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RESEARCH ARTICLE

WILEY AGGRESSIVE BEHAVIOR

The facial width-to-height ratio determines interpersonal distance preferences in the observer

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Facial width-to-height ratio (fWHR) is correlated with a number of aspects of aggressive behavior in men. Observers appear to be able to assess aggressiveness from male fWHR, but implications for interpersonal distance preferences have not yet been determined. This study utilized a novel computerized stop-distance task to examine interpersonal space preferences of female participants who envisioned being approached by a man; men's faces photographed posed in neutral facial expressions were shown in increasing size to mimic approach. We explored the effect of the men's fWHR, their behavioral aggression (measured previously in a computer game), and women's ratings of the men's aggressiveness, attractiveness, and masculinity on the preferred interpersonal distance of 52 German women. Hierarchical linear modelling confirmed the relationship between the fWHR and trait judgements (ratings of aggressiveness, attractiveness, and masculinity). There were effects of fWHR and actual aggression on the preferred interpersonal distance, even when controlling statistically for men's and the participants' age. Ratings of attractiveness, however, was the most influential variable predicting preferred interpersonal distance. Our results extend earlier findings on fWHR as a cue of aggressiveness in men by demonstrating implications for social interaction. In conclusion, women are able to accurately detect aggressiveness in emotionally neutral facial expressions, and adapt their social distance preferences accordingly.

KEYWORDS
aggression, face perception, facial width-to-height ratio, interpersonal distance

1 | INTRODUCTION

Humans are very sensitive to facial cues. They instinctively infer emotional, motivational, and social tendencies from observed facial shapes (Calder & Young, 2005; Cloutier, Mason, & Macrae, 2005; DeBruine, 2005), although the biosocial foundations and behavioral implications of such inferences are far from clear (Zebrowitz, 2006). One facial feature that may cue a variety of social judgements is the facial width-to-height ratio (fWHR; bizygomatic width divided by upper-face height), which is a sexually dimorphic characteristic of the face (although the sex difference is inconsistent across studies, men appear to have slightly larger fWHRs than women according to a recent meta-analysis: Geniole, Denson, Dixson, Carré, & McCormick, 2015). The metric was first described by Weston, Friday, and Liò (2007) and was proposed to be shaped by pubertal surges in testosterone (Carré & McCormick, 2008). Although one study found an association between this metric and concentrations of testosterone in adulthood (Lefevre, Lewis, Perrett, & Penke, 2013), replication attempts have indicated that the association is inconsistent and/or of trivial magnitude (Bird et al., 2016). More recent investigations have indicated marginal associations between prenatal (longitudinal sample: Whitehouse et al., 2015; also see Zebrowitz, Franklin, & Boshyan, 2015) or pubertal (cross-sectional sample, when controlling for age: Bird et al., 2016; Hodges-Simeon, Sobraske, Samore, Gurven, & Gaulin, 2016) concentrations of testosterone and the fWHR, although additional studies involving longitudinal designs are needed.

Notwithstanding the underlying mechanisms, empirical research has shown that the fWHR is associated with social perceptions. For

instance, men with higher fWHR are perceived to be less intelligent and friendly, and more intimidating (Hehman, Leitner, & Gaertner, 2013), untrustworthy (Stirrat & Perrett, 2010), and aggressive (Carré, McCormick, & Mondloch, 2009; Geniole, Keyes, Mondloch, Carré, & McCormick, 2012; Short et al., 2012). Perceptions based on fWHR have some accuracy, as men with higher fWHR are more willing to exploit others (Stirrat & Perrett, 2010), to cheat for their own financial gains (Haselhuhn & Wong, 2012; Geniole, Keyes, Carré, & McCormick, 2014), to endorse prejudicial beliefs (Hehman et al., 2013), and to react more aggressively (Carré & McCormick, 2008). Recently, Zilioli et al. (2015) showed that the fWHR predicts actual fighting ability among professional combatants and is used by observers to accurately estimate men's formidability. Moreover, men with greater fWHR were less likely to die from contact violence (Stirrat, Stulp, & Pollet, 2012). Although there are some exceptions (Gómez-Valdés et al., 2013; Özener, 2012), there is good agreement on the association between antisocial or aggression-related forms of behavior and the fWHR, also confirmed in two recent meta-analyses (review and meta-analysis: Geniole, Denson, Dixson, Carré, & McCormick, 2015; Haselhuhn, Ormiston, & Wong, 2015). Owing to its relevance for social interaction, the human perceptual system may have evolved to be particularly sensitive to such cues (Carré, Morrissey, Mondloch, & McCormick, 2010).

