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What colour should I wear? How clothing colour affects women's judgement of other women's body attractiveness and body size

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ABSTRACT

Research has indicated that female body perception and associated body-viewing gaze behaviour in women viewers can be influenced by a variety of internal and external factors (e.g., own body satisfaction, clothing style, and viewing angle). Although the clothing colour affects women's visual and aesthetic appearance rated by men or women wearer themselves, its impact on women judging other women's body attractiveness and body size is largely unclear. In this eye-tracking study we presented female body images of Caucasian and African avatars in a continuum of common dress sizes wearing different colours (black, grey, white, red, green and blue), and asked 31 young Caucasian women to rate the perceived body attractiveness and body size. Our analysis revealed that clothing colour black and red attracted the highest body attractiveness and slimmer body size ratings, whereas green and grey induced the lowest body attractiveness and overestimated body size judgements. Such colour-induced modulatory effect on body perception was further influenced by the avatar race (or skin tone; e.g., higher attractiveness ratings for colours white, blue and green in African than in Caucasian avatars), and was associated with the changes of body-viewing gaze allocation at the upper body and waist-hip regions (i.e. colour black and white attracting more viewing at the upper body and waist-hip regions, respectively). Taken together, it seems that the clothing colour and its contrast with skin tone play valuable roles in mediating women's body perception of other women.

1. Introduction

With their high perceptual saliency in our natural surroundings, human bodies tend to attract our visual attention and often lead to the conscious or unconscious assessment of body attractiveness and body size (Peelen & Downing, 2007). The viewing of female bodies is also accompanied by a stereotypical gaze distribution with longer viewing time directed at the chest and waist-hip area relative to other non-face local body features, most likely due to informative attractiveness and sexuality cues contained in these two regions (Cornelissen, Hancock, Kiviniemi, George, & Tovée, 2009; Cundall & Guo, 2017; Hall, Hogue, & Guo, 2011, 2014, 2015).

Previous research has revealed a range of external and internal factors that affect young women's judgements of other women's body attractiveness and body size, and associated body-viewing gaze behaviour. External factors are those visual cues contained in the viewed bodies, such as body mass index (BMI), waist-to-hip ratio (WHR), body fat, model race, clothing style and size. For instance, higher attractiveness and slimmer body size ratings are often associated with slender figures with large breasts and low WHR (Singh & Singh, 2011; Singh & Young, 1995), larger figures in oversized (Fan, Newton, Lau, & Liu, 2003) or loose clothing (with less gaze allocation at the waist-hip region masked by the loose cloth; Cundall & Guo, 2017), and figures from the viewers' own racial group (Rodway, Tatham, & Guo, 2019).

Internal factors include the viewers' own culture, mental state, body composition and body satisfaction. For instance, Caucasian women tend to prefer attractive body of a lower BMI (~20 to 22) and ~0.7 WHR, whereas African women prefer a heavier body with ~0.8 WHR (Tovée, Swami, Furnham, & Mangalparsad, 2006). Young women with eating disorder or low own body satisfaction often engage in body comparison with the others by looking more at body regions with low self-rated satisfaction scores, but looking less at regions with high satisfaction ratings (Cundall & Guo, 2017; Jansen, Nederkoorn, & Mulkens, 2005). Clearly, body size and body attractiveness assessment in young women involves both stereotypical pattern of concentrated gaze at the waist-hip and chest regions and individualised gaze comparison process. This gaze behaviour is modified by various internal and external factors, and is possibly driven by the need for social comparison to establish and/or to

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enhance one's own attractiveness (Hahn & Perrett, 2014).

Among these internal and external factors, the clothing colour is an interesting but relatively understudied (except for the colour red) factor in female body perception from women viewers' perspective. It is well-established that colour has substantial context-dependent impact on a range of human psychological functioning, such as emotion, cognition and behaviour (Elliot & Maier, 2014). For instance, bright and dark colours tend to be associated with positive and negative emotions, respectively (Boyatzis & Varghese, 1994). The higher colour and luminance contrast between a plate and table could further bias the judgement of food serving sizes (Van Ittersum & Wansink, 2012). It is plausible that these colour-associated changes in emotion and visual perception could subsequently affect human body perception, such as body attractiveness and size judgements.

A few studies have reported that appropriate choice of the clothing colour appears to enable women to enhance their self-image or physical attractiveness to men. These studies have been mainly focused on the colour red probably because of its close association with love, passion, sex and romance which is widely represented through the media in Western societies (Elliot, Greitemeyer, & Pazda, 2013; Elliot & Niesta, 2008). Specifically, in comparison with other colours, women wearing red clothes were often rated as more attractive and sexually desirable by men, but not by women (Elliot & Niesta, 2008). In an internet dating study men also tended to contact women for dates when they wore a red top in their profile picture rather than black, white, yellow, blue or green (Guéguen & Jacob, 2013). Interestingly, women were more likely to wear red or pink on high fertility days during their menstrual cycle, possibly reflecting an increased motivation to enhance their attractiveness and advertise ovulatory status (Eisenbruch, Simmons, & Roney, 2015; but see also Blake, Dixson, O'Dean, & Denson, 2017). In contrast to this so-called red effect in men's eyes, with different stimuli and context conditions, other studies have argued that red clothes did not induce higher scores than black or white clothes when men rated women sexual attractiveness in either short- or long-term mating conditions (Peperkoorn, Roberts, & Pollet, 2016). Furthermore in one case, comparable high attractiveness scores were received when men rated both male and female models in red and black T-shirts relative to other colours, and when women rated male models in red and black T-shirts (Roberts, Owen, & Havlicek, 2010). In other cases, both men and women were more often to wear black and red for their first dates (Kramer & Mulgrew, 2018), and rated themselves more attractive when wearing a red compared to blue t-shirt (Berthold, Reese, & Martin, 2017). Taken together, it seems this clothing colour-induced bias in attractiveness rating is limited neither to the colour red nor to the male viewers.

