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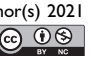

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Impact of Face Masks on Female Body Perception is Modulated by Facial Expressions

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Abstract

People routinely wear face masks during the pandemic, but little is known about their impact on body perception. In this online study, we presented female body images of Caucasian avatars in common dress sizes displaying happy, angry, and neutral facial expressions with and without face masks, and asked women to rate the perceived body attractiveness and body size. In comparison with mask-off condition, mask-on decreased body attractiveness ratings for happy avatars but did not affect ratings for neutral avatars irrespective of avatar dress sizes. For avatars displaying angry expressions, mask-on increased body attractiveness ratings for slimmer avatars but did not affect ratings for larger avatars. On the other hand, body size estimation was not systematically affected by face masks and facial expressions. It appears that face masks mainly show an expression-dependent influence on body attractiveness judgement, possibly through suppressing the perceived facial expressions.

Keywords

face mask, facial expression, body attractiveness, body size, women

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Introduction

The emergence of the COVID-19 pandemic has resulted in the legal requirement to wear face coverings in public spaces across the globe. Given that reliable recognition of an individual's face identity and facial expression requires the extraction and integration of local facial cues and their relations across the whole face (Bruce & Young, 2012; Guo, 2012), by concealing facial information from nose and mouth regions, face coverings will inevitably interfere with face perception,

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such as reducing identity and expression recognition accuracy (Carbon, 2020; Noyes et al., 2021). Their effect on body perception (i.e., perceiving an individual's physical body appearance), however, is unclear. Being one of the most common visual stimuli in our social surroundings, human bodies have high perceptual saliency and can easily attract our visual attention. When viewing other people, we often assess their body appearance, such as body attractiveness and body size, either consciously or unconsciously (Pawlowski & Dunbar, 1999; Peelen & Downing, 2007). The outcome of these assessments could have profound impact on our social behavior (e.g., approach or avoidance tendency), physical and mental health (e.g., eating disorders) (Slade, 1994; Adolphs, 2003). From this perspective, it is both timely and important to understand the potential impact of face coverings on body attractiveness and body size assessments.

Recent research has revealed that female body perception from women's perspective is modulated by both external and internal factors, such as body mass index (BMI), waist-to-hip ratio (WHR), body fat, skin color, clothing style and color in the viewed body, and the viewers' own culture, mental state, body composition and body satisfaction (e.g., Cornelissen et al., 2009; Cundall & Guo, 2017; Rodway et al., 2019; Sidhu et al., 2021). Typically, slender figures from the viewers' own racial group dressed in black or red are often judged as more attractive with slimmer body size ratings. Although the viewers mainly use visual information from the chest and waist–hip areas to assess female body attractiveness and body size (e.g., Cornelissen et al., 2009; Cundall & Guo, 2017), facial cues in the viewed bodies could further influence the judgement of body attractiveness or related body information (e.g., body shape, weight, and height; Coetzee et al., 2010; Schneider et al., 2013; Holzleitner et al., 2014). For instance, higher physical attractiveness ratings are often associated with women posing happy or neutral than sad facial expressions (Mueser et al., 1984); women's face attractiveness ratings can also serve as a predictor of their full-body attractiveness ratings (Currie & Little, 2009; Bleske-Rechek et al., 2014). To the best of our knowledge, the judgement of body size has not been reported to be influenced by facial cues.

These observations have shed light on the possible impact of face coverings on body attractiveness and body size judgements. Considering that face masks would reduce rather than eliminate facial expression recognition performance (Carbon, 2020), they may have an expression-dependent influence on the perceived body attractiveness. For instance, a happy/angry person wearing a face mask might be perceived as less happy/angry (rather than neutral), and hence is judged as less/more attractive. The perceived body size, on the other hand, might not be affected by face masks as body size judgements mainly rely on the assessment of BMI, WHR, and body fat distribution (e.g., Cundall & Guo, 2017). These hypotheses have been examined in this online study which focuses on female body perception from women's perspective, because human body perception is sensitive to the gender of both the viewers and viewed bodies (e.g., Hall et al., 2011). To represent real-world scenarios, we presented well-controlled female Caucasian full-body avatars of different body sizes in full frontal view posing happy, neutral, and angry expressions with and without face masks. Female participants were then required to rate the perceived body attractiveness and body size.

