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Original Article

A WOMAN'S WALK: ATTRACTIVENESS IN MOTION

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Abstract: Men are attracted to the movements of women's bodies. The aim of this paper is to answer the question: what is the mechanism? The role of the peak shift effect in perceptions of physical attractiveness involving women's waist-to-hip ratios (WHRs) in biological motion is presented. Photographs of a coordinated motor pattern, walking, are investigated with a novel measurement method. Evidence is presented that the behavior pattern contains alternating left and right side, attractive (S+) and unattractive (S-), WHR stimuli. A WHR stimulus range is established that is sufficient to generate peak shift effects in perceptions of physical attractiveness. It is predicted that WHRs in attractive behavior patterns will be significantly lower than those previously found to be preferred using 0.70 WHR still images. Therefore WHRs in motion represent S++, or "supernormal stimuli", in behavior.

Keywords: ethology, supernormal stimuli, WHR, peak shift, physical attractiveness, behavior patterns.

Introduction

Studies of the perception of physical attractiveness from a bio-behavioral perspective focus on natural and sexual selection of morphological characteristics of the face and body. One proposed theory states that physical attractiveness, as it relates to women's bodies and faces, are honest signals of health and fertility (Thornhill & Grammer, 1999). Faces that are rated most attractive are characterized by averageness (Langlois & Roggman, 1990), symmetry (Perrett et al., 1999; Little & Jones 2003) and prominent secondary sexual characteristics (Fink & Penton-Voak, 2002). Also termed, "hormone markers", (Johnston et al., 2001), the exaggeration of secondary sexual characteristics has been shown to increase ratings of physical attractiveness (Perrett et al., 1998). These markers, "…elicit appropriate cognitive and-or emotional responses in members of the opposite sex" (Johnston, 2006).

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To develop his neuroaesthetics perspective, Ramachandran draws upon previous work delineating "supernormal stimuli" (Tinbergen, 1958) as well as the peak shift effect when he claims that art is not about realism, but, "involves deliberate hyperbole, exaggeration, even distortion, in order to create pleasing effects on the brain" (Ramachandran, 2004). Ramachandran notes that Hindu artists attempt to evoke specific responses from viewers; "…what the artist tries to do (either consciously or unconsciously) is not only capture the essence of something but also to amplify it in order to more powerfully activate the same neural mechanisms that would be activated by the original object". Images of Chola bronze statues of the goddess Parvati are given to illustrate this perspective and it is explained that when masculine features are subtracted from androgynous human forms and the resulting female form is amplified, the result is a caricature of feminine form (Ramachandran & Hirstein, 1999). This portrayal involves artistic depictions of body-features that, when accentuated, create supernormal stimuli.

Morphological indicators of the reproductive capacity of females are prioritized by males and are used to evaluate physical attractiveness by men and women (Buss, 1992; Buss, 1989; Buss, 2005). Self report data have consistently shown that female actual waist-to-hip ratios (WHRs) in frontal-views of approximately 0.70 are perceived to be highly physically attractive (Singh, 1993a; 1993b; 2006; Streeter & McBurney, 2003; Furnham, Petrides & Constantinides, 2005). These findings have been extended using line drawings in profile-views that also measure WHR across the waist and hips, accounting for the protrusion of the buttocks, in contrast to actual-WHRs as measured from the circumference of the waist and hips, where they were shown to be perceived as preferentially physically attractive in Hadza hunter–gatherer and American societies (Marlowe, Apicella & Reed, 2005). Thus, men's preferences for actual-, frontal- and profile (lateral)-WHRs center on approximately 0.70 WHRs (but see; Freese and Meland, 2002 for a counter argument).

Body weight influences, as measured by body mass index (BMI), on WHRs of approximately 19-20 kg/m^2 are also postulated to be ideally physically attractive (Fernham, Tan & McManus, 1997; Tovée et al., 1999a; Tovée & Cornelissen, 2001). When the waist and hips are independently varied in front and back-view images, men's WHR preferences are found to be more sensitive to changes of waist sizes than hip sizes, suggesting both WHR and BMI influence physical attractiveness ratings differently (Rozmus-Wrzesinska & Pawlowski, 2004). Body fat distribution also influences women's breast size and interacts with WHR influencing ratings of physical attractiveness (Fernham & McClellan, 1998). Marlowe's nubility hypothesis suggests that fat stored in protruding breasts are honest, supernormal stimuli, signaling nubility and reproductive value (Marlowe, 1998). Jasienska et al. (2004) found that women with narrow waists and large breasts have higher levels of reproductive hormones than women who had smaller breasts and wider waists. Variations of features of female anatomy have been investigated across a wide range (e.g., 625 WHR images) in body "shape space" and these "image-driven" variations produce gradations in perceptions of physical attractiveness (Smith et al., 2007).

