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Eye-Tracking of Men's Preferences for Waist-to-Hip Ratio and Breast Size of Women

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Abstract Studies of human physical traits and mate preferences often use questionnaires asking participants to rate the attractiveness of images. Female waist-to-hip ratio (WHR), breast size, and facial appearance have all been implicated in assessments by men of female attractiveness. However, very little is known about how men make fine-grained visual assessments of such images. We used eye-tracking techniques to measure the numbers of visual fixations, dwell times, and initial fixations made by men who viewed front-posed photographs of the same woman, computer-morphed so as to differ in her WHR (0.7 or 0.9) and breast size (small, medium, or large). Men also rated these images for attractiveness. Results showed that the initial visual fixation (occurring within 200 ms from the start of each 5 s test) involved either the breasts or the waist. Both these body areas received more first fixations than the face or the lower body (pubic area and legs). Men looked more often and for longer at the breasts, irrespective of the WHR of the images. However, men rated images with an hourglass shape and a slim waist (0.7 WHR) as most attractive, irrespective of breast size. These results provide quantitative data on eye movements that occur during male judgments of the attractiveness of female images, and indicate that assessments of the female hourglass figure probably occur very rapidly.

Keywords Sexual attractiveness · Evolution · Female waist-to-hip ratio · Female breast size · Eye-tracking

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Introduction

The nature of physical attractiveness has fascinated scholars for centuries. Indeed, attractiveness has often been shrouded in mystery. However, people across cultures state that physical attractiveness is an important trait in a potential partner (Buss, 1989). Evolutionary psychologists have suggested that selection has shaped human cognitive mechanisms to recognize physical traits that signal health and fertility (Grammer, Fink, Møller, & Thornhill, 2003). The attractiveness of such traits may therefore represent the results of sexual selection operating within ancestral human populations (Buss, 2003; Miller, 2000).

Men and women are strikingly sexually dimorphic in muscularity and body fat. Women have almost twice the amount of body fat of men (Clarys, Martin, & Drinkwater, 1984). The distribution of body fat is a secondary sexual characteristic in women. Body fat is laid down during pubertal development on the hips, buttocks, thighs (the gluteofemoral region), and breasts. Body fat distribution is important for triggering menarche in girls (Lassek & Gaulin, 2007) and maintaining regular ovulatory cycles (Singh, 2002). The distribution of women's body fat can be measured using the waist-to-hip ratio (WHR), which computes the ratio between body circumference at the waist and the hips (Singh, 1993). Women with lower WHRs have a body fat distribution consistent with greater health and reproductive potential (Singh, 2002, 2006) and, at the physiological level, it has been shown that larger breasts and slim waists are associated with higher estrogen and progesterone levels (Jasienska, Ziomkiewicz, Ellison, Lipson, & Thune, 2004), which are predictors of the probability of conception (Lipson & Ellison, 1996). Images of women with low WHRs (in the range 0.6–0.8) are more attractive to men from Cameroon (Dixson, Dixson, Morgan, & Anderson, 2007), Germany (Henss, 2000), China (Dixson, Dixson, Li, & Anderson, 2007), the UK (Furnham, Tan, &

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McManus, 1997), the U.S., and New Zealand (Dixson, Dixson, Bishop, & Parrish, 2008).

The evolutionary significance of prominent breasts in women has been much debated. Some authors have ascribed a functional role to large breasts. For example, as humans evolved hairlessness and bipedal locomotion, larger pendulous breasts were adaptive for breast-feeding babies (LeBlanc & Barnes, 1974) and provided a soft cushion that is psychologically comforting to the infant (Smith, 1986). During times of nutritional scarcity, breasts may act as milk storage organs (Low, Alexander, & Noonan, 1987) and fat reserves for breast-feeding babies (Anderson, 1983). However, many of these arguments have since been refuted. There is no relationship between larger breasts prior to pregnancy and improved lactation, as women with smaller breasts are able to feed their babies as effectively (Anderson, 1988; Pond, 1998). Breast enlargement may occur as a by-product of gluteofemoral fat deposition (Pawlowski, 1999) and theories ascribing a functional role to permanently enlarged breasts remain debatable. However, sexual selection via male partner choice may also explain the evolution of prominent breasts in women as a cue to adult sexual maturity (Gallup, 1982; Marlowe, 1998). Studies of male preferences for female breast size have produced mixed results. Some studies have found that men rate line drawings of women with medium sized breasts as most attractive (Horvath, 1981; Wiggins, Wiggins, & Conger, 1968) while other studies have found that men prefer smaller breasts (Furnham, Swami, & Shah, 2006) or larger breasts (Singh & Young, 1995). The mixed responses from men reported in these studies suggest that further investigations of female breast size and sexual attractiveness would be valuable.