1.1 | Interpersonal distance preferences

Although the fWHR as a cue of aggressiveness and dominance in men is well established and is moderate to large in strength, the link between fWHR and actual dominance and aggression is weaker (see meta-analysis in Geniole et al., 2015), perhaps because the relationship between the face and behavior is moderated by other factors, such as one's socioeconomic status (Goetz et al., 2013; Zebrowitz et al., 2015). There is less research as to whether the fWHR is used by human observers to regulate their social behavior (Hehman et al., 2013). Several studies in other species suggested that physical cues are indeed used to gauge social rank within the hierarchy (Setchell, Smith, Wickings, & Knapp, 2008), with important consequences for social decision-making and interaction. For instance, a number of avian species are able to recognize the relative dominance, including fighting ability, of other members of their species upon first encounter, without having engaged in any overt aggression (Fretwell, 1969; Senar & Camerino, 1998). Likewise, paper wasps are able to detect combative abilities from facial patterns of one another (Tibbetts & Lindsay, 2008). Also, non-human primates use visual cues such as reductions in testicular volume and decreased reddening of the sexual skin to assess descent in social rank (Ghazanfar & Santos, 2004). Recent studies investigating the impact of the fWHR on social behavior found that male capuchins with larger fWHRs behave more assertively (Wilson et al., 2014), and are thus more likely to attain alpha status (Lefevre et al., 2014).

Few studies have investigated the relationship between perceived fWHR and social behavior, and the results of these studies present an interesting conundrum. On the one hand, fWHR is perceived in a negative manner, as studies show that observers interpret fWHR as a signal of untrustworthiness, and down-regulate their level of cooperation accordingly (Haselhuhn, Wong, & Ormiston, 2013; Stirrat & Perrett, 2010). On the other hand, social interaction with men with higher fWHRs may also have positive aspects, as studies show that wider faced men were preferred group members during intergroup competition (Hehman, Leitner, Deegan, & Gaertner, 2015). Men with wider faces are also preferred dating partners, as are dominant men in general, albeit only for short-term relationships (Valentine, Li, Penke, & Perrett, 2014), and have higher lifetime reproductive success (Loehr & O'Hara, 2013); thus, the fWHR may be important for female mate choice. Given the ambivalence inherent in this pattern, we asked what the direct and initial behavioral response of women to wider faced men is. Do they like to be approached by them or rather avoided? In other words, how do the perceived aggressiveness, masculinity, and attractiveness of wider faced men impact women's preferences to have these men come closer or move away from them? We are especially interested in preferred interpersonal distance as a crucial regulatory variable in social interactions (Hall, 1969; Hayduk, 1983). Social approach and avoidance tendencies depend on interpersonal evaluations: positive evaluations provoke approach forms of behavior whereas aversive stimuli elicit avoidance forms of behavior (Chen & Bargh, 1999). Accordingly, research shows that healthy people tend to react with avoidance-related behavior to observed expression of anger, while fearful or happy expressions elicit approach behavior (Marsh, Ambady, & Kleck, 2005; Miller, Chabriac, & Molet, 2013). To the degree that personal space offers protection against threats, it can be assumed that individuals who are perceived as threatening will cause the observer to increase the preferred spatial distance (Dosey & Meisels, 1969), whereas individuals judged as attractive will cause the observer to decrease the preferred distance (Powell & Dabbs, 1976).

In the present study, we investigated how the fWHR, values of actual aggressiveness, and ratings of aggressiveness, attractiveness, and masculinity determine approach- and avoidance behavior in women, measured as preferred interpersonal space. To measure preferred spatial distance we chose a modified version of the zooming social approach-avoidance Task (AAT) (Heuer, Rinck, & Becker, 2007; Rinck & Becker, 2007), which is a well validated "indirect" measurement of behavioral responses and attitudes. Because individuals use size as one means of judging distance (Bryan et al., 2012; Heuer et al., 2007), the AAT uses several sizes of images to serve as a proxy for distance. Female participants envisioned being approached by a man. By means of the keys on the computer, they could choose their preferred distance to the pictured man. To our knowledge, only Bryan, Perona, and Adolphs (2012) have investigated the effect of perspective distortion from interpersonal distance on social judgments: They found that photos of faces taken from within personal space elicited lower ratings of trustworthiness and attractiveness than did photos of faces taken outside of personal space.

1.2 | The current study

The aim of the present study was to examine, first, what information women derive from male fWHR in terms of attractiveness,

masculinity, and estimated aggressiveness, and secondly, how this information relates to actual behavior, namely women's preferred distance. To this end, we set up two studies. In Study 1, female participants were asked to provide ratings of perceived aggression, masculinity, and attractiveness for 65 male faces, posed in neutral expressions. This study was intended to replicate the findings of Geniole et al. (2012) and Carré et al. (2009), specifically, that the fWHR would share positive associations with aggression and masculinity and negative associations with judgements of attractiveness. Study 2 was newly developed and focused on the behavioral implications of fWHR in a subset of the photographed males: we measured female observers' preferred social distance to these male faces.