Regarding to body size judgement, fashion research has long posited that the clothing colour could change the perceived body size. For instance, the colour black absorbs light which in turn may reduce the appearance of the body to create a slimming effect, whereas the colour white reflects light which consequently enlarges the appearance of the body (Finney, 2006). Curiously, one recent study has reported that the clothing colour had little impact on women's satisfaction judgement of own local body regions and body image (Girman, Lukins, Swinbourne, & Leicht, 2014). However, it is unclear to what extent the clothing colour would systematically modify women's explicit judgement of other women's body size.

Taken together, while some studies have explored the effect of specific colours on female body attractiveness judgement, they often generated inconsistent findings due to limitations in research design, such as testing limited range of clothing colours and female body shapes or sizes, only presenting top half of female bodies without informative attractiveness cues from the waist-hip region, or collecting data from men viewers and women wearer themselves. Furthermore, it is unknown whether the clothing colour would bias both body attractiveness and body size judgements similarly; whether the same clothing colour would show the same judgement impact on bodies of different skin tones (e.g., Caucasian and African models wearing the same colour would show different colour/luminance contrast or simultaneous contrast because of their skin tones); and whether the body-viewing gaze behaviour would also be modified by the clothing colour.

Hence this eye-tracking study was designed to systematically address these research limitations in female body perception. To represent real world scenario, we presented well-controlled Caucasian and African female full-body avatars of different body sizes in full frontal view wearing red, green, blue, white, grey and black clothes. Young healthy heterosexual Caucasian women viewers were then required to rate the perceived body attractiveness and body size. Guided by previous research, we hypothesised that (1) avatars in specific clothing colours (e.g., red, black) would attract higher body attractiveness and slimmer body size ratings compared to other clothing colours; (2) the same clothing colour in Caucasian and African avatars of the same body size might induce different body attractiveness and body size ratings due to differences in the perceived colour/luminance contrast between clothing colour and skin tone; (3) participants would gaze more at the waist-hip and chest regions to assess body attractiveness and body size, but their gaze allocation at a given body feature might vary across the clothing colours.

2. Materials and methods

2.1. Participants

Thirty-one Caucasian female undergraduate students, aged between 19 and 22 years old (20.35 ± 0.16, mean ± SEM), were recruited and then successfully completed this study in return for course credit. All participants reported heterosexual orientation, no history of eating disorders, and had normal or corrected-to-normal visual acuity. Prior to the study, the research purpose, experimental tasks and procedure had been explained to the participants, and written informed consent was obtained from each of them. The Ethical Committee in School of Psychology, University of Lincoln, approved this study (PSY1920114), and all procedures complied with the British Psychological Society Code of Ethics and Conduct.

2.2. Body images

High-resolution full-colour female body images of computer-generated avatars in full frontal view were created via www.trymetail.com (Rodway et al., 2019). These bodies represented 2 Caucasian and 2 African avatars in 6 common UK dress sizes (size 6, 8, 10, 12, 14 and 16; standardised 165 cm height and 74 cm inner leg measurements; AA to C breast cup sizes increasing proportionally in parallel to dress sizes). Each avatar had similar age, hairstyle and facial expression with no distinctive facial or body markings. For each avatar at each dress size, the same style of a typical UK tight dress in one of six colours was placed onto the body via Adobe® Photoshop 2017 CC. The clothing colour was determined by using the CIELCh colour model with three parameters of lightness, chroma, and hue. The chosen clothing colours included black (LCh[0,0,0]), grey [61.27, 1.56, 19.27], white [92.83, 2.70, 41.74], red [46.79, 105.70, 318.62], green [72.89, 94.62, 135.93] and blue [30.62, 17.25, 240.16]. In total, 144 images (6 dress sizes × 4 avatars × 6 dress colours) were created for the testing (see Fig. 1 for examples). The background of the body image was set as white [100, 0.01, 296.81], and the size of the images was set to 300 × 450 pixels (11.54° × 17.31°).

