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Original Article

Perceived and experimentally manipulated status moderates the relationship between facial structure and risk-taking☆

Keith M. Welker [a,*], Stefan M.M. Goetz [b], Justin M. Carré [c]

[a] University of Colorado Boulder
[b] Wayne State University
[c] Nipissing University

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ABSTRACT

Previous work indicates that facial width to height ratio predicts aggressive behavior, particularly when social status is low. The current research extends these findings with experimental evidence that status can moderate the relationship between facial structure and risk-taking. Male participants ($N = 165$) completed a measure of status, had their facial structure measured, were randomly assigned to win or lose a competition, and completed a behavioral measure of risk-taking. Facial structure predict risk-taking when individuals' perceived status was low, but not high. Additionally, facial structure also predicted risk-taking in losers, but not winners of the competition. Individuals low in self-reported social status who lost the competition showed the highest relationship between facial structure and risk-taking. These findings provide evidence that FWHR is not always an indicator of risk-taking behaviors, but only when individuals perceive themselves as being low in status. These findings are interpreted from an ecological rationality perspective and suggest that risk-taking is adjusted appropriately to strive to meet social goals.

1. Introduction

Physiognomy, the study of the relationship between facial features and personality, has long been dismissed as pseudoscience. Nevertheless, recent evidence suggests that it may contain a kernel of truth. For instance, people make rapid dispositional attributions of faces after only brief exposure (Willis & Todorov, 2006). Some work also suggests that these judgments are accurate, as individuals perform above chance when judging sexual orientation (Rule, Ambady, Adams, & Macrae, 2008), physical strength (Sell et al., 2009; Sell, Tooby, & Cosmides, 2009), and aggressive behavior (Carré, McCormick, & Mondloch, 2009). This ability has been theorized as an adaptive mechanism to infer dominance and trustworthiness (Todorov, Said, Engell, & Oosterhof, 2008). One static facial cue that has gained much recent attention is the facial width-to-height ratio (hereafter FWHR), or the distance between the left and right zygomatic bone and dividing that distance by the distance between upper lip and mid-brow (e.g., Carré et al., 2009; Stirrat, Stulp, & Pollet, 2012). Having a high FWHR, or wider face, has been thought to be a biological index of physical dominance and motivation to achieve power (Carré & McCormick, 2008; Lewis, Lefevre, & Bates, 2012).

Through an examination of human skulls, Weston, Friday, and Liò (2007) found that FWHR was a size independent sexually dimorphic feature with males having relatively larger facial width relative to height compared to females. Importantly, this sex difference emerges around puberty in humans and capuchin monkeys (the only other primate in which this metric has been tested) implicating the potential role of pubertal androgens on facial structure and providing a link between structure and behavior through the organizational effects of androgens on the neural circuits underpinning these behaviors (Carré & McCormick, 2008). Consistent with this idea, neuroimaging work indicates that amygdala reactivity to threatening faces (relative to shapes and neutral faces) – a neural correlate of one's propensity toward aggressive behavior (Coccaro, Sripada, Yanowitch, & Phan, 2011) – is positively associated with aggressive behavior among men with relatively large FWHRs, but not those with smaller FWHRs (Carré, Murphy, & Hariri, 2013). Also, other work indicates that low-dose administration of testosterone in boys with delayed puberty is known to modulate craniofacial growth (Verdonck, Gaethofs, Carels, & de Zegher, 1999) and FWHR was found to be positively correlated with baseline and testosterone reactivity in two samples of men (Lefevre, Lewis, Perrett, & Penke, 2013).

Despite this initial evidence, subsequent research with relatively large samples has failed show sexual dimorphism in FWHR (Lefevre et al., 2012; Özener, 2012). Nevertheless, variation in FWHR within men has been repeatedly found to map onto behaviors and rater judgments that are conceptually linked to dominance and other antisocial behaviors. These include aggression (Carré & McCormick, 2008; Carré et al., 2009; Goetz et al., 2013), unethical behavior (Geniole, Keyes, Carré, & McCormick, 2014; Haselhuhn & Wong, 2012), trustworthiness (Stirrat & Perrett, 2010), prejudice (Hehman, Leitner, Deegan, & Gaertner, 2013; Hehman, Leitner, & Gaertner, 2013), achievement

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* Corresponding author. University of Colorado Boulder, Department of Psychology and Neuroscience, Boulder, CO 80305.
E-mail address: welkerk@wayne.edu (K.M. Welker).

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motivation (Lewis et al., 2012), performance in association football (Welker, Goetz, Galicia, Liphardt, & Carré, 2015) and physical formidability in mixed-martial arts fighters (Zilioli et al., in press).

Along with these findings, some studies have failed to replicate the link between FWHR and aggression (e.g., Deaner, Goetz, Shattuck, & Schnotala, 2012; Gómez-Valdés et al., 2013; Özener, 2012). For instance, using a large sample of Turkish participants, Özener (2012) found that FWHR and self-reported aggression were unrelated. Also, using a relatively large sample of National Hockey League players, Deaner et al. (2012) found only a small and non-significant ($p =$ .057) positive correlation between FWHR and penalty minutes (used as an ecological measure of aggression). These null results might be explained by a failure to take into account important moderators variables such as personality and social context. Indeed, psychological adaptations are often not obligate, context-insensitive processes rigidly deployed regardless of the environment, rather contextual factors facultatively adjust their deployment (Weisfeld, 1999; Williams, 1966). Relative social status and physical robustness vary at least to some degree intergenerationally and across the lifespan. Therefore, an obligate adaptation that is insensitive to this variance will suffer greater fitness loss than an adaptation that facultatively adjusts to variable parameters of one's self and the environment.

One important environmental moderator that has emerged from the literature is relative social status. A recent study found that relative social status moderated the relationship between facial structure and aggression. Goetz et al. (2013) found FWHR was positively correlated with reactive aggression, but only in men who reported low subjective social status. In a second study, this effect was conceptually replicated in a sample of professional hockey players. Player salary was used as a measure of relative status and found to moderate the relationship between FWHR and aggressive plays such that FWHR was positively correlated with aggression, but only among players with relatively low salaries. The role of social status as a moderator of the relationship between FWHR and dominance has also been documented in nonhuman primates. Lefevre et al. (2014) studied brown capuchin monkeys and found that FWHR was positively related to alpha status and assertiveness – indexed from a variety of behavioral traits including bullying, aggressive behavior, stinginess, dominance, and independence. In a re-analysis of these data, Carré (2014) showed that FWHR was only related to assertiveness among low status monkeys. Collectively, these series of studies highlight the importance of considering relative social status when examining the link between FWHR and dominance-related behaviors.

