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RESEARCH ARTICLE

Sex Differences for Preferences of Shoulder to Hip Ratio in Men and Women: an Eye Tracking Study

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Abstract

Shoulder to hip ratio (SHR) is a sexually dimorphic trait in humans, yet no previous study has investigated the gazing behavior and perceived physical attractiveness of men and women in relation to men and women's SHRs. Men and women are attentive to men's upper body and consider higher SHRs as cues to masculinity, strength, and formidability. Moreover, while women's shoulder width varies from one individual to another, to our knowledge no previous study has investigated perceived attractiveness and eye movement in relation to women's SHR. Therefore, in the current study, we investigated attractiveness ratings and eye movements of both men and women to front- and back-posed male and female stimuli varying in SHR. Our results showed that men prefer more masculine ratios for men and less masculine ratios for women. However, the results also showed that women preferred an intermediate SHR for both men and women in the back view while their preference in the front view is not influenced by SHR. Eye movements showed that men viewed the chest region of other men in the front and back views of stimuli, and they had longer dwell time on chests of male stimuli with higher SHRs, while no significant difference was found for dwell time on chests of female stimuli varying in SHR. Also, no differences were observed for female participants in dwell time, for either chest regions of SHRs of male stimuli or for the chests of female stimuli. Altogether, the results of this study suggest that men more than women are attentive to variations in SHRs.

Keywords Shoulder to hip ratio · SHR · Physical attractiveness · Eye tracking · Sex differences · Formidability

Adolescent and adult skeletal sexual dimorphism is influenced by dimorphic androgen serum levels (Kasperk et al. 1997), which facilitate differentiation between male and female body forms (Barber 1995; Grammer et al. 2003; Pazhoohi and Liddle 2012). Sexual dimorphism plays an important role in physical attractiveness, and there is a positive relationship between physical fitness, strength, and men's attractiveness (Dixson et al. 2003; Hönekopp et al. 2007). Specific sexually dimorphic traits, such as shoulder to hip ratio (SHR), have been associated with attractiveness in men (Braun and Bryan 2006) and are important traits in assessing other men due to its association with competitiveness, egalitarianism, and formidability (Sell et al. 2017; Price et al. 2011; Price et al. 2017). Although previous studies have investigated attractiveness and attention using a mate preferences paradigm, the aim of this study is to see how men and women rate and view male and female stimuli that vary in SHR to determine which SHRs (low, intermediate, or high) are most visually appealing and garner the most visual attention.

SHR, the circumference of the shoulders relative to the hips, is a sexually dimorphic trait that is associated with attractiveness in men (Braun and Bryan 2006; Horvath 1981). Men with broad shoulders are considered more attractive by women (Fan et al. 2005; Furnham and Nordling 1998; Tovée et al. 1999), and women report that they would prefer to engage in sexual

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activities with men who have more masculine ratios (Braun and Bryan 2006). The preference for men's masculine body forms by women is found across numerous cultures such as New Zealand and the USA (Dixson et al. 2010a), China (Dixson et al. 2007a), Cameroon (Dixson et al. 2007b), and Australia (Mautz et al. 2013). Cues of upper body strength have been predictive of 70% of the variance in women's attraction to men (Sell et al. 2017) and contribute to men's mating success (Hill et al. 2013; Kordsmeyer et al. 2018). Men also desire more masculine body forms because they consider muscularity to be related to increased attractiveness to women and increased success in intrasexual competitions (Frederick et al. 2007). Men with higher SHR also report higher body esteem and self-efficacy (Pazhoohi et al. 2012) and self-report an earlier age of sexual activity and masturbation, a greater number of sexual partners, and more extra-pair copulations (Hughes and Gallup 2003; Lassek and Gaulin 2009). It is reported that men are more attentive to rivals' upper body (including chest and shoulders) and their jealousy is evoked by exposure to rivals with high SHR (Buunk and Dijkstra 2005; Massar and Buunk 2009). Research exploring formidability has shown that men with high SHRs may be advertising physical competitiveness and lack of egalitarianism (Sell et al. 2017; Price et al. 2011, 2017). Counterintuitively, it appears that SHR does not influence the preferred comfort distance of social interactions in virtual environments, for either men or women (Pazhoohi et al. 2018).

In women, a sexually dimorphic trait that is commonly researched is the waist to hip ratio (WHR), which is the circumference of a women's waist divided by the circumference of her hips. WHR is known to be associated with important reproductive-relevant cues, and men find this characteristic attractive in investigations of mate preferences (Singh 1993; Singh & Young 1995). Women who display lower WHRs (i.e., 0.7) have been rated as more attractive, in better health, and of higher reproductive value (Singh & Young 1995). One explanation of why WHR is an attractive trait is that they are frequently associated with sex-typical features indicating fertility (Butovskaya et al. 2017). Low WHRs (i.e., $<.74$) are predominantly perceived as female, while higher WHRs (i.e., $>.86$) are typically perceived as male (Pazhoohi and Liddle 2012). Given that low WHRs are perceived as female sex-typical, reproductive-relevant cues, it can be inferred that men and women not only use this dimorphic attribute as a cue to attractiveness but also that variations in hip relative to shoulder size (SHR) will influence perceptions of femininity, masculinity, and attractiveness.

Eye tracking is considered a robust method to study human physical attractiveness and provides a behavioral link between evolutionary studies of sexual selection and morphology (Wenzlaff et al. 2016). Using eye tracking, Dixson et al. (2014) investigated women's visual attention to men's back-posed bodies differing in fat and muscle distribution and showed that mesomorph (muscular) somatotype was rated more attractive and attracted higher visual attention on the upper back compared with ectomorph (lean) and endomorph (overweight) somatotypes. Moreover, studying the effect of menstrual cycle on women's eye movement to men's front-posed bodies showed that women rated images of men with lower waist to chest ratio more attractive in a Hispanic (Garza et al. 2017) and Caucasian sample (Garza and Byrd-Craven 2019), although no significant result was found for dwell time and fixations on the chest region. In women, eye tracking studies have shown that there are specific regions of the female body to which most attention gravitates. The breasts and waist are areas of increased male gaze contingency attention as they are sexually dimorphic, physically attractive, and reproductively significant characteristics (Dixson et al. 2010b; Dural et al. 2008; Garza et al. 2016; Hewig et al. 2008; Suschinsky, Elias, & Krupp 2007). When women view women, it has been shown that the head, chest, and midriff are visually salient (Garza et al. 2016). Eye tracking research on women and men's viewing behavior has also focused on formidability ratings, where participants' visual time on men's bodies have demonstrated increased viewing time on the shoulder and chest regions, indicating that viewers access men's physiques in terms of fighting ability and ability to provide resources (Durkee et al. 2017).

In the current study, we investigate men and women's eye movements and the perceived physical attractiveness of male and female stimuli differing in SHR. While previous eye tracking studies investigated women's eye movement to men's fat and muscle distribution (Dixson et al. 2014; Garza et al. 2017), to our knowledge no previous investigation has studied the effect of men's SHR on women and men's eye movement and attractiveness ratings. Moreover, while women's shoulder width varies from one individual to another, to our knowledge no previous study has investigated the perceived attractiveness of female SHR and related eye movements. Although there is extensive research on women's WHR and attractiveness (Singh 1993, 1994; Singh & Young 1995; Dixson et al. 2010b), little if any is known about the attractiveness and visual perceptions of women's SHR. Since smaller WHRs (e.g., wider hips) indicate femininity and are preferred by men, and higher SHRs (wider shoulders) indicate masculinity and are preferred by women, similar predictions can be generalized to varying SHRs. WHR negatively correlates with WSR (waist to shoulder ratio) (Andrews et al. 2017), therefore using SHR as a measure that is similar to WSR, SHR can be applied to the perception of women's attractiveness. Additionally, since high SHRs may indicate physical fitness and upper body muscular tone (Andrews et al. 2017), predictions can be made as to the perceived attraction of lower SHRs. Accordingly, mimicking Darwinian selection on female body forms, Brooks and colleagues showed slender female body forms, including smaller shoulder span, are selected over generations (Brooks et al. 2015).