2.3. Procedure

The general experimental setup and procedure for data collection and analysis are similar to Rodway et al. (2019), from which the following details are reproduced. The digitized body images were presented through a ViSaGe graphics system (Cambridge Research Systems, UK) and displayed on a non-interlaced gamma-corrected colour monitor (30 cd/m^2 background luminance, 100 Hz frame rate, Mitsubishi

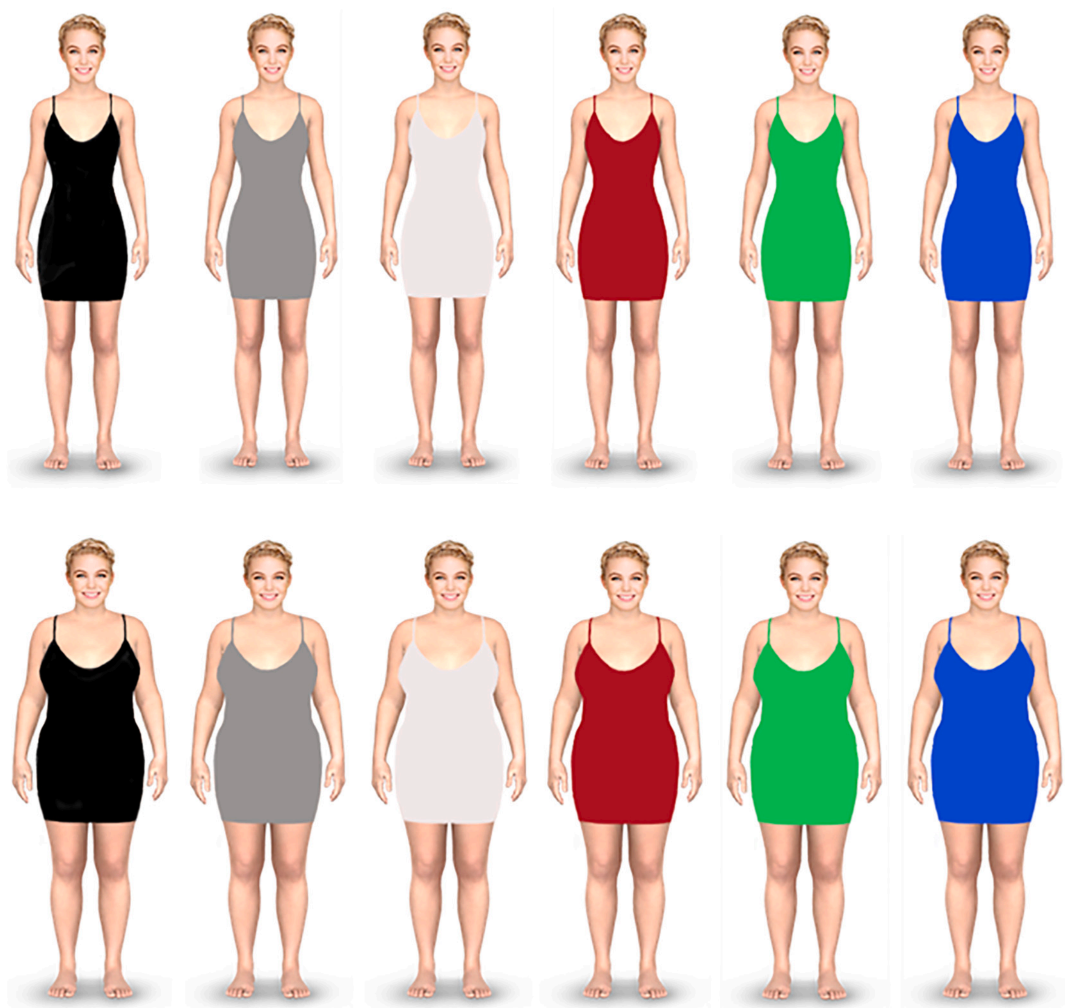

Fig. 1. Examples of a Caucasian female avatar in UK dress size 6 (top row) and 16 (bottom row) wearing black, grey, white, red, green and blue dresses. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Diamond Pro2070SB) with the resolution of 1024 × 768 pixels. At a viewing distance of 57 cm, the monitor subtended a visual angle of 40° × 30°.

During the eye-tracking experiment the participants sat in a chair with their head restrained by a chin-rest, and viewed the display binocularly. Horizontal and vertical eye positions from the dominant eye (determined through the Hole-in-Card test) were measured using a pupil-centre/cornea-reflection Video Eyetracker Toolbox with 250 Hz sampling frequency and up to 0.25° accuracy (Cambridge Research Systems, UK). Eye movement signals were first calibrated by instructing the participant to follow a fixation point (FP, 0.3° diameter, 15 cd/m^2 luminance) displayed randomly at one of 9 positions (3 × 3 matrix) across the monitor (distance between adjacent FP positions was 10°).

After the calibration procedure, the participants pressed the response box to initiate a trial. The trial was started with a FP randomly displayed 10° left or right to the screen centre to minimize central fixation bias. If the participant maintained fixation for 1 s, the FP disappeared and a testing image was presented at the centre of the screen for 3 s. The participants were instructed to "rate body attractiveness and body size as accurately as possible", and verbally report the perceived body attractiveness rating on a 9-point scale (1 represents 'not attractive at all' and 9 represents 'extremely attractive') and body size rating on a scale ranging from UK size 6 to 16. During the testing no feedback was given, and each body image was displayed once in a random order. After the testing, the participants were asked to indicate their favourite clothing colour.

