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Perceiving Aggression from Facial Structure: Further Evidence for a Positive Association with Facial Width-to-Height Ratio and Masculinity, but not for Moderation by Self-Reported Dominance

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Abstract: Recent work has indicated that individual differences in facial structure are linked to perceptions of aggressiveness. In particular, the relative width of a face [facial width-to-height ratio (fWHR)] has been suggested to be a reliable cue to aggressive behaviour, at least in men. Additionally, facial masculinity has been associated with perceptions of dominance, a close proxy of aggressiveness. In two studies, we assessed the robustness of this link using faces transformed along these vectors in men (Studies 1 and 2) and women (Study 2). Additionally, we examined whether individual differences in self-reported dominance of perceivers moderated this association in order to extend previous work indicating that own dominance affects perception of such behaviour in others. Results indicated that both male and female faces with increased fWHR and increased facial masculinity were perceived as more aggressive. However, we found no systematic evidence for moderating effects of self-reported dominance on the perception of aggression in others. Taken together, these results further support the robustness of fWHR and facial masculinity as cues to aggressiveness but question whether observers' own dominance moderates their perception of these cues in others. Copyright © 2013 European Association of Personality Psychology

Key words: facial width-to-height ratio; aggression; dominance; masculinity; face perception

INTRODUCTION

Human faces are highly informative, albeit complex, social stimuli (Bruce & Young, 1998), providing a wealth of information such as the sex, age and race of an individual. In addition to these basic judgements, more elaborate inferences can be made even from emotionally neutral faces, including personality traits (e.g. Penton-Voak, Pound, Little, & Perrett, 2006) and behavioural tendencies (e.g. Sell et al., 2009). One characteristic likely to be of particular interest to the human mind is others' propensity for aggression; indeed, being able to discern those individuals who are likely to pose a physical threat may be of particular evolutionary importance by helping survival and reproductive success (e.g. Sell et al., 2009). Although transient facial expressions of anger may signal an acute threat, structural facial cues to aggression provide valuable information concerning the propensity for aggression of an individual (Carré & McCormick, 2008; Sell et al., 2009). One static facial metric of interest in this context is the facial width-to-height ratio (fWHR). This metric has been associated with actual aggression (e.g. Carré & McCormick, 2008; although refer to Özener, 2012), dominance behaviour (e.g. Haselhuhn & Wong, 2012; Stirrat & Perrett, 2010; Lewis, Lefevre, & Bates, 2012) and testosterone (Lefevre, Lewis, Perrett, & Penke, 2013), which in turn has links to aggression and dominance behaviours (e.g. Josephs, Newman, Brown, & Beer, 2003; Mazur & Booth, 1998). Moreover, fWHR has also been linked with the perception of these traits (Alrajih & Ward, 2013; Carré, McCormick, & Mondloch, 2009; Carré, Morrissey, Mondloch, & McCormick, 2010; Geniole, Keyes, Mondloch, Carré, & McCormick, 2012; Short et al., 2012). Here, we sought to replicate and extend these findings in two studies.

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Facial width and aggression

Following the initial observation that higher fWHR was linked to increased perceptions of aggression (Carré et al., 2009), several follow-up studies by the same group provided further evidence for such a link. For example, they demonstrated that perceptions were more strongly impaired when structural facial cues were obscured than when featural information was diminished (Carré et al., 2010). Additionally, they demonstrated a cross-racial effect of fWHR with perceived aggression being linked to fWHR in both Caucasian and Chinese faces by observers from both racial groups (Short et al., 2012). Finally, they demonstrated that in female faces, higher fWHR is also associated with increased perceived aggression, although to a lesser extent than in men (Geniole et al., 2012).