This study predicts that (1) men and women will rate men with higher SHR and women with lower SHR as more attractive and (2) men and women will focus most of their visual attention to the upper region of higher SHR male stimuli and lower region of lower SHR female stimuli.

Method

Participants

In order to detect a moderate effect size, an a priori power analysis using G*Power 3.1.9.2 indicated a sample size of 70 participants. We oversampled in order to accommodate errors that may occur during the eye tracking procedure. The ANOVA power analysis for 12 conditions (3 SHR × 2 Avatar Sex × 2 Side) at 0.01 significance level, effect size of 0.25, and 0.8 power showed the least number of needed participants is 32 for each participant sex. Eighty-two heterosexual (32 male and 50 female participants) undergraduate students (M = 20.90, SD = 3.30) were recruited from the University of Minho. Students received course credit in return for their participation. All participants were Portuguese and possessed normal or corrected-to-normal vision. Each gave written informed consent. The experiment was approved by the Ethical Committee of the University of Minho and was conducted in accordance with the Declaration of Helsinki.

Stimuli

Three male and three female 3D models were created by Daz3D (http://www.daz3d.com) each differing in hairstyle and clothing. The 3D models for each sex were posed in front and back views. Each model SHR was then modified creating low (1.1), intermediate (1.2), and high (1.3) SHR variations, resulting in a total of thirty-six stimuli.

Eye Tracking Equipment and Procedure

Eye movements were monitored using a binocular infrared, remote, and eye tracker running at 250 Hz (RED250, SMI GmbH, Germany) controlled with iView X software (v2.8). Stimuli were presented on a 22-in LCD monitor (Dell P2210, 60 Hz, 1680 × 1050 pixels). Initially, participants completed a five-point calibration procedure. Calibration was research controlled, and it was accepted if the mean spatial shift for four validation points was 0.5 degrees of visual angle or less for vertical and horizontal deviations. The experiment was carried out in a room with dim light (~ 10 lx). Participants were seated, head free, at 70 cm from the monitor. Participants then viewed all thirty-six stimuli in a random order, for 5 s each. To ensure that the participants' attention was focused on the center of the screen before the onset of each stimulus presentation, a gaze-contingent fixation cross appeared in the center of the computer screen (500 ms dwell time required). Data analysis was performed using BGaze software (v3.6). Fixations with a duration of less than 50 ms were discarded. The number of fixations corresponds to the number of times that the gaze is kept in a specific region of interest. Several fixations in a region, independent of their duration, are indicative of exploration of the stimulus. Dwell time, in our case (other software may use other definitions), is defined as the sum of durations for all gaze data samples (saccades and fixations) that hit a region (Skuballa et al. 2015). The cumulative counting of time in a region starts when the first fixation is detected and ends when the last fixation in that region ends. The duration of saccades between the first and last fixations is also included in dwell time but blinks are excluded. Dwell time is an indicator of interest in a stimulus's attributes. After viewing the stimuli, participants viewed and rated all the images for perceived attractiveness on a 10-point Likert scale from 1 (*extremely unattractive*) to 10 (*extremely attractive*).

Regions of Interest

The stimulus images were divided into five regions of interest (ROI): (a) head, from the top of the head to the level of the clavicle; (b) chest, from the top of the clavicle to the end of the rib cage; (c) waist, beginning from the end of the rib cage to the widest part of the hips; (d) hip and thighs, from the widest part of the hips to the end of the knee; and (e) lower legs and feet. The ROI were the same size for all participants and were similar for front and back views.

Results

Ratings of Attractiveness

The interrater reliability for male participants was high. The average measure interclass correlation coefficient for male participants was .876 with a 95% confidence interval from .747 to .957 ($F(11,341) = 8.041$, $p < .001$). Similarly, for female participants, average measure ICC was high: 0.968 with a 95% confidence interval from .935 to .989 ($F(11,539) = 30.927$, $p < .001$).

Ratings of Attractiveness

A 2(Stimuli Sex: Male/Female) by 3(SHR: Low, Intermediate, High) repeated measures ANOVA with a Greenhouse-Geisser correction was conducted for all ratings of attractiveness. All pairwise comparisons were made with a Bonferroni correction. There was a significant two-way interaction between front-posed stimuli sex

and SHR ($F(1.16, 36.06) = 13.23$, $p < .001$, $\eta^2 = .225$). Men rated male stimuli with higher SHR as more attractive ($M = 4.97$) than the intermediate SHR ($M = 4.28$; 95% CI [3.53, 5.02]), and low SHR ($M = 3.93$, 95% CI [3.30, 4.56]) (see Fig. 1a). Female stimuli with intermediate SHR were rated as significantly more attractive ($M = 5.91$, 95% CI [5.40, 6.42]) by men than the low SHR ($M = 5.67$, 95% CI [5.17, 6.18]), but not significantly different than the high SHR ($M = 5.46$, 95% CI [4.18, 6.12]) (see Fig. 1b). There was a significant two-way interaction between back-posed stimuli sex and SHR ($F(1.331, 41.25) = 43.50$, $p < .001$, $\eta^2 = .58$). Men rating back-posed male stimuli rated the high SHR as more attractive ($M = 6.78$, 95% CI [5.83, 7.27]) than the intermediate SHR ($M = 6.06$, 95% CI [5.23, 6.89]) and the low SHR ($M = 5.03$, 95% CI [4.33, 5.72]) (see Fig. 1a). Female stimuli with low SHR were rated as more attractive ($M = 5.18$, 95% CI [4.62, 5.74]) than the high SHR ($M = 4.26$, 95% CI [3.50, 5.01]) but not significantly different than the intermediate SHR ($M = 4.99$, 95% CI [4.37, 5.60]) (see Fig. 1b).

For women rating front-posed female stimuli, the two-way interaction between stimuli sex and SHR was not significant ($F(1.64, 80.74) = .81$, $p = .42$) (see Fig. 2b). Women viewing back-posed stimuli by SHR displayed a marginally significant two-way interaction ($F(1.76, 86.41) = 3.08$, $p = .06$, $\eta^2 = .06$). Women rated back-posed male stimuli with intermediate SHR ($M = 5.40$, 95% CI [4.93, 5.87]) as more attractive than the low SHR ($M = 4.90$, 95% CI [4.43, 5.36]) but not the high ($M = 5.02$, 95% CI [4.55, 5.49]) (see Fig. 2a). Women rated back-posed female stimuli as more attractive for the intermediate SHR ($M = 3.92$, 95% CI [3.37, 4.46]) than the high SHR ($M = 3.70$, 95% CI [3.19, 4.20]) but not the low SHR ($M = 3.78$, 95% CI [3.28, 4.27]).

Eye Tracking

A 3(SHR: Low, Intermediate, High) by 3(ROI: Head, Chest, Waist, Hips/thighs, Legs/Feet) repeated measures ANOVA with a Greenhouse-Geisser correction was conducted for all eye tracking analyses. All pairwise comparisons were made with a Bonferroni correction.