In general, low status individuals are more likely to take risks than high status individuals (Wilson & Daly, 1985, 1997). This perception is supported by work suggesting that individuals low in social status are more likely to engage in – and suffer the consequences of – risky behaviors, such as drug use (Finkelstein, Kubzansky, & Goodman, 2006), risky sexual behaviors (e.g., Adler et al., 1994; Capaldi, Stoolmiller, Clark, & Owen, 2002), and aggression (e.g., Archer, 2009; Wilson & Daly, 1985). Risk-taking is often used as a means of enhancing one's position in a social hierarchy (see Ellis et al., 2012 for a review), or at least dissuade future challenges directed at oneself (e.g., Fessler, Tiokhin, Holbrook, Gervais, & Snyder, 2014). The form that risk-taking assumes depends on the options available to an individual and these are not evenly distributed across social strata. Thus, the cost-benefit ratio of using risky strategies (e.g., aggression) to achieve status can be shifted in favor of their use (Wilson, Daly, & Pound, 2009). Furthermore, both aggression and risk-taking have been associated with impulsivity (Campbell & Muncer, 2009; Lauriola, Panno, Levin, & Lejuez, 2014). Relevant to this research, several studies have linked FWHR to formidability (ability to win in an all-out fight). In a forensic sample of skeletal remains, FWHR was related to the means by which the victim was killed (Stirrat et al., 2012). Wider faced men were more likely to have been killed using methods that allow killing at a distance (e.g., projectiles or poison), whereas narrower faced men showed more signs of having been bludgeoned to death. Also, FWHR was positively associated with having a winning record (formidability) in mixed martial artists (Třebický et al., 2014; Zilioli et al., in press), and was related to subjects' own ratings of formidability (Stirrat & Perrett, 2010). Taken together, these results indicate that the costs of aggression might be further defrayed by ones formidability (Sell, Tooby, & Cosmides, 2009). Thus, FWHR might be more strongly related to risk-taking among low status men.

From an evolutionary perspective, the sex that experiences higher variance in reproductive potential is expected to be less risk-averse (Wilson & Daly, 1985). Consistent with this perspective, men are the more reckless sex (Byrnes, Miller, & Schafer, 1999). In a large meta-analysis drawing from over 150 studies, men displayed higher levels of risk-taking across 14 of the 16 categories of risk-taking (Byrnes et al., 1999). To the degree that FWHR co-varies with masculinity in men, it should also co-vary with risk-taking.

Returning to the issue of relative social status, risk-taking can become a suboptimal strategy under certain social conditions. Under conditions of high social status, risk-taking is suboptimal as further gains have diminishing returns (Ermer, Cosmides, & Tooby, 2008). However, having low status or experiencing an acute drop in status should motivate an individual to prefer risk-seeking strategies that can recover or close the gap. Risk-sensitivity theory proposes that when faced with the option of adopting a risky strategy (one with high variance in outcome) or a less risky strategy, one's state of need will determine which to adopt. In situations in which lower risk options are unlikely to meet one's needs, risk-aversion toward high risk options is expected to decrease (Mishra & Lalumière, 2010). This possibility is consistent with the evolutionary models positing that adaptations are formed to adjust to specific contexts (Weisfeld, 1999; Williams, 1966). Thus, FWHR may specifically promote risk-taking in situations where risk-taking is advantageous, such as low social status.

2. Overview of present research

The present research was designed to investigate whether social status moderates the relationship between facial structure and risk-taking behavior. This research not only measured participants' perceptions of status, but also experimentally manipulated their status using a rigged competition task. Based on previous reports that social status moderates the relationship between facial structure and aggression (Goetz et al., 2013), we hypothesized that FWHR would be positively correlated with risk-taking behavior, but only under conditions of low social status.

3. Methods

3.1. Participants and design

One hundred and sixty-five men ($M_{age} = 20.64$, $SD = 3.00$) enrolled at Wayne State University participated in the study for partial course credit. The sample was diverse (37.7% Caucasian, 20.1% African American, 18.8% Asian, 4.4% Latin American, .6% Native American, and 18.2% Other Race). Participants were randomly assigned to either win or lose a rigged competition manipulated as a video game participants played. Assuming a two-tailed alpha of .05, this sample size provided substantial power for detecting large effect sizes ($|r| = .50$, power > .99) and medium effect sizes ($|r| = .30$, power = .98), and low power for detecting small effect sizes ($|r| = .10$, power = .25). Data for this study are available in the online supplemental materials (available on the journal's website at www.ehbonline.org).

3.2. Procedure and materials

3.2.1. Consent and facial structure measurement

After providing informed consent, participants had a picture of their face taken. Specifically, participants were instructed to look directly at the camera, not tilting their head, with an emotionally neutral expression. After the study, two hypothesis-blind researchers independently measured facial width and height and calculated the FWHR of participants' faces. These measures were highly consistent ($r = .88$) and thus were averaged into one index of FWHR.

3.2.2. Subjective status

Participants then completed a 5-item measure of subjective status based on single-item measures of subjective status (Adler, Epel, Castellazzo, & Ickovics, 2000; Goetz et al., 2013). Measuring participants' subjective status has been argued to more fully reflect one's social status than single item indices of Socio-economic status such as income by reflecting other indicators of status such as social position, education level, and occupational prestige (Singh-Manoux, Marmot, & Adler, 2005). We chose to use a 5-item measure to enhance the measurement accuracy of this scale in comparison to one-item measures. Specifically, participants were shown a picture of a ladder with 9 numbered steps and given the following instructions:

> "Think of this ladder as representing where people stand in a specific social setting or domain. At the top are the people who have the highest standing in a domain. At the bottom are the people who have the lowest standing in a domain. For each of the settings/domains below, please select a number (1–9) that represents where you stand on this ladder in each setting."

Participants were then asked where on the ladder they stand across five domains: their community, the United States, their peers, their friends, and University students. These items had acceptable internal consistency (Cronbach's $\alpha = .67$). Additionally, principle components analysis indicated that all items had loadings ≥.50 on one factor that explained 44.44% of the total variance. Thus, these items were averaged into one index of subjective status ($M = 5.91$, $SD = 1.12$, range: 3.40–8.40).

