73	0.68	0.72	0.71	0.68
Original	0.77	0.76	0.70	0.79	0.76	0.72
Wider	0.82	0.81	0.71	0.85	0.80	0.74

pictures, measurements of the smallest hip and the broadest waist width were taken. The resulting waist-to-hip ratios are listed in Table 1. (It should be noted that these numbers are derived from two-dimensional representations, thus they are only rough estimates of the three-dimensional ratios; see footnote 4).

2.2. Subjects

The participants of the study were 180 males and 180 females ranging in age from 16 to 50 years (mean = 24.5; sd = 5.25; interquartile: 21–26). The majority were students from a variety of different fields. Subjects were paid for their participation. Each participant rated a single stimulus. Each picture was rated by a different group of 10 male and 10 female subjects.

2.3. Judgmental criteria and procedure

Ratings were made on 108 unipolar rating scales. The rating categories were transformed into values ranging from 1 to 6. Based on extensive research on facial judgments (Henss, 1998a) the items were systematically compiled to capture a broad range of personality factors. These included the Big Five (*Extraversion, Agreeableness, Conscientiousness, Emotional Stability, Intellect*), different aspects of *Mood* (e.g. cheerful, lively), several facets of *Attractiveness* (physical attractiveness, sexual attractiveness, youthfulness, health, sex typical features, fashionableness, social effects), and *Motherliness/Family Orientation* (good mother, likes children). The majority of the items were adjectives or brief statements (e.g., wants to have many children, faithful spouse). Twelve items were type nouns referring to sex-typical person types like luxurious woman, sex bomb, fashion-plate (for personality-descriptive type nouns see Henss, 1998b).

Subjects were tested individually. The experiment was run by a computer program. The order of the items was completely randomized, i.e., each subject rated the items in a different order. In addition to the ratings, the subjects estimated the stimulus persons' age, body height, and body weight (years, centimeters, and kilograms). Using these height and weight estimates, the body-mass index BMI = weight/height^2 was derived.

3. Results

To clarify the correlational structure of the judgments, a principal component analysis of the 108 rating scales was carried out. There were 21 Eigenvalues greater than 1. On the basis of the scree plot, seven factors were extracted and rotated using the varimax method[2]. These factors account for 47.7% of the total variance. On the basis of the loading pattern they were interpreted as follows.

- *Motherliness/Agreeableness* (e.g., good spouse, loves children, family oriented, warmhearted, considerate, good-natured).
- *Attractiveness* (physically attractive, erotic, sexy, good-looking, much courted).
- *Extraversion/Positive Affect* (sociable, withdrawn(−), quiet (−), cheerful, happy).
- *Self-Assurance/Career Orientation* (independent, self-confident, superior, career oriented, careerist).
- *Fashion-Plate* (fashion-plate, puppet, unimaginative, thinking slowly).
- *Figure* (slim, slender, corpulent (−), roly-poly (−), plump figure (−)).
- *Health/Youthfulness* (healthy, as sound as a bell, young, youthful, in good shape).

To capture the core of each factor, aggregated factor values were computed as follows. For each item the main loading and the largest secondary loading were determined. In order to get relatively independent factors, only those items were retained whose ratio 'main to secondary loading' was greater than 1.732 (this is equivalent to an angle of less than 30° in the two dimensional plane whose x and y axes are defined by the main and the secondary factor, respectively). Aggregated factor values were computed as the unweighted mean of all items that additionally fulfilled the requirement that the main loading was greater than 0.40. Based on this procedure the number of items constituting factors 1–7 was 22, 14, 10, 5, 4, 7, and 6, respectively. The alpha reliabilities of the aggregated scales were 0.94, 0.90, 0.81, 0.73, 0.67, 0.82, and 0.79. The correlations among the scales were generally low: the median was 0.13, the maximum correlation was between *Attractiveness* and *Figure* ($r = 0.40$).