Although these studies provide good evidence for a link between fWHR and perceived aggression, they were, to the best of our knowledge, all conducted within the same set of 37 male images (in addition to female and Chinese images in the respective studies), giving rise to concerns over whether the observed effects generalise to the wider population or are an artefact of other structural features inherent to

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this particular set of individuals. The latter point is of particular interest in light of failures to replicate sex differences reported in this data set (e.g. Lefevre et al., 2012; Özener 2012), as well as a recent failure to replicate associations between perceived aggression and fWHR in the only study conducted in a different data set using photographs of both business leaders and academics obtained from the Internet (Alrajih & Ward, 2013). These pictures may be conceivably different to those used in previous studies for two reasons: they are of considerably older men (mean age: 52.5 years) compared with those used in Carré et al. (Carré et al., 2009; mean age: 18.98 years) and were not taken under controlled photographic conditions. Nonetheless, the discrepancy in results between these studies warrants further investigation.

In addition, to date, only one study has addressed perceptions in female faces (Geniole et al., 2012). This issue is of particular interest given initial speculation concerning sexual dimorphism in fWHR (Carré & McCormick, 2008; Weston, Friday, & Lio, 2007), an observation that, as noted previously, was not able to be confirmed in a number of independent samples (e.g. Lefevre et al., 2012; Özener 2012). Moreover, Geniole et al. (2012) did not control for body mass index (BMI), potentially artificially enhancing the association between fWHR and perceived aggression: Indeed, BMI has been positively associated with fWHR in both men and women (Coetzee, Chen, Perrett, & Stephen, 2010; Lefevre et al., 2012) and with perceived aggression in women (Gallup & Wilson, 2009). It is thus currently unclear whether, in women, high fWHR is indeed associated with aggression perception when BMI is controlled. Furthermore, although previous work indicates that fWHR appears to be used as a cue to aggressive behaviour, it is currently unclear whether even subtle differences in fWHR can be used to infer aggressive intent or whether only the extremes of this vector drive such perceptions. Additional knowledge to this end will be useful with respect to determining how well attuned the human mind is to this facial feature.

Finally, and of particular interest in the current work, it is currently unclear if the putative perception of aggression cued by fWHR is moderated by factors such as self-reported dominance. Previous work has shown effects of perceivers' own level of dominance on accuracy in dominance perception from faces (Watkins, Fraccaro, et al., 2010; Watkins, Jones, & DeBruine, 2010), although Wolff and Puts (2010) found no such association in accuracy of dominance perception from voices. If the ability to accurately perceive another's propensity to behave aggressively functions, at least in part, as a means to reduce costly conflict (e.g. Puts, Gaulin, & Verdolini, 2006; Puts, Hodges, Cardenas, & Gaulin, 2007), and these potential costs are higher for men low in dominance (as they are more likely to incur an injury), such low dominance men should be particularly attuned to cues of aggression in others. In the current study, we thus sought to confirm this theoretical claim by testing whether participants' self-reported dominance moderated their ability to use fWHR as well as facial masculinity (a cue previously associated with dominance in both men and women; e.g. Boothroyd, Jones, Burt, & Perrett, 2007; Jones et al., 2010; Main, Jones, DeBruine, & Little, 2009; Perrett et al., 1998) to discern propensity to aggression.

The current studies

In short, then, the current set of studies were performed in order to establish the robustness of previous claims of an association between perceived aggressiveness and fWHR, as well as to test whether individual differences in self-reported dominance moderate these perceptual associations. In line with previous work (Carré et al., 2009, 2010; Geniole et al., 2012; Short et al., 2012), we predicted fWHR would be positively associated with enhanced perceptions of aggressiveness both in male and female target faces, with this effect more pronounced in men than in women. Moreover, we also predicted that self-reported dominance would moderate these perceptions, consistent with previous research indicating such an interaction (Watkins, Fraccaro, et al., 2010; Watkins, Jones, et al., 2010).

STUDY 1

In Study 1, we examined the validity of fWHR as a cue to aggression in male faces and whether self-reported dominance measures moderate perceptions of this cue. We employed a highly controlled design using a two-alternative forced choice paradigm with pairs of morphed images, manipulated to only differ along the axis of interest (fWHR or facial masculinity). We additionally assessed whether subtle differences in facial metrics are sufficient for consistent perception by testing three different levels of transform intensity: 25%, 37.5% or 50%.