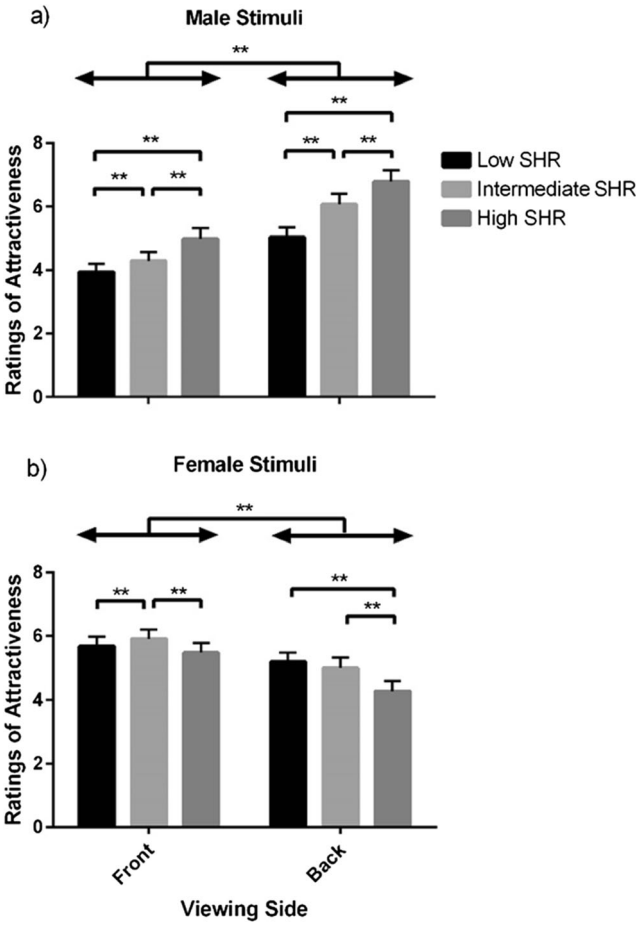

Fig. 1 Mean ratings (+SEM) of male participants for sexual attractiveness of **a** male and **b** female stimuli varying in SHR (low, intermediate, or high) and side view (front or back). Arrows show significant difference between front and back views. *$p < 0.05$, **$p < 0.01$

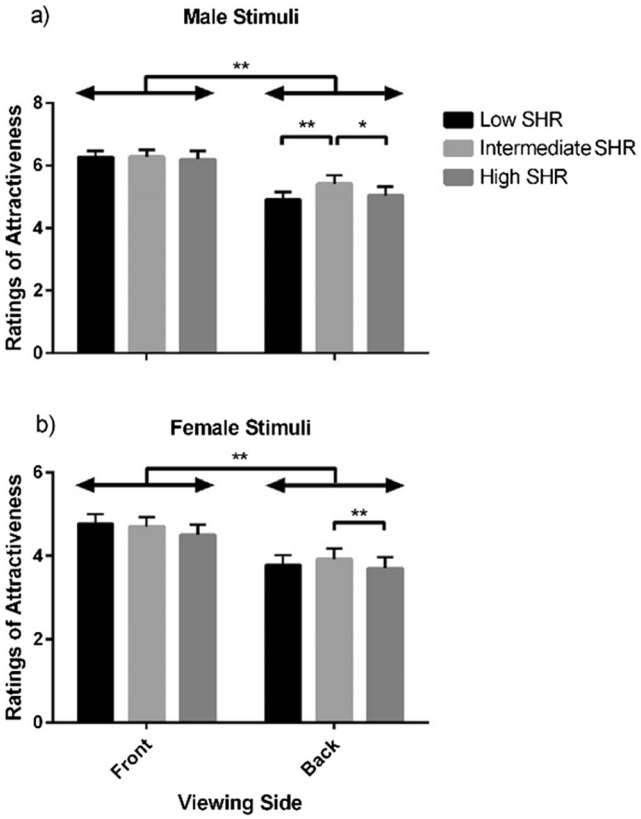

Fig. 2 Mean ratings (+SEM) of female participants for sexual attractiveness of **a** male and **b** female stimuli varying in SHR (low, intermediate, or high) and side view (front or back). Arrows show a significant difference between the front and back views. *$p < 0.05$, **$p < 0.01$

Dwell Time There was a significant two-way interaction between SHR and ROI for front-posed male stimuli ($F(4.15, 128.76) = 3.14$, $p = .01$, $\eta^2 = .09$). Men viewed the chest of high SHR men longer ($M = 1258.15$, 95% CI [908.85, 1607.45]) than low SHR men ($M = 783.24$, 95% CI [613.03, 953.44]) but not significantly longer than intermediate SHR men ($M = 977.33$, 95% CI [736.13, 1218.54]) (see Fig. 3a). In back-posed stimuli, the interaction between SHR and ROI was significant ($F(3.00, 93.03) = 16.30$, $p < .001$, $\eta^2 = .34$). Men viewed the chest region (i.e., upper back) of high SHR men longer ($M = 2097.35$, 95% CI [1692.73, 2501.97]), compared with intermediate SHR ($M = 1629.91$, 95% CI [1376.29, 1881.54]) and low SHR ($M = 1029.61$, 95% CI [811.89, 1247.32]). In viewing front-posed female stimuli, there was not a significant interaction between SHR and ROI ($F(3.69, 114.64) = 1.76$, $p = .09$). There was a main effect for ROI ($F(2.24, 69.63) = 11.55$, $p < .001$, $\eta^2 = .27$). The region of interest that was viewed the longest was the waist ($M = 1080.26$, 95% CI [803.45, 1357.13]) (see Fig. 5b), but it was only significantly different from the legs/feet ROI. In back-posed stimuli of women, there was a significant main effect for ROI ($F(2.30, 71.53) = 32.75$, $p < .001$, $\eta^2 = .51$). Men viewed the hips and thigh region longer ($M = 1432.95$, 95% CI [1247.83, 1617.86]) (see Fig. 5b)

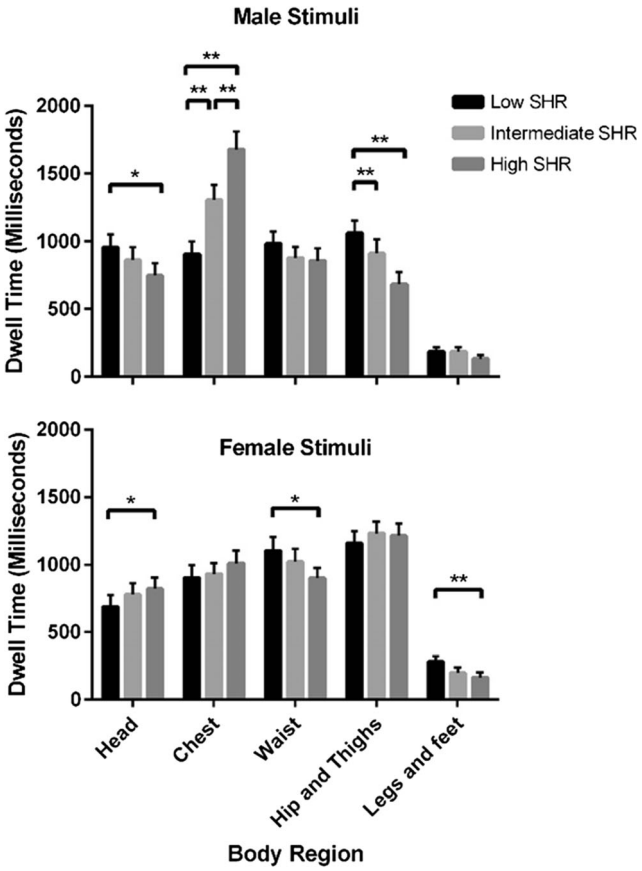

Fig. 3 Mean dwell time (+SEM) for male participants made on different body regions of male stimuli (upper graph) and female stimuli (lower graph). *$p < 0.05$, **$p < 0.01$

compared with the head ($M = 504.20$, 95% CI [399.94, 608.46]), chest ($M = 1025.24$, 95% CI [885.73, 1164.75]), and legs/feet ($M = 232.35$, 95% CI [161.39, 303.31]); however, this was not significantly longer than the waist ($M = 934.64$, 95% CI [718.91, 1150.38]).

There was not a significant two-way interaction between SHR and ROI when women were viewing front-posed images of male stimuli ($F(5.45, 267.36) = .27$, $p = .97$). There was a significant main effect for ROI ($F(2.32, 113.91) = 20.32$, $p < .001$, $\eta^2 = .29$). Women viewed the head region longer ($M = 1240.92$, 95% CI [1023.26, 1458.58]) than all other regions of interest (see Fig. 6a). In viewing back-posed male stimuli, there was a significant interaction between ROI and SHR ($F(5.68, 278.62) = 3.13$, $p = .002$, $\eta^2 = .06$). Women viewed the chest (i.e., upper back) longer for high SHR men ($M = 1352.58$, 95% CI [1151.46, 1553.61]) than for intermediate SHR ($M = 1110.72$, 95% CI [919.01, 1302.44]) and low SHR ($M = 1136.26$, 95% CI [975.45, 1297.07]). Women viewing female front-facing stimuli revealed a significant main effect for ROI ($F(2.80, 137.64) = 14.90$, $p < .001$, $\eta^2 = 23$). Women's viewing time was longer for the head region ($M = 997.04$, 95% CI [812.08, 1182.01]) but only when compared with the legs/feet region (see Fig. 6a). Women viewing back-posed female stimuli revealed a significant main effect for ROI ($F(3.03, 148.70) = 24.98$, $p < .001$, $\eta^2 = .33$). Women viewed the hips and thighs longer ($M = 1284.44$, 95% CI [1107.32, 1461.57]) compared with all other ROI (see Fig. 6b).