3.2.3. Socioeconomic status

We also measured socio-economic status by asking participants to indicate their family income in thousands of dollars on a 5-point scale (1 = "Less than 25 k", 2 = "25–40 k", 3 = "40–70 k", 4 = "70–90 k", 5 = "90 k or more").

3.2.4. Weight and height

Participants also wrote down their height in feet and inches, as well as their weight in lbs.

3.2.5. Experimental status manipulation

Similar to previous work (Carré, Campbell, Lozoya, Goetz, & Welker, 2013), we used a video game task to manipulate status. Participants played an XBOX 360 Kinect volleyball video game and were randomly assigned to either win or lose the video game. Those in the loss condition and those in the win condition were assigned to the hardest and easiest difficulty settings, respectively, and played multiple rounds of the game for a total of 15 minutes.[1] Participants were not informed that the difficulty of the game was set by the researcher. The researchers recorded if participants assigned to the win condition lost all rounds or if participants assigned to the win condition won all rounds.

3.2.6. Game difficulty

Participants indicated how difficult the game was using items with 7-point Likert-type scales. These to items consisted of "How difficult was the game?" and "How hard was the game to win?" (1 = not very, 7 = very). These items were strongly correlated ($r = .80$, Cronbach's $\alpha = .88$) and were thus averaged into one index of difficulty. To corroborate the notes of our researchers, participants also indicated the number of rounds that were played and the number of these rounds that they won.

3.2.7. Risk-taking measure

Participants then performed the Balloon Analogue Risk Task (BART; Lejuez et al., 2002). The BART is a widely used risk-taking task that has been well validated in predicting actual risk-taking behaviors (e.g., Lejuez et al., 2007). In our version of the task, participants accumulated "money points" in a temporary reserve by pumping up 30 virtual balloons. For each balloon pump, participants earned $.05, and each $.10 earned participants a raffle ticket that was placed into a drawing for a $150 gift card. Each balloon was set to explode after receiving anywhere between 1 and 30 pumps. If the balloon exploded, all points were lost from the temporary reserve. Participants also could press a button to save the points in the temporary reserve and move on to pumping the next balloon. The average number of pumps made on unexploded balloons was used as an index of risk-taking behavior (Lejuez et al., 2002; $M = 9.93$, $SD = 3.27$, range: 1.65–19.27). When performing this task, participants must decide to engage in a risky behavior (continuing to pump the balloon) or non-risky behavior (saving the points).

4. Results

One participant refused to play the game, while another participant who was assigned to the losing condition figured out a glitch that enabled him to win all of the matches he played. Another four participants assigned to the win condition did not successfully win any of the matches they played. A technical problem with a digital camera also resulted in an additional twelve participants not having pictures that were available for measurement, and another participant did not complete the subjective status measure. Altogether, the sample used in the statistical analyses included 146 participants. Although three of these participants did not indicate how many rounds were won in a post-test questionnaire, there was a robust difference in the percentages of matches won between those assigned to the win condition ($M = 87.25\%$, $SD = 17.96\%$) and loss condition ($M = 26.85\%$, $SD = 13.15\%$), $t(141) = -23.96$, $p < .001$, Cohen's $d = -4.04$). Thirty-eight participants in the win condition (57.58%), while one participant (1.3%) in the loss condition reported winning all of the games played. However, it is important to note that the self-report of the individual winning all matches was inconsistent with the research assistant notes and may not have been accurate. Excluding this individual from the analyses did not alter the significance of reported results. Unless otherwise mentioned, inclusion of the five participants that failed the manipulation and the one that declined to play in the competition manipulation did not change the significance of any results. Correlations and descriptive statistics of the study variables are presented in Table 1.

4.1. Moderated regression analyses

Hierarchical moderated regression analyses were conducted to examine all hypotheses. Simple slopes of interaction effects were examined at ± 1 SDs. The continuous predictors of FWHR and subjective status were mean centered, and competitive outcome was effects coded (-1 = loss, $+1$ = win). These predictors were then used to create 2-way and 3-way interaction terms that were used in our models. The results of these analyses are presented in Table 2. In step 1 of these analyses, neither competition outcome, subjective status, or facial structure predicted risk-taking as main effects ($|\beta s| \leq .09$, $ps \geq .274$).

In step 2 of the analyses, the predicted subjective social status X FWHR interaction was marginally significant ($\beta = -.16$, $p = .062$).[2] However, when the subjective social status X competitive outcome

[1] Participants were also randomly assigned to compete alone or with a confederate. This experimental condition was not relevant to the goals of the current study and hypotheses. Risk-taking did not vary as a function of the team condition manipulation ($p = .193$). This experimental condition did not moderate the association between FWHR and risk-taking ($p = .327$), or further moderate the 2-way subjective status X FWHR ($p = .115$) and competitive outcome X FWHR interaction ($p = .659$) effects on risk-taking we report later in the manuscript.

[2] When participants that failed the manipulation (e.g., failed to win in the win condition) were included the analyses, this status X FWHR interaction was statistically significant in steps 2 ($p = .049$) and 3 ($p = .039$) of the regression analyses presented in Table 1.

Table 1
Correlations and descriptive statistics of study variables.

	1	2	3	4	5	6	7	M	SD
1. FWHR	-							1.77	.15
2. Risk-taking	.07	-						9.93	3.27
3. Weight	.39**	−.03	-					177.79	39.50
4. BMI	.40**	−.07	.86**	-				25.07	5.02
5. Subjective Status	−.11	−.10	.00	−.08	-			5.91	1.12
6. Socioeconomic Status	.00	−.10	.09	.00	.33**	-		2.92	1.34
7. Game Difficulty	−.02	−.04	−.17*	−.17*	.02	.04	-	3.58	2.19

Note: FWHR = facial width-to-height ratio, Weight = weight in lbs, BMI = weight in lbs/height in inches². *p < .05, **p < .001.

and competitive outcome X FWHR interactions were not included in the model, the hypothesized subjective status X FWHR manipulation was significant ($\beta = -.18$, $t(141) = -2.22$, $p = .028$). The simple slopes of this interaction are presented in Fig. 1. Simple slopes analysis (Preacher, Curran, & Bauer, 2006) indicated that FWHR was positively related to risk-taking when subjective status was low ($b = 5.77$, $se =$ 2.67, $t(141) = 2.16$, $p = .032$), not high ($b =$ -2.59, $se = 2.57$, $t(141) = 1.01$, $p = .316$).