First, having explored the mechanism behind fWHR and women's behavior, we asked how valid women's estimates of aggression are. To this end, we investigated the association between estimated aggression ratings and males' actual aggression and predicted a positive association between aggressiveness ratings and values of actual aggression. Our main hypothesis was that women are influenced by the fWHR when making judgments about interpersonal distance because of its association with judgements of men's traits. We also investigated using hierarchical linear modeling which rating (aggressiveness, attractiveness, or masculinity) best predicted preferred interpersonal distance behavior. We speculated that estimated aggression predicted behavior more than any other variable derived from fWHR because of its direct physical implications, and hence its importance for survival.

Previous studies showed that other characteristics such as age and body weight affect perceived characteristics such as social power, wisdom, aggressiveness, and warmth (Deaner, Goetz, Shattuck, & Schnotala, 2012; Hehman, Leitner, & Freeman, 2014). Thus, the possible effect of age of men and female observers on the perceived characteristics was tested along with the effect of fWHR; we did not have body weight measures for the male.

2 | METHOD

2.1 | Participants

All procedures of the study were approved by the local ethics review board. Fifty-two women from the general population (mean age = 33.94, *SD* = 11.68, age range = 18–61 years) were recruited via flyers distributed in supermarkets, fitness centers, kindergartens, on university campus, and through information posted online in various internet forums. About 90.4% of the women were heterosexual oriented, 3.8% were oriented bisexual, and 5.8% were homosexual oriented. About 65.4% of the women indicated currently being in a relationship. Participants received a 20€ honorarium. Inclusion criteria were a female gender and an age between 18 and 65 years. Exclusion criteria were a life-time diagnosis of any psychiatric disorder or an actual psychiatric disorder. Only women were recruited because of our interest in extending the findings of this study to future investigations of whether traumatized women who suffer from posttraumatic stress disorder respond to cues of aggression in the same manner as do non-traumatized women.

2.2 | Stimuli

The stimulus material consisted of 65 grayscale photographs of Caucasian undergraduate college students. They were a combination of the photosets of two previous studies investigating the fWHR (Carré & McCormick, 2008; Geniole, Molnar, Carré, & McCormick, 2014) (*M* age = 19.30, *SD* age = 1.53). Participants were photographed in a forward-facing position while standing, with neutral facial expressions, direct gaze, and while wearing hair nets, to avoid variability related to expression and biases in social perceptions related to gaze and hair styling. The photos were also taken with the camera lens level with the face, also to avoid any tilt or rotation effects in the faces that may obscure measurement of the face ratio. Photographs were taken with a Nikon D50 digital camera. Photos were taken from the same distance for each participant. Nevertheless, because two photosets were combined in the present study, and average camera-to-face photo distance likely varied across the two studies (which were conducted by independent research assistants), we standardized the photos adjusting the height of all the faces (while constraining the ratio of the photo height and photo weight) to a hairline to chin distance of 400 pixels. Note that constraining the ratio of photo height and photo weight allowed us to standardize face size in terms of face height, while not changing the facial width-to-height ratio. Faces were then converted to 8-bit gray scale and were placed within a black background, to conceal background information. Photos were cropped such that the nose was roughly centered. FWHR was measured following the methodology of Carré and McCormick (2008), using IMAGEJ (NIH open-source software). We measured the distance between lip and brow and the left and right zygion of the digitized images, the landmarks originally used by Weston et al. (2007). The measurements were performed by two authors, using bivariate correlations and a one-way intraclass coefficient to determine inter-rater reliability. Both values of the inter-rater reliability for the measurement of fWHR were very high ($r = .98$, $p < .01$; ICC = .98). Overall, fWHRs ranged from 1.54 to 2.11 ($M = 1.83$, $SD = 0.14$).

2.3 | Measures of behavioral aggression

The men's actual aggressiveness was determined for 24 of the stimuli previously (Carré & McCormick, 2008), using a modified version of the Point Subtraction Aggression Paradigm, a well validated behavioral measure of aggression (Cherek, Schnapp, Moeller, & Dougherty, 1996) that is highly correlated with various self-report measures of aggression (Golomb, Cortez-Perez, Jaworski, Mednick, & Dimsdale, 2007: for more detail see Carré & McCormick, 2008).

2.4 | Procedure

Participants were seated in front of a 14 inch laptop (Lenovo T400, screen resolution: 1440 × 900). Images of the face stimuli were approximately 30 cm wide by 19 cm high and presented using E-Prime

software. E-Prime was programmed to display all photos in the center of the screen. The viewing distance was standardized across participants (position of table, chair and laptop were marked, participants were encouraged to place their feet on the ground and to lean on the chair rest; images were then seen from a 76 cm perspective).