Fixations There was a significant two-way interaction between SHR and ROI for men viewing front-posed images of male stimuli ($F(5.11, 173.33) = 4.80$, $p < .001$, $\eta^2 = .13$). Men made more visual fixations to male stimuli with high SHRs ($M = 3.30$, 95% CI [2.63, 3.97]) than low SHR ($M = 2.53$, 95% CI [2.05, 3.09]) but not significantly different than intermediate SHR ($M = 2.82$, 95% CI [2.30, 3.34]). In viewing back-posed male stimuli, the two-way interaction was significant between SHR and ROI ($F(5.11, 158.65) = 6.09$, $p < .001$, $\eta^2 = .16$). The chest region (i.e., upper back) received the most visual fixations for high SHR male stimuli ($M = 4.62$, 95% CI [3.92, 5.13]) than the low SHR ($M = 3.13$, 95% CI [2.56, 3.71]) but not the intermediate SHR ($M = 4.05$, 95% CI [3.44, 4.66]). For viewing female stimuli, SHR and ROI were not significant ($F(4.96, 153.88) = .90$, $p = .51$). There was a significant main effect for ROI ($F(3.07, 95.42) = 21.23$, $p < .011$, $\eta^2 = .40$). The waist ($M = 2.88$, 95% CI [2.45, 3.31]) received the most fixations, but this was only different from the legs/feet region. In back-posed images, ROI was significant ($F(3.16, 98.24) = 41.38$, $p < .001$, $\eta^2 = .57$). Men made more visual fixations to the chest region (i.e., upper back) on back-posed female stimuli ($M = 3.28$, 95% CI [2.88, 3.67]).

For women viewing male front-posed stimuli, there was not a significant main effect for ROI and SHR ($F(6.55, 321.19) = 1.35$, $p = .21$), but the main effect for ROI was

significant ($F(2.67, 131.01) = 16.29$, $p < .001$, $\eta^2 = .25$). Women made more visual fixations to the head region (M = 2.90, 95% CI [2.40, 3.41]), but this was only significantly different from the legs/feet region. In viewing back-posed male stimuli, the interaction between SHR and ROI was significant ($F(5.28, 268.81) = 3.38$, $p = .004$, $\eta^2 = .06$). The chest region (i.e., upper back) of back-posed high SHR male stimuli received the most visual fixations ($M = 3.96$, 95% CI [3.45, 4.48]). For front-posed female stimuli, the interaction between SHR and ROI was not significant ($F(5.76, 282.47) = 1.07$, $p = .73$), but the main effect for ROI was significant ($F(3.20, 156.80) = 15.78$, $p < .001$, $\eta^2 = .24$). The waist region received the most visual fixations ($M = 2.91$, 95% CI [2.58, 3.32]), but this was only significantly different than the legs/feet region. For back-posed female stimuli, the interaction between SHR and ROI was marginally significant ($F(6.25, 306.45) = 2.01$, $p = .06$, $\eta^2 = .04$). The chest region (i.e., upper back) received the most visual fixations for high SHR female stimuli (M = 3.11, 95% CI [2.63, 3.59]) than the intermediate SHR (M = 2.54, 95% CI [2.12, 2.97]) but not significantly different than the low SHR ($M = 2.62$, 95% CI [2.19, 3.05]).

Discussion

This study investigated attractiveness ratings and eye movement allocation of men and women to front- and back-posed male and female stimuli varying in SHR. Results for the ratings of attractiveness for male participants indicated that men preferred higher male SHRs compared with lower ones and rated them as more attractive as the SHR increased for both front and back views (Fig. 1a). This is consistent with men's self-report preferences for more masculine bodies (Frederick et al. 2007). Our results also showed that men rated female stimuli with intermediate SHR more attractive than low and high SHRs in the front view. Moreover, men rated the high SHR of female stimuli in back view less attractive than both low and intermediate SHRs (Fig. 1b). This indicates that men do prefer more feminine body forms (intermediate and lower SHR) for women and consider such physiques physically attractive. Similar findings have been found in previous studies examining female WHR, suggesting that preferences for low WHR are due to important reproductively relevant cues of women (Dixson et al. 2010b; Singh 1993; Singh & Young 1995). It may also suggest that physical characteristics associated with formidability in women (i.e., increases in SHR) are not traits preferred by men. Likewise, Lassek and Gaulin (2016) have shown that waist size is the key determinant contributor to female physical attractiveness. Men also rated female stimuli more attractive in front view compared with the back view. Similarly, Dixson et al. (2010b) found that men rate the front view of female stimuli higher than the back view.

Results for ratings of attractiveness for female participants showed that women rated intermediate SHR of male stimuli more attractive than both low and high SHRs in the back view (Fig. 2a). In an analogous vein, Frederick and Haselton (2007) showed that women rate and prefer muscular men as more sexually desirable compared with nonmuscular and very muscular men. Similar to the back view of our stimuli, the faces of the stimuli used in the Frederick and Haselton (2007) study were also covered. In a similar fashion, women rated intermediate SHR of female stimuli more attractive than high SHR in back view (Fig. 2b). However, we did not observe any difference for woman's ratings of attractiveness in front view where the faces were present, for either male or female stimuli. This finding is intriguing, as it may reflect that women are more sensitive to the variation of SHR in back view compared with the front view, which is a finding that was different when men viewed women. Also, women rated front views of both male and female stimuli more attractive than back views. Altogether, these results suggest that our female participants may have been more attentive of faces when they judged the attractiveness in front views, while when the faces were not visible in the back views, they rated the attractiveness of different SHR of both male and female stimuli differently.

Investigating the relationship between the menstrual cycle and women preference for men's masculinity, Jünger et al. (2018) did not find an effect for SHR and shoulder to chest ratio predicting men's body attractiveness. The differences between the results of the current study and Jünger et al.'s (2018) could be related to the methodological considerations such as using 3D scans of male natural body forms as stimuli in Jünger et al. (2018) study compared with computer-generated 3D stimuli in the current study. Furthermore, in the current study, the stimuli were in color and were variant in clothing and hairstyle, while Jünger et al.'s (2018) models were devoid of texture (including color and hairstyle). Other differences could be the result of the number of participants as well as cultural difference (German vs. Portuguese). However, using a large Spanish sample, men compared to women prefer larger male upper body sizes (Durkee et al., 2019), supporting the sex difference for male upper body sizes found in the current study and those reported by Federick and Hasleton (2007).

As with the attractiveness ratings, results of eye tracking showed that men had longer dwell time on the chest region of higher SHRs of male stimuli compared with the lower ones (Fig. 3). These findings are in line with Durkee et al. (2017) investigating men's visual attention to other men in assessments of formidability. The dwell time of male participants on the chest region was not significant for SHRs of female stimuli. Also, no differences were observed for female participants in dwell time, for either chest region of SHRs of male stimuli or for the chest of female stimuli (Fig. 4). Consistently, recent research has found no differences for attentional biases to regions of interest as a function of the waist to chest ratios (Garza et al. 2017; Garza and Byrd-Craven 2019).