There was also a significant two-way outcome X FWHR interaction in step 2 ($\beta = -.19$, $p = .024$), indicating the experimentally manipulated status also moderated the relationship between FWHR and risk-taking. The simple slopes of this moderation effect are presented in Fig. 2. Congruent with the previously reported moderation effect, simple slopes analysis revealed that FWHR was positively associated with risk-taking in losers of the competition ($b = 5.66$, $se = 2.50$, $t(139) = 2.68$, $p = .025$), but not in winners ($b = -2.65$, $se = 2.64$, $t(139) = 1.00$, $p = .319$).

In the third step of the analyses, we tested whether competitive outcome, FWHR, and subjective status interacted to affect risk-taking behavior. Although the 3-way outcome X subjective status X FWHR interaction was not statistically significant ($\beta = .11$, $p = .178$), exploratory simple slopes analysis showed a pattern consistent with the two-way interactions. The effects of FWHR were significant in low subjective status individuals that lost the competition ($b = 11.59$, $se = 3.49$, $t(138) = 3.32$, $p = .001$). However, the simple slopes of FWHR predicting risk-taking were nonsignificant in high subjective status individuals that lost the competition ($b = -.77$, $se = 3.87$, $t(138) =$ $-.20$, $p = .842$), low subjective status individuals that won the competition ($b = -1.96$, $se = 4.01$, $t(138) = .49$, $p = .626$), and high subjective status individuals that won the competition ($b = -4.17$, $se = 3.38$, $t(138) = -1.24$, $p = .219$). In summary, the relationship between FWHR and risk-taking in low status individuals was more apparent when low status individuals were assigned to lose a competition, but nonsignificant when low status individuals were assigned to win a competition.

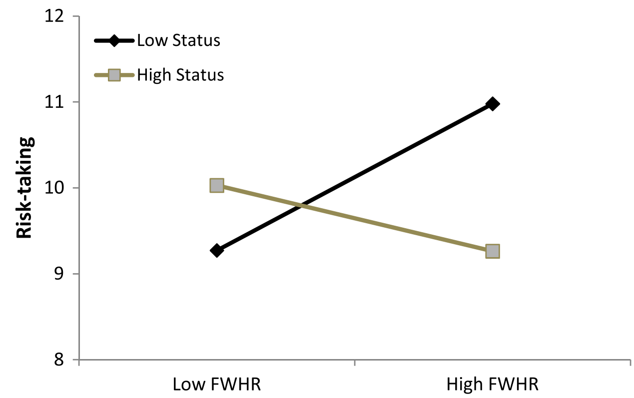

Fig. 1. Risk-taking as a function of subjective status and FWHR. Note: Conditional values are plotted at ±1 SDs of FWHR. Risk-taking was calculated as the average number of pumps on balloons that did not explode.

4.2. Analyses with objective status

Similar to other reports (e.g., Adler et al., 2000; Singh-Manoux et al., 2005), SES was moderately associated with subjective status ($r = .33$, $p < .001$). We also ran the same moderated regression analyses with SES in the place of subjective status. SES was not associated with risk-taking as a main effect ($\beta = -.09$, $t(139) = -1.02$, $p = .311$), SES did not significantly moderate the effects of FWHR and risk-taking ($\beta = .03$, $t(138) = .389$, $p = .698$), and the SES X FWHR X Outcome interaction was nonsignificant ($\beta = -.06$, $t(135) = -.77$, $p = .443$). The difference in the pattern of these findings for each status measure is consistent with other findings suggesting that subjective status is a more robust predictor of health outcomes than objective status (e.g., Singh-Manoux et al., 2005). Subjective status has been argued to more fully reflect social status due to its multidimensional nature (e.g., Jarrin, McGrath, & Quon, 2014; Singh-Manoux et al., 2005) and consequently is potentially a more robust moderator of behavior and psychological functioning.

Table 2
Summary of hierarchical moderated regression analyses for risk-taking.

	Predictor	β	t	p	CI$_{95}$	Partial r^2
Step 1	$F(3,142) = 1.00$, $p = .393$, $R^2 = .02$					
	Comp. Outcome	.09	1.04	.300	(−.25, .82)	.007
	Subjective Status	−.09	−1.10	.274	(−.75, .21)	.008
	FWHR	.07	.78	.438	(−2.21, 5.08)	.005
Step 2	$F(6,139) = 2.34$, $p = .035$, $R^2 = .09$					
	Comp. Outcome	.07	.84	.402	(−.30, .75)	.005
	Subjective Status	−.09	−1.13	.260	(−.75, .20)	.009
	FWHR	.07	.83	.407	(−2.07, 5.08)	.005
	Subj. Status X FWHR	**−.16**	**−1.88**	**.062**	**(−6.46, .17)**	**.024**
	Subj. Status X Comp. Outcome	.04	.54	.591	(−.34, .60)	.002
	Comp. Outcome X FWHR	**−.19**	**−2.28**	**.024**	**(−7.76,−.54)**	**.036**
Step 3	$F(7,138) = 2.28$, $p = .031$, $R^2 = .10$					
	Comp. Outcome	.08	.99	.324	(−.26, .79)	.007
	Subjective Status	−.09	−.1.09	.278	(−.74, .21)	.008
	FWHR	.05	.64	.521	(−2.43, 4.77)	.003
	Subj. Status X FWHR	**−.16**	**−1.95**	**.054**	**(−6.56, −.05)**	**.027**
	Subj. Status X Comp. Outcome	.03	.38	.704	(−.38, .57)	.001
	Comp. Outcome X FWHR	**−.19**	**−2.33**	**.021**	**(−7.84, −.64)**	**.038**
	Comp. Outcome X FWHR X Subj. Status	.11	1.35	.178	(−1.04, 5.57)	.013

Note: FWHR = facial width-to-height ratio, Subj. status = subjective status, comp. Outcome = competitive outcome.