2.4.1 | Study 1

Stimulus material of the first study consisted of the full set of 65 photographs described above. Observers were first asked to estimate the men's aggressive behavior. Presentation of the stimulus faces was preceded by a central fixation cross that appeared for 500 ms. Each face was then presented for 1,000 ms (also see Carré et al., 2009 for the set time limits). After the presentation of each face, the question "how aggressive would this person be if provoked?" appeared on the screen alongside a 7-point Likert Scale for the rating (1 = not at all aggressive, 7 = very aggressive). Participants were given an unlimited amount of time to make their judgments. Participants made their response by pressing the corresponding numerical keys on the keyboard. After completing the judgments of aggression, participants rated each face also for attractiveness and masculinity with the specific questions: "how attractive does this person look?" and "how masculine does this person look?" Ratings were also made on a 7 point Likert scale (1 = not at all, 7 = very much so). This process continued until all 65 photos were rated on all three questions. Within each block, faces were presented in a random order. Figure 1 displays a pictorial representation of the procedure of Study 1.

2.4.2 | Study 2

In this design, several versions of each face were required to produce different distance variations: thus, we used only 11 from the set of 24 faces for which measures of actual aggressive behavior had been obtained, to prevent participant fatigue. The 11 faces from the stimulus material described above were chosen to allow for variance with regard to fWHRs as well as values of aggressive behavior. This stimulus set constitutes a representative sample of the entire stimulus material. Participants responded to the presented pictures by pressing the arrow keys up (approach) or down (avoidance), which resulted in the picture respectively shrinking or growing in size. To use size of the image as the proxy for distance, 14 different sizes of each picture were created. The first size presented on the screen was the smallest in size. By pressing the arrow keys down, the picture was replaced by the same picture respectively larger in size, such that the up-and-down movement of the arrow keys created a series of changes in size of the picture (distance factor 10.8%, each size being 10.8% broader, and 10.8% higher than the picture before). Consequently, images were 24% as a minimum and 160% as a maximum of the original picture size. This zooming effect created the visual impression that pressing the arrow key up decreased the spatial distance between the participants and the pictured man and that pressing the arrow key down increased the distance. Participants received the following instruction: "Imagine the photographed men are actively approaching you, while you are not moving. By means of the arrow keys, you can let people move closer to you or move further away from yourself. When you have found your preferred distance, please confirm your decision by pressing enter." After finishing a practice phase, participants indicated their preferred distance for each of the 11 male faces. The faces were presented in a random order. Figure 2 displays an example of the different gradations of distance.

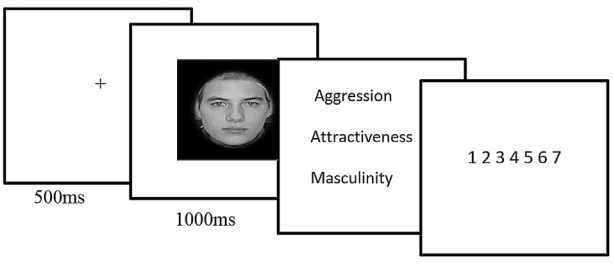

FIGURE 1 A pictorial representation of the procedure of experimental paradigm 1

A post-experiment debriefing confirmed that the size of faces was a cue of spatial distance. We asked 18 participants how close they felt the small and large images were from them. All participants reported that they had the impression that larger images were closer to them than smaller images (see Table 1).

The following values display the mean preferred interpersonal distances for each of the 11 images. Overall, distance settings ranged from 1 as a minimum to 14 as a maximum. Picture 1: $M = 7.71$ ($SD = 3.74$), Picture 2: $M = 9.15$ ($SD = 3.32$), Picture 3: $M = 9.63$ ($SD = 3.45$), Picture 4: $M = 10.15$ ($SD = 3.62$), Picture 5: $M = 8.46$ ($SD = 3.76$), Picture 6: $M = 9.27$ ($SD = 3.54$), Picture 7: $M = 8.71$ ($SD = 3.21$), Picture 8: $M = 9.96$ ($SD = 3.82$), Picture 9: $M = 11.12$ ($SD = 2.8$), Picture 10: $M = 8.0$ ($SD = 3.51$), Picture 11: $M = 9.56$ ($SD = 3.51$).

