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Does facial structure predict academic performance?☆

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Facial structure
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1. Introduction

During the past decade, individual differences in facial structure has been found to be linked to several social outcomes (Antonakis & Eubanks, 2017; Graham, Harvey, & Puri, 2017; Todorov, 2017; Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015). A particular metric, the facial width-to-height ratio (fWHR), has received a great deal of attention given its relationship to traits important to social interaction such as assertiveness or dominance (Dixson, 2017; Geniole, Keyes, Carré, & McCormick, 2014; Lefevre, Lewis, Perrett, & Penke, 2013; Valentine, Li, Penke, & Perrett, 2014; but for null results see Kosinski (2017) and Özener (2012)). For example, consistent with the notion that assertiveness is an important factor for leadership effectiveness (Hogan, 2006; Judge & Bono, 2000), Wong, Ormiston, and Haselhuhn (2011) found that firms whose CEOs had wider faces achieved superior financial performance than those whose CEOs had narrower faces. Hahn et al. (2017) found that both CEOs of companies listed in the stock market and leaders of influential non-governmental organizations tended to have higher fWHRs than matched control individuals. Interestingly, this line of research suggests that social outcomes are better explained by signals and expectations (e.g., perceptions of dominance) rather than actual behavior (Olivola, Funk, & Todorov, 2014; Stoker, Garretsen, & Spreeuwers, 2016). Other studies have suggested that self-fulfilling prophecies tend to play a major role in explaining these findings (Haselhuhn, Wong, & Ormiston, 2013).

In the present study, we examined whether fWHR is related to academic performance among students in an undergraduate business and economics program. Although academic performance is strongly predicted by cognitive abilities and self-discipline (Duckworth & Seligman, 2006; Kuncel, Hezlett, & Ones, 2004), social aspects play a role as well (Bowles, Gintis, & Meyer, 1999; Petrides, Frederickson, & Furnham, 2004; Wentzel & Wigfield, 1998). A widely-cited study by Rosenthal and Jacobson (1968) on the self-fulfilling prophecy, entitled the *Pygmalion in the classroom*, showed how teachers' biased expectations of students were related to students' academic performance, as measured by their grades (marks). In addition, when student in-class participation and presentations are an important element of grading (Fritschner, 2000), personality traits related to social behaviors tend to be significant predictors of academic performance. For example, Rothstein, Paunonen, Rush, and King (1994) found that dominance was a significant predictor of academic performance among MBA students. This relationship was explained by in-class participation but not by performance in written exams.

We expected that fWHR would be related to academic performance, but more strongly in some courses than in others. Business and economics programs are broad in terms of the courses offered (Gropper, 2007; Letcher & Neves, 2010). In turn, courses from different disciplines are affected differently by the social aspects of academic performance. Research in the sociology of science shows that social aspects are more likely to have an effect on academic outcomes in disciplines where mathematics are not crucial, such as anthropology and management, than in more quantitative-related disciplines, such as physics and economics (Glick, Miller, & Cardinal, 2007; Kuhn, 1970; Pfeffer, 1993). Consistent with this, non-quantitative courses are more likely to be assessed, in addition to written tests, using oral presentations and other non-written tasks. In contrast, quantitative-related courses are more likely to be assessed using exclusively "objective tests" (Braxton & Hargens, 1996; Shachar & Neumann, 2003). As such, we expected that fWHR would have a greater impact on academic performance in non-quantitative courses than in those in which quantitative elements have a more important role.

We also examined the moderating role of gender. Researchers have found that the relationship between fWHR and perceived aggressiveness is stronger in males than in females due to evolutionary reasons (Geniole, Keyes, et al., 2014; Geniole, Molnar, et al., 2014). This implies that some of the effects of fWHR on social outcomes are stronger among men than among women. Huh, Yi, and Zhu (2014) found that fWHR

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was a stronger predictor of endorsement income among men celebrities than among women celebrities. Other studies have concluded that face-based trait inferences predicting CEOs performance are different for men (i.e., dominance) than for women (i.e., warmth; Pillemer, Graham, & Burke, 2014; but for a different finding, see Rule & Ambady, 2009). We expected, based on this research, that the relationship between fWHR and academic performance would be stronger for men than for women.

2. Methods

2.1. Participants

We obtained complete data from 231 students in a school of economics and business at a Chilean (i.e., South American) university. Participants were undergraduate students who had completed all coursework for their economics and business degree between 2001 and 2012. They took 5–7 years to obtain their degree. The sample consisted of 101 females and 130 males; their mean age was 18.52 years ($SD = 0.55$; Range 18–21) at the time of entering the program.