Using the aggregated factors as dependent variables, univariate ANOVA-analyses were conducted. In a series of parallel analyses, factor scores were used instead of aggregated factor values (in contrast to the aggregated scales which are moderately correlated with each other, the factors are statistically independent). Not surprisingly, these analyses yielded almost identical results as the analyses reported below. The aggregated factors are preferred because they better represent the core of the respective construct. In a first round, an 'Individual × WHR × Sex of Subjects' ($6 \times 3 \times 2$) between subjects design was employed. Sex of subjects turned out to be of almost no importance. More specifically, there were only two significant effects involving the sex of subjects, namely a main effect on Self-Assurance/Career Orientation ($P = 0.025$), and an interaction 'WHR × Sex of Subjects' on Figure ($P = 0.046$). The lack of systematic differences between male and female judges is consistent with previous findings from Singh's set of line drawings (e.g. Furnham, Dias & McClelland, 1998; Furnham et al., 1997; Henss, 1995; Singh, 1994b, c; Tassinary & Hansen, 1998; based on a different set

[2] The first ten Eigenvalues were: 17.37, 13.49, 6.39, 4.61, 3.97, 3.08, 2.64, 2.15, 1.85, 1.77.

of line drawings Furnham & Baguma, 1994, also found no sex differences while Furnham & Radley, 1989, reported evidence to the contrary).

In a second round, the Sex of Subjects factor was dropped, and an 'Individual × WHR' design was employed. ANOVA results reveal a massive main effect of the Individual for each of the seven factors (all $P < 0.001$). That is, on each dimension the six women yielded very different impressions. These results underline the fact that there is considerable inter-individual consensus on the personality of strangers (Borkenau & Liebler, 1992; Henss, 1997, 1998a; Kenny, 1994). In the present context, however, the consensually presumed differences between the stimulus persons' personalities are of no importance. With regard to the focal variable, i.e. to WHR, there was only one significant main effect. Most remarkably, the only variable that was significantly affected by the manipulation of the waist-to-hip ratio was *Attractiveness* ($P = 0.031$). In accordance with Singh's evolutionary conceptualization WHR and physical attractiveness were negatively related. The smallest WHR was most attractive (4.16), the highest WHR yielded the least positive evaluation (3.95), and the unmanipulated WHR fell in between (4.06). Notably, the interaction Individual × WHR was not significant. Thus, the overall effect of WHR was *not* qualified by the stimulus person. For the sake of completeness it should be mentioned that in two out of seven cases there was a significant interaction Individual × WHR. For both *Extraversion/Positive Affect* ($P = 0.028$) and *Health/Youthfulness* ($P = 0.013$) the manipulation of the waist-to-hip ratio yielded different effects for different stimulus persons. Both interactions, however, are difficult to interpret. Moreover, in the present context, they are of no particular interest.

The foregoing results are based on aggregated factor values. To get more detailed information, a series of univariate ANOVAs (Individual × WHR) was run with each single rating scale as dependent variable (of course, single ratings scales are much less reliable than the aggregated scales). Only 5 out of 108 analyses yielded a significant main effect of WHR ($P < 0.05$). They concerned the following items: erotic, sexy, fashion-conscious, feminine figure, figure-conscious. Two additional items, which narrowly failed the 5% level, were 'attractive' and 'good figure'. Evidently, the WHR manipulation had an impact on perceived attractiveness and the evaluation of the figure. On all of these scales the smallest waist-to-hip ratio came off best and the highest ratio received the least positive evaluation. This is perfectly in line with evolutionary psychological expectations.

Previous research has shown that the manipulation of the waist-to-hip ratio may affect perceptions of age, height, and body weight (Henss, 1995). To elucidate the influence of WHR on these criteria, the age, height, and weight estimates as well as the derived body-mass index were also subjected to univariate ANOVA-analyses. The manipulation of the waist-to-hip ratio had a significant effect on the estimated body height ($P = 0.005$). Height estimates were negatively related to the waist-to-hip ratio, i.e., a woman appeared to be taller when her hip was tightened and smaller when her hip was widened (lower WHR: 175.53 cm, original: 174.16 cm, higher WHR: 173.58 cm). Furthermore, there was a significant main effect of WHR on the body-mass index which, of course, is significantly correlated with height estimates ($r = -0.25$). The figures with the lowest ratio appeared less plump than both the unmanipulated pictures and the pictures with the higher WHR (19.47, 20.00, 19.99).

4. Discussion

Overall, the present study provides compelling support for Singh's contention that the waist-to-hip ratio is an essential attribute of the attractiveness of the female figure. In accordance with evolutionary psychological considerations, the waist-to-hip ratio plays a significant role in judgments of female attractiveness: a lower ratio is more attractive than a higher one.

