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Lower 2D:4D digit ratio is associated with reduced impulse control in women

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Abstract

Sex hormones induce sexual differentiation of the brain which might result in sex-specific behaviors. 2D:4D digit ratio is commonly used as a marker of the balance between prenatal testosterone and estrogen. In this study we analyzed if there was an association between 2D:4D and personality in women. We found that 2D:4D might be related with emotional stability, and specifically with its subdimension impulse control; while no associations were found with the dimensions energy, friendliness, conscientiousness and openness.

Introduction

Sex hormones induce sexual differentiation of the brain. In specific stages of the neural development, the mechanisms involved in this differentiation cause a dimorphic organization of certain brain regions which results in sex-specific behaviors (Turano, Osborne, & Schwarz, 2018). Using the five factor models of personality many studies have found differences between sexes, being neuroticism one of the most highlighted dimensions (Weisberg, Deyoung, & Hirsh, 2011). This personality trait is included in almost all major models of personality traits. It is highly associated with emotional instability and predicts many mental and physical disorders. Neurotic people experience more negative emotions, tend to worry and have less control of their impulses and desires. Previous studies have shown that women tend to be more neurotic than men and these differences vary with age. The magnitude of these differences become fewer, although small differences are present even in old age (Soto, John, Gosling, & Potter, 2011).

In this scenario, the second to fourth digit ratio (2D:4D) describes the relative length of the index finger (2D) to the ring finger (4D). On average males have lower ratios compared to females. This digit ratio is commonly used as a marker of the balance between prenatal testosterone and estrogen. Other authors consider that the differences between the sexes are due only to the fact that the hands of men are larger than those of women (Leslie, 2019). Nonetheless, in the present study all the participants were women and no significant differences in the size of the hands were observed. On the other hand, in adults the

relationship between 2D:4D and levels of sex hormones is not significant (Manning, Kilduff, Cook, Crewther, & Fink, 2014).

Digit ratio has been associated with neuroticism (Fink, Manning, & Neave, 2004; Sindermann et al., 2016) and several physical and psychological variables, including certain psychiatric disorders. In the present study we analyzed if there was an association between 2D:4D and personality using the Big Five Questionnaire (Caprara, Barbaranelli, Borgogni, & Perugini, 1993) in women, in which neuroticism is measured through the emotional stability dimension.

Materials And Methods

Participants

One hundred one healthy women with a mean age of 21,02 ± 2,049 years old took part of the current research. Participants were university students randomly selected from two faculties of the University of Córdoba (Spain). They were selected from an initial sample of 132 students where some were declined due to missing data or age higher than established for the study (range between 18 and 28 years old). They provided written informed consent for an anonymous research. The study was approved by the ethical research committee of the Reina Sofía University Hospital (Córdoba, Spain).

Big Five Questionnaire (BFQ)

The BFQ is a personality test based on the Five Factor Model, that identifies five fundamental dimensions in the human personality. The Spanish version of the BFQ (Caprara, Barbaranelli, & Borgogni, 1995) consists in 132 multiple-choice items of a 5-points Likert scale. The punctuations obtained are used to measure 5 different dimensions, each one divided into two facets which are: Energy (divided into Dynamism and Dominance), Friendliness (divided into Cooperativeness/Empathy and Politeness), Conscientiousness (divided into Scrupulousness and Perseverance), Emotional Stability (divided into Emotion Control and Impulse Control) and Openness (divided into Openness to Culture and Openness to Experiences). The BFQ also includes a Lie scale with the purpose

of identifying altered profiles. These dimensions and its subdimensions are measured in a continuum where an individual might be anywhere between the two extremes of each one.

2D:4D digit ratio measurement

A picture of both hands was taken, and the length of the index and ring fingers was measured using ImageJ software. 2D:4D digit ratio was computed as the quotient of the lengths of these fingers.

Statistical analysis

Statistical analysis was carried out using IBM SPSS Statistics 20. Bivariate correlations among the different quantitative variables analyzed were performed through Pearson correlation coefficient. Results were accepted as significant at $p \leq .05$.