Method

One-hundred eighteen women (114 Caucasian and 4 Asian), aged between 16 and 71 years old (26.17 ± 1.1, Mean $\pm$ SEM), volunteered to take part in this online study. All participants reported normal or corrected-to-normal visual acuity, and had no self-reported history of eating disorders. To control for potential race- and age bias in body attractiveness and size judgements (Rodway et al., 2019), only data from 97 Caucasian participants, aged between 16 and 30 years old (21.14 ± 0.2), were included in final analysis. The suitability of this sample size was confirmed by power analysis using G*power software. With a conservative effect size of 0.25 reported in previous studies on

avatar body attractiveness and size judgements (e.g., Cundall & Guo, 2017; Rodway et al., 2019), a sample of 63 participants in this study would have been large enough for this effect to be detected with a power of 0.95 at alpha level 0.05 in a within-factor repeated measures design with 9 groups (avatars of different facial expressions and body sizes), 2 measurements (face mask conditions: mask-on vs. mask-off), and 1 nonsphericity correction. The Ethical Committee in the School of Psychology, University of Lincoln approved this study (PSY20211014). Written informed consent was obtained from each participant, and all procedures complied with the British Psychological Society Code of Ethics and Conduct.

High-resolution female body images of computer-generated young adult Caucasian avatars wearing a tight dress in full frontal view were created via www.trymetail.com (Sidhu et al., 2021). These bodies represented three common UK dress sizes (sizes 8, 12, and 16; standardized 165 cm height and 74 cm inner leg measurements; AA to C breast cup sizes increasing proportionally in parallel to dress sizes). Female face images, consisting of four Caucasian models displaying happy, neutral, and angry expressions in full frontal view, were selected from the Karolinska Directed Emotional Faces CD ROM (Lundqvist et al., 1998). These faces, either with or without a surgical face mask, were then placed onto the bodies via Adobe® Photoshop 2017 CC. In total, 72 images (3 dress sizes $\times$ 4 face identities $\times$ 3 facial expressions $\times$ 2 face mask conditions) were created for the testing (see, e.g., Figure 1).

During the self-paced online data collection via Qualtrics, these grayscale images (300×450 pixels) were displayed once in a random order in two blocks (36 images per block with avatars of different facial expressions and body sizes). Each block consisted an equal mixture of masked and unmasked avatars, and two versions of the same avatar (mask-off vs. mask-on) were presented in separate blocks to prevent participants from simply remembering and duplicating the responses given to one version to the other version. Each image was co-presented with two response boxes in which participants could enter 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 sizes 6 to 18. The participants were instructed to "rate body attractiveness and body size as carefully as possible". There was no time limit for each trial, and no feedback was given during the testing.

Two repeated measures analysis of variance (ANOVAs) were conducted to examine the effect of face mask, facial expression, and dress size on participants' body attractiveness and body size

Figure 1. Examples of a Caucasian female avatar in UK dress size 12 displaying happy, neutral, and angry facial expressions without and with wearing a surgical face mask.

judgements. For each ANOVA, Greenhouse–Geisser correction was applied where sphericity was violated, and a Bonferroni adjustment was made for *post hoc* multiple comparisons.

Results

Body attractiveness judgement: to explore to what extent body attractiveness judgements were affected by face mask, facial expression and dress size, a 2 (face mask: mask-on vs. mask-off) × 3 (facial expression: happy vs. neutral vs. angry) × 3 (dress size: 8 vs. 12 vs. 16) ANOVA was conducted with attractiveness rating as the dependent variable. The analysis revealed a nonsignificant main effect of face mask ($F(1, 96) = 0.37$, $p = .55$, $\eta_p^2 = 0.004$; Figure 2A); but a significant main effect of facial expression ($F(1.19, 114.12) = 35$, $p < .001$, $\eta_p^2 = 0.27$) with happy avatars attracting the highest body attractiveness ratings (6.56 ± 0.11) followed by neutral (6.38 ± 0.11) and then by angry avatars (6.12 ± 0.13, all $ps < .01$); and a significant main effect of dress size ($F(1.3, 124.36) = 75.89$, $p < .001$, $\eta_p^2 = 0.44$) with size 8 avatars attracting the highest attractiveness ratings (7.02 ± 0.12) followed by size 12 (6.47 ± 0.12) and then by size 16 (5.57 ± 0.15, all $ps < .01$).