How do men analyze female morphological traits, such as WHR and breast size, when reaching decisions about the overall attractiveness of the female face and body? Eye-tracking provides a more objective measurement of the focus of attention during judgments of attractiveness than questionnaire-based studies. Attractiveness, particularly in women, comprises a set of physical traits that captures the attention of the opposite sex (Maner, Gailliot, & DeWall, 2007). Eye-tracking research has shown that participants of both sexes look preferentially at faces of attractive women (Fink et al., 2008; Maner, DeWall, & Gailliot, 2008). However, there is currently only limited information on how men process female WHR when making attractiveness judgments. Suschinsky, Elias, and Krupp (2007) conducted eye-tracking studies to measure men's responses to female images varying in WHR. The images were clothed, but a consistent finding was that men spent more time examining the breasts, irrespective of variations in WHR. Eye-tracking techniques have also been used to measure visual attention of both sexes to images depicting erotic heterosexual interactions (Lykins, Meana, & Kambe, 2006; Rupp & Wallen, 2007). However, in such cases, the visual scenes are complex, making it difficult to conduct fine-grained analyses of visual attention in relation to specific morphological traits.

In this study, we used eye-tracking procedures to measure how men examined images of front-posed naked women varying in WHR and breast size. Specifically, we measured the initial fixation, number of visual fixations, and the amount of time men spent looking at defined areas of the female body and face. Men were also asked to rate the various images for sexual attractiveness. The purpose was to quantify eye movements and visual attention along with judgments of female attractiveness. Several hypotheses might be advanced regarding eye movements during judgments of female attractiveness. Men might spend significant time examining the face, the breasts, the waist or the pubic area given that all these areas are involved in female attractiveness and reproduction. However, the crucial issue was to obtain quantitative measures of which areas of the body men looked at and how frequently they examined them during eye-tracking experiments.

Method

Participants

A total of 36 men of European descent, ranging in age from 22 to 42 years ($M = 27.42$ years; $SD = 4.99$), were recruited opportunistically from the post-graduate student body at Victoria University. Participants were given individual verbal orientation before the start of data collection and allowed some time to familiarize themselves with the room and eye-tracking machine. The details of the study were not discussed with participants beforehand. However, when each participant had completed the experiments, they were provided with written details of the rationale for the research. Each participant was told of their right to withdraw themselves or their data from the study without prejudice. The project was pre-approved by the Human Ethics Committee of the School of Psychology at Victoria University.

Measures and Procedure

A photograph of a front-posed naked woman was scanned from Simblet (2001). Waist-to-hip ratio (WHR) and breast size were manipulated in this image using Photoshop Version 7.0. Three different breast sizes were created using anthropometric measurements taken from Brown et al. (1999). Images with small breasts (80% of the original image), medium (unchanged), and large (120% of the original size) were made. Each breast size was shown on a figure with a waist-to-hip ratio of 0.7 or 0.9. Thus, six images were constructed in total. The experiment was programmed using the SR Research Experiment Builder (version 1.4.128 RC) and

conducted on a 3-GHz Pentium D computer. Stimuli were presented on a 21 inch monitor at a resolution of 1024 × 768 pixels and with a refresh rate of 60 Hz.

Participants were seated in a comfortable chair in a quiet room facing the monitor at eye level at a viewing distance of 57 cm, maintained by a forehead and chin-rest. They underwent eye-tracking trials in which each image was presented individually, in random order on the computer screen for 5-s.

Attractiveness

At the end of each presentation, participants were instructed to rate the image for attractiveness using a keyboard with a six point Likert scale in which 1 = unattractive, 2 = somewhat attractive, 3 = moderately attractive, 4 = attractive, 5 = very attractive, and 6 = extremely attractive.

