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The 2:4 Digit Ratio, Sex and Personality

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Abstract

This study explores the correlation between the 2:4 Digit Ratio and trait Neuroticism alongside gender expression. In all, 260 adults indicated the 2:4 Digit Ratio on their left hand and completed a work-related personality measure. As established in many studies, sex differences were present in the ratio. We also identified significant differences associated with masculine-feminine ratings and trait Adjustment (low Neuroticism). Implications and limitations are discussed.

Keywords

2:4 Digit Ratio, Sex, Gender, Personality, Neuroticism

1. Introduction

Around 150 years ago, Ecker (1875) demonstrated the sex difference in 2nd and 4th digit ratio (2:4 DR). Seventy-five years ago, Phelps (1952) observed that females tended to exhibit a higher ratio than males. That is, the ratio of the 2nd digit (index finger) to the 4th digit (ring finger) in females was closer to 1.00, while in males, this ratio was significantly lower. However, for both males and females, the digit ratio is associated with levels of prenatal exposure to testosterone and oestrogen (Austin et al., 2002). This finding intrigued researchers from many fields, including evolutionary, personality, social, and work psychology (Voracek, 2011). There has been a recent review of this area (Swift-Gallant et al., 2025).

Most, but not all, studies depict the established sex difference in the ratio across very wide cultural and population groups, further assessing the digit ratio in many different ways. In this study, we are interested in two issues: the link between the digit ratio and personal sexual expression (ratings on a femininity-masculinity self-report scale) and personality, specfifically trait Neuroticism.

Over the years, several studies have linked the digit ratio and personality. Luxen and Buunk (2005) found a relation between right-hand 2:4 DR and Verbal and Numerical Intelligence, alongside Agreeableness (R^2's around .22). Hampson et al. (2008) tested 164 undergraduates (87 men, 77 women), discovering in both sexes, that lower 2:4 DR associates with increased Aggressiveness and Sensation Seeking.

There is some consistency in the finding that Neuroticism (low Adjustment) is associated with the 2:4 DR. Lindová et al. (2008) correlated the 2:4 DR in 184 women and 101 men with the Cattell's 16 Personality Factor (16PF) score, revealing that women with a higher (more 'feminine') right hand 2:4 DR scored lower in Emotional Stability and Social Boldness, and higher in Privateness. In a study with 78 Chinese and 370 German participants, Sindermann et al. (2016) found a positive association between the 2:4 DR and Neuroticism in females, as shown in Lindová et al.'s earlier study. "*Thus, prenatal exposure to sex steroids appears to influence the personality factor Neuroticism in females specifically. This finding potentially has implications for mental health, as Neuroticism has been shown to be a risk factor for various forms of psychopathology*" (p 811). Recently, Rodriguez-Ramos et al. (2021) sought to determine whether there was an association between the 2:4 DR and personality, measured through the Big Five Questionnaire (BFQ) in a homogeneous sample of 101 young female college students. They found a positive association between the 2:4 DR and Emotional Stability and its sub-dimensions, Emotion Control and Impulse Control.

This Study

In the present study, we explored two main issues using a large group of adults and a well-established measure of work personality, which measures six work related traits: *Conscientiousness, Adjustment* (low Neuroticism), *Curiosity* (Openness) *Ambiguity Acceptance*, *Competitiveness,* and *Courage, or Approach to Risk,* First, is the association between the measure of Neuroticism used in this study and the 2:4 DR. Second, is the relationship between gender expression-the extent to which people rate themselves as feminine to masculine- to the 2:4 DR.

2. Method

2.1. Participants

A total of 260 participants completed the questionnaire, 118 were men, and 142 were women. They ranged in age from 20 to 78 years, with a mean age of 46.22 years (*SD* = 11.41) Half (51%) reported their nationality as British, while 13% as South African, 12% as American.

2.2. Questionnaires

1. *High Potential Trait Indicator (HPTI)* (MacRae & Furnham, 2020) measures personality traits within a workplace context. It comprises six factors with 78 items. Each trait is converted into Rasch measurement scores, favoured for its in-

terval and linear properties. It has been used in numerous studies (Teodorescu et al., 2017).

2. *Fingers*: Participants are shown the figure below (see **Figure 1**) and asked to indicate whether they are more likely to be A (4^{th} digit longer than 2^{nd}), B (2^{nd} finger longer than 4^{th}), and C (2^{nd} and 4^{th} digits are equal in length).

