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Are facial width-to-height ratio, 2D:4D digit ratio and skeletal muscle mass related to men dominant behavior in the Chicken Game?

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ABSTRACT

Facial width-to-height ratio (fWHR), 2D:4D digit ratio and skeletal muscle mass are morphological traits that have been linked to status-seeking behaviors throughout dominance. However, this link has been contested recently, since the empirical evidence about the relationship between these traits and behavior is mixed. In this study, we tested whether fWHR, 2D:4D digit ratio and skeletal muscle mass were related to dominant behavior employing the Chicken Game, an economic game that may represent a good scenario to investigate hierarchy formation and in which these relationships remain untested. We tested this hypothesis in a sample of 210 Chilean young men (mean = 22.43, *SD* = 4.35 years old) who played the Chicken Game against an anonymous same-sex individual and one-shot. Our results showed that fWHR was related to dominant choices in the Chicken Game, but null results were found for 2D:4D digit ratio and muscle mass. Accordingly, this study suggests that in a challenging but anonymous interaction only fWHR was related to dominance. Further studies using different conditions of anonymity may contribute to clarify the role of these traits in status-seeking behaviors.

1. Introduction

Social status is of sum importance since it may affect resource acquisition, including mates, influencing quality of life, longevity and reproduction (von Rueden et al., 2010). One of the paths that individuals can use to gain and maintain social status is dominance, defined as a set of behaviors aimed to provoke submission based on fear and involving aggressive and intimidating displays (Cheng et al., 2013). Accordingly, there are some morphological traits in men, as the facial width-to-height ratio (fWHR), 2D:4D digit ratio, and skeletal muscle mass (SMM) that have been linked to status-seeking behaviors through dominance (Carré & McCormick, 2008; Gallup et al., 2010; Geniole et al., 2015; Manning, 2002; Muñoz-Reyes et al., 2020; Turanovic et al., 2017).

The fWHR was first proposed as a signal of dominance and aggression by Carré and McCormick (2008), showing that men that had wider faces were more dominant and aggressive in both experimental and naturalistic settings. Posterior studies found that fWHR was associated with self-perceived and other-perceived aggression and dominance (Lefevre et al., 2014; Mileva et al., 2014), and with aggression and fighting success in experimental and naturalistic settings (e.g., MacDonell et al., 2018; Muñoz-Reyes et al., 2020; Třebický et al., 2015; Zilioli et al., 2015). Moreover, metanalytic studies showed that fWHR was weak but significantly related to dominance and aggression (Geniole et al., 2015; Haselhuhn et al., 2015). However, these findings are debated since other studies failed to find a relationship between fWHR and fighting success (Deaner et al., 2012; Krenn & Meier, 2018), aggression (Gómez-Valdés et al., 2013; Özener, 2012) or self-perceived behavioral tendencies (Kosinski, 2017; Wang et al., 2019). Regarding the 2D:4D digit ratio, this trait was associated with dominance measured by questionnaires and by third-party women (Manning & Fink, 2008; Neave et al., 2003), and with aggression and sports performance (Hill et al., 2012; Perciavalle et al., 2013). However, the relationship between digit ratio and aggression is weak and inconsistent across studies (Turanovic et al., 2017). Finally, SMM is associated with physical dominance rated by third parties (Frederick & Haselton, 2007), with self-perceived fighting ability (Muñoz-Reyes et al., 2019), and with aggression in both dyadic and intergroup conflict scenario (Muñoz-Reyes et al., 2020). In addition, SMM is a visual cue related to physical strength (Muñoz-Reyes

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et al., 2019), that plays a key role in intrasexual contest between men (Puts et al., 2015).