2.4. Data analysis

All the collected data were analysed off-line. For eye movement data, the software developed in Matlab computed horizontal and vertical eye displacement signals as a function of time to determine eye velocity and position. Fixation locations were then extracted from raw eye-tracking data using velocity (less than 0.2° eye displacement at a velocity of less than 20°/s) and duration (greater than 50 ms) criteria (Guo, 2007). To determine gaze allocation within key body regions (Cundall & Guo, 2017), each body was divided into five regions of interest: face (including hair), upper-body (from the base of the neck to the end of the rib cage), waist–hip region (including stomach, hips, and pubic region), arms (including hands) and legs (including feet). The viewing time allocated to each region was normalised in proportion to total viewing time sampled in that trial.

A series of repeated measures analysis of variance (ANOVAs) were conducted to examine the effect of clothing colour, avatar race and dress size on participants' body attractiveness and body size judgements, and their body-viewing gaze allocation. For each ANOVA, Greenhouse–Geisser correction was applied where sphericity was violated, and a Bonferroni adjustment was made for post hoc multiple comparisons. Only significant results were reported.

3. Results

3.1. Effect of clothing colour, avatar race and dress size on body attractiveness and body size judgements

Body attractiveness judgement: to explore to what extent body attractiveness judgements were affected by clothing colour, avatar race and dress size, a 6 (clothing colour) × 2 (avatar race) × 6 (dress size) ANOVA was conducted with attractiveness rating as the dependent variable. The analysis revealed significant main effect of clothing colour (F(2.23, 66.98) = 11.74, $p < .001$, $\eta_p^2 = 0.28$; Fig. 2) with higher attractiveness ratings for the colours black (6.79 ± 0.17) and red (6.67 ± 0.15) than for grey (6.20 ± 0.18) and green (6.00 ± 0.22; all $ps < 0.01$), and distinguishable ratings for red, blue (6.39 ± 0.18) and white (6.35 ± 0.18; all $ps > 0.05$). The main effect of avatar race was also significant (F(1,30) = 8.08, $p < .01$, $\eta^2_p = 0.21$) with higher attractiveness ratings for African than Caucasian avatars (6.49 ± 0.17 vs 6.31 ± 0.17). Furthermore, the significant main effect of dress size (F(1.55, 46.39) = 22.70, $p < .001$, $\eta^2_p = 0.43$) indicated that sizes 6, 8, 10 and 12 attracted similarly high attractiveness ratings (6.78 ± 0.2 vs 6.82 ± 0.15 vs 6.69 ± 0.14 vs 6.41 ± 0.18, all $ps > 0.05$), followed by size 14 (6.05 ± 0.2) and then by size 16 (5.64 ± 0.24, all $ps < 0.05$).

Although clothing colour × avatar race × dress size interaction was not significant (F(10.32, 309.47) = 1.31, $p = .22$, $\eta^2_p = 0.04$), there were significant clothing colour × avatar race interaction (F(2.81, 84.31) = 3.94, $p = .01$, $\eta^2_p = 0.12$) with higher attractiveness ratings for the colours white, blue and green in African than in Caucasian avatars (6.55 ± 0.18 vs 6.15 ± 0.19, 6.51 ± 0.18 vs 6.28 ± 0.19, 6.11 ± 0.22 vs 5.88 ± 0.22; all $ps < 0.05$) and similar ratings between African and Caucasian avatars wearing black, grey or red (6.8 ± 0.19 vs 6.78 ± 0.17, 6.25 ± 0.19 vs 6.16 ± 0.19, 6.73 ± 0.17 vs 6.6 ± 0.15; all $ps > 0.05$). The significant avatar race × dress size interaction (F(2.98, 89.25) = 2.74, $p < .05$, $\eta^2_p = 0.08$) revealed that African models in dress sizes 6, 10, 12 and 16 were rated more attractive than Caucasian models (6.9 ± 0.21 vs 6.65 ± 0.21, 6.78 ± 0.14 vs 6.61 ± 0.14, 6.55 ± 0.17 vs 6.27 ± 0.2, 5.77 ± 0.23 vs 5.52 ± 0.25 for size 6, 10, 12, 16 respectively; all $ps < 0.05$). Furthermore, the significant clothing colour × dress size interaction (F(9.51, 285.33) = 3.14, $p = .001$, $\eta^2_p = 0.1$) suggested that dress size could modify the colour attracting the highest (red or black) and lowest (green or grey) attractiveness ratings. Specifically, black and red received indistinguishable high ratings for size 6, 8, 10, 12 or 14 (all $ps > 0.05$), but black received higher rating than all the other colours for size 16 (all $ps < 0.05$). Furthermore, green tended to receive lower ratings than red and/or black for smaller sizes 6–10, whereas both green and grey received similarly lower ratings than red and/or black for larger size 12–16 (all $ps < 0.05$).