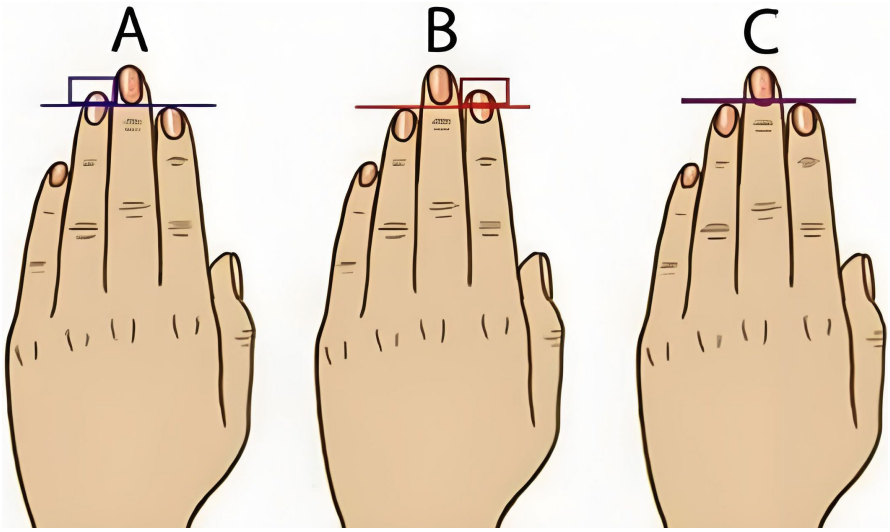

Figure 1. Stimulus shown to participants.

Ideally, we would have also had a picture of the right hand and an actual finger length measure used in this research, but this was not feasible given the study constraints.

3. *Gender expression*: Participants are asked to rate their gender expression from 1 (strongly feminine) to 9 (strongly masculine).

2.3. Procedure

Participants were recruited from a pool of individuals who had completed a psychometric assessment provided by test publisher Thomas International. We obtained informed consent to analyse and publish the anonymised. The study was conducted on an online survey platform and was not timed. The research received approval from the committee LSA/TI/2022. Finally, participants were debriefed, thanked for their time, and provided feedback on their scores. This research pool has been used in many studies as the data has been found to be of high quality (Cuppello et al., 2023a, 2023b, 2024).

3. Results

The correlation results suggest five significant correlates of the "male" 2:4 DR hand (A). Findings indicate that older males who identify as more masculine had higher Adjustment and Risk Taking (courage) scores. They also show that for the "female" 2:4 DR hand (B), the opposite pattern was true-though age and Risk Taking failed to reach significance.

Table 1. Descriptive statistics, reliability, and spearman's correlation coefficients.

Variable	*M*	*SD*	alpha	p.rel	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Sex	—	—	—	—	—										
(2) Age	46.2	11.4	—	—	−0.21***	—									
(3) Gender expression	4.95	2.58	—	—	−0.83***	0.13*	—								
(4) Conscientiousness	0.73	0.49	0.73	0.63	0.04	0.12*	−0.05	—							
(5) Adjustment	0.46	0.60	0.83	0.80	−0.11	0.27***	0.00	0.32***	—						
(6) Curiosity	0.83	0.57	0.75	0.71	0.02	−0.03	−0.02	0.38***	0.15*	—					
(7) Risk Approach	0.45	0.54	0.80	0.75	−0.14*	0.21***	0.08	0.59***	0.45***	0.45***	—				
(8) Ambiguity Acceptance	−0.08	0.43	0.76	0.71	−0.09	0.22***	0.06	0.23***	0.38***	0.32***	0.45***	—			
(9) Competitiveness	−0.19	0.48	0.80	0.77	−0.14*	−0.21***	0.17**	0.27***	−0.07	0.08	0.23***	0.07	—		
(10) Finger ratio A	—	—	—	—	−0.30***	0.17**	0.24***	0.11	0.16*	0.01	0.14*	0.02	−0.01	—	
(11) Finger ratio B	—	—	—	—	0.24***	−0.11	−0.21***	−0.10	−0.14*	−0.01	−0.06	−0.01	0.09	−0.72***	—
(12) Finger ratio C	—	—	—	—	0.13*	−0.11	−0.07	−0.04	−0.05	−0.01	−0.12	−0.02	−0.09	−0.53***	−0.21***

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Sex 0 = male, 1 = female; Finger ratios 0 = no, 1 = yes.

Chi-square: A chi-square test for independence was conducted to examine the relationship between sex and 2:4 DR (see Table 2). The results confirmed the previous findings ($\chi^2 = 24.2$, $df = 2$, $p < 0.001$). Cramer's V revealed the association to be moderate ($V = 0.305$).

Table 2. Contingency table for sex and 2D:4D finger ratio.