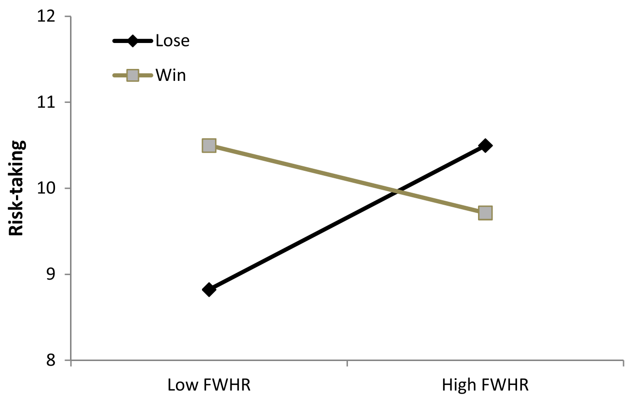

Fig. 2. Risk-taking as a function of competitive outcome and FWHR. Note: Conditional values are plotted at ±1 SDs of FWHR. Risk-taking was calculated as the average number of pumps on balloons that did not explode.

4.3. Inclusion of covariates

Based on the findings of Deaner et al. (2012), which suggest that the effect of FWHR structure on aggression in hockey players becomes non-significant when controlling for weight, we also asked participants to indicate their weight in pounds. Participants' weight was not significantly associated with risk-taking ($r = -.03$, $p = .688$), indicating that it was not an ideal covariate for the current research. Including weight as a covariate in this papers' moderated regression analyses did not change the significance of any reported significant effects. We also used body mass index (BMI) as an alternative covariate to weight. BMI was strongly correlated with weight ($r = .86$, $p < .001$), unrelated to risk-taking ($r = -.07$, $p = .435$), and did not change the significance of any reported effects.

We also examined whether controlling for game difficulty altered the effects in our findings. Participants in the losing condition found that game to be more difficult ($M = 5.22$, $SD = 1.45$) than individuals in the winning condition ($M = 1.66$, $SD = 1.03$; $t(144) = 16.81$, $p = < .001$). However, game difficulty was unrelated to risk-taking ($r = -.04$, $p = .644$) and controlling for game difficulty did not alter the significance of any reported findings.

5. Discussion

Broadly, the current research supports work showing that social status moderates the relationship between facial structure and human behavior (e.g., Goetz et al., 2013) and assertiveness in nonhuman primates (Carré, 2014). In this study, both perceived status and experimentally manipulated status moderated the relationship between men's facial width-to-height ratio and risk-taking behavior. When perceived status and experimentally manipulated status were low, FWHR was positively associated with risk-taking. In contrast, there was no relationship between FWHR and risk-taking when perceived status and experimentally manipulated status were high. Although the three-way interaction between FWHR, subjective status, and experimentally manipulated status on risk-taking was nonsignificant, individuals with low perceived status that were assigned to the loss condition showed the strongest relationship between FWHR and risk-taking.

Our results are consistent with evolutionary models that propose that adaptations are facultatively adjusted to one's context (Weisfeld, 1999; Williams, 1966). There is some evidence that FWHR may index power or status motivation (Lewis et al., 2012). When these data are considered in conjunction with risk sensitivity models from behavioral ecology (see Rode, Cosmides, Hell, & Tooby, 1999), our results support the notion that when individuals with high FWHR – a putative index of power motivation – perceive themselves as lacking social status, they respond by increasing risk-taking tendencies. Following a low risk strategy is unlikely to meet their desired status needs; as such, switching to a more risky behavioral profile allows for some chance at meeting these needs (Mishra & Lalumière, 2010). Conversely, men with high social status may have already satisfied these needs so a more risky orientation provides few benefits. Future research is needed to more directly test these speculations.

This work extends research on the behavioral effects of facial structure in three important ways. First, it was found that experimentally manipulated status (i.e., winning vs. losing) also altered the relationship between facial structure and behavior. This work now demonstrates causal support that status can alter the link between FWHR and behavior. These differences in the association between FWHR and behavior were evoked by a 15 minute video game task. The short nature of this tasks suggests that facial structure may predict risk-taking not only when individuals perceived themselves as having a low status in general (e.g., being low status within their communities and in the United States), but in response to smaller scale, short-term fluctuations in perceived status. This may be taken as evidence that men with high testosterone exposure display a greater need for power and are willing to take risks to achieve culturally valued resources such as money (Ermer et al., 2008).

Second, these studies also suggest for the first time that FWHR is associated with risk-taking. This association may in part underlie previously observed associations between FWHR and aggression (Carré & McCormick, 2008; Goetz et al., 2013). Because aggression involves a potential loss of status, along with potential for retaliation, aggression can be seen as a risk-taking strategy. Aggressive behavior falls under the net of a broad range of impulsive, risk-taking behaviors, such as reckless driving (Simons-Morton et al., 2011), substance use (e.g., Kopetz et al., 2014), and poor-financial decision making (Noussair, Trautmann, & Van de Kuilen, 2014) which can create substantial burden on individuals and society. Despite the potential costs placed on individuals and society, risk-taking can still provide fitness dividends for the individual in terms of reputational enhancement (e.g., Fessler et al., 2014). Furthermore, following a risk-taking strategy under some circumstances (e.g., low status) may be the only means available to 'satisfice' status needs (Simon, 1956; Todd & Gigerenzer, 2000). Future work is needed to determine if the increased risk-taking behavior associated with high FWHR men in low status positions mediates the link between FWHR and aggression.

Finally, the present research suggests many other important maladaptive behavioral and psychological variables are associated with facial structure in addition to aggression. Our measure of risk-taking – the BART – has been found to predict a wide variety of dysregulatory behaviors, such as drug, cigarette, and alcohol use, unsafe vehicular behaviors, criminal activity (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Crowley, Raymond, Mikulich-Gilbertson, Thompson, & Lejuez, 2006; Fernie, Cole, Goudie, & Field, 2010; Lejuez et al., 2003; MacPherson, Magidson, Reynolds, Kahler, & Lejuez, 2010; MacPherson et al., 2010). Additionally, the BART also has been found to have moderately-sized correlations with measures of impulsivity, behavioral constraint, and sensation-seeking (Lejuez et al., 2002). Thus, the current research suggests that when social status is low, FWHR may be associated with a wider variety of psychological characteristics and behaviors linked with poor self-control, impulsivity, and sensation seeking. In summary, it is possible that individuals with higher FWHR are more likely to engage in dysregulatory behaviors such as aggression due to their elevated preference for risk.