Body size judgement: to explore to what extent body size judgements were affected by clothing colour, avatar race and dress size, a 6 (clothing colour) × 2 (avatar race) × 6 (dress size) ANOVA was conducted with body size estimation error for each dress size (reported size – actual dress size) as the dependent variable. The positive or negative estimation error indicated an overestimation or underestimation of the presented body size, respectively. The analysis revealed significant main effect of clothing colour (F(5, 150) = 47.8, $p < .001$, $\eta_p^2 = 0.61$; Fig. 3) with body size underestimation for avatars wearing black (−0.50 ± 0.17), blue (−0.39 ± 0.17) and red (−0.26 ± 0.17), and overestimation for avatars wearing green (0.14 ± 0.18), grey (0.15 ± 0.18) and white (0.37 ± 0.2) (black/blue/red vs green/grey/white, all $ps < 0.05$). The main effect of dress size was also significant (F(2.22, 66.48) = 136.04, $p < .001$, $\eta^2_p = 0.82$) with increased body size overestimation for smaller dress sizes (size 6: 1.4 ± 0.11, size 8: 0.46 ± 0.16, size 10: 0.31 ± 0.21) and increased underestimation for larger dress sizes (size 12: −0.38 ± 0.23, size 14: −0.69 ± 0.21, size 16: −1.58 ± 0.19) (size 6 vs 8/10 vs 12/14 vs 16, all $ps < 0.05$). The main effect of avatar race, on the other hand, was not significant (F(1,30) = 2.62, $p = .12$, $\eta_p^2 = 0.08$).

There were also significant clothing colour × avatar race (F(5,150) = 12.3, $p < .001$, $\eta_p^2 = 0.29$), avatar race × dress size (F(5,150) = 4.5, $p = .001$, $\eta_p^2 = 0.13$), clothing colour × dress size (F(11.61, 348.36) = 8.66, $p < .001$, $\eta_p^2 = 0.22$), and clothing colour × avatar race × dress size interactions (F(12.81, 384.29) = 5.63, $p < .001$, $\eta^2_p = 0.16$). Although participants tended to overestimate for smaller dress sizes (6–10) and underestimate for larger dress sizes (12–16), the directions (overestimation vs underestimation) and magnitudes of their estimation errors were systematically manipulated by the clothing colour and avatar race (Fig. 3). Specifically for smaller dress sizes (especially 6 and 8), the colours black, grey and blue tended to induce more overestimation for African than for Caucasian models, whereas white induced more overestimation for Caucasian than for African models (all $ps < 0.05$). For larger dress sizes (12–16), the colours black and blue induced similar underestimation for both Caucasian and African models (all $ps > 0.05$), but white and grey induced more overestimation for Caucasian than for African models in dress size 12 and 14 respectively (all $ps < 0.05$). Furthermore, the colours red and green showed avatar race-modulated impact on estimation errors only for dress size 10, with more overestimation induced by red and less overestimation induced by green for Caucasian than for African models (all $ps < 0.05$).

3.2. Effect of clothing colour and avatar race on body-viewing gaze allocation

To further examine to what extent body-viewing gaze behaviour was altered by clothing colour and avatar race, a 6 (clothing colour) × 2 (avatar race) × 5 (body region) ANOVA was conducted with the proportion of viewing time directed at each body region as the dependent variable. The analysis revealed non-significant main effect of clothing colour (F(5, 150) = 2.13, $p = .07$, $\eta^2_p = 0.07$; Fig. 4) and avatar race (F(1,

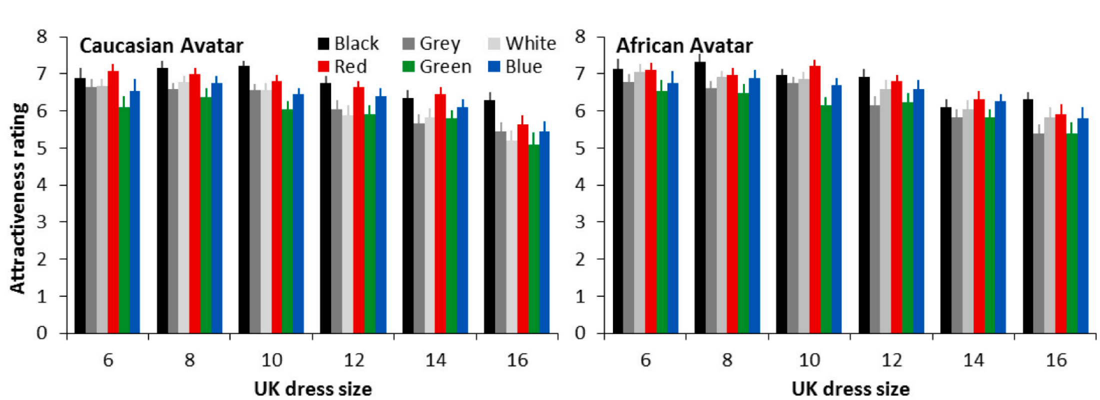

Fig. 2. Attractiveness ratings for Caucasian (left) and African avatar (right) in each dress size wearing the colour black, grey, white, red, green and blue. Error bars represent SEM. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