Some of the inconsistencies found in previous studies are argued to emerge because the association between fWHR and 2D:4D with aggression and dominance emerges in challenging situations but not in neutral contexts (Manning et al., 2014; Millet & Buehler, 2018; Ryckmans et al., 2015). In this regard, economic games may be important tools to assess behavioral tendencies as they frame a real interaction between individuals. One paradigm commonly used to study the relationship between fWHR and 2D:4D with dominance is the receiver's behavior to unfair offers in the Ultimatum Game, as unfair offers can be interpreted as challenges for reputation (Page & Nowak, 2001). Previous studies have shown that rejections of unfair offers were more frequent in men with low 2D:4D digit ratio (Van den Bergh & Dewitte, 2006) and high fWHR (Inoue et al., 2017). However, other studies failed to replicate the findings (Brañas-Garza et al., 2019; Kaltwasser et al., 2017; Ronay & Galinsky, 2011), so the controversy remains.

Although Ultimatum Game has been the normative game to estimate the relationship between morphological traits and dominance, a paradigm named the Chicken Game or The Hawk-Dove Game (Rapoport & Chammah, 1966) could be a more realistic approach to study the effect of these traits over dominance. This is a dilemma where two individuals have to decide between two options: competitive or defensive. It can be contextualized as a challenge between two competitors that are driving their cars in the same line but in opposite directions, one in front of the other. Individuals can decide to go straight (the competitive option) or to swerve (the defensive option). The worst outcome results when both players play the competitive option as both cars crash. The best outcome is achieved by the individual that plays the competitive option when the opponent plays the defensive role. And the second-best option is achieved when both play the defensive option. Accordingly, playing the competitive option can result in the best or the worst outcome depending on the other player's decision and, therefore, is a risky choice. However, playing defensive can be viewed as submissive behavior and, then, may represent a loss of status compared to individuals who decide to play competitively (Maynard Smith, 1982). Therefore, given its payoff structure, this game can be viewed as a confrontation for status through dominance (Van Vugt & Tybur, 2015) and it has been employed to study the formation of dominance hierarchies and to model the strategy used in a conflict for resources and their stability under certain conditions (Hall et al., 2020; Przepiorka et al., 2020). In addition, a previous study found that basal testosterone was related to dominant decisions in the game (Mehta et al., 2017); however, to the best of our knowledge, there is a lack of evidence relating 2D:4D digit ratio, fWHR and SMM with responses in the Chicken Game.

Another possible source to explain inconsistencies in the results is that some studies failed to take into account the moderating effect of socioeconomic status in the relationship between morphological traits and behavior. There is evidence that the fWHR is positively related to physical and reactive aggression only in men reporting low socioeconomic status (Noser et al., 2018; Welker et al., 2015). Similarly, there is some evidence that suggests that 2D:4D digit ratio is related to economic decisions but only for individuals with low status (Millet & Dewitte, 2008).

In this study, we tested whether 2D:4D digit ratio, fWHR, and musculature are related to status-seeking behavior by measuring behavioral responses in a game that contextualizes a confrontation for status. We employed the Chicken Game paradigm to evaluate the relationship between traits and responses taking into account the socioeconomic status and controlling for the Body Mass Index since affects measures of fWHR and muscle mass (Lassek & Gaulin, 2009). Accordingly, we expected that men with higher fWHR, higher SMM, and lower 2D:4D digit ratio showed a high frequency of competitive choices in the Chicken Game, especially when they reported to have a low socioeconomic status.

2. Material and methods

2.1. Participants

Our sample was 210 men aged 18 to 38 years (mean = 22.43, *SD* = 4.35) recruited through public announcements in the Region of Valparaíso (Chile). The game was played in isolated cabins that are prepared for behavioral experiments. All the procedures were approved by the Institutional Ethical Committee. At the end of each data collection session, participants received 5.000 Chilean pesos (around 6.80 USD) for showing up and a variable amount between 0 and 2.000 Chilean pesos according to their outcomes in the Chicken Game.