There were also significant face mask × facial expression ($F(1.52, 145.92) = 20.8$, $p < .001$, $\eta_p^2 = 0.18$), face mask × dress size ($F(2, 192) = 4.68$, $p = .01$, $\eta_p^2 = 0.05$), facial expression × dress size ($F(4, 384) = 2.56$, $p = .04$, $\eta_p^2 = 0.03$), and face mask × facial expression × dress size interactions ($F(3.53, 338.42) = 4.34$, $p = .003$, $\eta_p^2 = 0.04$). The impact of face mask on body attractiveness assessment was dependent upon avatar facial expression and dress size. Specifically, in comparison with mask-off conditions, mask-on significantly decreased attractiveness ratings for happy avatars in size 8 (7.36 ± 0.11 vs. 7.13 ± 0.12, $t(96) = 2.82$, $p = .006$, $d = 0.29$), size 12 (6.75 ± 0.12 vs. 6.54 ± 0.13, $t(96) = 2.89$, $p = .005$, $d = 0.29$) and size 16 (6 ± 0.16 vs. 5.6 ± 0.16, $t(96) = 4.65$, $p < .001$,

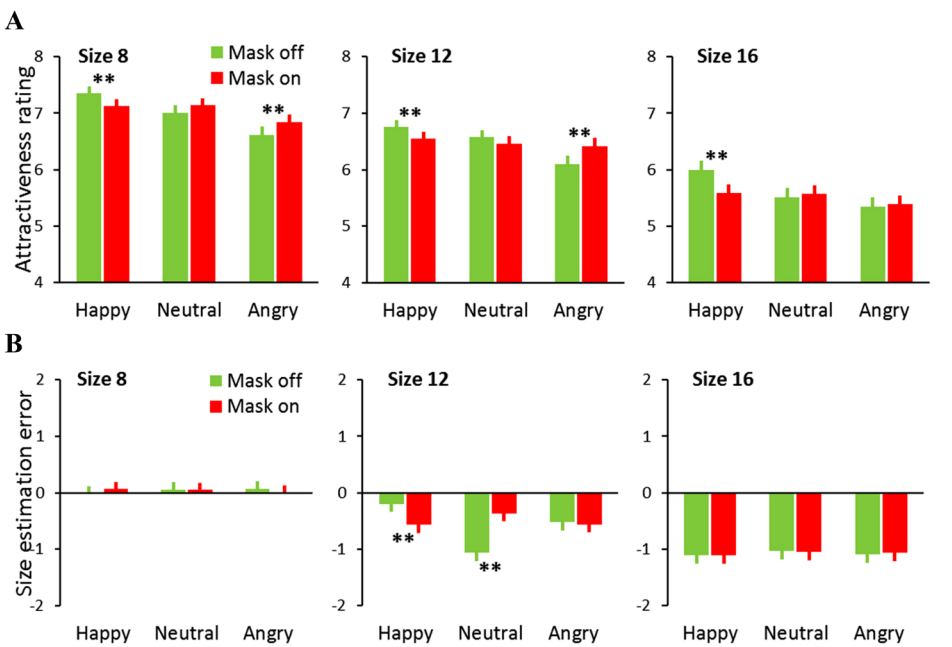

Figure 2. Body attractiveness ratings (A) and body size estimation error between reported and actual size (B) for happy, neutral, and angry avatars in each dress size (sizes 8, 12, and 16) with and without face masks. Error bars represent standard error of mean (* $p < .05$, ** $p < .01$).

$d = 0.47$); but did not affect ratings for neutral avatars irrespective of their dress sizes (size 8: 7.01 ± 0.13 vs. 7.13 ± 0.13, $t(96) = 1.78$, $p = .08$, $d = 0.18$; size 12: 6.58 ± 0.12 vs. 6.46 ± 0.13, $t(96) = 1.62$, $p = .11$, $d = 0.17$; size 16: 5.51 ± 0.16 vs. 5.57 ± 0.16, $t(96) = 1.07$, $p = .29$, $d = 0.11$). Interestingly, when assessing angry avatars, mask-on increased attractiveness ratings for slimmer avatars (size 8: 6.62 ± 0.15 vs. 6.84 ± 0.13, $t(96) = 2.89$, $p = .005$, $d = 0.3$; size 12: 6.09 ± 0.15 vs. 6.42 ± 0.14, $t(96) = 4.35$, $p < .001$, $d = 0.45$) but did not affect ratings for larger avatars (size 16: 5.35 ± 0.17 vs. 5.38 ± 0.17, $t(96) = 0.61$, $p = .54$, $d = 0.06$). Furthermore, wearing masks could not fully diminish the impact of facial expression on body attractiveness assessment. Whereas in mask-off conditions, happy avatars typically attracted the highest attractiveness ratings followed by neutral and then by angry avatars irrespective of avatar dress sizes (all $ps < .01$), in mask-on conditions similar attractiveness ratings were given to happy and neutral avatars in the same dress size (all $ps > .05$) which were significantly higher than those ratings for angry avatars (especially) in dress sizes 8 and 16 (size 8: happy vs. angry, $t(96) = 3.97$, $p < .001$, $d = 0.4$; neutral vs. angry, $t(96) = 3.89$, $p < .001$, $d = 0.39$; size 16: happy vs. angry, $t(96) = 3.38$, $p = .001$, $d = 0.35$; neutral vs. angry, $t(96) = 3.04$, $p = .003$, $d = 0.32$).