Digit ratio	Male	Female	Total
A	95	73	168
B	13	44	57
C	10	25	35
Total	118	142	260

Note: A - Ring finger is longer than index finger, B - Index finger is longer than ring finger, C - Index finger is the same length as ring finger

Kruskal-Wallis: Due to the bimodal and ordinal nature of the gender expression variable, the non-parametric alternative to a one-way analysis of variance (ANOVA) was used to assess whether there are differences in gender expression between finger ratios. The results revealed a significant difference in gender expression between finger ratios, H (2, $n = 260$) = 15.2, $p < 0.001$, $\varepsilon^2 = 0.059$. Post-hoc pairwise analysis revealed that finger ratio A ($Md = 6$) was reported as more masculine than finger ratio B ($Md = 3$). No significant differences were found between finger ratio C ($Md = 4$) and the others. The finding does not necessarily indicate that finger ratio is associated with gender expression, but as sex and gender expression are highly correlated ($rho = -0.83$, $p < 0.001$), this further connects finger ratio and biological sex.

ANOVA: A one-way analysis of variance (ANOVA) was conducted to assess whether there were personality differences between finger ratios A, B, and C. The results imply significant differences in Adjustment, $F(2, 257) = 3.54$, $p = 0.03$, $\eta^2 = 0.03$). Bonferroni post-hoc analysis ($p = 0.02$, Cohen's $d = 0.416$) revealed that finger ratio A ($M = 0.54$, $SD = 0.64$) had higher Adjustment than finger ratio B ($M = 0.29$, $SD = 0.40$). No differences were found between finger ratio C ($M = 0.38$, $SD = 0.57$) and the others.

Multinomial logistic regression: Based on the Chi-Square and ANOVA results, sex and Adjustment were entered into a multinomial logistic regression as predictor variables to assess the probability of having A, B, or C finger ratios. (see Table 3) Age was entered into the model as a control variable. The model was significant, $\chi^2(6, n = 256) = 30.3$, $p < 0.001$, Nagelkerke $R^2 = 0.087$. The results depicted in Table 3 reveal a higher likelihood of having a longer index finger than a longer ring finger if an individual is female ($OR = 3.78$, $p < 0.001$) and lower in Adjustment ($OR = 0.52$, $p < 0.05$). Similarly, the likelihood of having a longer index finger than equal 2:4 digits is higher if an individual is female ($OR = 2.80$, $p < 0.05$); however, Adjustment was not a significant variable. No significant findings were evident in the likelihood of having a longer index finger over equal length 2:4 digits.

Table 3. Multinomial logistic regression with finger ratio as the criterion variable.

Finger ratio (reference - comparison)	Variable	Estimate	SE	Odds ratio (OR)	Z
A - B	Sex (0 - 1)	1.331	0.361	3.783	3.684***
	Age	−0.011	0.015	0.989	−0.738
	Adjustment	−0.652	0.322	0.521	−2.029*
A - C	Sex (0 - 1)	1.031	0.414	2.803	2.487*
	Age	−0.018	0.018	0.982	−1.031
	Adjustment	−0.299	0.346	0.742	−0.864
B - C	Sex (0 - 1)	−0.300	0.499	0.741	−0.601
	Age	−0.007	0.020	0.993	−0.353
	Adjustment	0.354	0.417	1.425	0.849
χ^2			30.3		
p-value			<0.001		
Nagelkerke R^2			0.087		

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Sex 0 = male, 1 = female.

4. Discussion

This paper adds to the literature in two ways. First, using another measure of Neuroticism/Adjustment, we replicated previous findings, namely that Adjustment was related to the more typically "male hand ratio" (Lindová et al., 2008). Secondly, we established that the 2:4 DR was related to gender expression as much as

sex differences. Of course, sex and gender expression are very highly correlated ($r = -0.83$).

The central question is to explain the association between Adjustment and the 2:4 DR. The link between prenatal testosterone exposure and the 2:4 DR is well established. Prenatal testosterone exposure, by proxy of the 2:4 DR measurement, has also been associated with levels of testosterone concentration in later life (Garcia-Cruz et al., 2011; Klimek et al., 2014). Similarly, in studies of adolescents to adults, testosterone has been inversely linked to levels of Neuroticism (Rodriguez-Ramos et al., 2021; Sindermann et al., 2016; Tajima-Pozo et al., 2015) and positively associated with fear-reducing properties. This is due to testosterone's role in inhibiting the hypothalamic-pituitary-adrenal axis, which is also involved in stress and fear (Terburg et al., 2009; Viau, 2002). Sequentially, it makes sense that prenatal testosterone exposure directly influences individuals' Adjustment levels, at least to some extent. Some other studies demonstrate a relationship between Neuroticism and the prefrontal cortex and amygdala, and tyroid (Terburg & van Honk, 2013) and Neuroticism and thyroid hormones which suggests that prenatal testosterone exposure organises neural systems that affect behaviour, including the amygdala and, therefore, Neuroticism.

Like all others, this study had limitations. Our measure of the 2:4 DR was crude and based on only the left hand, yet showed results in the predicted direction. Further, we were reliant exclusively on self-reports which increases the risk of common method bias. There were also sample Limitations: The age range is wide (20 - 78 years), potentially introducing confounding variables related to age-related changes in hormone levels and personality. Future research should consider the replicability of these findings across populations from different countries.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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