2.2. Anthropometric measures

2.2.1. 2D:4D digit ratio

We measured the 2D:4D digit ratio from the right hand following previous evidence suggesting that it reflects more precisely prenatal levels of testosterone (Manning, 2002). We measured the length of the 2nd and 4th fingers from the basal crease to the fingertip placing the hand in a ventral position (Manning, 2002). The length of the 2nd finger was divided by the length of the 4th finger. Accordingly, a lower 2D:4D digit ratio would represent higher levels of developmental testosterone. The measures were taken by PP twice with an electronic caliper (Insize© 1102-150) with a precision of ±0.01 cm, except for the seven first measures that were taken only one. The mean standard deviation of these measures was 0.010 cm. For one individual, we lack measures of 2D:4D. Accordingly, the sample size for analysis involving 2D:4D digit ratio was 209 individuals.

2.2.2. Facial width-to-height ratio

We took frontal facial photographs with a digital SLR camera (Nikon D7000). The photographs were taken under standard conditions in terms of head orientation, light and camera configuration. Participants were instructed to look straight to the camera with a neutral expression, and any facial adornment was removed. Once we obtained the photos, we placed four landmarks (Carré & McCormick, 2008) which correspond to the distance between the left and right zygions (face width) and the distance from the upper part of the lip and the forehead (facial height), and were placed with the software TPS (http://life.bio.sunysb.edu/morph). Finally, the measure (in pixels) of width was divided by the height to obtain the fWHR.

2.2.3. Skeletal muscle mass and body mass index

Skeletal muscle mass was measure in kg using a body composition analyzer (InBody 370). This device employs an 8-point tactile electrode for measurements through a direct segmental multifrequency bioelectrical impedance analysis method (DSM-BIA). The body composition analyzer also measured total weight in kg and information about height in cm was provided to the device in order to calculate BMI. Body height was measured barefoot and with a stadiometer (SECA 213).

2.3. Behavioral measure: Chicken Game

Participants played the Chicken Game (Rapoport & Chammah, 1966) one-shot against an anonymous same-sex participant. They were informed that their decision would be randomly matched with the decision of another participant in order to produce a dyadic interaction. They played the game in a pencil and paper format. Detailed instructions of the game, including the payoff matrix, were provided by the experimenter and written on the paper of the game. Participants were categorized according to their responses as dominant (competitive choices) or submissive (defensive choices) individuals.

2.4. Social status scale

We employed the MacArthur Scale for Subjective Social Status (Adler & Stewart, 2007). In this scale, participants have to place themselves on a ladder with 10 steps representing the place that people occupy in the society in terms of job, education, and incomes. The top represents the people who have more money, more education, and better jobs. The bottom represents the people with less money, less education, and worse jobs or unemployed.

2.5. Statistical analysis

First, we employed Chi-Square tests in order to describe and test for differences in the frequencies of submissive and dominant choices in the game. Then, we employed *t*-tests for independent samples in order to test whether 2D:4D digit ratio, fWHR, and SMM were different between the individuals that behave submissive or dominant. As fWHR and SMM are influenced by BMI, we employed in the analysis the residuals obtained when we regressed the BMI on both variables. And finally, we employed logistic binary regression in order to test simultaneously whether 2D:4D digit ratio, fWHR, and SMM affected the probability of behaving dominant, controlling for age and the possible moderating effect of socioeconomic status taking into account the three two-way interactions between socioeconomic status and morphological traits. Following the same reasoning as for t-tests, we employed the residuals obtained when we regressed the BMI on fWHR and SMM. We employed a step-up strategy to identify the simplest model that provides the best fit to the observed data (Burnham & Anderson, 2002).

All the analyses were performed with the IBM SPSS 25 statistical package. All the tests were two-tailed and the level of significance was set to 0.05.

3. Results

Table 1 shows the descriptive statistics for the variables employed in this study. Regarding the distribution of choices in the Chicken Game, we found that 52.4% of the individuals chose the submissive role but this was not significantly different from 50% ($\chi^2 = 0.476$, df = 1, $p = .490$). Regarding the relationship between choices and morphological traits, we found that only fWHR was related to decisions in the Chicken Game ($t = -2.353$, df = 208, $p = .020$; Cohen's d = −0.325). Individuals that chose the dominant role had wider faces (M = 0.025, SD = 0.154) that individuals that chose the submissive role (M = −0.023, SD = 143). SMM ($t = 0.338$, df = 208, $p = .736$; Cohen's d = 0.047) and 2D:4D digit ratio ($t = 0.167$, df = 207, $p = .868$; Cohen's d = 0.023) were not related to decisions in the Chicken Game. When analyzed all the variables simultaneously and controlling for age, BMI, and the interactions between socioeconomic status and morphological traits only fWHR was a significant predictor of the odds to choose a dominant role (B = 2.138, Wald = 5.003, $p = .025$; odds-ratio = 8.487; Table 2; Fig. 1).