In several respects, this finding is an important addition to previous studies. Firstly, the present study is based on photographic stimuli while prior WHR research has largely been restricted to line drawings. As mentioned above, research on face perception has repeatedly demonstrated that line drawings and photographs may yield fundamentally different results. Therefore, the validity of line drawing studies is doubtful. The present study, however, presents some evidence that the inverse relationship between WHR and female attractiveness can be generalized to photorealistic stimuli. This positive result not withstanding, it is hard to understand why studies on the human figure have almost exclusively relied on line drawings (this restriction does not only hold for WHR research but also for the huge number of investigations into ideal body build and body (dis-)satisfaction). It is even harder to understand why time and again researchers use line drawings that are extremely impoverished and repelling (for examples of widely used impoverished stimuli see Furnham & Radley, 1989; Rozin & Fallon, 1988). Interestingly, in a recent paper, the authors remarked "Retrospectively, it may have been better to use the more carefully drawn and systematic pictures used by Singh ... and others" (Furnham & Nordling, 1998, p. 638) Given the widespread availability of modern techniques of image manipulation, researchers should use more realistic representations (for examples see Lavanchy, Furnham & McClelland, submitted for publication; Henss, Riederer & Schoeller, 1998; Singh, 1994a; Singh & Luis, submitted for publication; Tovée, Reinhardt, Emery & Cornelissen, 1998). In comparison with face research, which is predominantly based on photographs and partly on video or live ratings (Henss, 1992, 1998a; Sporer, 1992; Zebrowitz, 1997), body research is based on poor stimulus material.

Another important aspect concerns the number of different individuals that served as stimuli. The common procedure is to take a single stimulus person, usually a single line drawing, which is systematically modified to yield different body builds, WHRs etc. This procedure has the advantage of relatively clear manipulations of the parameters of interest. On the other hand, however, there always remain doubts of whether the experimental effects (or the lack of such) are due to the specific single stimulus. The present study took a different approach by using six different stimulus persons as point of departure. This enables a generalizability check. Regarding the present study, it is important to note that the different individuals yielded very different impressions on each personality dimension. Notably, however, the effect of WHR on the attractiveness ratings was not qualified by an Individual $\times$ WHR interaction. Thus, the support for the WHR hypothesis is not merely due to a specific stimulus. Of course, the non-significant Individual $\times$ WHR interaction does not imply that the WHR effect is identical for each stimulus person. Indeed, a monotone negative relationship was found for only three out of the six women. (However, for two of the remaining women the figure with the lowest WHR was judged most attractive; and in the last case, it was the original figure which received the highest ratings. Thus, it was never

the case that the highest WHR was most attractive.) Incidentally, the number of stimulus persons is another aspect where research on the human figure comes off badly when compared with face research. Body research usually relies on variations of a single stimulus person, and different researchers use the same set of stimuli. Face research, on the other hand, is typically based on relatively large numbers of faces, and different researchers use different picture sets. Thus, face researchers (in contrast to researchers of the human figure) are in a good position to gauge the generalizability of their findings.

This point may be illustrated by our own research on facial judgments. We have run a series of experiments with different picture sets to thoroughly check the generalizability of the findings (Henss, 1998a). Roughly speaking, we obtained the following results. (1) The factorial structure that emerges from facial judgments on a large number of personality scales is perfectly replicable over different sets of faces. (It shows large overlap with the Big Five; and contrary to the so-called attractiveness stereotype, physical attractiveness consistently emerged as a factor independent from the Big Five); (2) The degree of inter-individual consensus in ratings of strangers' faces varies systematically with the trait being judged, and the pattern of results is replicable over different sets of faces; (3) For each set of faces, there are a number of statistically significant correlations (simple or multiple correlations) between personality impressions or attractiveness on the one hand, and physiognomic features on the other hand. Most importantly, however, almost all of these correlations turned out to be *not* replicable in cross-validation studies. The consistent failure of cross-validating correlations between attractiveness and physiognomic traits seriously challenges a large number of findings from the attractiveness literature which are based on single stimulus sets. With regard to our present considerations, our studies on facial judgments clearly demonstrate that the use of different stimulus persons is indispensable. This is the only way to clarify which findings are generalizable over different stimuli and which are not. This problem has been almost completely neglected in research on the human figure.