This work is not without limitations. First, women were not included in the study. Previous work has primarily found behavioral and psychological associations with FWHR within men, rather than women (e.g., Carré, Murphy, et al., 2013; Geniole et al., 2014). Indeed, previous work indicated that social status moderated the relationship between FWHR and aggression in men, but not women (Goetz et al., 2013). Future work will be required to assess the extent to which FWHR (and status-x-FWHR) map onto other behavioral outcomes in women. Additionally, there are other experimental approaches for manipulating social status other than competitive outcomes, such as assigning individuals to a subordinate status position in social interactions and group decision-making tasks (e.g., Josephs, Sellers, Newman, & Mehta, 2006; Mendelson, Thurston, & Kubzansky, 2008). Although others have used competitions as an acute manipulation of status (e.g., Mehta, Snyder, Knight, & Lassetter, in press), future work is needed to explore the differences and similarities between the effects of competitive outcomes and being assigned to a status in a group. However, it is important to note that previous work suggests competitive and non-competitive successes and failures can alter self-esteem (Meeker, 1990), which is conceptually linked to status.

It is also possible that subtle differences in head tilt may have influence the results observed. Previous work has found that individuals spontaneously tilt their heads when trying to appear intimidating, which increases their FWHR (Hehman, Leitner, & Gaertner, 2013). Although our participants were instructed to look directly at the camera, this does not rule of the possibility that a small amount of the variance in our findings is explained by individual differences in the tendency to tilt one's head.

Future research is needed to investigate how facial structure affects the way in which people migrate through social hierarchies. Broadly, aggressiveness and risky behavior can have negative consequences in the workplace (e.g., Bowie, Fisher, & Cooper, 2012; Burke & Cooper, 2010) and relational contexts (e.g., Blair, 2010, See Rubin, Bukowski, & Laursen, 2011 for a review) and can lead to losses in social status through financial and relational means. Given that high FWHR men engage in more risk-taking when their perceived status is low – especially in response to temporary decreases in status – high FWHR men may be less likely to climb the social ladder compared to low FWHR men. However, previous work also suggests that FWHR is associated with increased performance in male CEOs (Wong, Ormiston, & Haselhuhn, 2011), achievement motivation in presidents (Lewis et al., 2012), and predicts better negotiation outcomes (Haselhuhn, Wong, Ormiston, Inesi, & Galinsky, 2014). Thus, although people with high FWHR in low status positions may have trouble ascending the social ladder due to their increased aggression, high FWHR individuals in high status positions may more easily maintain their high social status.

5.1. Conclusion

These findings suggest that FWHR – which may be indicative of pubertal testosterone exposure (Lefevre et al., 2013; Verdonck et al., 1999) – is a biological index of dominance similar to testosterone (e.g., Josephs et al., 2006). Consistent with the findings of Josephs et al. (2006) on testosterone and social status, high FWHR individuals, like high testosterone individuals, may perform well in high status positions but poorly in low status positions. These findings, along with the emerging work of others (e.g., Carré, Campbell, et al., 2013; Carré, Murphy, et al., 2013; Goetz et al., 2013; Josephs et al., 2006) continue to suggest an important interaction between hormones and social context in predicting psychological states and behavior. Existing research suggests that FWHR is predictive of a wide variety of behaviors and psychological variables centered around social dominance. However, the present research adds to this work by suggesting that FWHR and status may jointly predict a wider range of indicators of maladaptive decision-making and poor self-control.

Supplementary materials

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.evolhumbehav.2015.03.006.

References

Adler, N. E., Boyce, T., Chesney, M. A., Cohen, S., Folkman, S., Kahn, R. L., et al. (1994). Socioeconomic status and health: The challenge of the gradient. *American Psychologist*, *49*, 15–24.

Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy, White women. *Health Psychology*, *19*, 586–592.

Aklin, W. M., Lejuez, C. W., Zvolensky, M. J., Kahler, C. W., & Gwadz, M. (2005). Evaluation of behavioral measures of risk-taking propensity with inner city adolescents. *Behaviour Research and Therapy*, *43*, 215–228.

Archer, J. (2009). Does sexual selection explain human sex differences in aggression? *Behavioral and Brain Sciences*, *32*, 249–266.

Blair, S. L. (2010). The influence of risk-taking behaviors on the transition into marriage: An examination of the long-term consequences of adolescent behavior. *Marriage & Family Review*, *46*, 126–146.

Bowie, V., Fisher, B. S., & Cooper, C. (Eds.). (2012). *Workplace violence*. Routledge.

Burke, R. J., & Cooper, C. L. (Eds.). (2010). *Risky business: Psychological, physical and financial costs of high risk behavior in organizations*. Gower Publishing, Ltd.

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk-taking: A meta-analysis. *Psychological Bulletin*, *125*, 367–383.

Campbell, A., & Muncer, S. (2009). Can 'risky' impulsivity explain sex differences in aggression? *Personality and Individual Differences*, *47*, 402–406.

Capaldi, D. M., Stoolmiller, M., Clark, S., & Owen, D. L. (2002). Heterosexual risk behaviors in at-risk young men from early adolescence to young adulthood prevalence, prediction, and association with STD contraction. *Developmental Psychology*, *38*, 394–406.

Carré, J. M. (2014). Social status, facial structure, and assertiveness in brown capuchin monkeys. *Frontiers in Psychology*, *5*(567), 1–3.

Carré, J. M., Campbell, J. A., Lozoya, E., Goetz, S. M., & Welker, K. M. (2013). Changes in testosterone mediate the effect of winning on subsequent aggressive behaviour. *Psychoneuroendocrinology*, *38*, 2034–2041.

Carré, J. M., & McCormick, C. M. (2008). In your face: facial metrics predict aggressive behaviour in the laboratory and in varsity and professional hockey players. *Proceedings of the Royal Society B: Biological Sciences*, *275*, 2651–2656.

Carré, J. M., McCormick, C. M., & Mondloch, C. J. (2009). Facial structure is a reliable cue of aggressive behavior. *Psychological Science*, *20*, 1194–1198.

Carré, J. M., Murphy, K. R., & Hariri, A. R. (2013). What lies beneath the face of aggression? *Social Cognitive and Affective Neuroscience*, *8*, 224–229.

Coccaro, E. F., Sripada, C. S., Yanowitch, R. N., & Phan, K. L. (2011). Corticolimbic function in impulsive aggressive behavior. *Biological Psychiatry*, *69*, 1153–1159.

Crowley, T. J., Raymond, K. M., Mikulich-Gilbertson, S. K., Thompson, L. L., & Lejuez, C. W. (2006). A risk-taking "set" in a novel task among adolescents with serious conduct and substance problems. *Journal of the American Academy of Child & Adolescent Psychiatry*, *45*, 175–183.