Methods

Participants

A total of 102 participants (34 men) took part (mean age = 25.91 years, $SD = 8.88$ years) via the Internet. Of the participants, 97.1% self-identified as white, with the remaining ($N = 3$) participants reporting a range of ethnicities. Participants were recruited through advertisement within the University of Stirling as well as through lab webpages. They took part voluntarily and did not receive any reimbursement.

Stimuli

Twelve individual composite identities were generated by combining three images of Caucasian men each. These composite identities were then transformed in shape according to ±25%, 37.5% and 50% of the shape difference between low and high fWHR prototypes (see Stirrat & Perrett, 2010, for full details). As discussed in Stirrat and Perrett (2010), two separate prototype sets (i.e. pairs of prototypes) were used for the transform to avoid idiosyncratic properties of a specific prototype to drive results. These procedures led to 72 fWHR stimuli pairs: 12 (identity) × 3 (transform level) × 2 (prototype set). Additionally, we created transform pairs of all 12 identities on the basis of facial sexual dimorphism (the linear shape difference between male and female faces) in the same intensities, yielding 36 sexual dimorphism

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stimuli pairs. These were transformed according to the average shape difference between a male face and a female face (see Figure 1 for example images). Importantly, the sexual dimorphism transform did not change the fWHR of either male or female stimuli (mean fWHR change = 0.005, $SD = 0.005$) and is thus treated as an independent transform.

Dominance assessment

Social and physical dominance of participants were assessed separately using single-item measures following Puts et al. (2007). Social dominance was indicated by participants on a 10-point Likert scale with endpoints labelled extremely dominant and extremely submissive, following the statement: ‘A dominant person tells other people what to do, is respected, influential, and often a leader; whereas submissive people are not influential or assertive and are usually directed by others’ (Mueller & Mazur, 1997). Physical dominance was assessed on a 10-point Likert scale with endpoints labelled strongly agree and strongly disagree, following the statement: ‘If you were engaged in a physical fight with a same-sex peer, you would probably win!’ (Puts et al., 2006).

Procedure

Participants took part in the study online and were randomly assigned to one of three transform level conditions (25%, 37.5% or 50%). Participants were then presented with 24 fWHR image pairs and 12 sexual dimorphism image pairs transformed according to the intensity level that the participant had been assigned to. In order to minimise the chance of participants detecting the fWHR cue and subsequently-actively looking for this cue, presentation of fWHR transformed and sexual dimorphism transformed stimuli was randomly intermixed. Additionally, presentation order and the side of the screen on which each image was presented were fully randomised across fWHR and sexual dimorphism transforms. During each trial, participants were asked to ‘choose the person you think would react more aggressively if provoked’ by clicking on the respective image. Following the experimental trials, participants completed the short dominance questionnaire outlined previously.

Results

A one-way ANOVA showed a trend towards transform level affecting frequency of the high fWHR face chosen as more aggressive [$F(2,99) = 2.86$, $p = .06$]; however, post hoc tests did not reach significance (with Bonferroni corrections for multiple comparisons; but also see following text), indicating that transform level did not affect results. There was no effect of prototype set [$t(11) = 0.50$, $p = .63$] in the fWHR condition, and transform level had no effect in the masculinity transform condition [$F(2,99) = 1.13$, $p = .33$]. All subsequent analyses were therefore performed across all transform levels and prototype sets (for fWHR only). Participants chose the higher fWHR face as more aggressive in 58.3% of the trials. This was significantly above chance [$t(101) = 4.06$, $p < .001$]. Similarly, for sexual dimorphism, participants chose the masculine face as more aggressive [mean = 0.62; $t(101) = 6.27$, $p < .001$].

In line with the trend to significance observed in the initial ANOVA in fWHR, we next split the data by transform level and assessed accuracy for each level independently. Results indicated that in both the 25% and 50% transform level conditions, the wider face was chosen as more aggressive significantly above chance [25%: $t(34) = 3.30$, $p = .002$; 50%: $t(28) = 3.00$, $p = .006$] and choices did not differ between these two levels [$t(44.6) = 1.01$, $p = .32$]. In the 37.5% transform level, however, there was no preference for the wider face [$t(34) = 1.01$, $p = .32$; Table 1].