A specific feature of our own investigations is the use of a between subjects design (also see Henss, 1995; Henss et al., 1998). In most previous WHR studies, the stimuli were presented simultaneously to the subjects. In the present experiment, however, each participant saw a single picture. Thus, he or she had no opportunity to compare the figure with another one, and he or she was not aware of the critical variable. In contrast to the common procedure, there needs to be no concern about demand characteristics in our study. Another aspect of our approach may—at first sight—appear to be a disadvantage. In a between subjects design, systematic inter-individual differences cannot be separated from the error variance. As a consequence, the test power is lower than it might be in a within subjects design. However, in light of the lower test power, our finding of a significant main effect of WHR is even more impressive. It occurred despite the fact that our WHR manipulation was subtle, despite the fact that participants could not compare different stimulus persons with each other, and despite the fact that any systematic inter-individual differences added to the error variance. Clearly, a between subjects design is not generally preferable to a within subjects design (or vice versa). Each method has its particular strengths and weaknesses. With regard to judgments in real life contexts, there are situations which can be modeled by a between subjects design while others are similar to a within subjects design. Sometimes we judge a single target person, and sometimes there is the opportunity to simultaneously compare different persons with one

another. However, one should note that the typical within subjects design (which employs variations of a single stimulus person) does not exactly match a pool comparison in real life: Simultaneous comparisons are not between one and the same person who systematically differs in WHR (or any other feature)—they are between *different* persons who may or may not differ in WHR but who definitely differ in a large number of features independent from WHR. In general, people differ along an infinite number of aspects, and it is by no means obvious, which aspects are most relevant. On the contrary, it is an extremely difficult task to determine the relevant parameters of person perception. As Brunswik (1956) pointed out half a century ago, it is crucial to use a large set of different stimuli that are representative of the 'universe' of stimuli. This, of course, is an additional argument for the use of realistic stimuli.

In the introduction we touched on a specific aspect that is often neglected in WHR research. It may be exemplified by the following quotation. "If the aesthetic-preference interpretation of the WHR hypothesis is correct, then a WHR of 0.5 should be ranked as the most attractive and fecund relative to larger WHRs" (Tassinary & Hansen, 1998, p. 154). This is a typical misconception of evolutionary psychological theory (and the concept of a runaway selection, in particular). Nothing in evolutionary theory implies that the relationship between WHR and female attractiveness be strictly monotone. Although there is abundant evidence that supranormal stimuli may be more effective than naturally occurring variations of a trait, it is self-evident that this principle cannot be stretched till infinity. For WHR, as for any other morphological trait, there is a certain point, beyond which it appears grotesque, thoroughly unhealthy, and repelling. Consequently, evolutionary thinking would predict a curvilinear relationship between WHR and female attractiveness. Although there are some conflicting results (Furnham et al., 1997; Henss, 1995; Tassinary & Hansen, 1998), most studies revealed a monotone negative relation between WHR and perceived attractiveness. However, the location of the optimum, beyond which this relationship will be reversed, is still unknown. My personal guess is that the optimum is significantly, but not very much, below the female population mean. Thus, WHR would be in line with a lot of other features that are most attractive if there is a slight deviation from the population mean that goes into the sex typical or the species typical direction (Henss, 1992, 1998a; Symons, 1995). Tassinary and Hansen's (1998) data suggest that the optimum may be well above 0.5. Future research should follow their lead and study WHRs that fall below the naturally occurring range.

Tassinary and Hansen's (1998) main argument concerns the fact that the stimulus set developed by Singh confounded WHR with relative waist size. Indeed, in previous studies—as well as in the present experiment—WHR was almost exclusively manipulated by varying the waist size while leaving hip size constant (an exception is Singh & Young, 1995, who varied waist and hip size). It is clear, however, that both waist and hip contribute to WHR. Tassinary and Hansen systematically varied both parameters. Furthermore, they also varied overall body weight (light, moderate, heavy). Within each weight category, three waist sizes (small, medium, large) were combined with three hip sizes (small, medium, large), to yield 1, 2, 3, 2, and 1 figures with WHRs of 0.5, 0.6, 0.7, 0.8, and 0.9, respectively. Thus, Tassinary and Hansen's complete set consists of 27 figures. In addition to their own figures, they also employed Singh's stimulus set. The data from Singh's set replicated the well established inverse relationship between WHR and attractiveness. Their own stimulus set, however, yielded a diametrically opposed picture. Overall, the results that are depicted in Fig. 4 (Tassinary and Hansen's 1998