Body size judgement: To explore to what extent body size judgements were affected by face mask, facial expression, and dress size, a 2 (face mask) × 3 (facial expression) × 3 (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 nonsignificant main effects of face mask ($F(1, 96) = 1.61$, $p = .21$, $\eta_p^2 = 0.02$; Figure 2B) and facial expression ($F(2, 192) = 2.38$, $p = .1$, $\eta_p^2 = 0.02$), but a significant main effect of dress size ($F(1.33, 128.05) = 51.56$, $p < .001$, $\eta_p^2 = 0.35$) with body size overestimation for small dress size 8 (0.04 ± 0.12) and increased underestimation for larger dress sizes (size 12: -0.54 ± 0.13, size 16: -1.07 ± 0.14; all $ps < .01$).

There were also nonsignificant face mask × dress size interaction ($F(1.81, 173.4) = 1.16$, $p = .32$, $\eta_p^2 = 0.01$); but significant face mask × facial expression ($F(2, 192) = 10.55$, $p < .001$, $\eta_p^2 = 0.1$), facial expression × dress size ($F(4, 384) = 7.18$, $p < .001$, $\eta_p^2 = 0.07$), and face mask × facial expression × dress size interactions ($F(4, 384) = 14.16$, $p < .001$, $\eta_p^2 = 0.13$). Specifically, in comparison with mask-off conditions, mask-on increased body size estimation error for happy avatars in size 12 (-0.2 ± 0.14 vs. -0.57 ± 0.14, $t(96) = 4.29$, $p < .001$, $d = 0.44$), decreased body size estimation error for neutral avatars in size 12 (-1.07 ± 0.14 vs. -0.36 ± 0.15, $t(96) = 7.33$, $p < .001$, $d = 0.75$); but did not affect body size estimation for angry avatars in size 12 and happy/neutral/angry avatars in size 8 and 16 (all $ps > .05$). Furthermore, body size estimation for avatars in size 8 and 16 were not affected by avatar facial expressions (all $ps > .05$), but the estimation for avatars in size 12 were more accurate for happy avatars (-0.38 ± 0.1) followed by angry (-0.54 ± 0.1) and then by neutral avatars (-0.71 ± 0.11, all $ps < .04$).

Discussion

This study extended previous research on modulatory factors in body perception by investigating the effect of face masks and facial expressions on body attractiveness and body size assessments. Our analysis revealed that the same-identity avatars posing happy expressions attracted higher body attractiveness ratings over neutral and then angry expressions, but these expression-induced attractiveness differences were significantly reduced by putting face masks on avatars. Specifically, face masks decreased, increased, and did not affect attractiveness ratings for happy, angry, and neutral avatars, respectively. Contrary to body attractiveness, body size ratings were not systematically affected by facial expressions and face masks. It seems that face masks have an expression-

dependent influence on body attractiveness judgement, possibly through suppressing the perceived facial expressions.

Our findings support previous suggestion that women face attractiveness could be a powerful predictor of their full-body attractiveness (Mueser et al., 1984; Currie & Little, 2009; Bleske-Rechek et al., 2014). Happy faces are typically perceived with high attractiveness scores (Golle et al., 2014) because of their association with attractive human traits, such as sincerity, friendliness and warmth, sociability, likability, generosity, and trustworthiness (e.g., Reis et al., 1990; Mehu et al., 2008; Li et al., 2021). Angry faces, on the other hand, indicate threat and unpleasantness, and are perceived with low attractiveness (Calder et al., 2011). As the theory of holistic body perception or face–body integration (i.e., a person's face and body are processed as a single unit; Hu et al., 2020) indicates a direct impact of face attractiveness on body attractiveness assessment, it is not surprising that irrespective of dress sizes, avatars posing happy expressions attracted the highest body attractiveness ratings followed by neutral and then by angry avatars (Figure 2A).