There were no sex differences in frequency of choosing the high fWHR face [$t(100) = 0.76$, $p = .45$] or masculinised face [$t(100) = 0.52$, $p = .60$] as more aggressive. All results remained virtually unchanged when excluding non-Caucasians ($N = 3$) or participants older than 40 years ($N = 7$).

We next assessed possible effects of self-reported dominance on perception of aggression. Because the measures of physical (mean = 3.90, $SD = 1.57$) and social (mean = 4.34, $SD = 1.14$) dominance were not normally distributed [Kolmogorov–Smirnov tests: physical: $D(99) = .182$, $p < .001$; social: $D(99) = .202$, $p < .001$], Spearman’s rank-order correlations were performed. There was no significant correlation in our sample between the frequency of choosing the high fWHR face as more aggressive and participants’ self-reported physical (rho = −.15, $p = .14$) or social (rho = −.11, $p = .26$)

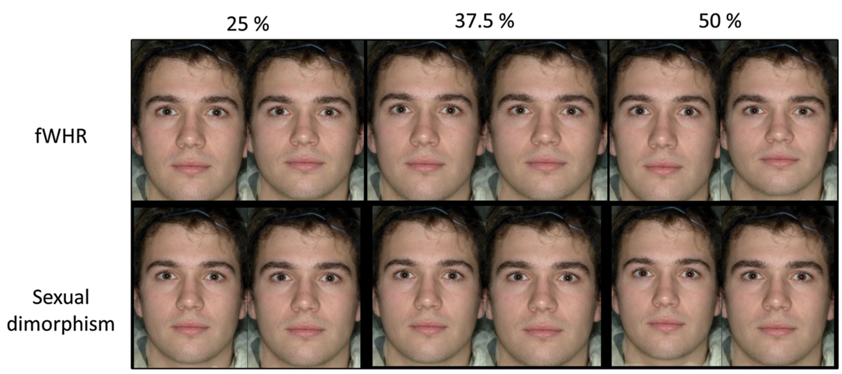

Figure 1. Example stimuli. Example pairings of transformed male face pairs at 25%, 37.5% and 50% for both facial width-to-height ratio (fWHR; top) and facial masculinity (bottom). The low fWHR/sexual dimorphism face is always presented on the left, and the high fWHR/masculinity face is presented on the right.

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Table 1. Mean frequency proportion of trials on which participants chose the high fWHR versions of faces as more aggressive (Study 1)

Condition	Mean 25%	Mean 37.5%	Mean 50%
fWHR	0.59*	0.53	0.65*
Masculinity	0.59*	0.61*	0.66*

Note: *Significantly above chance.

dominance. Similarly, there was no association between either form of dominance and the frequency of choosing the more masculine face as more aggressive (social dominance: rho = .13, $p = .20$; physical dominance: rho = .10, $p = .31$).

Subsequent sex splits showed that for women, there was a significant negative correlation between social dominance and the frequency of choosing the higher fWHR face as more aggressive (rho = −.24, $p = .05$), as well as a significant positive correlation for choosing the more masculine face as more aggressive (rho = .29, $p = .02$). There were no such associations for men (fWHR: rho = .09, $p = .63$; masculine: rho = −.18, $p = .32$). Self-reported physical dominance was not associated with choosing the higher fWHR as more aggressive in either men (rho = −.09, $p = .60$) or women (rho = −.19, $p = .13$). It was, however, correlated with the frequency of choosing the more masculine face as more aggressive by both men and women. This correlation was negative in men (rho = −.36, $p = .04$) but positive in women (rho = .30, $p = .02$), and these countervailing effects likely explain why we see null effects when collapsing across sex.