However, varying body-shapes in frontal and profile-view still images, whether of line drawings, color photographs (Henss, 2000), in feminine (e.g., 0.7, 0.8 WHR) or masculine (e.g., .0.9, 1.0 WHR) conditions, in combination with a range of breast sizes (Streeter & McBurney, 2003), 2D and 3D computer generated images (Fan et al., 2004) only approximates the body-shapes ancestral hominids adapted in response to: communicating bodies are not static forms but dynamic sources of affective information in movement (Oberzaucher & Grammer, 2008). Therefore, while previous findings may be applicable to presentations of images of female forms, they fall short of adequately representing perceptions of physical attractiveness in 'real world' situations in which women's bodies are in motion.

Percepting physical attractiveness from static sources (e.g., photographs, paintings, sculptures, stationary bodies) differs from those of moving bodies by changing viewpoint-dependant perception of shape. Voracek and Fisher analyzed adult media actresses staring frequencies in magazines and films finding that low BMI actresses appeared more frequently in films while low WHR, low waist-to-bust ratio (WBR) and larger breasted actresses appeared more frequently in magazines (Voracek & Fisher, 2006). In an experimental investigation of proceptive behavior Clark used videos of men and women performing mock interviews in proceptive and unreceptive conditions and found that proceptivity increased attractiveness ratings suggesting intentionally directed proceptive signaling is used by receivers to allocate mating effort (Clark, 2008). Physical attractiveness is related to both body-shape and behavior. But how is women's behavior attractive?

Human gaits are dynamic behavior patterns that human visual systems use to identify socially relevant information, including walker's genders (Smith et al., 2002)."In one field investigation of women's nonverbal courtship signals at singles bars, a university snack bar, library and Women's Center, Moore catalogued "flirting behavior" and identified "parade" as a distinct form of walking:

> …rather than maintaining a relaxed attitude, the woman exaggerated the swaying motion of her hips. Her stomach was held in and her back was arched so that her breasts were pushed out; her head was held high. In general she was able to make herself "look good." (Moore, 1985).

Moore found that women who procept more frequently, in mate relevant contexts, are approached by more men. In another observational study, trained sexologists were able to accurately discern women's orgasmic history from video recordings of women walking, suggesting that rotation of the pelvis and vertebrae, as well as stride length signify, "fluidity, energy, sensuality, [and] freedom", that are cues embedded in movement from which astute observers may infer past sexual functioning (Nicholas, et al., 2008). Johnson and Tassinary's study of gait animations varied morphology and motion (e.g., sway and swagger) and found that men's and women's walks can be differentiated on the basis of shoulder and WHR cues. When subjects in their study were told the sex of the stimuli, visual scanning decreased suggesting that viewers use WHR cues more to determine the sex of ambiguous walkers. These behavior patterns are also modeled and exaggerated using light-point walkers; viewers can identify individual's gaits, discriminate between them in frontal, half-profile and profile-views and continue to recognize them even when rotated to novel views (Troje et al., 2005). Visual adaptation aftereffects to masculine and feminine stimuli also shift the perceived gender of neutral stimuli: from male to female and from female to male (Troje, 2002, Troje & Geyer, 2002, Troje et al., 2006). Gender shifts away from masculine characteristics (> ~0.80-.0.90 WHRs) toward more feminine characteristics (< ~0.70-.0.80 WHRs) in behavior patterns are physically attractive to heterosexual males.

Cultural practices of beautification, as other artistic practices, may rely on peak shift as a principle applied to the human form. Humans, considered as, "Homo Aestheticus", are natural artisans using their bodies as a medium to display the art of attractiveness (Dissanayake, 1992). In a previous study it was hypothesized that, just as the exaggeration of forms from a neuroaesthetic perspective may elicit greater responses from viewers of artistic works, exaggeration of secondary sexual characteristics may be particularly attractive physical stimuli eliciting heightened (i.e., peak-shifted) responses (Doyle, 2006).

In this early attempt to extend research on the peak shift effect to cultural practices of beautification and the physical attractiveness of secondary sexual characteristics, computer generated images of women's breasts in a semi-profile view were created using breast augmentation modeling software in "naturalistic" and "augmented" conditions that differed by "displacement", a measure from, "the point of greatest concavity or convexity to a line drawn from the nipple to the superior base [of the chest wall]" (Hsia & Thomson, 2003).

The naturalistic condition modeled symmetrical breasts with concave top contour lines and the augmented condition depicted "high profile" breast implants which created convex top contour lines. A manipulation of the bra size modeled was used to create four images in each condition: A-D cups. Though males, as recorded on a 7-point scale, reported overall more positive attitudes towards breasts than females, results failed to support the prediction that subjects would report more positive attitudes toward augmented breasts than naturalistic breasts. Shape changes alone did not affect self reports of the attractiveness of breasts; respondents may have found the augmented condition more 'unnatural' than attractive.

