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Digit Ratio: An Indicator to the World Within

Tanvi Khurana[1], Tanuja Jukariya[2], Suman Singh[3]

[1]Research Scholar, tanvi_0207@yahoo.co.in, Department of Resource Management and Consumer Science, College of Home Science, MPUAT, Udaipur, Rajasthan
[2]Research Scholar, tnjjkr45@gmail.com, Department of Resource Management and Consumer Science, College of Home Science, MPUAT, Udaipur, Rajasthan
[3]Professor, Department of Resource Management and Consumer Science, College of Home Science, MPUAT, Udaipur, Rajasthan

Abstract

The ratio of index finger length to ring finger length known as digit ratio (2D:4D) is an indicator of prenatal androgen exposure. The 2D:4D ratio is sexually dimorphic, with average male 2D:4D lesser than average female 2D:4D. It recently was suggested that 2D:4D is negatively correlated with prenatal testosterone and positively correlated with prenatal estrogen. It is argued that high prenatal testosterone and low estrogen (indicated by low 2D:4D) favours the male foetus and low prenatal testosterone and high estrogen (indicated by high 2D:4D) favours the female foetus. According to a broad array of studies, this ratio, determined by the level of prenatal testosterone, can predict a diversity of personality traits. In particular, individuals whose index finger is almost as long--or even longer--than is their ring finger are more likely to display characteristics that are characteristic of females. Even their writing tends to be more feminine in style. But usually, not always, these observations apply to the right hand only. Even within each sex, 2D:4D has been found to be linked with a variety of physical and psychological characteristics. For example, men with lower 2D:4D are more aggressive, more athletic, less feminine, and more musically talented. Women with lower 2D:4D have higher waist-to-hip ratio, are more masculine, and are more athletic. Among both men and women, 2D:4D is correlated positively with verbal intelligence and agreeableness, and negatively with numerical intelligence and physical fitness. The present paper aims at establishing the relationship between various physical and psychological aspects of personality and digit ratio through a review of existing literature.

Keywords: 2D:4D ratio, Digit Ratio, Personality, Sexually dimorphic, Testosterone

Introduction

The ways in which men and women differ reach into almost every aspect of our behaviour and health- verbal, mathematical, spatial, musical and other abilities; strength, running and swimming speed, jumping, height and distance, handedness, throwing accuracy and distance; the prevalence of heart disease and the probability of heart attack, predisposition to most cancers, asthma, rheumatoid arthritis, autism, attention-deficit syndrome, stammering, migraine, depression and many tropical, diseases. All these and more show different intensities of development, or are more common, manifest earlier or once manifest have different patterns or rates of progression in one sex compared to the other. (Collaer and Hines, 1995; Hepper *et al*. 1997)

Sex differences span the whole range of traits, from those that are apparently trivial to those that are life threatening. How do these differences arise, and why do some men show what we might call female-type traits, while some women seem rather masculine? It may sound weird, but our fingers, and more accurately our ring and index finger, can shed light on this debate. Our fingers provide us with data of how men and women differ, and how they are programmed before birth to show certain sex-related behaviour patterns and disease predispositions. In this paper it is aimed to demonstrate that the early growth of our ring finger is sensitive to testosterone levels in the womb. Testosterone is the so-called 'male hormone', and the longer the ring finger is the more masculine a person turns out to be. Since finger length is also dependent on body size, so the length of ring finger must be compared with another of the fingers. The best comparison is done with index finger, since its early growth is believed to be dependent on the 'female-hormone' oestrogen. Thus the relative length of ring finger and index finger indicates a balance of masculinity and feminity of mind and body in a person.

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Digit Ratio: An Overview

The digit ratio is the ratio of the lengths of different digits or fingers typically measured from the midpoint of bottom crease (where the finger joins the hand) to the tip of the finger (Manning, 2002; Mayhew *et al.* 2007). The ratio between 2^{nd} (the index finger) and 4^{th} (the ring finger) digit length tends to be lower in males compared to females. That is men tend to have longer 4^{th} digits compared to their 2^{nd} than do women. (Zheng and Cohn, 2011).

The ratio of 2D length to 4D length, also known as the 2D:4D ratio, is therefore **2D:4D < 1** for most men and **2D:4D ≥1** for most women. Averaged across samples from various populations, female values were found to be about .25 standard deviations higher than male values (Manning *et al.*, 2000). This sexually dimorphic character of the limb was described >120 y ago (Baker, 1988), but it was not until 1998 that the 2D:4D ratio was linked to sex steroids by the observation that men with lower 2D:4D ratios have higher serum testosterone and lower estrogen levels (Manning *et al.* 1998). The discovery that sexually dimorphic digit ratios exist in 2-y-old children raised the possibility that 2D:4D ratios are determined early in life (Manning *et al.* 1998). Several lines of evidence suggest this relationship of sex hormone (especially androgen) levels with sex difference in 2D:4D and also intra-sexual variability in this measure.