2.5 | Statistical analyses

Cronbach's alpha was used to examine the consistency of the ratings of aggression, attractiveness, masculinity, and preferred interpersonal distance across individual participants. Hierarchical linear models with two levels were conducted to test for (1) the effect of values of actual aggressiveness on aggression ratings; (2) the influence of fWHR on ratings of aggressiveness, attractiveness, and masculinity; (3) the effect of fWHR and values of actual aggressiveness on ratings of preferred distance; (4) the simultaneous effect of estimations, fWHR, and actual aggression values on preferred distance ratings. As each stimulus face was rated by 52 female observers, ratings of aggressiveness, attractiveness, masculinity, and preferred interpersonal distance were not independent from each other; ratings of the same stimulus face were more similar than ratings of different stimulus faces. Level-1-ratings of female observers were therefore clustered in estimations (level 2). We added the age of female observers and stimulus faces as potential influential factors into the models. We tested whether ratings of aggressiveness possibly mediated the effect of fWHR on preferred distance ratings using the classical steps of Baron and Kenny (1986) within the framework of hierarchical lineal models. We used the Bonferroni correction

FIGURE 2 An example of different gradations of distance of experimental paradigm 2

method to control for the α-error rate, by dividing the α-error by the number of our four hypotheses. As all hypotheses were proposed one-sided, findings with *p*-values divided by two <.05/4 indicate a significant result.

3 | RESULTS

3.1 | Inter-rater reliability

Inter-rater reliability was high for all three dimensions, aggressiveness, attractiveness and masculinity (Cronbach's α for aggression: .96; attractiveness: .96; masculinity: .97). Estimates of preferred interpersonal distance were also highly consistent across observers (Cronbach's α: .97).

3.2 | Study 1

3.2.1 | Validity of aggression estimates

Results of the HLM showed that the effect of actual aggressiveness was a highly significant predictor of aggression ratings ($t(785) = 6.29$; $p < .0001$), with a coefficient β of .002, when controlling statistically for the age of observers and of the stimulus faces.

3.2.2 | Effects of fWHR on ratings of aggressiveness, attractiveness, and masculinity

The fWHR was a significant predictor of ratings of aggressiveness. The positive effect of fWHR on ratings of aggressiveness (coefficient $\beta = 1.51$) indicated that wider faced men are rated as more aggressive. When the potential confounding variables (age of observers and of the stimulus faces) were modeled as additional factors, the influence of fWHR remained significant ($t(2,217) = 8.87$; $p < .0001$). In this model, the age of observers was also a predictor of ratings of aggressiveness ($t(912) = -5.58$; $p < .0001$), and the age of the stimulus faces had no significant effect on aggressiveness ratings ($t(2,217) = 1.17$; $p = .24$). The fWHR also was a significant predictor of ratings of attractiveness ($t(2,354) = -5.24$; $p < .0001$) with a coefficient $\beta = -.80$. The negative coefficient sign indicates that men with higher fWHRs were rated as less attractive. The age of observers ($t(1,187) = 6.18$; $p < .0001$) as well as the age of the stimulus faces ($t(2,354) = 5.14$; $p < .001$) were significant predictors of attractiveness ratings. Men with higher fWHRs were rated as more masculine ($t(2,202) = 6.14$; $p < .001$; coefficient $\beta = 1.00$); and older men were rated as more masculine ($t(2,202) = 9.001$; $p < .0001$; coefficient $\beta = .13$). The age of the observers was not a significant predictor of masculinity ratings.

3.3 | Study 2

3.3.1 | Effects of fWHR and actual aggression on preferred distance ratings

Results of the hierarchical model, exploring the simultaneous effect of fWHR and values of actual aggressiveness on preferred distance ratings, showed that both variables were highly significant predictors of preferred distance ratings, when controlling statistically for age. There was a significant positive effect of fWHR ($t(205) = 3.05$; $p = .003$) on preferred distance, with a coefficient β of 2.95, indicating that men with higher fWHRs were kept at a greater distance. Men with higher values of actual aggressiveness were also kept at a greater distance ($t(205) = 3.63$; $p < .0001$; coefficient $\beta = .003$). Both the age of female observers ($t(93) = -22.77$; $p < .0001$; coefficient $\beta = -.19$) and the age of the stimulus sample ($t(205) = -2.84$; $p = .005$; coefficient $\beta = -.42$) predicted measures of preferred distance. The coefficients indicate that younger women tend to keep (more aggressive) younger men at a greater distance. Figure 3 displays correlations between preferred interpersonal distance and fWHR/actual aggression based on aggregated data.