Here it is proposed that WHR preferences are due to the peak shift effect, "…a displacement of peak responding away from the S+ (a stimulus signaling availability of reinforcement) in a direction opposite the S– (a stimulus signaling lack of reinforcement)" (Keith, 2002), which is operative during reproductive age women's walking. This outline suggests that reproductive age human female motions while walking are "patterns in time" (Eibl-Eibesfeldt, 1975) and that these provide both attractive (S+) and unattractive (S-) stimuli from a reproductive age female body with an actual 0.70 WHR morphology. First, the natural motion of reproductive age women's gait is demonstrated to provide alternating left and right side S+ and S- WHR stimuli from frontal-view photographs. Second, a WHR stimulus range is established that is sufficient to generate peak shift effects in perceptions of physical attractiveness. Finally, it is predicted that WHRs in physically attractive behavior patterns will be significantly lower than those found to be preferred using 0.70 WHR stimuli. The still images below show that movement changes the spatial relationship between the waist and hips thereby changing the WHR and producing S++ stimuli and therefore WHRs in motion represent "supernormal stimuli" in behavior (Tinbergen, 1951).

Figure 1. Frontal and Actual 0.70 WHR.

The peak shift effect has yet to be investigated in ecologically valid scenarios involving women's WHRs. Here photographs of a female model (fig. 1) with a 0.70 actual-WHR (the circumference of the waist and the hips) and frontal-view WHR (the length across the waist and hips) are used to demonstrate the role of WHR and the peak shift effect in biological motion.

The distinction between previous research using measures of WHR and the viewpoint-dependant observational approach advanced here allows researchers to focus on observations of naturalistic scenarios. Actual-WHR measured as the circumference around the waist and the hips is not information that is available to observers in natural encounters and WHRs may change as bodies move through their normal repertoire. The shape of any complex object appears to change from one perspective to another whether the observer changes perspective or an object is in motion and WHRs in motion are dynamic sensory perceptions involving both the senders and receivers. They are viewpoint-dependant. Peak shift is proposed as a mechanism that 'attunes' physical attractiveness preferences to behavior. The outline presented here uses information available to observers, such as WHR as measured across the body at the level of the waist and hips, during species-typical behaviors which occur in naturalistic situations.

Methods

Measuring Supernormal Stimuli in Behavior

The photos below (fig. 2) show a 0.70 actual and frontal-view (see fig. 1) WHR model walker who was selected because her known WHR (0.70) corresponds with those used in previous research establishing WHR preferences. The model was 28 yrs., 5' 6' tall, weighed approximately 120lbs, was not a user of hormonal contraceptives and had a regular menstrual cycle at the time the photos were taken. After the model's waist and hips were measured, she was instructed to walk with arms raised to avoid obscuring her lower body. The model was aware of the purpose of the investigation. The photos were taken from a series of walking ‘trails’: only a representative sample depicted below.

Figure 2. Alternating sinusoidal curves while walking.

As the leading leg moves forward while walking, the lower body and torso align vertically causing the curve between the waist and hip to straighten increasing the WHR from an observer’s perspective. Simultaneously, on the opposite or trailing side of the body, the hip can be seen to jut outward accentuating the actual 0.70 curve between the waist and hip. Thus, while walking, the waist and hip on opposing sides of the body may both be conceptualized to be oscillatory sinusoidal curves alternately acting as S+ (preferred) and S- (non-reinforcing) stimuli.

By adding a vertically placed centerline and calculating separate WHRs from it for both the right and left side sinusoidal curves, it can be seen that frontal-view WHRs of substantially less than 0.70 and nearing 1.0 continuously alternate while walking. The accompanying images of a reproductive age woman taken while walking show .81 left-side, .64 right-side WHRs (fig. 3) and .55 left-side and .94 right-side WHRs (fig. 4). The structure of this behavior pattern therefore contains supernormal, or S++, WHRs that are significantly lower than 0.70.

*Figure 3.*WHR(.81|.64)

Figure 4. WHR (.55|.94)

Figure 5. WHR (.40|.96)

Figure 6. WHR (.94|.42)

When the model volitionally displayed a 'runway walk' in a separate trail the photos show exaggerated hip sway. The left WHR image (fig. 5) shows (.40|.96 WHR) and the right WHR image (fig. 6) shows (.94|.42).

Discussion

It was proposed that the continuously alternating motion of the waist and hips measured from a model with an actual 0.70 WHR while walking would create left and right side, S++ WHR stimuli of significantly less than 0.70 that are perceived to be highly physically attractive, supernormal stimuli in behavior. If the theoretical outline presented here is correct, the preference for frontal and actual WHRs of 0.70 may be applicable to still images while bodies in motion are dynamic sources of information requiring analysis in their own right.