4. Discussion

In this study, we tested whether fWHR, 2D:4D, and SMM were related to status-seeking behaviors employing an economic game that represents confrontation for status through dominance and controlling for the potential effects of BMI and socioeconomic status. We found that only fWHR was positively related to status defense and null results were found for 2D:4D digit ratio, SMM and socioeconomic status.

The positive association between fWHR and dominance behavior in the Chicken Game is in accordance with previous evidence showing that this facial metric may be an indicator of the behavioral predisposition in men to compete for resources and status through dominance (Geniole et al., 2015; Haselhuhn et al., 2015). However, it is in contrast with recent evidence suggesting that fWHR is not a reliable cue of the behavioral predispositions (Kosinski, 2017; Wang et al., 2019). Our study differs from those mainly in the measure employed to assess dominant behavior. Whereas Wang et al. (2019) and Kosinski (2017) employed measures based on self-perceptions or perceptions of third parties, in our study, we measured the actual behavior of the individuals in a context that may reflect a status challenge. In this sense, our results suggest that the experimental paradigm employed to test relationships between fWHR and dominance may be crucial to elicit the relationship between them.

The Chicken Game has a payoff structure particularly well suited to study status interactions and the formation of hierarchies in humans (Maynard Smith, 1982). The best collective pay-off is reached when both individuals establish a hierarchical relationship, that is, when one chooses dominant and the other chooses defensive behavior. Status hierarchies in humans seem to be consistent with this structure since there is evidence that hierarchical dyads and groups outperform groups of only dominant or only submissive individuals (Ronay et al., 2012). Consequently, the Chicken Game is an alternative and may be a better paradigm than the Ultimate Game to tests hierarchy's formation.

We found null results for the 2D:4D digit ratio and the SMM. In the case of 2D:4D digit ratio, a possible explanation, that in turn may underlie the mixed results found in previous studies (Brañas-Garza et al., 2019; Ronay & Galinsky, 2011; Van den Bergh & Dewitte, 2006), is that the effect of 2D:4D digit ratio on social behavior may be moderated by circulating levels of testosterone (Buskens et al., 2016; van Honk et al., 2012). Then, a lower 2D:4D digit ratio may be associated with dominance-related behavior but only if the context elicits an increase in the circulating testosterone levels in those individuals. Future studies measuring circulating levels of testosterone can be useful to test that explanation.

In the case of the SMM, we did not find previous studies about its role in the Ultimatum Game nor the Chicken Game. We expected that as a trait indirectly related to pubertal testosterone levels should be associated with status-seeking behaviors, even more, when has been associated with strength, self-perceived fighting ability and other-perceived dominance (Frederick & Haselton, 2007; Muñoz-Reyes et al., 2019). However, muscularity is also attractive for women, especially for short-term mating (Frederick & Haselton, 2007) being associated with a higher number of sexual partners (Polo et al., 2019). Considering that muscularity is a more malleable trait than fWHR and can be affected by current conditions and personality traits like self-esteem (Smolak & Stein, 2006), some persons may increase their muscularity across their life in order to outcompete rivals in attractiveness rather than dominance. However, this proposal is highly speculative and future studies should address specifically this issue.

Finally, we did not find that socioeconomic status moderated the relationship between morphological traits and behavior in the Chicken Game. Previous studies found a moderation effect and explained it considering that aggression and risk-taking behaviors are costly for high-status individuals as they can lose status or result injured during the aggression (Millet & Dewitte, 2008; Noser et al., 2018; Welker et al., 2015). But, at the same time, dominant behavior is one of the pathways through which individuals can gain and maintain status (Cheng et al., 2013), so individuals with wider faces and high status may behave dominantly to keep their status while those with wider faces and low status may behave dominantly to gain it.