3.3.2 | Simultaneous effects of fWHR, actual aggression, and variables of estimations on preferred interpersonal distance

To explore the effect of perceived aggressiveness, masculinity, and attractiveness, values of actual aggressiveness, and fWHR on interpersonal distance ratings, we calculated a hierarchical model. Results of this model showed that all three estimations were significant predictors of preferred interpersonal distance ratings. While ratings of aggressiveness had a positive effect on distance settings ($t(270) = 5.27$; $p < .0001$; coefficient $\beta = .38$), ratings of attractiveness ($t(328) = -5.39$; $p < .0001$; coefficient $\beta = -.46$) and masculinity ($t(174) = -4.78$; $p < .0001$; coefficient $\beta = -.32$) had a significantly negative effect on distance settings. While values of actual aggression remained a significant predictor of distance ratings in this complex model ($t(323) = 2.17$; $p = .03$), the influence of fWHR on

TABLE 1 Mean estimations of spatial distance of participants between themselves and the pictured men (in 14 gradations of image size)

Rated distance	Distance 14	Distance 13	Distance 12	Distance 11	Distance 10	Distance 9	Distance 8	Distance 7	Distance 6	Distance 5	Distance 4	Distance 3	Distance 2	Distance 1
Mean	14.75	8.51	6.36	4.42	3.11	2.55	2.09	1.84	1.42	1.17	1.01	0.81	0.57	0.43

Note: Based on $N = 18$ ratings; measured in a post-experiment debriefing, the values are described in meter.

preferred distance settings was no longer significant ($t(347) = 1.6$; $p = .11$; coefficient $\beta = 1.6$). Table 2 displays the results of the HLM.

3.3.3 | Results of the mediation model

A mediation analysis to test whether ratings of aggressiveness potentially mediated the effects of fWHR on preferred distance ratings was calculated by additional HLMs following the steps of Baron and Kenny (1986). The analysis indicated that the total effect of fWHR on preferred distance ratings (controlled for age) was positive (coefficient $\beta = 8.94$) and significant ($t(309) = 7.5$; $p < .0005$). Significant results were obtained for the model wherein higher fWHRs led to higher ratings of aggression (coefficient $\beta = 2.97$; $t(346) = 7.87$; $p < .0005$). Ratings of aggression also proved to be a significant predictor of preferred distance ratings (coefficient $\beta = .49$; $t(309) = 8.05$; $p < .0005$). Considering the indirect effect model, which included both influential factors, fWHR and ratings of aggressiveness, the results showed that fWHR still reached statistical significance ($\beta = 3.94$; $t(346) = 8.05$; $p < .0005$). However, the coefficient as well as the t-value were smaller than in the first model (with the fWHR as only variable), indicating a partial mediation of ratings of aggressiveness on the relationship between fWHR and preferred distance (see Figure 4).

4 | DISCUSSION

The aim of the present study was to examine whether women adjust their preferred distance with men based on their fWHR because of the relationships between the fWHR and judgements of men's traits. In Study 1, we found that female observers do indeed rate men who have greater fWHRs as significantly more aggressive. Men with greater fWHRs were also rated as being more masculine, but were judged as less attractive. These results replicate the findings of previous studies (Carré et al., 2009; Geniole et al., 2012; Geniole & McCormick, 2012). As previous research indicates that these effects might be explained by variables other than fWHR alone, such as the body size or age (Deaner et al., 2012; Hehman et al., 2014), we controlled for the age of observers as well as the age of our stimulus sample in our statistical analyses. Although the fWHR remained a significant predictor of the ratings when controlling statistically for age, the age of observers significantly affected ratings of aggressive and attractiveness; older women judged the men as less aggressiveness and more attractive than did younger women. The age of the men was positively associated with ratings of attractiveness and masculinity.

In Study 2, we investigated the behavioral implications of fWHR, specifically, the question of how interpersonal distance regulation might depend on observed fWHR. The results suggest that women detect implicit cues of aggressiveness in male faces and adjust their interpersonal distance behavior accordingly, a behavioral reaction that may be processed implicitly. Both the age of female observers as well as the age of the approaching men predicted ratings of preferred distance: Younger women tended to keep younger and more aggressive men at a greater distance than did older women. Moreover,