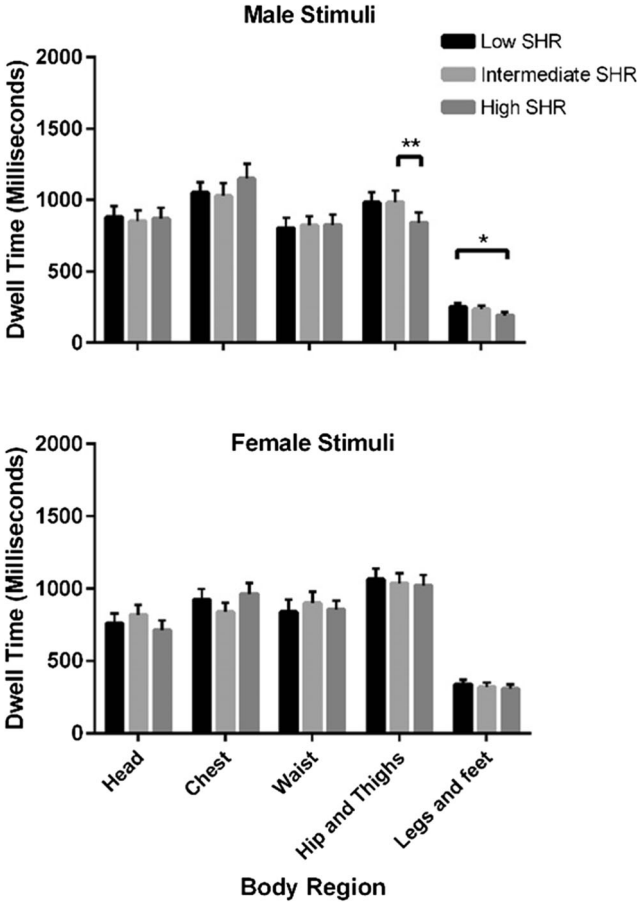

Fig. 4 Mean dwell time (+SEM) for female participants made on different body regions of male stimuli (upper graph) and female stimuli (lower graph). *$p < 0.05$, **$p < 0.01$

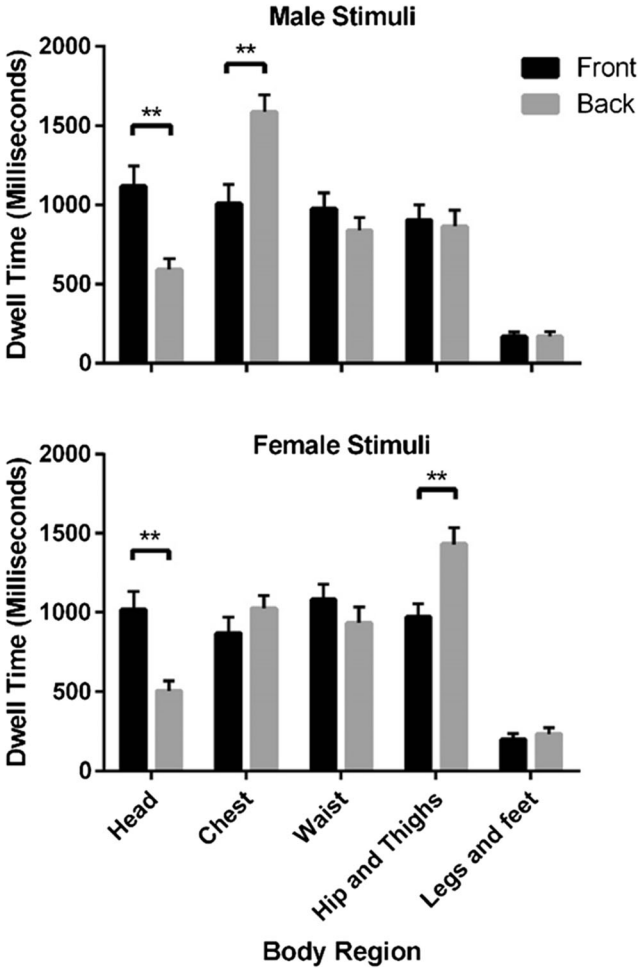

Fig. 5 Mean dwell time (+SEM) for male participants made on different body regions, comparing front and back views of male stimuli (upper graph) and female stimuli (lower graph). *$p < 0.05$, **$p < 0.01$

Additionally, results of eye tracking showed no difference between front and back views in overall dwell time and the number of fixations. This is consistent with the eye movement results from previous similar studies comparing front and back views (Dixson et al. 2010b; but see Bovet et al. (2016) for higher fixations on front view). However, both male and female participants had longer dwell time and more fixations to the upper back of male stimuli in the back view compared with the front view (Figs. 5, 6, 7, 8, 9, and 10). In contrast, dwell time and fixations on the head region in back view were significantly lower than front view for both men and women. This signifies the importance of faces in body perception and shows that participants' attention was captured by the chest region only in the absence of faces. It can also suggest that participants are attentive to sexually dimorphic features that underpin attractiveness considering the head region was viewed longer in front posed compared with back-posed stimuli. Although not manipulated in this study, recent work has shown that cultural and ecological variations influence women's preferences for masculine and feminine (Marcinkowska et al. 2014, 2019).

Attractiveness, SHR, Formidability, and Coalition Formation

Sexually dimorphic secondary sex characteristics, which may be present in adults of both sexes to varying degrees, are primary determinates of physical and sexual attractiveness and constitute individuals' gender orientations (Feierman 2010). Humans are primarily attracted to sexually dimorphic characteristics such as breasts (Doyle and Pazhoohi 2012; Havlíček et al. 2017), WHR (Dixson et al. 2011), buttock size (Furnham and Swami 2007), waist to shoulder ratio (Braun and Bryan 2006; Grillot et al. 2014), and body mass index (BMI) (Andrews et al. 2017), rather than sexed characteristics (e.g., vaginas, penises). SHR is such a sexually dimorphic characteristic. Higher SHRs are more frequent in adult males, and lower SHRs are more characteristic of females. As SHR is related to the physical attractiveness of both sexes and is associated with formidability, here we briefly comment on some implications for women and men's coalition membership value, mate guarding, and inter- and intrasexual competition.

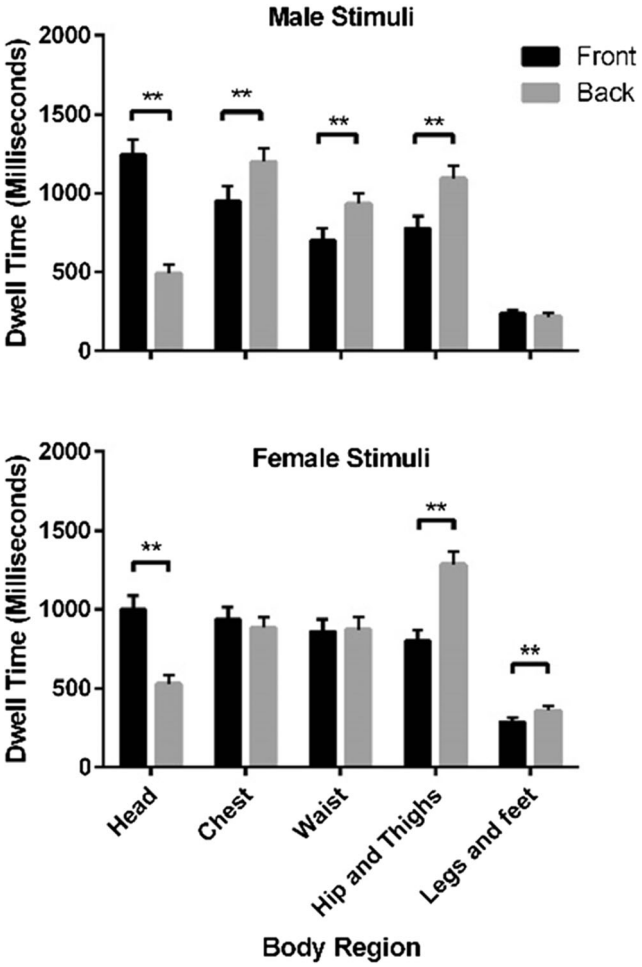

Fig. 6 Mean dwell time (+SEM) for female participants made on different body regions, comparing front and back views of male stimuli (upper graph) and female stimuli (lower graph). *$p < 0.05$, **$p < 0.01$