Eye-Tracking

Using the EyeLink® 1000 Tower Mount Head Supported System (SR Research Ltd., Ontario, Canada), eye position and eye movements were determined by measuring the corneal reflection and dark pupil with a video-based infrared camera and an infrared reflective mirror. The eye tracker had a spatial resolution of 0.01° of visual angle and the signal was sampled and stored at a rate of 1000 Hz. While viewing was binocular, recording was monocular, measuring right eye movements only as this is a standard procedure in eye-tracking studies (e.g., Lykins et al., 2006). Calibration and validation of measurements were performed before each experimental session.

The stimulus image was divided into six anatomical regions for subsequent analysis of eye-tracking data (Fig. 1). The six regions were defined as follows: (1) the face and neck, from the top of the head to the level of the clavicle; (2) breasts, from the top of the clavicle to the posterior border of each breast; (3) midriff, including the waist; beginning from the below the breasts to the widest part of the hips; (4) pubic triangle, as defined by the limits of the pubic hair; (5) the thighs, the upper portion of the leg ending at the knee and (6) lower leg and feet. The arms were not included in the analyses as they received so little visual attention.

In each of the six regions, three dependent variables of eye movement were measured: first fixation, number of fixations, and amount of time spent (dwell time) examining the area. The first region of the body to be examined, from 200 ms after the start of the test, was defined as the first fixation. The lag time of 200 ms was allowed in order to give sufficient time for the eye to move from its initial fixation point in the center of the screen. Each time the eye moved, the eye-tracking machine recorded a new fixation. Total fixations which occurred in each area were summed during the analysis. Likewise, the machine measured individual fixation times, so that it was possible to obtain the total time spent examining each of the six regions.

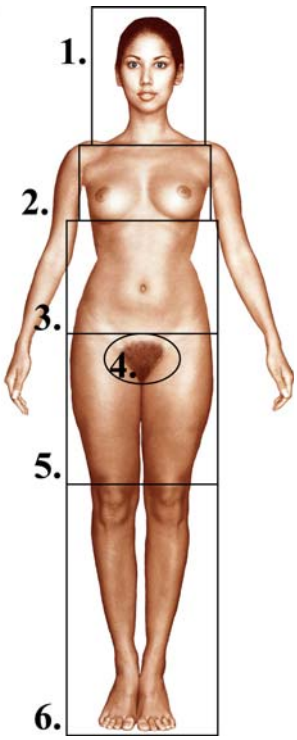


Fig. 1 Female images were divided into six regions in order to analyze male visual attention during eye-tracking. 1 = head, 2 = breasts, 3 = midriff, 4 = pubic region, 5 = thighs and 6 = lower legs and feet

Results

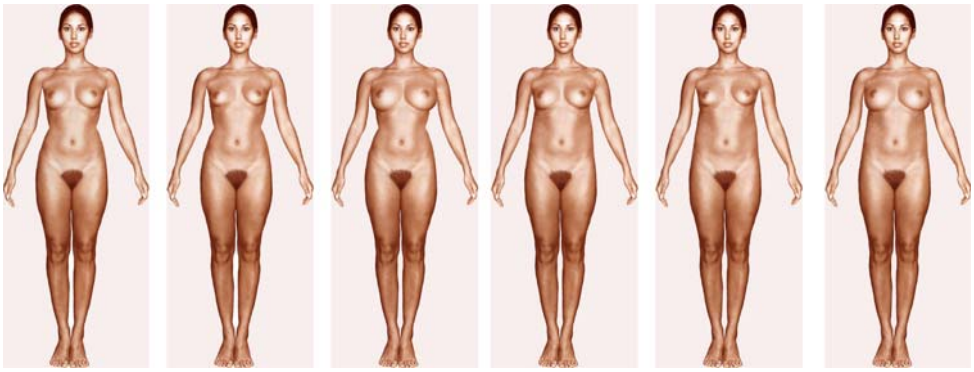
Attractiveness

Figure 2 shows the mean attractiveness ratings as a function of WHR and breast size. A 2 (WHR: 0.7 vs. 0.9) × 3 (Breast Size: Small, Medium, Large) analysis of variance (ANOVA) yielded a significant main effect for WHR on attractiveness ratings, $F(1, 35) = 64.26, p < .0001$. Images with a 0.7 WHR ($M = 4.08$, $SD = 1.04$) were more attractive than images with a 0.9 WHR ($M = 2.93$, $SD = 1.07$).