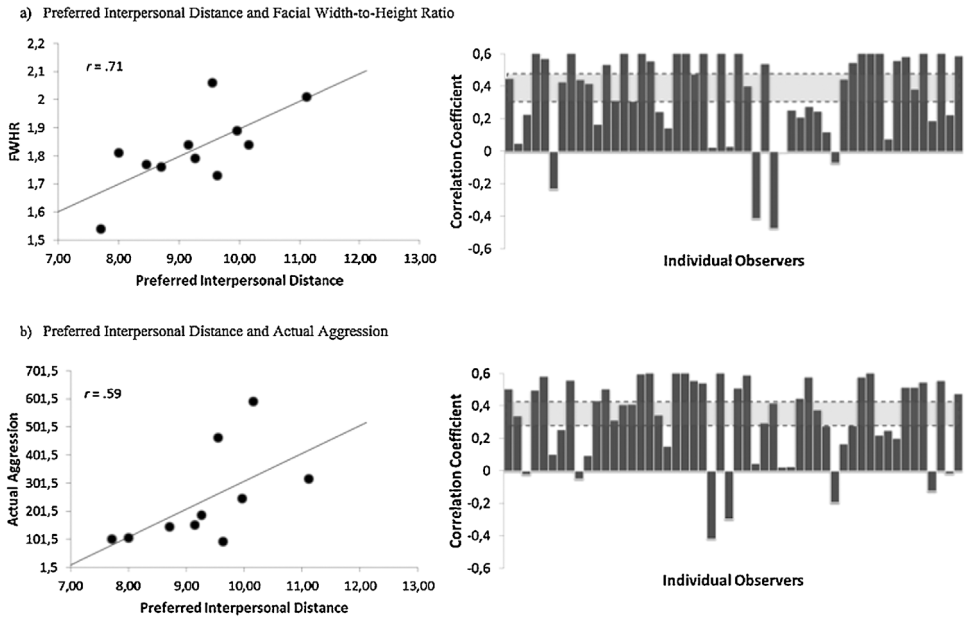

FIGURE 3 Relationships between preferred interpersonal distance and fWHR (a) and preferred interpersonal distance and actual aggression (b). In the scatterplots each dot represents the average value of the preferred distance ratings and the value of fWHR/actual aggression. The bar graphs show the correlations for each individual observer ($N = 52$). Shaded areas represent the 95% confidence intervals (CIs)

ratings of aggressiveness, attractiveness, and masculinity all influenced preferred interpersonal distance settings. We proposed that estimated aggression would predict preferred distance more than would the other qualities that women may derive from fWHR because of its relationship with actual aggression. Results of the HLM, however, showed that ratings of attractiveness most strongly (negatively) predicted interpersonal distance preferences, suggesting that mate-preferences influence interpersonal distance behavior to a greater extent than do the potential threat and costs related to aggressiveness. It may be that reproductive success and good genetic inheritance outweighs costs associated with aggression. It also is possible that women do not see aggressiveness as detrimental; instead, they may associate aggression in men with the potential to protect them from other threats.

This possibility is in line with prior studies that showed that women may prefer aggressive men under certain circumstances depending on the temporal context of the relationship sought (Puts, Jones, & DeBruine, 2012; Valentine et al., 2014). Thus, on the one hand, women may value in a romantic partner some characteristics aggressive men appear to possess, as aggressive men have a decreased risk of death by physical violence (Stirrat et al., 2012), they have a greater reproductive success (Loehr & O'Hara, 2013), and they can protect a mate from other formidable individuals (Fink, Neave, & Seydel, 2007; Puts et al., 2012). On the other hand, they are also perceived to be emotionally cold, to have a poor parental quality and to be dishonest (Perrett et al., 1998). Women may weigh off these possible advantages and disadvantages of bonding with aggressors depending on their sought duration of a relationship, their own physical condition, their age, and local violence and stress (Puts et al., 2012). Our participants may have had little exposure to violence, which may be why they discounted men's aggressiveness.

Thus, our study provides further evidence that the fWHR guides social behavior in the observer (Haselhuhn et al., 2013; Valentine et al., 2014). We conclude that fWHR is a valid cue of aggression

TABLE 2 Effects of fWHR, facial ratings, and actual aggression on preferred interpersonal distance in the framework of a HLM

Parameter	Estimate	Std. error	*t*	Significance[a]
Intercept	7.298	1.769	4.126	.000*
FWHR	1.598	1.006	1.589	.113
Actual aggression	.002	.001	2.165	.031
Estimated aggressiveness	.384	.073	5.270	.000*
Estimated attractiveness	−.457	.085	−5.387	.000*
Estimated masculinity	−.324	.068	−4.781	.000*

Note: Based on $N = 3{,}380$ ratings.
*Significant after Bonferroni correction ($p < .0125$).
[a]*p*-values .000 indicate a *p*-value <.0005.

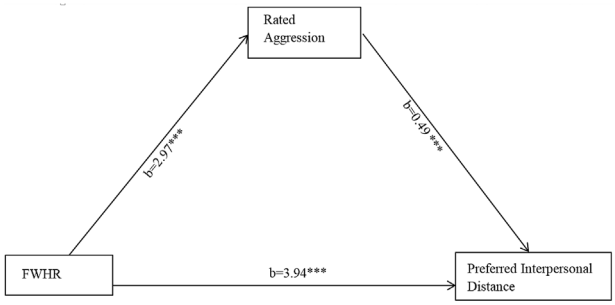

FIGURE 4 Mediation model with direct and indirect path of fWHR on preferred distance with coefficients evaluated in HLM controlled for age

that strongly, and perhaps subconsciously, influences behavioral reactions in the observer. Although the face ratio slightly decreases in size with age, and the degree to which the fWHR influences perceptions change across the lifespan (Geniole et al., 2015; Hehman et al., 2014), it is a stable feature within any given social interaction because it is based on the individual's bone structure. Nevertheless, because of its strong links with perceptions of aggressiveness and threat, people may strategically adjust the tilt of their head (Hehman et al., 2013) or their emotional expression (Marsh et al., 2005) to exaggerate the size of this cue and appear more intimidating in interactions with strangers.