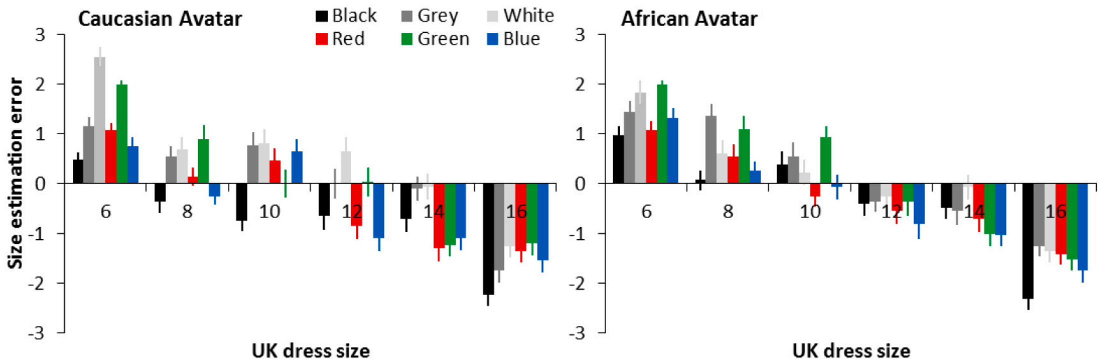

Fig. 3. Mean body size estimation error between reported and actual size for Caucasian (left) and African avatar (right) in each dress size wearing the colour black, grey, white, red, green and blue. Error bars represent SEM. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

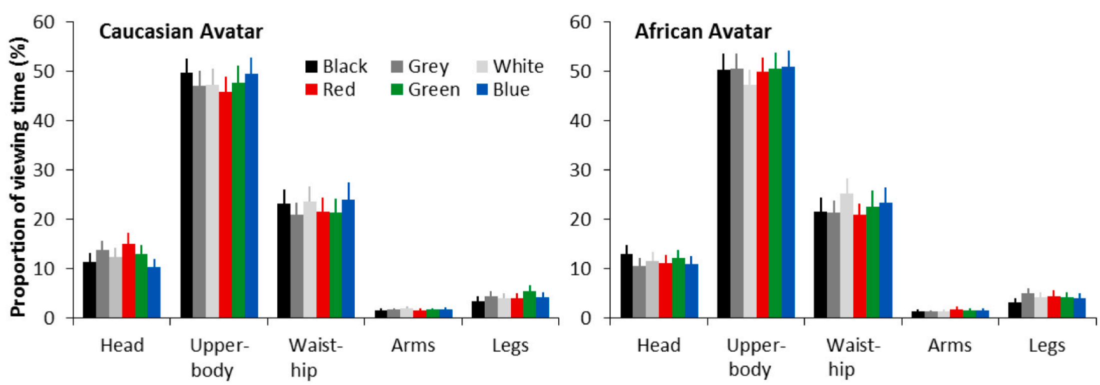

Fig. 4. Mean proportion of viewing time directed at individual body regions in Caucasian (left) and African avatar (right) wearing the colour black, grey, white, red, green and blue. Error bars represent SEM. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

30) = 2.56, p = .12, η^2_p = 0.08), but significant main effect of body region (F(1.58,47.45) = 71.77, p < .001, η^2_p = 0.71). Specifically, the highest proportion of viewing time was allocated at the upper-body region (48.94% ± 3.02; upper-body vs other body regions, all ps < 0.001), a reduced but similar amount of viewing time was directed at the waist-hip and head (22.51% ± 2.79 vs 12.17% ± 1.62; p = .13), and the least but indistinguishable proportion of viewing time was allocate at the legs and arms (4.26% ± 2.22 vs 1.64% ± 0.31; p = .28).

The significant clothing colour × body region interaction (F(7.62, 228.50) = 2.36, p = .02, η^2_p = 0.07) further revealed that the clothing colour tended to affect gaze allocation at the waist-hip (F(3.44, 103.14) = 3.65, p = .01, η^2_p = 0.11), upper-body (F(5, 150) = 2.12, p = .06, η^2_p = 0.07) and legs (F(3.55, 106.57) = 2.5, p = .05, η^2_p = 0.08). In comparison with other clothing colours, white induced more viewing at the waist-hip region, whereas black tended to attract more viewing at the upper-body but less viewing at the legs. Moreover, there exist significant avatar race × body region interaction (F(2.34, 70.28) = 5.04, p = .006, η^2_p = 0.14) with African models attracting more viewing at the upper body than Caucasian models (49.99% ± 3.04 vs 47.9% ± 3.03, p < .01) but less viewing at the head (11.48% ± 1.59 vs 12.71% ± 1.71, p < .05). The clothing colour × avatar race interaction (F(5, 150) = 0.27, p = .93, η^2_p = 0.01) and clothing colour × avatar race × body region interaction (F(9.54, 286.16) = 1.85, p = .06, η^2_p = 0.06) were non-significant.