Brief discussion

In Study 1, we found evidence that fWHR is positively associated with perceived aggression. The same pattern was also found for facial masculinity. We thus demonstrate that even subtle differences in these facial cues (25% shape difference) were sufficient for aggression attribution. There was no moderation of self-reported dominance on perceptions of aggression for either fHWR or facial masculinity; there was evidence, however, that women who reported as being more dominant (socially and physically) were more likely to select the high masculinity faces as aggressive. For men, we saw the reverse pattern, in that more physically dominant men were less likely to use facial masculinity as a cue of aggressiveness. This latter result is consistent with recent work by Watkins, Jones, et al. (2010).

STUDY 2

Following the results of Study 1, finding that both fWHR and sexual dimorphism are used as cues to aggression in male faces, we next assessed whether similar results would be found in female faces. Because we wanted to ensure that possible effects in female faces would be detected, we chose to use the 50% transform level in this study. In addition, and because of the surprising null result for the medium transform level (37.5%) in Study 1, we also used this transform level. Furthermore, we wished to further investigate the effect of own dominance on aggression perception, using both a larger number of participants and a more elaborate measure of self-reported dominance [the International Personality Item Pool (IPIP) dominance scale].

Methods

Participants

Two hundred and fifty eight participants (190 women) who had not completed Study 1 took part in this study (mean age = 24.1 years, $SD = 9.25$ years). Of the participants, 86.4% self-identified as white, with the remaining participants reporting a range of ethnic backgrounds. Participants were recruited using an established participant pool at the University of Stirling, through advertisement at the University of Stirling and through lab webpages. All participants took part online either as part of their course requirement or voluntarily.

Stimuli

Stimuli were created in identical fashion to Study 1. The same 12 male identities were used, at two transform levels: 37.5% and 50% in both the fWHR and the sexual dimorphism transform. Because there was no perceptual difference between the two prototype pairs used in Study 1, we only used one set of prototypes for this study. In addition, we created 15 female composite faces by combining three female identities each, which were transformed along the sexual dimorphism as well as the fWHR axis. For the fWHR axis, female high and low fWHR prototypes were created.

Dominance measures

In addition to the two one-item dominance measures used in Study 1, we used the 11-item dominance subscale of the IPIP (http://ipip.ori.org/ipip/; Goldberg, 1999). Scores ranged from 11 to 51 with a mean score of 29.63 ($SD = 7.35$), which is similar to previous work (Havlicek, Roberts, & Flegr, 2005; Watkins, Jones, et al., 2010). Internal consistency of the scale was good ($\alpha = .84$).

Procedure

Participants took part online and were randomly assigned to either the 37.5% or the 50% transform condition. Participants were then presented 12 male and 15 female fWHR image pairs as well as 12 male and 15 female sexual dimorphism image pairs transformed according to the intensity level that the participant had been assigned to. Male and female stimuli were blocked, and block presentation was counterbalanced between participants. Presentation of fWHR transformed and sexual dimorphism transformed stimuli were randomly intermixed. Additionally, presentation order and the side of the screen on which each image was presented were fully randomised across fWHR and sexual dimorphism transforms. During each trial, participants were asked to ‘choose the person you think would react more aggressively if provoked’ by clicking on the respective image. Following the experimental trials, participants completed the dominance questionnaires outlined previously.

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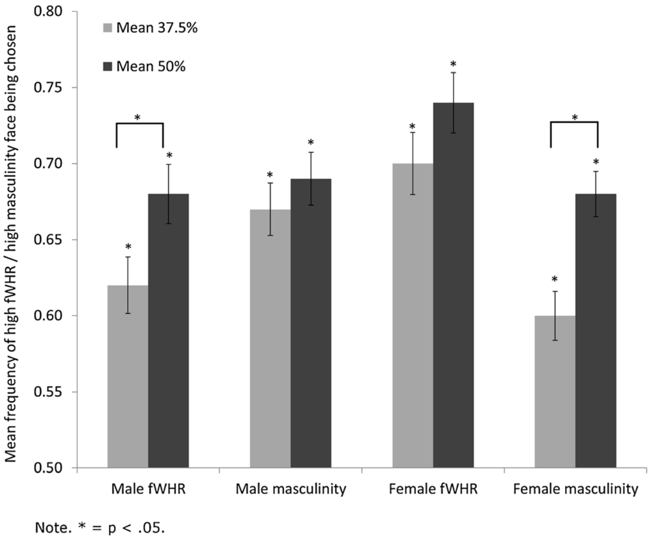

Figure 2. Effect of transform intensity on probability of choosing the high facial width-to-height ratio (fWHR)/high masculinity face in each sex. All conditions were significantly above chance level, and for male fWHR and female masculinity, performance increased significantly with higher transform intensity.