p. 153), indicate a *positive* WHR attractiveness correlation![3] Strikingly, the authors do not comment on this fact. A closer inspection makes clear that this surprising result is due to a specific confound, inherent in Tassinary and Hansen's set. Within any combination of weight category and waist size, a lower WHR can only result from larger hips. Larger hips, however, yield the impression of a heavier figure. Thus, the surprising WHR attractiveness correlation is presumably due to the well known fact that heavier figures are less attractive. Although Tassinary and Hansen's figure set is not free from confounds, their study highlights an important aspect: it is not WHR per se that determines female attractiveness; rather, the relationship between WHR and attractiveness depends on waist *and* hip size (and overall body weight). This is a significant contribution which deserves further scrutiny, empirically as well as theoretically.

Tassinary and Hansen argue that hip size may be more influential than waist size. The importance of the hips has also been noted by Singh and Young (1995), who pointed out that large hips are preferred in many societies. The case of particularly large hips is also interesting with respect to a specific methodological problem. A large circumference of the hips may be obtained in different ways. At one extreme it may result from enormous fat deposits at the thighs while the buttocks are small—at the other extreme it may result from massive fat deposits at the buttocks while the thighs are pretty narrow. Only the first, but not the second, variant would yield a low WHR in a frontal view, which is typically used in two-dimensional pictorial representations of the stimulus persons. The fact that WHR as determined by a two-dimensional representation may not correspond well with three-dimensional measurements has not yet received much attention in the literature[4]. However, there is evidence that different ethnic groups vary dramatically with respect to relative buttock size (an extreme variant is steatopygia which has been described for Hottentots and South African Bushmen as well as the unrelated Andaman Islanders of Southeast Asia; Barber, 1995). Thus, one might suspect that the relationship between WHR and attractiveness may yield strong cross-cultural differences if the target persons were viewed in three dimensions and if there were high variability in buttock size.

The foregoing considerations have shown that the relationship between WHR and female attractiveness may be more complex than has been thought. However, there is ample empirical evidence that WHR can honestly signal a female's reproductive potential, and that perceptions of female attractiveness are in line with evolutionary psychological predictions (at least for a wide range of naturally occurring waist and hip sizes). Although WHR is a significant attribute of female attractiveness, it must be stressed that it is definitely not the most important one. Whenever both WHR and overall body weight have been manipulated it has become evident that weight accounts for much more variance than WHR. In the present study, overall body weight was not systematically varied. Instead, there were different stimulus persons who

[3] This is particularly true for the heavy and (to a lesser extent) the moderate weight category. For the light figures the results are mixed.

[4] Almost all studies reported exact WHRs for the figures (Singh's set: 0.7, 0.8, 0.9, and 1.0; Tassinary and Hansen's set: 0.5, 0.6, 0.7, 0.8, 0.9). One usually gets the impression that the researchers do not realize that these numbers are hardly more than crude approximations. (At least for Singh's figures, it seems evident that the value of 1.0 is not correct).

differed in a large array of morphological attributes. Not surprisingly, there were huge differences between the target persons on each dimension, while the WHR manipulation only affected the Attractiveness factor. However, even in regard to Attractiveness, the independent variable Individual explained more than twice as much variance than the WHR. A large body of face research suggests that a great deal of the perceived differences between the target persons may be attributable to the face (Henss, 1997, 1998a). Although there is no doubt that both the face and the figure play an important role in person perception, there is an intriguing scarcity of studies that take both aspects into account. In one of his earliest WHR papers Singh suggested the following hypothesis: ''WHR may be involved in initial stages of mate selection ... WHR could act as a wide first-pass filter, which would automatically exclude those women who are unhealthy or have low reproductive capability... the man may make contact with a potential mate, and in that event a second and much narrower filter may become operative. At this level other bodily features and facial attributes can be processed'' (Singh, 1993a, p. 394). From everything we know, we must conclude that the ''WHR as first-pass filter hypothesis'' is definitely untenable. All empirical evidence underlines the fact that WHR plays a much less potent role than the weight category or the face. A similar argument has been put forward by Lavanchy et al. (1999) and Henss et al. (1998). For further clarification, future research should figure out the relative contribution of the face and the body, and the methods must become far more sophisticated.

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