Results

2D:4D digit ratio shows a positive correlation with emotional stability but not with the other four dimensions

2D:4D was computed as the ratio of the lengths of the index and ring fingers (means shown in Table 1). Correlation analysis results have been collected in Table 2. We found a positive correlation between the 2D:4D digit ratio and the dimension emotional stability. Referring to its two subdimensions, we have found a positive correlation between the digit ratio and emotion control while impulse control only shows a tendency toward significance. These correlations were obtained using the mean of the digit ratio of both hands. Taking each hand separately, we found that the right hand is not correlated with any of these variables, while the left hand is correlated with all of them. No association was found between 2D:4D and the dimensions energy, friendliness, conscientiousness and openness or any of its subdimensions. Otherwise, a positive association was found between the left hand 2D:4D digit ratio and the distortion punctuation. Thus, people with higher 2D:4D may have a more positive view of themselves.

Discussion

In the present study we have found a positive correlation between the 2D:4D digit ratio and emotional stability in the mean of both hands, and separately with the left hand but not with the right hand. We also have found the same relationship with the left hand in its subdimensions emotion control and impulse control. Thus, our results indicate that lower 2D:4D, and hence presumably more prenatal testosterone, is associated with lower emotional stability (higher neuroticism) in females. These results partially disagree with Sindermann et al. (2016) that found a positive relationship between the 2D:4D and neuroticism in females, but not in males, in two different populations, German and Chinese. In the German sample they found that the 2D:4D of both hands were positively and significantly associated to neuroticism; however, in the Chinese sample only the left hand was associated. Fink et al. (2004) found similar results but only an association between the right hand of females with neuroticism. These discrepancies could be due to the different tests used to measure the emotional stability-neuroticism dimension. In both previous studies, neuroticism was measured through the Neo Five-Factor Inventory, and here we measured emotional stability through the BFQ. So, more research is needed in this field.

Several studies have investigated the association between 2D:4D and ADHD. ADHD is characterized by inattention, impulsivity, and in some cases, hyperactivity. So, it is not unexpected that some of these studies have focused in measuring these dimensions. A previous work has associated prenatal testosterone exposure with increased hyperactivity-impulsivity in girls and not in boys in preschool age. They proposed that hyperactivity-impulsivity might be sensitive to organizational effect of sex hormones and, by this way, high prenatal testosterone exposure may increase risk for ADHD in girls (Roberts & Martel, 2013). Impulsivity seem to be higher during childhood and adolescence than adulthood (Casey, Jones, & Hare, 2008). Thus, according with our results, maybe this higher impulsivity observed in preschool girls with lower 2D:4D could be preserved as a personality trait as a lower impulse control even during adulthood.

Early manifestation of hyperactivity-impulsivity could predispose to disruptive behavior problems (Martel et al., 2009). General disruptive behaviors such as aggression, hyperactivity and conduct problems have been related to higher prenatal testosterone

exposure, and also to hyperactivity and conduct problems in preschool girls (Roberts & Martel, 2013). Another research has shown that low digit ratio is associated with anger, hostility and aggression in women (Hampson, Ellis, & Tenk, 2008). Although we did not measure directly aggression or any disruptive behavior, the subdimension impulse control refers to the capability of controlling discontent, irritation and anger, so these constructs would be highly related. Thus, maybe the reason of these behaviors might be, between other variables, the lower impulse control that we have observed in people with lower 2D:4D, at least in women.

On the other hand, a recent study has shown that *AR* rs615 and *OPRM1* rs2075572, SNPs of the androgen receptor and the b-endorphin receptor genes respectively, might affect impulsivity mediated by 2D:4D digit ratio (Pearce, Wlodarski, Machin, & Dunbar, 2018). Moreover, they found a relationship between *AR* rs615 and left hand 2D:4D only in women. This, together with the weak association between *AR* CAG-repeat length and 2D:4D only in women found in a recent meta-analysis (Warrington et al., 2018), could lead to imagine that testosterone plays a role in some way in women. Although it does not seem to exist a relationship between sex hormone levels in adults with 2D:4D, maybe testosterone sensitivity is increased in women with lower 2D:4D that could lead to more masculine-like behaviors. Another hypothesis could be that testosterone may have a higher effect in females, since they exhibit more variable levels of prenatal testosterone than males that normally exhibit more uniformly high levels of prenatal testosterone (Roberts & Martel, 2013).