Results

We first assessed whether the level of transform (37.5% or 50%) influenced performance. For each of the four stimuli types (male fWHR, male sexual dimorphism, female fWHR and female sexual dimorphism), the mean level of perceiving the high fWHR or highly masculine face as more aggressive increased in the 50% compared with the 37.5% condition (Figure 2). This increase was significant for male fWHR [$t(258) = 2.12$, $p = .035$] and female masculinity [$t(258) = 3.41$, $p = .001$].

In all four conditions and across both transform levels, participants chose the high fWHR or high masculinity face more often as the more aggressive face than would be expected by chance (all $p < .001$). Importantly, this was true in both male and female faces. For subsequent analysis, because of identical patterns, we collapsed across transform levels.

As in Study 1, there were no participant sex effects on perceptions of aggression from male faces in either the fWHR or the facial masculinity condition (both $p > .25$). For female faces, there was also no sex difference in the frequency of choosing the high fWHR face as more aggressive [$t(252) = 1.05$, $p = .30$]. However, women choose the masculinised female face as more aggressive significantly more often than men [$t(252) = 3.69$, $p < .001$].

Next, we tested which cue, fWHR or facial masculinity, was more readily used for perception of aggression in each sex. In men, sexual dimorphism was more readily used in aggression detection [$t(259) = 1.99$, $p = .05$], whereas in women, fWHR was a significantly better cue [$t(259) = 4.91$, $p < .001$]. This pattern was further supported when assessing whether the frequencies of choosing the high transform face in each condition differed between sexes: high fWHR was significantly more frequently chosen in female than in male faces [$t(259) = 4.67$, $p < .001$], whereas high masculinity was significantly more frequently chosen in the male face [$t(259) = 2.74$, $p = .01$].

We next turn to our measures of participant self-rated dominance. We found evidence that self-reported social dominance was negatively associated with perceptions of aggression in male facial masculinity faces. We also observed a negative association for physical dominance and perceived aggression in male fWHR faces. In both cases, these associations were specific to female raters, with no such associations apparent for male raters. The full results are presented in Table 2.

Brief discussion

In Study 2, we again found evidence that fHWR and facial masculinity in male faces were both positively associated with perceptions of aggression and extended this finding to female faces. Evidence for self-reported dominance moderating these associations was less clear, however, and not consistent with the results of Study 1. Here, we found that social dominance was negatively associated with aggression

Table 2. Correlations between self-report measures of dominance and tendency to perceive the high fWHR (male fWHR and female fWHR condition) or masculinised face (male masculinity and female masculinity condition) as more aggressive in Study 2

	Condition	Social dominance	Physical dominance	IPIP dominance score
Whole sample	Male fWHR	−0.08	−0.16*	0.02
	Male masculinity	−0.15*	−0.04	−0.11
	Female fWHR	0.02	−0.08	0.03
	Female masculinity	−0.10	−0.04	−0.07
Male participants	Male fWHR	−0.13	−0.12	0.17
	Male masculinity	−0.10	−0.04	−0.05
	Female fWHR	0.12	0.15	0.22
	Female masculinity	0.01	0.18	0.04
Female participants	Male fWHR	−0.07	−0.16*	−0.02
	Male masculinity	−0.16*	−0.02	−0.12
	Female fWHR	−0.02	−0.13	−0.02
	Female masculinity	−0.04	−0.04	−0.06

Note: Correlation coefficients are spearman's rho.
*$p < .05$.