Deaner, R. O., Goetz, S. M., Shattuck, K., & Schnotala, T. (2012). Body weight, not facial width-to-height ratio, predicts aggression in pro hockey players. *Journal of Research in Personality*, *46*, 235–238.

Ellis, B. J., Del Giudice, M., Dishion, T. J., Figueredo, A. J., Gray, P., Griskevicius, V., et al. (2012). The evolutionary basis of risky adolescent behavior: implications for science, policy, and practice. *Developmental Psychology*, *48*, 598–623.

Ermer, E., Cosmides, L., & Tooby, J. (2008). Relative status regulates risky decision making about resources in men: Evidence for the co-evolution of motivation and cognition. *Evolution and Human Behavior*, *29*, 106–118.

Fernie, G., Cole, J. C., Goudie, A. J., & Field, M. (2010). Risk-taking but not response inhibition or delay discounting predict alcohol consumption in social drinkers. *Drug and Alcohol Dependence*, *112*, 54–61.

Fessler, D. M., Tiokhin, L. B., Holbrook, C., Gervais, M. M., & Snyder, J. K. (2014). Foundations of the Crazy Bastard Hypothesis: Nonviolent physical risk-taking enhances conceptualized formidability. *Evolution and Human Behavior*, *35*, 26–33.

Finkelstein, D. M., Kubzansky, L. D., & Goodman, E. (2006). Social status, stress, and adolescent smoking. *Journal of Adolescent Health*, *39*, 678–685.

Geniole, S. N., Keyes, A. E., Carré, J. M., & McCormick, C. M. (2014). Fearless dominance mediates the relationship between the facial width-to-height ratio and willingness to cheat. *Personality and Individual Differences*, *57*, 59–64.

Goetz, S. M., Shattuck, K. S., Miller, R. M., Campbell, J. A., Lozoya, E., Weisfeld, G. E., et al. (2013). Social Status Moderates the Relationship Between Facial Structure and Aggression. *Psychological Science*, *24*, 2329–2334.

Gómez-Valdés, J., Hünemeier, T., Quinto-Sánchez, M., Paschetta, C., de Azevedo, S., González, M. F., et al. (2013). Lack of support for the association between facial shape and aggression: a reappraisal based on a worldwide population genetics perspective. *PLoS One*, *8*, e52317, http://dx.doi.org/10.1371/journal.pone.0052317.

Haselhuhn, M. P., & Wong, E. M. (2012). Bad to the bone: Facial structure predicts unethical behaviour. *Proceedings of the Royal Society B: Biological Sciences*, *279*(1728), 571–576.

Haselhuhn, M. P., Wong, E. M., Ormiston, M. E., Inesi, M. E., & Galinsky, A. D. (2014). Negotiating face-to-face: Men's facial structure predicts negotiation performance. *The Leadership Quarterly*, *25*, 835–845.

Hehman, E., Leitner, J. B., Deegan, M. P., & Gaertner, S. L. (2013). Facial structure is indicative of explicit support for prejudicial beliefs. *Psychological Science*, *24*, 289–296.

Hehman, E., Leitner, J. B., & Gaertner, S. L. (2013). Enhancing static facial features increases intimidation. *Journal of Experimental Social Psychology*, *49*, 747–754.

Jarrin, D. C., McGrath, J. J., & Quon, E. C. (2014). Objective subjective socioeconomic gradients exist for sleep in children and adolescents. *Health Psychology*, *33*, 301–305.

Josephs, R. A., Sellers, J. G., Newman, M. L., & Mehta, P. H. (2006). The mismatch effect: when testosterone and status are at odds. *Journal of Personality and Social Psychology*, *90*, 999–1013.