Eye-Tracking

First Fixation

Table 1 shows the number of first fixations made on each of the five body regions for the six images used in this study. Chi-square tests were conducted for each image to determine whether these fixations occurred on specific body regions more frequently than predicted by chance. Due to the absence of first fixations on the lower legs and feet this body region was not included in the analyses. In each image the breasts received the highest number of first fixations. First fixation counts on the breasts reached statistical significance for images with 0.7 WHRs with small ($p < .05$) and medium sized breasts



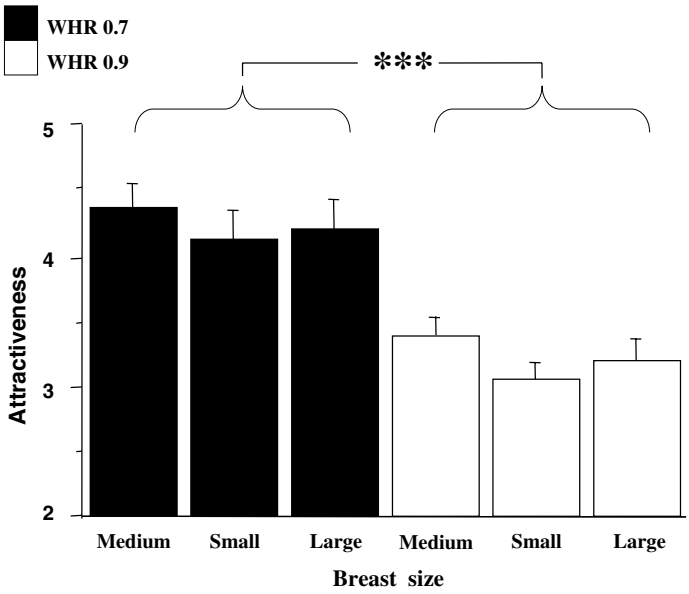


Fig. 2 Mean ratings (+SEM) for sexual attractiveness of six front-posed female figures varying in WHR (0.7 or 0.9) and breast size (small, medium or large). *** $p < .001$

($p < .01$), and images with 0.9 WHRs and medium ($p < .01$) or large sized breasts ($p < .001$). The midriff was also looked at very frequently in all images (Table 1). Although these effects were not statistically significant it was noteworthy that 33%of first fixations overall involved the midriff, while 47% involved the breasts. Thus, 80% of first fixations were on the breasts and midriff of the figures, while the remaining body regions accounted for only 20% of first fixations.

Number of Fixations and Dwell Times

A 2 (WHR) × 3 (Breast Size) × 6 (Body Region) × 5 (Time: Seconds 1–5) repeated measures ANOVA yielded a significant main effect of time for number of fixations, $F(4, 840) = 5.62$, $p = .001$, and dwell times, $F(4, 840) = 8.71$, $p = .001$. As illustrated in Fig. 3, a rapid drop in both number of fixations and dwell times occurred after the first three-seconds. Therefore, subsequent analysis was based only on the first three-seconds of the eye-tracking experiment.

For number of fixations, a 2 (WHR) × 3 (Breast Size) × 6 (Body Region) × 3 (Time: Seconds 1–3) mixed model repeated measures ANOVA yielded a significant Body Region × Time interaction, $F(10, 350) = 7.38$, $p = .001$ and a significant Breast Size × Time interaction, $F(4, 140) = 3.23$, $p = .014$. These two-way interactions were qualified by a three-way interaction between Breast Size, Body Region, and Time, $F(20, 700) = 4.07, p = .001$. Figure 4 shows that this interaction was driven primarily by attention to the breasts and head during the first second of the eye-tracking session. When looking at images with large breasts, participants made significantly more fixations on the breasts than the head ($t = -10.21$, $df = 35$, $p < .001$) and the midriff ($t = 7.94$, $df = 35$, $p < .001$). When participants looked at figures with small breasts, fixations were more often on the breasts than the head ($t = -2.45, df = 35, p < .01$) and the midriff ($t = 3.09$, $df = 35$, $p < .01$). When looking at images with medium sized breasts, participants looking at the head more than the breasts, although this was not statistically significant ($t = 1.37$). The breasts were looked at more than midriff ($t = 5.68$, $df = 35$, $p < .001$), as was the head ($t = 6.47, df = 35, p < .001$).

