Personality and Individual Differences 52 (2012) 643–646

Contents lists available at SciVerse ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

Digit ratio and academic performance in dentistry students

Renato Nicolás Hopp *, Juliana Pucci de Moraes, Jacks Jorge

Department of Oral Diagnosis, Piracicaba Dental School, University of Campinas, Piracicaba, São Paulo, Brazil

ARTICLE INFO

Article history:
Received 28 September 2011
Received in revised form 21 November 2011
Accepted 11 December 2011
Available online 16 January 2012

Keywords:
Digit ratio
Students
Dentistry
Intelligence
Prenatal testosterone
Prenatal oestrogen

ABSTRACT

It has been suggested that prenatal testosterone (PT) is positively related to intelligence or learning-ability skills. Digit ratio (2D:4D) is a negative correlate of PT. This study considered the correlations between 2D:4D and success in practical and theoretical examinations in the Dental School curriculum of a Brazilian University. Overall, 80 subjects (40 males) had their right hand palm photographed by a digital camera attached to a standardising device. The index and ring fingers were measured using Adobe Photoshop. Digit ratio was correlated to the grades obtained by the students through four semesters. Theoretical and practical grades were significantly negatively correlated to digit ratio in males (and this was particularly so after the influence of age and hours of study were removed, $p = 0.02$ and 0.004, respectively), but not in females ($p = 0.89$ and 0.77, respectively). This finding supports a link between high PT and intelligence in males. Our finding of no relationship between 2D:4D and examination marks in female students, suggests that PT may not influence intelligence in females.

1. Introduction

Prenatal testosterone (PT) has been proposed to directly influence intelligence or learning-ability skills by modulating the developmental processes of neuronal proliferation, migration, differentiation, and apoptosis. This is thought to increase the density of neuronal networks in certain areas of the brain (Mrazik & Dombrowski, 2010). In addition, high PT at the end of the first trimester is thought to increase the probability of autism and Asperger's Syndrome (Manning, Baron-Cohen, Wheelwright, & Sanders, 2001), traits that are often associated with 'islets' of giftedness.

Here we consider the possibility that digit ratio (2D:4D), as a putative marker for prenatal testosterone (Manning, Bundred, & Flanagan, 2002; Manning, Scutt, Wilson, & Lewis-Jones, 1998), could reflect these alterations, and be a marker for learning ability. Previous studies have correlated digit ratio (and by implication PT) to autism and Aspergers' Syndrome, concluding that autistic children had the lowest digit ratio (which could be translated as an excess in PT), while Aspergers' children, who have communication impairments similar to autistic children but are thought to have normal or high IQ (Soulières, Dawson, Gernsbacher, & Mottron, 2011) have higher-than-autistic but lower-than-normal 2D:4D (Manning et al., 2001).

Human hands can present index and ring fingers of relatively different lengths for males and females, a difference first attributed to prenatal hormone exposure – high digit ratio indicating low PT relative to prenatal oestrogen and low digit ratio pointing to high PT relative to prenatal oestrogen (Manning, 2011; Manning et al., 1998). There is correlational evidence that 2D:4D is negatively related to 2D:4D (Breedlove, 2010), and experimental evidence that 2D:4D is related to the relative amounts of PT and prenatal oestrogen (Zheng & Cohn, 2011). Differences in prenatal hormone exposure can lead to different traits in personality, aggression, behaviour and ability to perform tasks such as playing sports, driving carefully, investing money or doing manual labour. Low 2D:4D has been correlated to success and profitability in financial trading (Coates, Gurnell, & Rustichini, 2009) and success in sports such as rugby, sprinting and running (Bennett, Manning, Cook, & Kilduff, 2010; Manning & Hill, 2009; Manning, Morris, & Caswell, 2007). In addition, low 2D:4D has been correlated with numeric capabilities and ability to understand information communication technology (Brosnan, 2006; Brosnan, Gallop, Iftikhar, & Keogh, 2011), and is also thought to correlate with learning in manual labour tasks (Rosler, 1957). Digit ratio, and therefore PT, can influence cognitive skills and analysis of situations in order to develop better solutions to a given problem (Coates, Gurnell, & Rustichini, 2009). Earlier reports have shown that individuals with higher cognitive skills are more patient and have a greater ability to plan and persevere, as well as a greater perception of situations (Burks, Carpenter, Goette, & Rustichini, 2009).