Males may perceive lower SHR, lower formidability male body types to be less threatening whether they are attracted to them or not, whereas lower SHR, more attractive females may

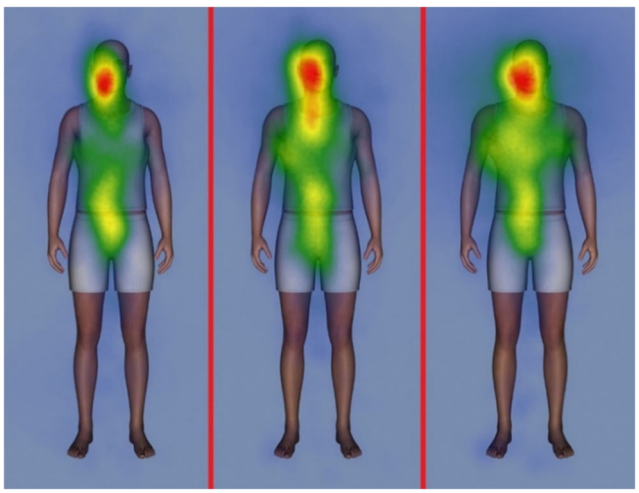

Fig. 7 Heat maps showing one set of male stimuli with low, intermediate, and high SHRs from left to right

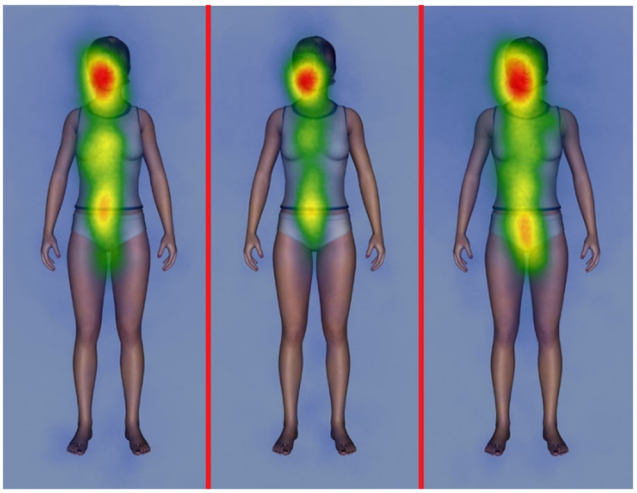

Fig. 8 Heat maps showing one set of female stimuli with low, intermediate, and high SHRs from left to right

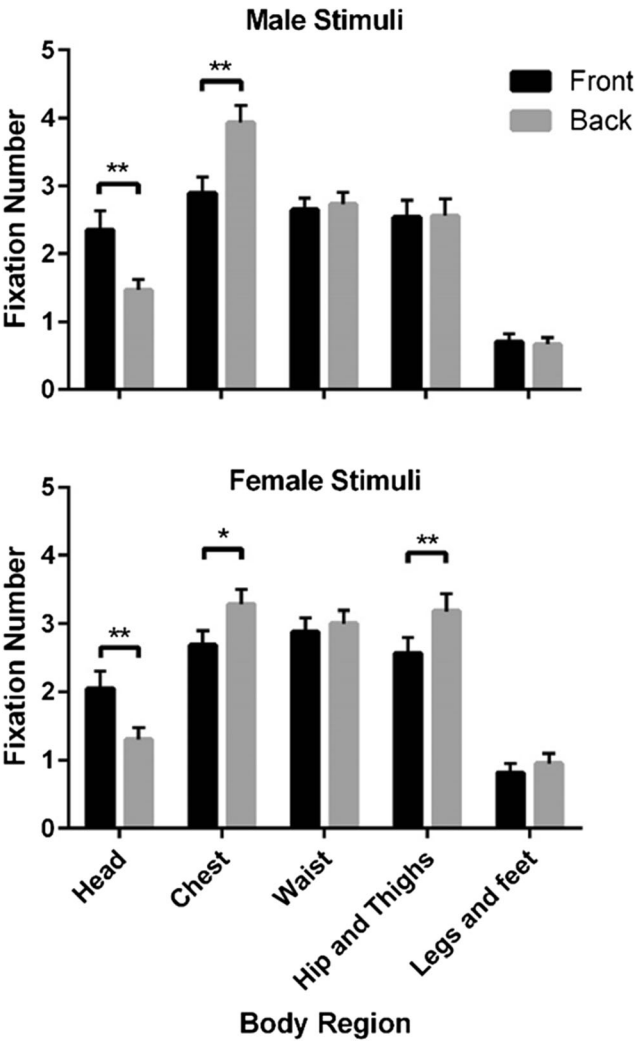

Fig. 9 Mean fixation number (+SEM) for male participants made on different body regions, comparing front and back views of male stimuli (upper graph) and female stimuli (lower graph). *$p < 0.05$, **$p < 0.01$

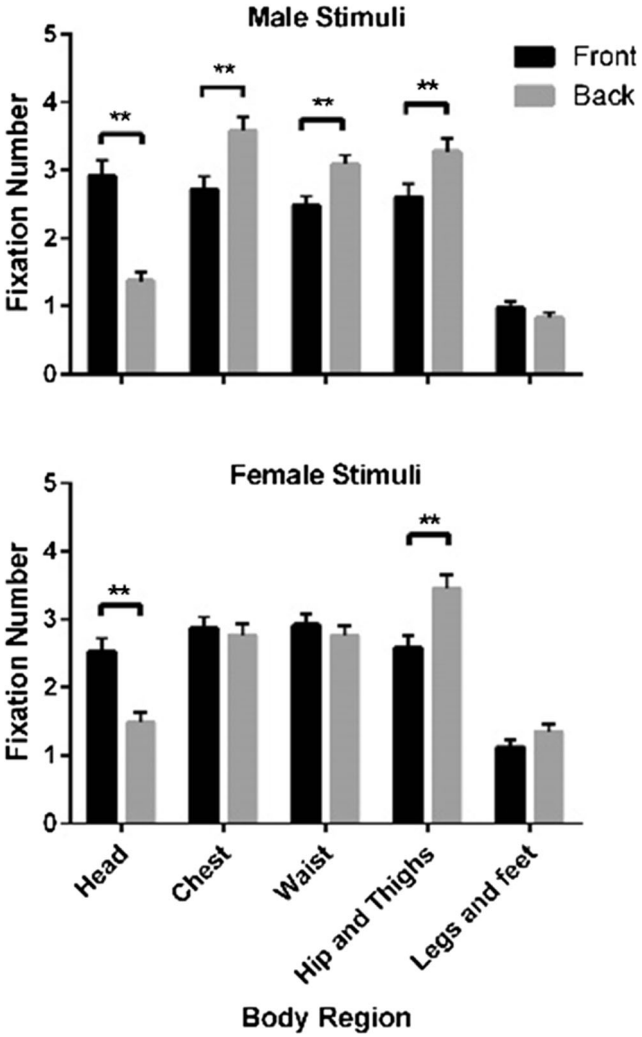

Fig. 10 Mean fixation number (+SEM) for female participants made on different body regions, comparing front and back views of male stimuli (upper graph) and female stimuli (lower graph). *$p < 0.05$, **$p < 0.01$

be perceived as potential mates when other feminine characteristics, such as low waist to hip ratios are present. Higher SHR males may be perceived as more formidable and hence as more threatening foes, or they may be perceived as more attractive as potential coalition members whose higher body esteem and self-efficacy increase their potential coalitional membership value (CMV), (Pazhoohi et al. 2012). Recent evidence suggests that men show a willingness to form alliances with other men who have previously demonstrated themselves capable of defeating them in combat (Barbaro et al. 2018), indicating that some men find formidable opponents to be worthy alliance partners.