Table 1
Descriptive statistics for independent variables employed in this study.

Variable	Mean	SD	(Min, Max)
Age	22.43	4.35	(18, 38)
fWHR	2.11	0.17	(1.75, 2.57)
2D:4D	0.9533	0.0353	(0.8642, 1.0778)
Skeletal muscle mass	32.13	4.14	(22.0, 43.7)
BMI	24.08	3.55	(16.7, 36.2)
Social status	5.87	1.62	(2,10)

Note: fWHR = facial width-to-height ratio; BMI = body mass index.

Table 2
Logistic regression model for dominant choices. Models were fitted by step-up strategy.

Model	$R^2_{Nagelkerke}$	*p*-Value	Parameters	B	SE	Wald test	*p*-Value	Exp(B)
	0.033	0.023	Intercept	−0.106	0.140	0.568	0.451	0.900
			fWHR	2.138	0.956	5.003	0.025	8.487

Note: fWHR = residuals of facial width-to-height ratio, Exp(B) = Odds ratio.

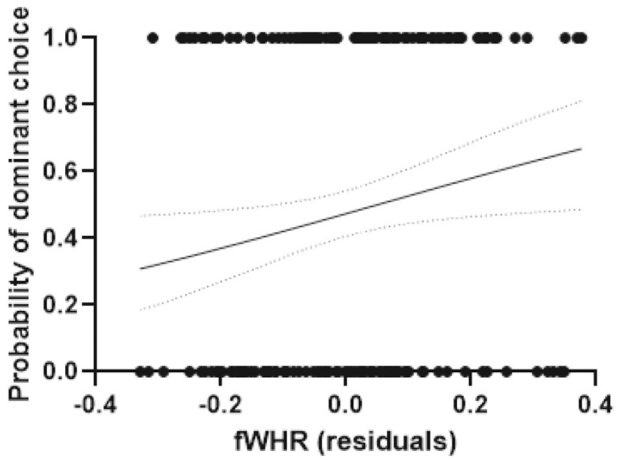

Fig. 1. Predicted probabilities (full line) of select the dominant option according to values of fWHR corrected by body mass index. Dotted lines represent 95% asymptotic confidence bands. Dots are observed responses.

Another limitation of our study that may explain null results is the anonymous one-shot structure of the game. This may limit the ecological validity of the game as in real life the decision to compete or withdraw are non-anonymous and depends on the assessment of the opponent's physical features compared with their own (Sell, 2011). However, we were interested in capture the general predisposition to behave dominant and assessing this behavioral tendency in the same context for all the participants. Future studies, in addition to including basal levels of testosterone, could include several rounds of the Chicken Game and different conditions of anonymity and dyads (e.g. participants with physical differences).

To conclude, our study supports the relationship between fWHR and status-seeking behaviors in a sample of Chilean men and stressed out the importance of the experimental framework when testing behavioral responses to status challenges. In this regard, we suggest that Chicken Game represents a better scenario compared to self and third-party measures to test hierarchy formation and responses to status challenges. Our results may contribute to generalize previous findings of the relationship between fWHR and status-seeking behaviors. Measures of circulating testosterone levels and modification of the cues in the game to indicate a more neutral or more challenging scenario are needed to further understand the role of 2D:4D and muscularity in status-seeking behaviors.

CRediT authorship contribution statement

Pablo Polo: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Funding acquisition, Writing – original draft. **Jose Antonio Muñoz-Reyes:** Conceptualization, Methodology, Investigation, Writing – review & editing. **Nohelia Valenzuela:** Investigation, Writing – review & editing. **Valeska Cid:** Investigation, Data curation, Writing – review & editing. **Oriana Ramírez-Herrera:** Investigation, Writing – review & editing. **Paula Pavez:** Investigation, Writing – review & editing.

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