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perception in male facial masculinity faces and that physical dominance was negatively associated with aggression perception in male fWHR faces. These results, however, were limited to female perceivers: we found no evidence in Study 2 that more dominant men were less likely to use fWHR and facial masculinity in their perceptions of aggressiveness. These mixed results are discussed in greater detail in the succeeding text.

GENERAL DISCUSSION

Facial width-to-height ratio has been linked to perceptions of aggression in several recent studies (Carré et al., 2009, 2010; Geniole et al., 2012; Short et al., 2012). Here, we present further evidence for this link in a highly controlled sample. In two studies, we found consistent associations between high fWHR and perceptions of aggression in stimuli differing only along the fWHR axis. This effect was present across sex of both the target face and the perceiver but was sex moderated, such that fWHR was more closely linked to aggression perception in female than male faces (Study 2). We additionally observed that even subtle differences in fWHR (25% transform) are sufficient to affect aggression perception, indicating that humans are acutely attuned for detection of cues to aggressive behaviour. In addition to these fWHR findings, we also observed effects of sexual dimorphism, such that more masculine faces were perceived as more aggressive across transform levels as well as across sex for both the target face and the perceivers. This is an important observation as the facial masculinity transform was essentially dissociable from the fWHR transform (high and low masculinity faces did not differ in fWHR), indicating that facial masculinity and fWHR likely provide independent information concerning aggression propensity.

When comparing the influence of fWHR and masculinity on aggression perception, there was some evidence that in men, masculinity served as a more readily employed cue to aggression, whereas in women, fWHR was more salient. These results, while intriguing and warranting further research, should be treated with caution as it is not possible to ensure that our transforms in facial masculinity and fWHR were matched in magnitude. Stimuli were transformed according to the shape difference between high and low fWHR prototypes or male and female prototypes. As such, although all stimuli were transformed by the same magnitude (i.e. 25%, 37.5% or 50%) of shape difference, it is not possible to ascertain whether the absolute difference in shape between the prototypes used is comparable between these transforms. Nonetheless, both transforms were based on population extremes, such that fWHR prototypes were created from the highest and lowest fWHR individuals in our sample and masculinity prototypes were created by averaging all male and all female faces in the sample. Accordingly, results regarding the importance of these cues are likely meaningful, given they reflect the natural variation of both cues within the population.

Of some interest, in the current study, we find no consistent evidence for self-reported dominance as a moderator of sensitivity to aggression cues. Although we found some support for the results of Watkins, Jones, et al. (2010), finding here that perceptions of aggression in more masculine faces were negatively associated with self-reported physical dominance, this effect was only observed among male participants in Study 1. Moreover, we found a positive link between physical dominance and perception of aggression from masculine faces in female participants in Study 1. In Study 2, we found that physical dominance was negatively associated with aggression perception from male fWHR faces and that social dominance was negatively associated with aggression perception from male facial masculinity faces. However, here these results were only noted for female participants, with no evidence for such moderation in male participants. Taken together, the results from Studies 1 and 2 indicate that self-reported dominance does not moderate aggression perception in others. These observations are important as they run contrary to previous work by Watkins, Jones, et al. (2010) while closely approximating their methods.

In general, our results confirm the importance of fWHR and, independently, facial masculinity, in perceptions of aggression from both male and female faces, although they show certain inconsistencies with previous work to which we now turn. Firstly, contrary to Geniole et al. (2012), we report that fWHR is a stronger cue in female faces as compared with male faces. One possible explanation for this difference between studies is that our study design more strongly controls for BMI, which has previously been shown to affect fWHR (Coetzee et al., 2010; Lefevre et al., 2012) and may also affect aggression perception. Secondly, whereas Alrajih and Ward (2013) find no effect of fWHR on aggression perception, the current study, in line with previous work, shows a strong association. This discrepancy is perhaps caused by Alrajih and Ward (2013) using a sample of older men (average age = 52.5 years), which may trigger the use of different sets of cues for making attributions of aggression. More specifically, aggression perception is likely associated with perceptions of physical strength (e.g. Sell et al., 2009), which is inversely associated with age past early adulthood. If the faces used in Alrajih and Ward's (2013) study showed salient cues to age—such as would be the case if age was at least moderately variable within the stimuli set—then participants may base judgements predominantly on these cues rather than fWHR, explaining the null finding in that paper.