2.2. Facial measure

Our main independent variable was the students' facial width to height ratio (fWHR). The university provided us with front-side photographs of each student taken during their first year. These photographs were taken at a distance of 1–2 m from participants. We converted the photographs to 8-bit, gray-scale images (Carré, McCormick, & Mondloch, 2009) using ImageJ (Schneider, Rasband, & Eliceiri, 2012). Based on these photographs, we measured facial *height* using the vertical distance between the highest point of the upper-lip and the highest point in the middle of the eyebrows. We also measured facial *width* using the horizontal distance between the left and right zygion (i.e., the bizygomatic width, maximum horizontal distance between right and left facial boundary). Both measures were computed using FACE++ (Zhou, Fan, Cao, Jiang, & Yin, 2013; see Kosinski, 2017, for a similar procedure). This software locates and returns high-precision facial landmarks, including face contour, eye, eyebrow, lip and nose contour. We automated the use of this software through an algorithm in MatLab created by the fourth author, which connected to the Application Programming Interface of FACE++.[1] The fWHR was calculated as the facial width divided by the facial height. This variable ranged from 1.57 to 2.23.

To check this measure, a research assistant manually measured the height and width based on the photographs, thus obtaining a second fWHR measure. There was a high correlation between this measure of fWHR and the one obtained from the algorithm in MatLab ($r = 0.82$). We decided to use the measurements based on the MatLab algorithm.[2]

2.3. Dependent variables

We sought to test whether the students' fWHR was related to their academic performance. Academic performance was operationalized as students' grade averages across different courses. Grades (marks) in the Chilean higher education system range from 1 to 7, with higher grades meaning better academic performance. We focused on grades from courses that were included in the program's core curriculum (i.e., elective courses were excluded). A total of 16 courses were included. Based on the program's curriculum, the team led by the vice-dean of academic affairs determined whether these different courses had quantitative elements. The courses were classified in three types: (a) Applied quantitative (7 courses in total; e.g., Microeconomics, Finance, Operations Research, Econometrics); (b) Basic quantitative (4 courses in total, e.g., Algebra, Calculus); and (c) Non-quantitative (5 courses in total; e.g., Marketing, Principles of Management, Organizational Behavior).

The crucial issue that determined whether a course was classified as non-quantitative (vs. quantitative) was whether tests and homework assignments for the course involved algebra or calculus or not. This classification also corresponded with the specific background of the courses' instructors. The quantitative courses were generally taught by faculty from the Economics department. In contrast, non-quantitative courses were generally taught by faculty in the Business Administration department. Another important difference is that all non-quantitative courses involved student presentations at the end of the semester; nearly all quantitative courses (basic or applied) did not.

The grades' internal consistencies were 0.80 for applied quantitative, 0.70 for basic quantitative, and 0.66 for non-quantitative courses.

2.4. Controls

We included as a first control the participants' score in the *Prueba de Selección Universitaria* (PSU; *University Selection Test*), as it correlates with both students' cognitive skills and academic performance before entering undergraduate programs in Chile (DEMRE, 2012; Ramos, Coble, Elfernan, & Soto, 2013). This standardized test is required for applying to most universities in Chile, akin to the Scholastic Assessment Test (SAT) in the United States. Internal consistency of this measure tends to be high (e.g., $\alpha > 0.90$, Bravo et al., 2010; Donoso & Contreras, 2009). Research suggests that the PSU has predictive validity for academic performance during the first year of college (Manzi et al., 2008). Gómez-Arízaga and Conejeros-Solar (2014) found that the PSU tapped cognitive abilities but not non-cognitive factors. The measure has a population mean set at 500 points and standard deviation set at 100. The values typically range from around 200 to around 800 points, where higher scores mean better performance in the test. The range of scores in our sample was from 637 to 800.

In addition to the PSU scores, other control variables were included as well. We included the individuals' age when they entered the university. We did not include years of graduation as a control because there was little variance in this variable. We also included the individuals' perceived attractiveness as a control variable. In order to assess the students' perceived attractiveness, a research assistant—blind to our hypotheses—evaluated each student by responding the question "How attractive is this individual?" on a seven-point scale, with higher numbers indicating greater perceived attractiveness. As requested by a reviewer, we asked a different research assistant to rate the attractiveness of the students in our sample on a seven-point scale. The correlation between these two raters was $r = 0.51$. We used rater 1's ratings in our analyses.[3]

The rater also assessed the presence of glasses and whether the individual was smiling or not, which were included as controls.

3. Results

3.1. Initial analyses and descriptive statistics

Before our main analyses, in order to test the factorial validity of the students' grades, we ran a Confirmatory Factor Analysis (CFA) using Lavaan's (Rosseel, 2012) maximum likelihood estimation. We included 16 grades as indicators and the three latent factors mentioned above: Basic quantitative, applied quantitative, and non-quantitative. Results revealed that the 3-factor structure of the grades fit the data reasonably

[1] The algorithm and MatLab file is available from the authors upon request.

[2] However, results using the manual measurements were identical, in terms of statistical significance, to those reported below.

[3] Importantly, when running the set of regressions reported below using rater 2's ratings, the results were substantially the same.