Some limitations of the present study should be taken into account when interpreting the findings. First, the small age range of our stimulus faces (*SD* age = 1.53) might have limited the variability in attractiveness, aggressiveness, and masculinity ratings, as some men presumably had not yet developed their adult levels of facial masculinity. The difference of mean age between the male stimulus faces and our sample of female observers was 15 years, which could have led the female participants to view the men as unlikely mating partners, reducing the extent to which the women viewed the men as attractive and masculine and thus keeping them at a greater distance. Another limitation is that neither the faces nor the rating blocks were presented in a random order, which might have influenced raters (e.g., ratings of aggressiveness first might affect later assessments of the same person's ratings of attractiveness). A second methodological limitation could be found in the construction of our stop-distance task. In our current study, we produced 14 different graduations of size of a picture to produce distance variations. However, several other parameters of an image are altered when the distance between the object and the viewer is changed, for example, when the distance decreases, the ears look smaller, the face appears with sharper features, and the nose looks relatively larger (Bryan et al., 2012; Verhoff, Witzel, Kreutz, & Ramsthaler, 2008). Our method of resizing the faces to the same height while altering their dimensions may have led to differences in distortedness that might have influenced or mediated our effects. Future research could ask participants to rate large and small versions of the faces on distortedness, to assess whether the differences in distortedness are perceivable, thus controlling for possible effects of distortion. Future research could add some static objects (e.g., an environment) in the picture, making the change in the distance clearer, which would serve raters as a guide or install size cues to control for these effects. Alternatively, future studies could use different images of the faces varying in standardized distances as research showed that the viewing distance influences ratings of social judgments (Bryan et al., 2012). We cannot make statements about whether ratings change when seeing the faces from within or from outside the interpersonal distance. However, this manipulation method also seems to have some limitations: First, photographs of the same individual can vary intensely with variables (e.g., head pose, facial expression) significantly altering a person's apparent fWHR (Hehman et al., 2013; Jenkins, White, Van Montfort, & Burton, 2011). The distance between the camera and the face also affects fWHR judgments: faces photographed closer to the camera appear thinner, thus are judged as having lower fWHRs (Bryan et al., 2012; Kramer, 2016), with these effects potentially influencing social judgments. Paradoxically, in the study of Bryan et al. (2012), ratings of distance revealed that farther faces appeared closer than did close faces, indicating that people may use the heuristic of size to judge closeness since the far faces were marginally wider than the close faces, giving support for our method. Thus, in the context of previous research and by our post-experiment debriefing, our stop-distance task appears to be a valid measurement of preferences for interpersonal distance (Miller et al., 2013). Nevertheless, a match with real-life distance settings would be ideal.

The following aspects should find consideration in future studies using our paradigms: first, the impact of the menstrual cycle on the dependent measures should be investigated. The extent to which women are attracted to the masculinity of male faces varies significantly depending on hormone levels and fertility (Little, Jones, & DeBruine, 2011; Welling, Jones, & DeBruine, 2008). Women show stronger preferences for men displaying masculine facial characteristics around ovulation, than during other phases of the menstrual cycle (Johnston, Hagel, Franklin, Fink, & Grammer, 2001; Jones et al., 2005; Penton-Voak et al., 2001). The personal space zone tends to be smaller during the middle of the cycle and larger during menstruation (Sanders, 1978). We assume that womens ratings of attractiveness and preferred interpersonal distances are influenced by their menstrual cycle. Secondly, although we specified the sexual orientation of our participants, our sample size of homosexual women was too small to explore effects of the sexual orientation on perceptual processes. However, sexual orientation might influence attractiveness ratings (Donovan, Hill, & Jankowiak, 1989). In heterosexual women, perceived attractiveness is strongly associated with the evolutionary potential of a man in terms of signaling health (Rhodes, 2006), being nurturing and honest, resulting in preferring an average level of facial masculinity (Perrett et al., 1998; Swaddle & Reierson, 2002). We assume that homosexual women do not judge men's attractiveness in dependence of their mating partner potential and thus differ in attractiveness ratings and their preferred distance from heterosexual women. Additional research on this topic is needed. Lastly, it would be interesting to compare ratings of men and women, to broaden our understanding about underlying mechanisms of approach and avoidance behavior and the perception of aggression in others.

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