One novel finding in this study is that wearing face masks significantly reduced expression-modulated body attractiveness ratings for happy and angry avatars while showing no impact on the ratings for neutral avatars. As the mouth region transmits diagnostic cues for decoding happiness (Smith et al., 2005), once it is concealed by face masks, the viewers show difficulty to recognize happiness and frequently misclassified it as neutral expression (Carbon, 2020). It is plausible this diminished happiness interpretation would reduce avatar face attractiveness value and subsequently abolish the enhancement in body attractiveness rating associated with happy faces. Indeed, the ratings for masked happy avatars were indistinguishable from those ratings for masked or unmasked neutral avatars. Similarly, face masks on angry faces would decrease the recognition of anger (Carbon, 2020), increase avatar face attractiveness value, and then reduce the detraction in body attractiveness rating associated with angry faces. Interestingly, the ratings for masked angry avatars were still lower than those for masked happy or neutral avatars, indicating the leakage of unattractiveness facial cues from masked angry faces which might be perceivable by the viewers. Given that the eye region transmits diagnostic information for decoding anger (Smith et al., 2005) and is not concealed by face masks, the reduced but still detectable angry facial cues in masked angry avatars would negatively influence body attractiveness ratings. Furthermore, while face masks on angry avatars could increase attractiveness ratings for more attractively rated slimmer avatars by our participants, they showed no impact on judging relatively less attractively rated larger avatars. It seems that face and body have non-additive contributions in driving full-body attractiveness assessment, supporting the holistic process of body/person perception (Hu et al., 2020). The observation of different body attractiveness ratings for the same expressive face on the bodies of different dress sizes further indicates that body attractive characteristics may play a dominant role in judging full-body attractiveness. Once the bodily cues, such as larger body size, have been perceived as highly unappealing, negative facial expressions would not further reduce full-body attractiveness ratings.

Another novelty in this study is that contrary to body attractiveness assessments, body size estimations were not systematically affected by facial expressions and face masks. The commonly reported body size overestimation for smaller avatars (size 8) and underestimation for larger avatars (size 16), which are probably caused by the participants' social etiquette conformation (e.g., reluctance to judge someone as skinny or fat) and judgment bias (tendency to shift toward the middle of the scale when uncertain in magnitude judgments; Cundall & Guo, 2017, Rodway et al., 2019), were not affected by facial expressions and face masks (Figure 2B). Only the estimation for medium-sized avatars (size 12) were more accurate for happy avatars than for angry or neutral avatars. Probably because happy faces do not signal threat but are inviting, and medium body size rating is more socially acceptable, the participants were more comfortable to assess body size carefully and accurately. This could also explain the observed interaction effect

between face mask, facial expression, and dress size on body size estimation. Specifically, differences in body size judgements between masked and unmasked avatars were only noticed for happy and neutral avatars in size 12. Our participants underestimated body size of masked happy avatars or unmasked neutral avatars probably because these avatar faces were less inviting than unmasked happy or masked neutral faces.

Furthermore, although body attractiveness and body size judgements could be interdependent when manipulating bodily cues (e.g., slender bodies are often rated as more attractive with slimmer body size when manipulating dress style and colour; Cundall & Guo, 2017; Sidhu et al., 2021), in this study these two aspects of body perception were largely independent when manipulating facial cues. Different facial expressions and mask-on/mask-off on the same avatar could induce different body attractiveness ratings, but similar body size ratings (at least for avatars in sizes 8 and 16). It seems that body size estimation mainly relies on the assessment of bodily cues, such as BMI, WHR, and body fat distribution (e.g., Cundall & Guo, 2017).

It is worth noting because of the nature of online study, we used a relatively small set of well-controlled stimuli to test (mainly) healthy Caucasian female participants. Although this approach ensured lower participant drop-out rate and data comparability between testing conditions, it has inevitably restricted variability in avatar facial expression, body shape and size across stimuli, and in individual differences across participants. Given people from different culture backgrounds have different social experience in face coverings (e.g., hijab in Muslim culture), different strategies to read facial expressions (Jack et al., 2009), and individuals' sexual cognition and preference can systematically modify their body attractiveness assessment (Hall et al., 2014), it remains to be seen to what extent the current findings can be generalized to participants of different age, gender, and ethnicity in viewing of naturalistic women figures posing a range of facial expressions with and without face coverings. Furthermore, the face coverings used in this study were typical surgical masks via Photoshop. Considering that face masks used in real life vary in physical saliency (e.g., mask color, design, shape, and texture) which may attract different amount of visual attention to the face and subsequently affect the amount of attention allocated at the body region, it would be interesting to investigate whether body attractiveness assessment could be further influenced by different types of face masks in real-life social interactions. Nevertheless, the current study advances our understanding of how face coverings impact body perception. While showing little influence on body size estimation in most cases, face masks have an expression-dependent influence on body attractiveness judgement, possibly through suppressing the perceived facial expressions. Future research could further examine whether this mask-modulated body perception could impact on consequential overt social behaviors.

Declaration of Conflicting Interests

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