Previous research has successfully negatively correlated 2D:4D to success in written admission tests for a medical school, but failed to replicate such a correlation to written exams taken throughout the six years of the course (Coco et al., 2011). Within the framework of this background, the present study aimed to consider the hypothesis that 2D:4D could be negatively correlated to

* Corresponding author. Address: Avenida Limeira, 901, Piracicaba, São Paulo 13414-903, Brazil. Tel.: +55 1921065267; fax: +55 1921065320.
E-mail address: renhopp@gmail.com (R.N. Hopp).

0191-8869/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.paid.2011.12.013

success in practical and theoretical examinations in the Dental School curriculum. Our hypothesis was that individuals with low 2D:4D (high PT relative to prenatal oestrogen) would score higher marks than individuals with high 2D:4D in both theoretical and practical (manual) activities.

2. Methods

This work was carried out in accordance with The Code of Ethics of the World Medical Association for experiments involving humans, and approved by the local Institutional Review Board. Students from the Piracicaba Dental School, Piracicaba, São Paulo, Brazil, were invited to participate in this study. Digit ratio is known to vary with ethnicity (Manning, 2002). Therefore, we restricted recruitment to White participants. Those with a history of fractures in the fingers of the right hand or hormonal disease were excluded. Only students that had completed more than 4 semesters or the equivalent to two levels were selected, in order to give a range of theoretical and practical grades that could be used. Students that had failed one class and retaken the same class had their grade from the first examination recorded. The participants were asked to complete a questionnaire regarding age, gender, the performance of manual activities at home, and hours of home study in theoretical aspects of their subject. After answering the questionnaire, the participants had the ventral surface of their right hand photographed using a digital camera (Canon Powershot A550, Canon, USA) attached to a standardising device, forming a 90° angle with the base, a technique previously described by Hopp and Jorge (2011). We chose to measure the right hand 2D:4D because there is evidence that sex differences in right 2D:4D are greater than sexual dimorphism in left 2D:4D (Hönekopp & Watson, 2010). All photographs were made using the same camera configuration. Image analysis was performed using Adobe Photoshop 7.0® (Adobe Systems, USA) measuring tool, at 100% zoom. Right hand index and ring fingers were measured twice (second measurement blind to first) in linear fashion from the middle point of the most proximal crease up to the tip of the finger (Manning et al., 1998). Mean grades were calculated from theoretical (MT) and practical (MP) examinations, in addition we calculated the ratio between practical and theoretical (MP:MT) grades to give an indication of whether a given student was more likely to do well in the theoretical or practical part of the course. Data are presented as means (±standard deviations). Statistical analysis used Student's t test for male versus female digit ratio comparison, and Pearson's correlation coefficient and linear multiple regression for 2D:4D versus grades relationships.

3. Results

After exclusion criteria, 80 individuals were selected to participate in the study (Males $n = 40$). The mean age for the participants was 19.5 ± 1.1 years for males and 19.7 ± 1.2 for females (range 18–22).

A comparison of 2D:4D from the first and second measurements showed a high intra-class correlation (ICC = 0.94, $F = 31.6$, $p = 0.0001$). This meant that the differences in 2D:4D between-individuals were much greater than measurement error. Therefore, we calculated mean 2D:4D from our first and second measurements and used the mean 2D:4D in all subsequent analyses.