Higher SHR males may appear more formidable and have higher mate value and CMV to females, and lower SHR males may appear to be lower in formidability, mate value, and CMV. To women, lower formidability females may pose a resource reallocation threat when provisioning efforts are diverted away from them. Also, higher attractiveness in females may pose an additional higher threat in intrasexual competitions. Our finding that women rate intermediate male SHR highest for attractiveness suggests that pair-bonded women, their mates, and their offspring who are guarded and provisioned by higher SHR male coalition members may gain additional benefit from their formidability when they assist in guarding against outgroup threats. If formidability is also only moderately sexually attractive to women, it follows that more formidable males can be valuable coalition members who are not a higher risk for cuckolding other male ingroup members, at least due to their apparent masculinity. Yet, males with moderate SHRs, who were rated more physically attractive by women in our sample may, conversely, be greater mate poaching threats to higher SHR males.

Conclusion

The current study contributes to the current literature in physical attractiveness by having men and women rate and view male and female stimuli with varied SHRs. By having both sexes view both same and opposite sex stimuli, an interesting comparison is provided across sexes to determine which of the varied SHRs are physically appealing and visually salient. In addition, it lends to novel predictions for future testing based on the stimuli that each sex is viewing. With heterosexual men and women viewing the same sex, predictions about the perceived formidability of the stimuli can be made because views of same sex stimuli can allude to intrasexual competition, while viewing the opposite sex stimuli can suggest interest as it relates to mate preferences. Nonetheless, the current study is not without limitations. In most research using sexually dimorphic traits in women, the waist to hip ratio is manipulated as opposed to the shoulder to hip ratio in the current study. Since a secondary goal of the current study was to discuss visual cues associated with formidability in both sexes, we elected to manipulate the shoulders only as it may relate to physical fitness and increased muscle tone (Andrews et al. 2017), rather than varying waist stimuli, which would likely have influenced physical attractiveness ratings as well. Furthermore, the presence of a face, different hairstyles, and clothing might have been confounded with body form (e.g., SHR) attractiveness in our study. Moreover, the disproportionately high number of females compared with male participants in the current study could be considered a limitation. This difference reflects the enrollment ratio for psychology at the University of Minho.

Overall, the results of the current study showed that men and women differently judged the attractiveness of varied male and female SHRs. Altogether, the results of this study suggest that men more than women are attentive to variations in SHRs. Specifically, our results showed that women prefer an intermediate SHR for both men and women only in the

back view, while SHR does not influence their viewing behavior in front view. However, men prefer more masculine ratios for men and less masculine ratios for women. Moreover, only men showed differences in visual attention to chests of male stimuli, which is congruent with previous studies that suggest men desire more masculine body forms as means for mating success, as well as in making assessments of formidability (Buunk & Dijkstra 2005; Durkee et al. 2017; Frederick et al. 2007; Massar and Buunk 2009).

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Data Availability All relevant data are within the paper.

Compliance with Ethical Standards

Conflict of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

Andrews, T. M., Lukaszewski, A. W., Simmons, Z. L., & Bleske-Rechek, A. (2017). Cue-based estimates of reproductive value explain women's body attractiveness. *Evolution and Human Behavior, 38*, 461–467.

Barbaro, N., Mogilski, J. K., Shackelford, T. K., & Pham, M. N. (2018). Men's interest in allying with a previous combatant for future group combat. *Human Nature, 29*, 328–336.

Barber, N. (1995). The evolutionary psychology of physical attractiveness: sexual selection and human morphology. *Ethology and Sociobiology, 16*, 395–424.

Bovet, J., Lao, J., Bartholomée, O., Caldara, R., & Raymond, M. (2016). Mapping female bodily features of attractiveness. *Scientific Reports, 6*, 18551.

Braun, M. F., & Bryan, A. (2006). Female waist-to-hip and male waist-to-shoulder ratios as determinants of romantic partner desirability. *Journal of Social and Personal Relationships, 23*(5), 805–819.

Brooks, R. C., Shelly, J. P., Jordan, L. A., & Dixson, B. J. (2015). The multivariate evolution of female body shape in an artificial digital ecosystem. *Evolution and Human Behavior, 36*(5), 351–358.

Butovskaya, M., Sorokowska, A., Karwowski, M., Sabiniewicz, A., Fedenok, J., Dronova, D., Negasheva, M., Selivanova, E., & Sorokowski, P. (2017). Waist-to-hip ratio, body-mass index, age and number of children in seven traditional societies. *Scientific Reports, 7*(1), 1622.

Buunk, B. P., & Dijkstra, P. (2005). A narrow waist versus broad shoulders: sex and age differences in the jealousy-evoking characteristics of a rival's body build. *Personality and Individual Differences, 39*(2), 379–389.

Dixson, A. F., Halliwell, G., East, R., Wignarajah, P., & Anderson, M. J. (2003). Masculine somatotype and hirsuteness as determinants of sexual attractiveness to women. *Archives of Sexual Behavior, 32*(1), 29–39.

Dixson, B. J., Dixson, A. F., Li, B., & Anderson, M. J. (2007a). Studies of human physique and sexual attractiveness: sexual preferences of men and women in China. *American Journal of Human Biology, 19*(1), 88–95.

Dixson, B. J., Dixson, A. F., Morgan, B., & Anderson, M. J. (2007b). Human physique and sexual attractiveness: sexual preferences of men and women in Bakossiland, Cameroon. *Archives of Sexual Behavior, 36*(3), 369–375.

Dixson, B. J., Dixson, A. F., Bishop, P. J., & Parish, A. (2010a). Human physique and sexual attractiveness in men and women: a New Zealand–US comparative study. *Archives of Sexual Behavior, 39*(3), 798–806.

Dixson, B. J., Grimshaw, G. M., Linklater, W. L., & Dixson, A. F. (2010b). Watching the hourglass. *Human Nature, 21*(4), 355–370.

Dixson, B. J., Grimshaw, G. M., Linklater, W. L., & Dixson, A. F. (2011). Eye-tracking of men's preferences for waist-to-hip ratio and breast size of women. *Archives of Sexual Behavior, 40*(1), 43–50.

Dixson, B. J., Grimshaw, G. M., Ormsby, D. K., & Dixson, A. F. (2014). Eye-tracking women's preferences for men's somatotypes. *Evolution and Human Behavior, 35*(2), 73–79.

Doyle, J. F., & Pazhoohi, F. (2012). Natural and augmented breasts: is what is not natural most attractive? *Human Ethology Bulletin, 27*, 4014.

Dural, S., Cetinkaya, H., & Gulbetekin, E. (2008). The role of the waist to hip ratio in evaluation of female physical attractiveness: eye-tracker data. *Turkish Journal of Psychology, 23*, 75–91.

Durkee, P. K., Goetz, A. T., & Lukaszewski, A. W. (2018). Formidability assessment mechanisms: examining their speed and automaticity. *Evolution and Human Behavior*, *39*(2), 170-178.

Durkee, P. K., Polo, P., Muñoz-Reyes, J. A., Rodríguez-Ruiz, C., Losada-Pérez, M., Fernández-Martínez, A. B., Turiégano, E., Buss, D. M. & Pita, M. (2019). Men's bodily attractiveness: Muscles as fitness indicators. *Evolutionary Psychology, 17*(2), 1474704919852918.

Fan, J., Dai, W., Liu, F., & Wu, J. (2005). Visual perception of male body attractiveness. *Proceedings of the Royal Society of London B: Biological Sciences, 272*(1560), 219–226.

Feierman, J. R. (2010). Pedophilia: its relationship to the homosexualities and the Roman Catholic Church, Part I. *Antonianum, LXXXV*, 451–177.

Frederick, D. A., & Haselton, M. G. (2007). Why is muscularity sexy? Tests of the fitness indicator hypothesis. *Personality and Social Psychology Bulletin, 33*(8), 1167–1183.

Frederick, D. A., Buchanan, G. M., Sadehgi-Azar, L., Peplau, L. A., Haselton, M. G., Berezovskaya, A., & Lipinski, R. E. (2007). Desiring the muscular ideal: men's body satisfaction in the United States, Ukraine, and Ghana. *Psychology of Men & Masculinity, 8*(2), 103–117.