In agreement with previous research (e.g., Cundall & Guo, 2017), individual participant's gaze allocation at each body region (head, upper-body, waist-hip, arms and legs) did not significantly correlate with their body attractiveness or body size ratings across all clothing colours and dress sizes (Pearson correlation, p > 0.05 for all comparisons). Regarding their own clothing colour preference, out of 31 participants, 5 (16%) participants preferred black, 1 (3%) preferred grey, 1 (3%) preferred white, 13 (42%) preferred red, pink or purple, 3 (10%) preferred green, 4 (13%) preferred blue, and 4 (13%) preferred yellow or orange. No significant interaction was observed between own clothing colour preference and presented clothing colour for either body attractiveness rating (F(30, 288) = 0.25, p = 1, η^2_p = 0.03) or body size estimation (F(30, 288) = 0.16, p = 1, η^2_p = 0.02). However, given our relatively small and homogeneous participant group (i.e. young healthy heterosexual Caucasian female undergraduate students), these findings on the relations between individual's body-viewing gaze distribution or colour preference and body assessment behaviour should be treated cautiously.

4. Discussion

This study aimed to extend our previous research on internal and external factors surrounding female body perception in women, by specifically examining the effect of the clothing colour on judging Caucasian and African avatars' body attractiveness and body size, and associated body-viewing gaze distribution. The analysis has revealed that clothing colour black and red tended to attract the highest body attractiveness and slimmer body size ratings, whereas green and grey tended to induce the lowest body attractiveness and overestimated body size judgements. This colour-related modulatory effect on body perception was further influenced by the avatar's skin tone (i.e. African avatars wearing colour white, blue and green attracting higher attractiveness ratings than Caucasian avatars), and was associated with the changes of gaze allocation at the upper body and waist-hip regions (i.e. colour black and white attracting longer viewing at the upper body and waist-hip regions, respectively).

The evolution-related ‘red effect’ theory has proposed that men have a predisposition and show enhanced attraction for the colour red due to its close association with sexual availability and desirability (Elliot & Niesta, 2008; Wen, Zuo, Wu, Sun, & Liu, 2014). For instance, men tend to rate women wearing red tops as more attractive (Elliot & Niesta, 2008; Guéguen & Jacob, 2013; Roberts et al., 2010); women also often prefer to wear red due to its enhancement in the perceived sexual receptivity (Kramer & Mulgrew, 2018; Pazda, Elliot, & Greitemeyer, 2013). Another popular clothing colour, black, is preferred by women probably because of its perceived fashionableness (Pazda et al., 2013) and its slimming effect on (especially larger) body images, which promotes men's preference for slender female figures (Jiang & Vartanian, 2016; Singh & Singh, 2011). In this study with the presentation of full (rather than top half) body images varying in dress sizes, we further extended this colour-induced enhancement in the perceived attractiveness to women participants judging other women's body, indicating that the same colour cues are used by both men and women to assess female body attractiveness in general rather than to assess own body attractiveness. This finding is in agreement with the influential mate selection theory which suggests women may compare each other's attractiveness to determine their own chance for successful mate selection or to monitor potential attractive competitors posing a greater threat to partner sexual fidelity (Pawlowski & Dunbar, 1999; Hughes, Harrison, & Gallup Jr, 2004; O'Connor & Feinberg, 2012). By adopting a body perception strategy similar to men, women are more likely to conduct a reliable social comparison for such purpose.

The low attractiveness ratings to avatars wearing green and grey may be partly caused by individual's preference for the clothing colour, given that personal colour preference can highly affect the perception of person attractiveness (Damhorst & Reed, 1986). Although an individual's colour preference (e.g., most and least preferred colours) is affected by their subjective experience and is context- or object-dependent (Holmes & Buchanan, 1984; Jonauskaite et al., 2016; Schloss, Strauss, & Palmer, 2013), green and grey have often been rated as neither liked nor disliked colours (Jonauskaite et al., 2016) or as one of the least preferred colours (Lind, 1993) by majority of participants in previous colour preference research. Similarly in this study among our 31 participants, only 4 chose either green or grey as their favourite clothing colour. Some participants also vocalized their dislike for green at the end of their testing. Furthermore, while red was typically perceived with high dominance and arousal, green and grey were often associated with low arousal in colour perception studies (Briki & Hue, 2016; Jonauskaite, Parraga, Quiblier, & Mohr, 2020). It is plausible such personal preference has led to the reduced body attractiveness ratings for the clothing colours grey and green.

In addition to body attractiveness ratings, the clothing colour could also modulate body size ratings. Across all the tested dress sizes, black, blue and red induced body size underestimation, whereas green, grey and white led to body size overestimation (Fig. 3). This observation is consistent with the common practice in fashion design to use black and white dress to achieve the largest underestimation and overestimation in body size respectively (Finney, 2006), and may partly explain why women often choose blue and purple-blue hues as both their favourite colour for a garment and the dominant colour in their wardrobe (Lind, 1993). For those avatars wearing grey and green, our participants had the closest body size estimation to the actual dress size (especially for larger dress sizes 12–14). Perhaps this also accounts for lower attractiveness ratings for larger avatars in grey and green (size 12–16 in Fig. 2). Interestingly, the same clothing colour does not always show the same direction of impact on body size and attractiveness judgements. While black, red and blue attracted slimmer body size and higher body attractiveness ratings, white induced a larger body size overestimation than grey and green (Fig. 3), but still attracted similarly high body attractiveness rating as red and blue (Fig. 2). It seems that the perceived body thinness does not necessarily equate to attractiveness in the context of the clothing colour.