First, the sex difference in 2D:4D is already observable at the end of the first trimester of foetal development (Malas *et al*., 2006). Second, the development of both, genitals and digits, is controlled by the same genes HoxA and HoxD (Kondo *et al*., 1997). Third, the sex difference in 2D:4D appears unaffected by puberty as is evidenced by cross-sectional (Manning *et al*., 1998) and longitudinal (McIntyre *et al*., 2005; Trivers *et al*., 2006) data. Fourth, right hand 2D:4D at the age of two years was found to be negatively correlated with the testosterone/estrogen ratio as measured by amniocentesis in the second trimester (Lutchmaya *et al*., 2004). Fifth, individual 2D:4D values were shown to have high longitudinal stability from age 10 to 14 (Trivers *et al*., 2006) and some stability from infancy throughout to age 17 (McIntyre *et al*., 2005). Sixth, females with male co-twins appear to be exposed to higher testosterone levels in-utero and they have lower 2D:4D values than females with female co-twins (van Anders *et al*., 2006). For these reasons, 2D:4D may be a valid marker of prenatal testosterone exposure. As prenatal testosterone affects human behaviour and cognition and since other ways of studying these effects in humans are laborious and pose various difficulties (Collaer and Hines, 1995; Cohen-Bendahan *et al*., 2005) 2D:4D has become popular as a means to study the effects of prenatal androgenization in humans, especially regarding sex-linked behaviours and traits (Manning, 2002). In other words, a foetus with more exposure to testosterone is expected to have lower (masculine) digit ratio. Usually, the male foetuses have a higher testosterone exposure and hence, the males always have lesser digit ratios when compared to females. Likewise, the females have lesser testosterone exposure and therefore, higher (feminine) ratios.

Further, Manning and colleagues have shown that 2D:4D ratios vary greatly between different ethnic groups. In a study with Han, Berber, Uygur and Jamaican children as subjects, Manning *et al.* found that Han children had the highest mean values of 2D:4D (0.954±–0.032), they were followed by the Berbers (0.950±0.033), then the Uygurs (0.946±0.037), and the Jamaican children had the lowest mean 2D:4D (0.935±0.035)(Manning *et al.* 2000; Manning *et al.* 2004). This variation is far larger than the differences between sexes; in Manning's words, "There's more difference between a Pole and a Finn, than a man and a woman." In 2007 Manning *et al*. also found that mean 2D:4D varied across ethnic groups with higher ratios for Whites, Non- Chinese Asians, and Mid-Easterners and lower ratios in Chinese and Black samples (Manning *et al.*, 2007). Studies in South Indian Population have also identified the sexual dimorphism in 2D:4D ratios (Jacob *et al.* 2015) Two studies conducted by Loehlin *et al*., 2006 and Xu and Zheng, 2016) also explored the question of whether geographical differences in 2D:4D ratios were caused by gene pool differences, or whether some environmental variable associated with latitude might be involved (e.g., exposure to sunlight or different day-length patterns). The conclusions were that geographical differences in 2D:4D ratios were caused by genetic pool differences, not by geographical latitude.

Digit Ratio and Personality

There has been increasing use of the 2D:4D ratio as an index of prenatal hormone exposure, and extensive studies in humans have found correlations between digit ratios and a variety of physiological and psychological conditions, including

1)	Academic success	Romano *et al*., 2006
2)	Athletic ability	Manning and Taylor, 2001
3)	Attention deficit hyperactivity disorder	Martel *et al*., 2008
4)	Autism	de Bruin *et al*., 2006
5)	Cooperative behaviour	Millet and Dewitte, 2006
6)	Disordered eating	Klump *et al*., 2006; Smith *et al*., 2010
7)	Fertility	Manning *et al*., 2000
8)	Gender-identity	Wallien *et al*., 2008
9)	Gender-typical play	Alexander, 2006; Burton *et al*., 2009
10)	Pain perception	Keogh *et al*., 2007
11)	Personality	Fink *et al*., 2004; Hampson *et al*., 2008; Loehlin *et al*., 2009
12)	Psychological femininity and masculinity	Scarbrough and Johnston, 2005
13)	Schizotypal personality disorder	Walder *et al*., 2006
14)	Sensation seeking	Fink *et al*., 2006
15)	Sex role identity	Csatho *et al*., 2003
16)	Sex-biased diseases	Manning and Bundred, 2000; Manning *et al.* 2001
17)	Sexual orientation	Rahman and Wilson, 2003; Williams *et al*., 2000
18)	Social behaviours	Breedlove, 2010; Coates *et al*., 2009
19)	Social cognition	Williams *et al*., 2003
20)	Spatial ability	Kempel *et al*., 2005; Loehlin *et al*., 2009
21)	Spatial performance on visual tasks	Manning & Taylor, 2001
22)	Sporting ability	Manning and Taylor, 2001
23)	Verbal ability	Luxen & Buunk, 2005

Most of the evidence linking digit ratios to differences in androgen and estrogen during development is indirect and based on correlational studies in humans after birth (Honekopp *et al.* 2007; Manning, 2002).It remains unknown whether prenatal androgen and estrogen play causal roles in sexual dimorphism of the digit ratios and how these sex steroids could influence the mechanisms of digit development.

Conclusion

Digit ratio is sexually dimorphic and can be used as window for in utero exposure to androgens, especially testosterone. 2D:4D ratio has been shown to differ in all sexually dimorphic traits. However, there is no consensus on the intra-sexual and inter-sexual variations in digit ratios and traits across various ethnic groups. The recent surge in the number of studies on digit ratios, especially in India may open more avenues to be explored in this regard. More robust studies on large samples can help us establish meaningful associations between digit ratios, prenatal androgen exposure and sexually dimorphic traits.

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