Furnham, A., & Nordling, R. (1998). Cross-cultural differences in preferences for specific male and female body shapes. *Personality and Individual Differences, 25*(4), 635–648.

Furnham, A., & Swami, V. (2007). Perception of female buttocks and breast size in profile. *Social Behavior and Personality an International Journal, 35*, 1–8.

Garza, R., & Byrd-Craven, J. (2019). Fertility status in visual processing of men's attractiveness. *Evolutionary Psychological Science*, 1–15. https://doi.org/10.1007/s40806-019-00190-4

Garza, R., Heredia, R. R., & Cieślicka, A. B. (2016). Male and female perception of physical attractiveness: an eye movement study. *Evolutionary Psychology*, *14*(1), 1474704916631614.

Garza, R., Heredia, R. R., & Cieślicka, A. B. (2017). An eye tracking examination of men's attractiveness by conceptive risk women. *Evolutionary Psychology, 15*(1), 1474704917690741.

Grammer, K., Fink, B., Møller, A. P., & Thornhill, R. (2003). Darwinian aesthetics: sexual selection and the biology of beauty. *Biological Reviews, 78*(3), 385–407.

Grillot, R. L., Simmons, Z. L., Lukaszewski, A. W., & Roney, J. R. (2014). Hormonal and morphological predictors of women's body attractiveness. *Evolution and Human Behavior, 35*, 176–183.

Havlíček, J., Třebický, V., Valentova, J. V., Kleisner, K., Akoko, R. M., Fialová, J., et al. (2017). Men's preferences for women's breast size and shape in four cultures. *Evolution and Human Behavior, 38*, 217–226.

Hewig, J., Trippe, R. H., Hecht, H., Straube, T., & Miltner, W. H. (2008). Gender differences for specific body regions when looking at men and women. *Journal of Nonverbal Behavior, 32*, 67–78.

Hill, A. K., Hunt, J., Welling, L. L., Cárdenas, R. A., Rotella, M. A., Wheatley, J. R., et al. (2013). Quantifying the strength and form of sexual selection on men's traits. *Evolution and Human Behavior, 34*(5), 334–341.

Hönekopp, J., Rudolph, U., Beier, L., Liebert, A., & Müller, C. (2007). Physical attractiveness of face and body as indicators of physical fitness in men. *Evolution and Human Behavior, 28*(2), 106–111.

Horvath, T. (1981). Physical attractiveness: the influence of selected torso parameters. *Archives of Sexual Behavior, 10*(1), 21–24.

Hughes, S. M., & Gallup, G. G. (2003). Sex differences in morphological predictors of sexual behavior: shoulder to hip and waist to hip ratios. *Evolution and Human Behavior, 24*(3), 173–178.

Jünger, J., Kordsmeyer, T. L., Gerlach, T. M., & Penke, L. (2018). Fertile women evaluate male bodies as more attractive, regardless of masculinity. *Evolution and Human Behavior, 39*(4), 412–423.

Kasperk, C., Helmboldt, A., Börcsök, I., Heuthe, S., Cloos, O., Niethard, F., & Ziegler, R. (1997). Skeletal site-dependent expression of the androgen receptor in human osteoblastic cell populations. *Calcified Tissue International, 61*(6), 464–473.

Kordsmeyer, T. L., Hunt, J., Puts, D. A., Ostner, J., & Penke, L. (2018). The relative importance of intra-and intersexual selection on human male sexually dimorphic traits. *Evolution and Human Behavior, 39*(4), 424–436.

Lassek, W. D., & Gaulin, S. J. C. (2009). Costs and benefits of fat-free muscle mass in men: relationships to mating success, dietary requirements, and native immunity. *Evolution and Human Behavior, 30*, 322–328.

Lassek, W. D., & Gaulin, S. J. (2016). What makes Jessica Rabbit sexy? Contrasting roles of waist and hip size. *Evolutionary Psychology, 14*(2), 1474704916643459.

Marcinkowska, U. M., Kozlov, M. V., Cai, H., Contreras-Garduno, J., Dixson, B. J., Oana, G. A., Kaminski, G., Li, N. P., Lyons, M. T., Onyishi, I. E., Prasai, K., Pazhoohi, F., Prokop, P., Rosales Cardozo, S. L., Sydney, N., Yong, J. C., & Rantala, M. J. (2014). Cross-cultural variation in men's preference for sexual dimorphism in women's faces. *Biology Letters, 10*(4), 20130850.

Marcinkowska, U. M., Rantala, M. J., Lee, A. J., Kozlov, M. V., Aavik, T., Cai, H., Contreras-Garduño, J., David, O. A., Kaminski, G., Li, N. P., Onyishi, I. E., Prasai, K., Pazhoohi, F., Prokop, P., Cardozo, S. L. R., Sydney, N., Taniguchi, H., Krams, I., & Dixson, B. J. W. (2019). Women's preferences for men's facial masculinity are strongest under favorable ecological conditions. *Scientific Reports, 9*(1), 3387.

Massar, K., & Buunk, A. P. (2009). Rivals in the mind's eye: jealous responses after subliminal exposure to body shapes. *Personality and Individual Differences, 46*(2), 129–134.

Mautz, B. S., Wong, B. B., Peters, R. A., & Jennions, M. D. (2013). Penis size interacts with body shape and height to influence male attractiveness. *Proceedings of the National Academy of Sciences, 110*(17), 6925–6930.

Pazhoohi, F., & Liddle, J. R. (2012). Identifying feminine and masculine ranges for waist-to-hip ratio. *Journal of Social, Evolutionary, and Cultural Psychology, 6*(2), 227–232.

Pazhoohi, F., Hosseinchari, M., & Doyle, J. F. (2012). Iranian men's waist-to-hip ratios, shoulder-to-hip ratios, body esteem and self-efficacy. *Journal of Evolutionary Psychology, 10*(2), 61–67.

Pazhoohi, F., Silva, C., Lamas, J., Mouta, S., Santos, J., & Arantes, J. (2018). The effect of height and shoulder-to-hip ratio on interpersonal space in virtual environment. *Psychological Research*, 1–10. https://doi.org/10.1007/s00426-017-0968-1

Price, E. M., Kang, J., Dunn, J., & Hopkins, S. (2011). Muscularity and attractiveness as predictors of human egalitarianism. *Personality and Individual Differences., 50*, 636–640.

Price, M. E., Sheehy-Skeffington, J., Sidnaius, J., & Pound, N. (2017). Is sociopolitical egalitarinsim related to bodily and facial formidability in men? *Evolution and Human Behavior, 38*, 626–634.

Sell, A., Lukazsewski, A. W., & Townsley, M. (2017). Cues of upper body strength account for most of the variance in men's bodily attractiveness. *Proceedings of the Royal Society B, 284*, 1–8.

Singh, D. (1993) Adaptive significance of female physical attractiveness: Role of waist-to-hip ratio. *Journal of Personality & Social Psychology, 65*(2):293-307.

Singh, D. (1994). Is thin really beautiful and good? Relationship between waist-to-hip ratio (WHR) and female attractiveness. *Personality & Individual Differences, 16*(1), 123-132.

Singh, D., & Young, R. K. (1995). Body weight, waist-to-hip ratio, breasts, and hips: Role in judgments of female attractiveness and desirability for relationships. *Ethology & Sociobiology, 16*(6), 483-507.

Skuballa, I. T., Fortunski, C., & Renkl, A. (2015). An eye movement pre-training fosters the comprehension of processes and functions in technical systems. *Frontiers in Psychology, 6*, 598.

Suschinsky, K. D., Elias, L. J., & Krupp, D. B. (2007). Looking for Ms. Right: Allocating attention to facilitate mate choice decisions. *Evolutionary Psychology, 5*(2), 147470490700500214.

Tovée, M. J., Maisey, D. S., Vale, E. L., & Cornelissen, P. L. (1999). Characteristics of male attractiveness for women. *The Lancet, 353*(9163), 1500.

Wenzlaff, F., Briken, P., & Dekker, A. (2016). Video-based eye tracking in sex research: a systematic literature review. *The Journal of Sex Research, 53*(8), 1008–1019.