For dwell times, a 2 (WHR) × 3 (Breast Size) × 6 (Body Region) × 3 (Time: Seconds 1–3) mixed model repeated measures ANOVA yielded a significant Body Region × Time interaction, $F(10, 350) = 4.20$, $p = .001$, and a Breast Size ×

Table 1 Number of men ($N = 36$) who made their first visual fixations on each of the five body regions

Image no.	Head χ^2	Midriff χ^2	Breast χ^2	Thighs χ^2	Pubis χ^2
1.	2	13	16	1	4
	3.76	4.67	10.76*	5.34	1.42
2.	2	9	17	1	7
	3.76	0.45	13.34**	5.34	0.09
3.	3	13	15	3	2
	2.45	4.67	8.45	2.45	3.76
4.	3	13	15	0	5
	2.45	4.67	8.45	7.20	0.67
5.	2	11	18	1	4
	3.76	2.01	16.20**	5.34	1.42
6.	0	13	20	1	2
	7.20	4.67	22.76***	5.34	3.76

Data are shown for all six female images

WHR/breast sizes are as follows: Image 1. = 0.7/small; 2. = 0.7/medium; 3. = 0.7/large; 4. = 0.9/small; 5. = 0.9/medium; 6. = 0.9/large. Chi-square analyses compared observed number of men fixating on a given region to the numbers expected by chance (7.20)

* $p < .05$; ** $p < .01$; *** $p < .001$

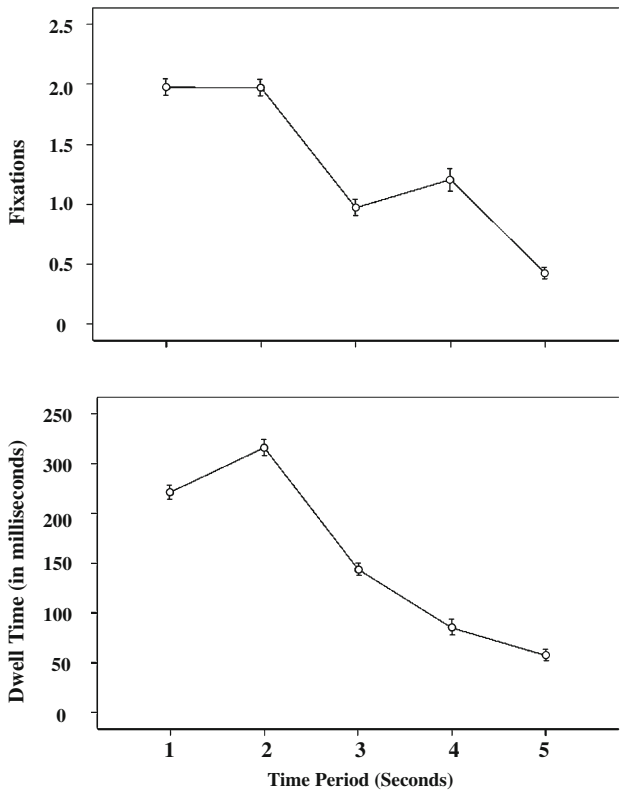


Fig. 3 Combined means (+SEM) across the six images for number of fixations (*upper graphs*) and dwell times (*lower graphs*) made over the five-seconds of the eye-tracking study