Further observational research and experiments focusing on the peak shift effect and patterns of motion from an ethological perspective may reveal subtler relationships between sexual dimorphism, proceptive behavior and women's ability to peak shift perceptions of physical attractiveness with intentional behaviors. Researchers utilizing evolutionary frameworks to discover relationships between behavior patterns and evolved psychology using wider ranges of actual WHRs, as well as other salient measures that could interact (e.g., BMI, leg length, WBR), may gain insight into variations in preferences for both static and dynamic body shapes as well as their development. The author believes that a wider range of actual WHRs in motion, both lower and particularly higher than .07, could create alternating left-right WHRs that are supernormal stimuli in behavior, which includes a wider range of female body shapes that are attractive to men.

This theoretical outline of supernormal stimuli in women's walks is acknowledged to be faulty in at least two ways. Walking was selected as an attractive behavior for this theoretical outline because it is an uncontroversial example of a coordinated motor pattern that most people are familiar with. However, by focusing on frontal WHRs, a naturalistic aspect of view-dependency was lost since the frontal perspective was held constant while many more are observed in naturalistic situations. The author's position is that this inadequacy allowed a simplified version of the overall outline of supernormal stimuli in behavior and was a reasonable trade-off for clarity in the presentation.

The outline presented here is intended to be applicable to secondary sexual characteristic and behavior generally. For example, the 0.70 actual WRH images below (figs. 7-10) are from a dance-like behavior sequence. It can be seen that the WHRs, as measured across the figures, vary as the body moves through the behavior pattern resulting in a collage of left-right WHRs changing in sequence.Though the theoretical outline presented here used the coordinated motor pattern of walking for clarity and to hold view-point constant, the above suggests its applicability to a wider range of behaviors including intentional and unintentional proceptive signaling in profile, side and posterior views.

Figures 7-10 (Left to Right).
Figure 7. WHR .82 across, L-R WHR (.43|1.90).
Figure 8. WHR .70 across, L-R WHR (.45|1.14).
Figure 9. WHR .69 across, L-R WHR (.52|1.0).
Figure 10. WHR .66 across, L-R WHR (.62|.68).

Though WHRs are used to example peak shifted behavior patterns, it is suggested that the adaptiveness of structural modifications and behavioral exaggeration is not limited to either sex or WHRs but may also be important to sex characteristics and cultural practices of beautification. Height and leg length preferences may shift perception of physical attractiveness as bodies move in the coronal plane. For example, images exaggerating leg lengths by 5 percent, changing leg-to-body ratio (LBR), have been found preferentially physically attractive (Sorokowski & Pawlowski, 2008) and wearing high heeled shoes makes the legs appear longer.

Also, hormone markers may be honest signals of fertility while volitionally controlled proceptive behavior patterns may be deceptive. An exaggerated 'runway walk' is an obvious volitional and pseudo-proceptive signal but a subtler relationship may still exist within gait patterns across the menstrual cycle. If intentional proceptive signaling is under volitional control during times of high fertility, the contrast between a less feminine 'baseline' walk found during ovulation (Provost, Quinsey & Troje, 2008) and subtle or exaggerated movement variations would be more effective, not less, when peak-shifted against more typical gaits over the menstrual cycle. A less feminine baseline would be both easier to exaggerate and subtler changes may have a greater effect. It remains to been shown that men find intentionally proceptive behavior physically attractive but also manipulative and not honest signals, or if men respond differently to exaggerated proceptive signaling as it occurs in contrast to typical gaits across the menstrual cycle.

A second weakness of this theoretical outline is that adding a vertically placed centerline assumes that viewers are stationary rather than also in motion. An example image (fig. 11) of a vertically placed centerline that is tilted from the middle of the pelvic bone to the center of the sternum shows that results of alternate placements of reference points from which to measure left and right side WHRs give similar results to those presented above. The tilted centerline measurement was not presented since bodies in motion are changing position in reference to a perceiver; not changing the reference point of the perceiver (i.e., head position). The frontal view was held constant in order to measure WHRs in motion. The brain's visual systems may use the equivalent of vertical and horizontal line detecting cells to process edges and contour, or use prototypes during ontogeny where, as Eibl-Eibesfeldt writes, "The interpretation of stimuli apparently proceeds on the basis of phylogenetic experience.", (Eibl-Eibesfeldt, 1989), whether the viewer's head is stationary or in motion. This component remains open to further investigation but is beyond the scope of this thesis. Following on the above, it is suggested that WHR values observed in behavior patterns are supernormal stimuli sufficient to merit further investigation of the peak shift approach to physical attractiveness in motion.

Figure 11. WHR(.68|.77)

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