Conclusions

In women, 2D:4D might be related with emotional stability, and specifically with its subdimension impulse control. This link could be modulated through prenatal testosterone. The main limitation of our study is that the sample only includes students and may not reflect the general population. Nevertheless, this study could help to understand better how impulsivity is influenced by prenatal testosterone and could give rise to future projects in order to dilucidated the mechanisms involved in this relationship.

Declarations

Ethical approval and consent to participate

The present study was approved by the ethical research committee of the Reina Sofía University Hospital (Córdoba, Spain) and in accordance with the 1964 Helsinki declaration and its later amendments. Each participant provided individual informed consent for an anonymous research.

Consent for publication

Each participant provided individual informed consent for publication the results of an anonymous research.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to privacy/ethical restrictions but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no conflict of interests.

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Authors' contributions

ÁRR, JAM and MRR designed the experiments; ÁRR performed the experiments; ÁRR, JAM, MRR and FGT analyzed the data; ÁRR wrote the paper, and all the authors read and approved the final manuscript.

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Tables

Table 1. *Mean score and standard deviation of self-report questionnaires.*

Variable	Mean	Std. Dv.
2D:4D (Mean)	1.005	0.035
Left-Hand	1.012	0.039
Right-Hand	0.997	0.041
BFQ		
Energy	52.22	9.371
Dynamism	51.49	9.506
Dominance	51.75	8.141
Friendliness	53.49	10.994
Cooperativeness/Empathy	53.59	11.393
Politeness	52.66	10.783
Conscientiousness	59.28	9.512
Scrupulousness	57.52	9.956
Perseverance	57.15	8.798
Emotional Stability	51.62	10.159
Emotion control	51.30	9.266
Impulse control	51.60	10.871
Openness	53.73	10.445
Openness to Culture	52.57	10.629
Openness to Experiences	53.68	10.087
Lie	50.09	7.354

Table 2. *Statistical results of correlation analysis.*

Variable 1	Variable 2	r (99)	P value
2D:4D (mean)	Energy	-.084	.402
	Dynamism	-.026	.796
	Dominance	-.132	.187
	Friendliness	.026	.795
	Cooperativeness/Empathy	-.046	.647
	Politeness	.054	.589
	Conscientiousness	-.021	.835
	Scrupulousness	-.014	.889
	Perseverance	-.034	.735
	Emotional stability	.211	.034
	Emotion control	.203	.042
	Impulse control	.172	.085
	Openness	.002	.983
	Openness to Culture	.076	.449
	Openness to Experiences	-.068	.496
	Lie	.190	.058
2D:4D (left)	Energy	-.069	.495
	Dynamism	-.035	.725
	Dominance	-.095	.343
	Friendliness	.016	.872
	Cooperativeness/Empathy	-.076	.453
	Politeness	.091	.365
	Conscientiousness	-.093	.357
	Scrupulousness	-.104	.301
	Perseverance	-.045	.658
	Emotional stability	.254	.010
	Emotion control	.249	.012
	Impulse control	.200	.045
	Openness	-.084	.403
	Openness to Culture	-.017	.862
	Openness to Experiences	-.107	.288
	Lie	.218	.028
2D:4D (right)	Energy	-.091	.366
	Dynamism	-.024	.813
	Dominance	-.142	.158
	Friendliness	.019	.854
	Cooperativeness/Empathy	-.017	.868
	Politeness	-.004	.971
	Conscientiousness	.050	.622
	Scrupulousness	.070	.490
	Perseverance	-.017	.866
	Emotional stability	.116	.251
	Emotion control	.106	.295
	Impulse control	.102	.312
	Openness	.074	.463
	Openness to Culture	.145	.149
	Openness to Experiences	-.030	.768
	Lie	.126	.211