Thirdly, although our results concerning a lack of individual differences in aggression perception ran contrary to previous work in faces (Watkins, Fraccaro, et al., 2010; Watkins, Jones, et al., 2010), they are in line with similar null results reported in dominance perception from voices (Wolff & Puts, 2010). Nonetheless, the discrepancy between the current work and those of Watkins, Fraccaro, et al. (2010) and Watkins, Jones, et al. (2010) requires discussion, particularly as the methods across these two studies are closely approximated. Watkins et al. also presented pairs of male or female stimuli, morphed by ±50% of the shape difference between the average male and average female face shape (which is identical to the transform we performed for the 50% condition) to participants. Furthermore, they also assessed self-reported dominance of the participant using the IPIP dominance scale, thus closely matching our work. Contrary to our study,

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however, in Watkins and colleagues' work, participants were not asked to indicate which face looked more aggressive, but instead, which face looked more dominant. Dominance ratings and aggression ratings show some conceptual distinction (e.g. Alrajih & Ward, 2013), which may account for the diverging results between the current study and the work of Watkins, Jones, et al. (2010), although it is noteworthy that perceptually these two dimensions appear to be closely aligned (Oosterhof & Todorov, 2008). Furthermore, the theoretical basis for the presence of individual differences in sensitivity to others' dominance (e.g. Watkins, Fraccaro, et al., 2010) suggests that humans are attuned to detecting subtle cues to dominance in order to alleviate the need for potentially costly fights (e.g. Puts et al., 2006, 2007). These potential costs are particularly high for individuals who are low ranking, leading to those individuals having a great need for accurate assessment of other's dominance levels. These points indicate, then, that ability to detect aggressive intent should be even more readily attuned in low-dominance individuals, because aggression in particular, rather than dominance per se, increases the probability of a fight. Moreover, Watkins, Jones, et al. (2010) only used male raters in their experiment. However, even when splitting by rater sex, our results indicate no association between own dominance and judgement accuracy in masculinity transforms for either male or female raters, indicating that collapsing analyses across sex does not account for differences in results (Table 2).

Another possible explanation for diverging results between the current study (as well as Wolff & Puts, 2010) and Watkins and colleagues' work may be systematic differences in the stimuli sets used. It is possible that sensitivity to cues of dominance and aggression is not globally lowered in high dominance men, as Watkins et al. suggest, but rather that sensitivity for subtle differences in aggression is only present for faces within a narrow range of dominance above and below that of the observer. In other words, observers are only very sensitive to cues of aggression after they have broadly classified a person as being within their own range of dominance. As such, if the current stimuli set better accounted for all levels of dominance (as opposed to low dominance only), this variance could account for a lack of individual differences effects. This possibility should be followed up in future work.

Specific limitations of the current studies include the following: Firstly, aggression is a complex construct, with physical and verbal aggression forming at least two elements of this broader trait (e.g. Archer, 2009). Although these forms of aggression are often moderately correlated (Buss & Perry, 1992), here we cannot discern which element of aggression may best reflect the observed associations with fWHR and facial masculinity. Future research may thus wish to address this issue with finer-grained measures of aggression. Secondly, we did not measure participants' levels of aggression. This may have provided another insight into ability to discern another's propensity to behave aggressively, although as we argue previously, dominance may be the more theoretically relevant construct in this context.

In sum, the current studies provide further evidence for a robust association between fWHR and perceptions of aggression in both male and female faces, extending previous work in this area. In addition, the relationship between fWHR and facial masculinity as cues to aggression differs in male and female faces and warrants further investigation in order to fully understand the respective perceptual and behavioural importance of these cues. Finally, and in contrast to some recent work, the current studies suggest that perceptions of aggression from the face of others are not moderated by the perceivers' own level of dominance.

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