Mean 2D:4D for males was 0.980 ± 0.038 and for females 0.991 ± 0.025 with an effect size (Cohen's d) of 0.34. This sex difference in 2D:4D was in the expected direction but the sexual dimorphism was significant ($t = 1.47$, $p = 0.15$). However, the effect size of the sex difference was within the expected range for 2D:4D (Manning, 2002). With regard to sex differences in the marks for theoretical and practical examinations, males and females did not differ in their theory marks (males 7.55 ± 0.90, females 7.79 ± 1.04, $t = 1.07$, $p = 0.29$), but females scored significantly higher practical marks than males (males 8.01 ± 0.59, females 8.38 ± 0.54, $t = 2.90$, $p = 0.005$).

With regard to relationships between 2D:4D and examination marks for males we found these to be significant for both theory and practical. With regard to theory, there was a significant negative correlation between 2D:4D and mean theory mark ($r = -0.32$, $p = 0.04$) (Fig. 1). Multiple regression analysis showed that the relationship between 2D:4D and theory marks remained significant after the influence of age and hours of study were removed (2D:4D $b = -0.42$, $t = 0.02$; age $b = -0.18$, $t = 1.10$, $p = 0.27$; hours study $b = 0.04$, $t = 0.27$, $p = 0.79$). A similar association was found for 2D:4D and practical marks ($r = -0.317$, $p = 0.046$). This remained significant after controlling for age and hours of study. However, in this instance age was also significantly related to practical marks in that young males scored higher than older males (2D:4D $b = -0.47$, $t = 3.07$, $p = 0.004$; age $b = -0.38$, $t = 2.50$, $p = 0.02$; hours study $b = -0.001$, $t = 0.008$, $p = 0.99$). It is to be noted that the correlations between 2D:4D and theory and practical marks are of similar strength, and this was confirmed by an examination of the correlation between 2D:4D and the ratio between practical and theory marks ($r = 0.18$, $p = 0.26$).

With regard to females, there was no significant correlation between 2D:4D and theory ($r = -0.02$, $p = 0.89$) or practical marks ($r = -0.05$, $p = 0.77$). Multiple regression analyses showed 2D:4D and hours of study were not related to examination marks, but age tended to be negatively associated with both theory (significant) and practical (marginally significant). For theory marks, 2D:4D $b = 0.04$, $t = 0.26$, $p = 0.79$, age $b = -0.41$, $t = 2.46$, $p = 0.02$, hours study $b = -0.12$, $t = 0.74$, $p = 0.46$. For practical marks, 2D:4D $b = -0.06$, $t = 0.40$, $p = 0.69$, age $b = -0.32$, $t = 1.96$, $p = 0.06$, hours study $b = 0.20$, $t = 1.21$, $p = 0.24$. As with males the correlation between 2D:4D and the ratio between practical and theory marks was not significant ($r = 0.05$, $p = 0.75$).

4. Discussion

We have found that right hand 2D:4D is negatively related to theory and practical marks in male dental students. The effect size for these correlations is similar and 2D:4D is not predictive of the ratio between practical and theory marks. This finding suggests

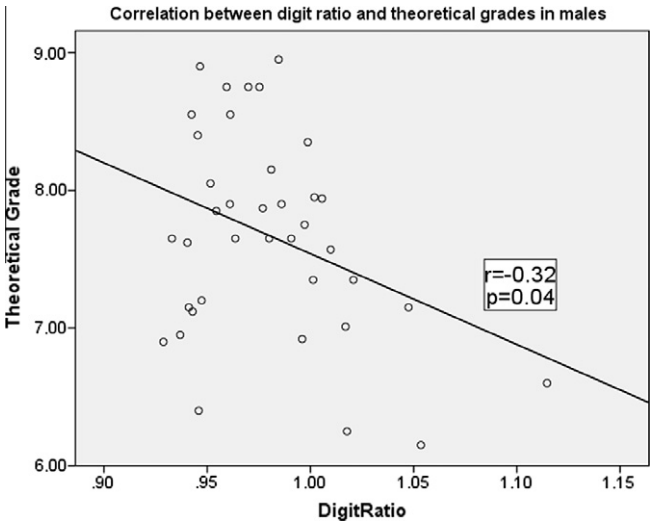

Fig. 1. Correlation between digit ratio and theoretical grades in males.