Furthermore, the avatar race or skin tone showed an evident impact on the modulatory effect of the clothing colour on body attractiveness and size judgements. Overall African and Caucasian avatars wearing black, red and grey were similarly attractive, but African avatars wearing white, blue and green were rated more attractive than Caucasian avatars. This may be partly caused by the effect of the clothing colour on body size assessment, as white in induced less overestimation in African than in Caucasian avatars, subsequently leading to increased African body attractiveness ratings. Blue and green, on the other hand, had little impact on body size assessment. The increased attractiveness ratings for African avatars in blue and green could due to the enhancement of the perceived lightness contrast and saturation similarity between the dress colour and dark skin tone, given that humans often prefer higher over lower lightness in single colour, and higher over lower lightness contrast and saturation similarity in two-colour combinations (Camgöz, Yener, & Güvenç, 2002; Palmer, Schloss, & Sammartino, 2013). Overall, our findings could dispute previous suggestion that differences in body image perception between African American and Caucasian women are purely based upon cultural and societal expectations (Ackard, Croll, & Kearney-Cooke, 2002; Duncan, Anton, Newton, & Perri, 2003). It is likely that the skin tone could affect the perceived dress colour and subsequently influence the body image-related attractiveness and size judgements.

When viewing the presented avatars, our participants directed the highest proportion of viewing time at the upper body, followed by the waist-hip and head, and then by the legs and arms. This pattern of body-viewing gaze distribution was not affected by the clothing colour and avatar race, and has also been observed when viewing African, Asian and Caucasian women dressed in underwear from different viewpoints (Rodway et al., 2019). It appears that the same local bodily cues have been extracted and analysed in body perception regardless of avatar race, dress colour and style. The concentrated gaze allocation at the upper body and waist-hip further supports previous observation that these two body regions provide diagnostic cues in evaluating sexual maturity, body attractiveness and size (Cornelissen et al., 2009; Garza, Heredia, & Cieslicka, 2016; Lykins, Ferris, & Graham, 2014).

Although the clothing colour did not qualitatively affect the pattern of body-viewing gaze distribution, it showed limited modulation on quantitative gaze allocation at given local body regions. For instance, the white dress tended to induce more viewing at the waist-hip region, whereas the black dress attracted more viewing at the upper-body but less viewing at the legs (Fig. 4). In comparison with other clothing colours, the colour/luminance contrast between the white dress and image background is relatively low (Fig. 1), causing difficulty to assess WHR which is crucial for body attractiveness and size judgements (Cornelissen et al., 2009; Garza et al., 2016; Lykins et al., 2014). Consequently, our participants may need longer viewing time to process details from the waist-hip region. The higher colour/luminance contrast between the black dress and image background, on the other hand, would facilitate the processing of the waist-hip and leg shape and size, hence relatively shorter viewing time was directed at these two regions in avatars wearing black.

It is worth mentioning that in this study we used a relatively small set of well-controlled avatar bodies wearing a limited range of colours, and only tested young healthy heterosexual Caucasian female undergraduate students. This approach would generate more comparable data between testing conditions, but has inevitably restricted variability in the clothing colour, body shape and size across stimuli, and in individual differences across participants. Given people from different culture backgrounds have different ideal body shape and size (Sugiyama, 2004; Tovée et al., 2006), and individuals' sexual cognition and preference can systematically modify their body attractiveness assessment and associated body-viewing gaze behaviour (Hall et al., 2011, 2014, 2015), it remains to be seen to what extent the current findings can be generalized to participants of different age, gender, sexual orientation and ethnicity in viewing of naturalistic women figures wearing a large range of representative clothing colours. This would also explicitly address whether the clothing colour-modulated body attractiveness and size judgement is a general property of female body perception or is subject to mate preference and selection process.

In conclusion, this study has clearly demonstrated that female body perception could be affected by the clothing colour. Specifically, black and red would attract higher body attractiveness and slimmer body size ratings, whereas green and grey would induce lower body attractiveness and overestimated body size ratings. Such impact of the clothing colour was further modulated by the avatar skin tone (i.e. higher attractiveness ratings for African avatars wearing white, blue and green relative to Caucasian avatars), and was associated with varying gaze allocation at the upper body and waist-hip regions (i.e. black and white dress attracting more viewing at the upper body and waist-hip regions, respectively). Taken together, it seems that the clothing colour and its contrast with skin tone play valuable roles in mediating women's body perception of other women. From applied perspective, fundamentally this work will move our understanding about the relations between body image and clothing colour from opinion to a more scientific basis. This would have practical implication to areas such as fashion design and personal body image management or intervention in our modern multi-culture society.

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Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Declaration of competing interest

All authors declare no conflict of interest with the reported research.

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