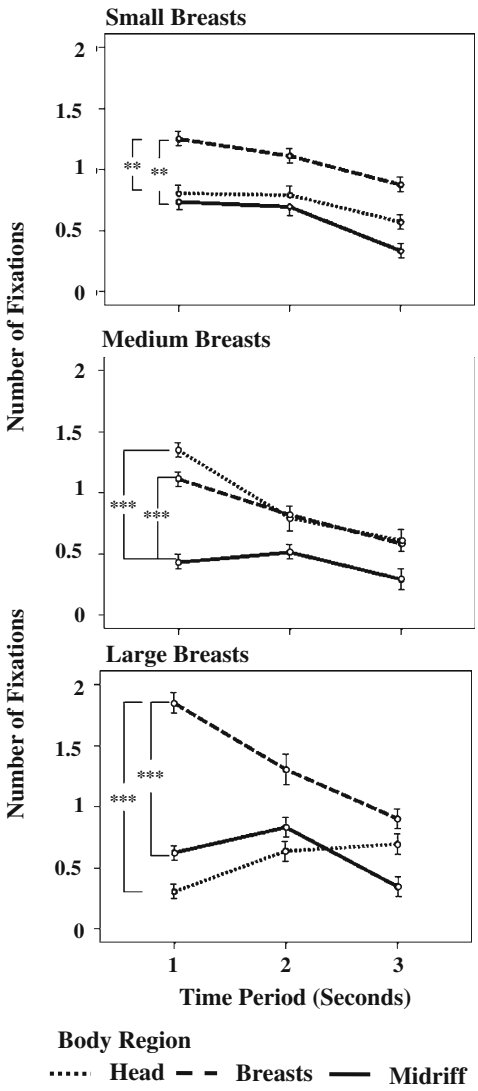


Fig. 4 Mean number of fixations (+SEM) made on images with small, average or large breasts for the first three-seconds of the eye-tracking study. Separate lines indicate the body region (head, breasts and midriff) within the image being looked at. ** $p < .01$; *** $p < .001$

Body Region interaction, $F(10, 350) = 8.34$, $p = .001$. These two-way interactions were qualified by a three-way interaction between Body Region, Breast Size, and Time, $F(20, 700) = 1.57, p = .053$. These interactions reflect the fact that the amount of time spent looking at either the head or the breasts was most pronounced during the first second of the eye-tracking experiment (Fig. 5). When images had small breasts, participants spent longer looking at the breasts than the head ($t = 2.62$, $df = 35$, $p < .01$) and the midriff ($t = 2.42$, $df = 35$, $p < .01$). When looking at images with large breasts, men spent more time looking at the breasts than the head ($t = 10.77$, $df = 35$, $p < .001$) and the midriff ($t = 5.53$, $df = 35, p < .001$). When the images had average sized breasts, participants spent more time looking at the breasts than the midriff ($t = 4.63$, $df = 35, p < .001$). The head

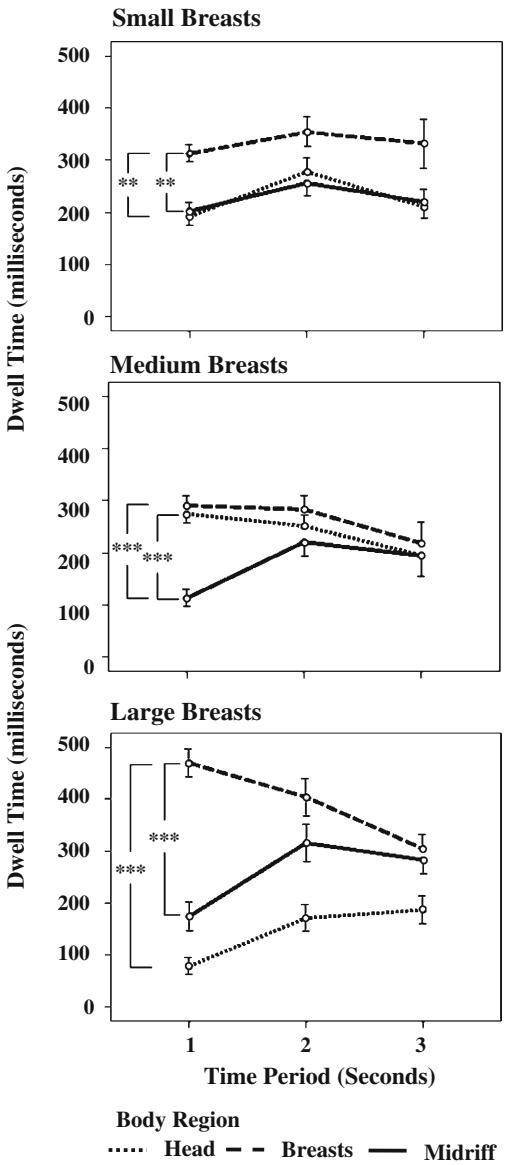


Fig. 5 Mean dwell times (+SEM) made on images with small, average or large breasts for the first three-seconds of the eye-tracking study. Separate lines indicate the body region (head, breasts and midriff) within the image being looked at. ** $p < .01$; *** $p < .001$

was also looked at for longer than the midriff ($t = 4.35$, $df = 35$, $p < .001$). However, men spent almost as much time looking at the head as the breasts ($t < 1$).