Kopetz, C., Pickover, A., Magidson, J. F., Richards, J. M., Iwamoto, D., & Lejuez, C. W. (2014). Gender and social rejection as risk factors for engaging in risky sexual behavior among crack/cocaine users. *Prevention Science*, *15*, 376–384.
Lauriola, M., Panno, A., Levin, I. P., & Lejuez, C. W. (2014). Individual differences in risky decision making: a meta-analysis of sensation seeking and impulsivity with the balloon analogue risk task. *Journal of Behavioral Decision Making*, *27*, 20–36.
Lefevre, C. E., Lewis, G. J., Bates, T. C., Dzhelyova, M., Coetzee, V., Deary, I. J., et al. (2012). No evidence for sexual dimorphism of facial width-to-height ratio in four large adult samples. *Evolution and Human Behavior*, *33*, 623–627.
Lefevre, C. E., Lewis, G. J., Perrett, D. I., & Penke, L. (2013). Telling facial metrics: facial width is associated with testosterone levels in men. *Evolution and Human Behavior*, *34*, 273–279.
Lefevre, C. E., Wilson, V. A., Morton, F. B., Brosnan, S. F., Paukner, A., & Bates, T. C. (2014). Facial width-to-height ratio relates to alpha status and assertive personality in capuchin monkeys. *PLoS One*, *9*, e93369.
Lejuez, C. W., Aklin, W., Daughters, S., Zvolensky, M., Kahler, C., & Gwadz, M. (2007). Reliability and validity of the youth version of the balloon analogue risk task (BART–Y) in the assessment of risk-taking behavior among inner-city adolescents. *Journal of Clinical Child and Adolescent Psychology*, *36*, 106–111.
Lejuez, C. W., Aklin, W. M., Jones, H. A., Richards, J. B., Strong, D. R., Kahler, C. W., et al. (2003). The balloon analogue risk task (BART) differentiates smokers and nonsmokers. *Experimental and Clinical Psychopharmacology*, *11*, 26–33.
Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L., et al. (2002). Evaluation of a behavioral measure of risk-taking: the Balloon Analogue Risk Task (BART). *Journal of Experimental Psychology: Applied*, *8*, 75–84.
Lewis, G. J., Lefevre, C. E., & Bates, T. C. (2012). Facial width-to-height ratio predicts achievement drive in US presidents. *Personality and Individual Differences*, *52*, 855–857.
MacPherson, L., Magidson, J. F., Reynolds, E. K., Kahler, C. W., & Lejuez, C. W. (2010). Changes in sensation seeking and risk-taking propensity predict increases in alcohol Use among early adolescents. *Alcoholism: Clinical and Experimental Research*, *34*, 1400–1408.
MacPherson, L., Reynolds, E. K., Daughters, S. B., Wang, F., Cassidy, J., Mayes, L. C., et al. (2010). Positive and negative reinforcement underlying risk behavior in early adolescents. *Prevention Science*, *11*, 331–342.
Meeker, B. F. (1990). Cooperation, competition, and self-esteem: Aspects of winning and losing. *Human Relations*, *43*, 205–219.
Mehta, PH, Snyder, N, Knight, EL, Lassetter, B (in press). Close versus decisive victory moderates the effect of testosterone change on competitive decisions and task enjoyment. *Adaptive Human Behavior and Physiology*.
Mendelson, T., Thurston, R. C., & Kubzansky, L. D. (2008). Affective and cardiovascular effects of experimentally-induced social status. *Health Psychology*, *27*, 482–489.
Mishra, S., & Lalumière, M. L. (2010). You can't always get what you want: The motivational effect of need on risk-sensitive decision-making. *Journal of Experimental Social Psychology*, *46*, 605–611.
Noussair, C. N., Trautmann, S. T., & Van de Kuilen, G. (2014). Higher order risk attitudes, demographics, and financial decisions. *The Review of Economic Studies*, *81*, 325–355.
Özener, B. (2012). Facial width-to-height ratio in a Turkish population is not sexually dimorphic and is unrelated to aggressive behavior. *Evolution and Human Behavior*, *33*, 169–173.
Preacher, K. J., Curran, P. J., & Bauer, D. J. (2006). Computational tools for probing interactions in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics*, *31*, 437–448.
Rode, C., Cosmides, L., Hell, W., & Tooby, J. (1999). When and why do people avoid unknown probabilities in decisions under uncertainty? Testing some predictions from optimal foraging theory. *Cognition*, *72*, 269–304.
Rubin, K. H., Bukowski, W. M., & Laursen, B. (Eds.). (2011). *Handbook of peer interactions, relationships, and groups*. Guilford Press.
Rule, N. O., Ambady, N., Adams, R. B., Jr., & Macrae, C. N. (2008). Accuracy and awareness in the perception and categorization of male sexual orientation. *Journal of Personality and Social Psychology*, *95*, 1019–1028.
Sell, A., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C., & Gurven, M. (2009). Human adaptations for the visual assessment of strength and fighting ability from the body and face. *Proceedings of the Royal Society B: Biological Sciences*, *276*, 575–584.
Sell, A., Tooby, J., & Cosmides, L. (2009). Formidability and the logic of human anger. *Proceedings of the National Academy of Sciences*, *106*, 15073–15078.
Simon, H. A. (1956). Rational choice and the structure of the environment. *Psychological Review*, *63*, 129–138.
Simons-Morton, B. G., Ouimet, M. C., Zhang, Z., Klauer, S. E., Lee, S. E., Wang, J., et al. (2011). The effect of passengers and risk-taking friends on risky driving and crashes/near crashes among novice teenagers. *Journal of Adolescent Health*, *49*, 587–593.
Singh-Manoux, A., Marmot, M. G., & Adler, N. E. (2005). Does subjective social status predict health and change in health status better than objective status? *Psychosomatic Medicine*, *67*, 855–861.
Stirrat, M., & Perrett, D. I. (2010). Valid facial cues to cooperation and trust: male facial width and trustworthiness. *Psychological Science*, *21*, 349–354.
Stirrat, M., Stulp, G., & Pollet, T. V. (2012). Male facial width is associated with death by contact violence: narrow-faced males are more likely to die from contact violence. *Evolution and Human Behavior*, *33*, 551–556.
Todd, P. M., & Gigerenzer, G. (2000). Précis of simple heuristics that make us smart. *Behavioral and Brain Sciences*, *23*, 727–780.
Todorov, A., Said, C. P., Engell, A. D., & Oosterhof, N. N. (2008). Understanding evaluation of faces on social dimensions. *Trends in Cognitive Sciences*, *12*, 455–460.
Třebický, V., Fialová, J., Kleisner, K., Roberts, S. C., Little, A. C., & Havlíček, J. (2014). Further evidence for links between facial width-to-height ratio and fighting success: Commentary on Zilioli et al. *Aggressive Behavior* (in press).
Verdonck, A., Gaethofs, M., Carels, C., & de Zegher, F. (1999). Effect of low-dose testosterone treatment on craniofacial growth in boys with delayed puberty. *The European Journal of Orthodontics*, *21*, 137–143.
Weisfeld, G. E. (1999). *Evolutionary principles of human adolescence*. New York, NY: Basic Books.
Welker, K. M., Goetz, S. M. M., Galicia, S., Liphardt, J., & Carré, J. M. (2015). An examination of the associations between facial structure, aggressive behavior, and performance in the 2010 World Cup association football players. *Adaptive Human Behavior and Physiology*, *1*, 17–29, http://dx.doi.org/10.1007/s40750-014-0003-3.
Weston, E. M., Friday, A. E., & Liò, P. (2007). Biometric evidence that sexual selection has shaped the hominin face. *PLoS One*, *2*, e710.
Williams, G. C. (1966). *Adaptation and natural selection: a critique of some current evolutionary thoughts*. Princeton, New Jersey: Princeton University Press.
Willis, J., & Todorov, A. (2006). First impressions: Making up your mind after a 100-ms exposure to a face. *Psychological Science*, *17*, 592–598.
Wilson, M., & Daly, M. (1985). Competitiveness, risk-taking, and violence: The young male syndrome. *Ethology and Sociobiology*, *6*, 59–73.
Wilson, M., & Daly, M. (1997). Life expectancy, economic inequality, homicide, and reproductive timing in Chicago neighbourhoods. *British Medical Journal*, *314*, 1271–1274.
Wilson, M., Daly, M., & Pound, N. (2009). Sex differences and intrasexual variation in competitive confrontation and risk-taking: An evolutionary psychological perspective. In D. W. Pfaff, A. P. Arnold, A. M. Etgen, S. E. Fahrbach, & R. T. Rubin (Eds.), *Hormones, brain and behavior* (pp. 2825–2852) (2nd ed.). San Diego, CA: Academic Press.
Wong, E. M., Ormiston, M. E., & Haselhuhn, M. P. (2011). A face only an investor could love CEOs' facial structure predicts their Firms' financial performance. *Psychological Science*, *22*, 1478–1483.
Zilioli, S., Sell, A. N., Stirrat, M., Jagore, J., Vickerman, W., & Watson, N. V. (in press). Face of a fighter: bizygomatic width as a cue of formidability.