Discussion

Eye-tracking techniques provide novel insights in the study of male preferences for female body shape. Men spent consistently more time looking at the breasts of front-posed female images and also made significantly more fixations upon the breasts than other regions of the body or head. The midriff and thighs received less attention. However, men in general allocated more attention to the upper body, including the face, breasts, and midriff, than to the thighs, pubic area, legs, and feet. These effects were most pronounced during the first three-seconds of a five-second eye-tracking session. By the fourth and fifth second, men paid significantly less attention to all regions of the female body and head.

Despite the large amount of attention paid to the breast area, it was the WHR that primarily determined male ratings of female attractiveness. Thus, images having WHRs of 0.7 were consistently rated as more attractive than the 0.9 WHR images, irrespective of breast size. The *initial* visual fixation of a session most frequently involved either the breasts or the midriff, including the waist. The initial eye-movement occurs within the first 200 ms and was followed by longer and more frequent fixations upon adjacent areas.

It appears, therefore, that men may make assessments of female WHR very rapidly during the eye-tracking procedure, but spend most time examining those areas where secondary sexual deposition of fat has occurred (i.e., the breasts). The gluteofemoral region is also an important site of fat accumulation in women. The buttocks were not visible in the images used for these experiments. Anthropological studies of the Hadza hunter-gatherers in Tanzania have shown that men find the female buttocks to be highly attractive and rate images with a low WHR and larger buttocks as most sexually attractive (Marlowe, Apicella, & Reed, 2005). This leads us to predict that eye-tracking studies using back-posed images of women varying in WHR should provide further insights concerning how men make visually-based judgments of female attractiveness. We predict that numbers of fixations and dwell times will be highest for the buttocks when men view back-posed images of women.

A potential shortcoming of the current research was that the face was identical in each figure presented. Facial features are important in male assessment of female physical attractiveness (Hassebrauck, 1998). Novel or unique features capture attention during eye-tracking studies (Sütterlin, Brunner, & Opwis, 2008). As facial features were not manipulated in the current study, one could argue that men paid more attention to the breasts and midriff as these were the novel items that were manipulated. This is a valid criticism; however, in a recent eye-tracking study where participants viewed photographs depicting complex erotic and non-erotic heterosexual scenes, men spent more time looking at women's bodies than their faces (Lykins, Meana, & Strauss, 2008). Interestingly, women with higher levels of estrogens have been rated as having more attractive faces (Law-Smith et al., 2006). Thus, facial features may signal healthier levels of estrogens to potential partners in the same way as breast size and WHR (Jasienska et al., 2004). Therefore, it would be valuable in future studies to manipulate facial features as well as body morphology to gain a more complete understanding of male assessments of female sexual attractiveness.

In a previous eye-tracking study, Johnson and Tassinary (2005) found that men used WHR in assessing the sex of people when walking. However, it is crucial to note that these researchers employed as stimuli figures from which "all observable sex characteristics had been removed." Thus, the figures used lacked cues such as pubic hair, breasts, and genitalia. In the absence of these cues, subjects paid particular attention to the waists of moving images. In another study, Suschinsky et al. (2007) presented men with sets of three clothed images of identical women, varying only in WHR. Despite the possible distraction of the clothing, Suschinsky et al. found that men attended more to the breasts as well as the face of such images. Both the studies cited above produced results that were consistent with our findings concerning the importance of the breast and waist (midriff) for male assessments of female attractiveness.

It is likely that a constellation of traits influences female sexual attractiveness to men. WHR is instrumental as a precopulatory cue to female health and fertility. Eye-tracking research suggests that men dwell longest on those areas of the female body where fat reserves are greatest (i.e., the breasts and gluteofemoral region), but also achieve an overall or gestalt appreciation of the hourglass body shape incorporating a narrow waist and full breasts. Results of the current study indicated that men began to analyze essential components of the hourglass feminine shape, including the midriff and breasts, during the first 200 ms of viewing. This provides further evidence that the WHR is rapidly processed and that it represents a "first pass filter" in men's ratings of female attractiveness (Singh, 1993). Men may be looking more often at the breasts because they are simply aesthetically pleasing, regardless of the size. However, breast morphology is more complex than size alone. Breast shape and firmness, as well as nipple and areola configuration, may signal age and reproductive status (Gallup, 1982; Marlowe, 1998; Symons, 1995). Thus, it would be valuable for future eye-tracking research to manipulate more aspects of female breast morphology. The results presented here provide additional evidence confirming that female WHR and breasts represent important sexually selected traits that are highly attractive to men.

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