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## Sexual dimorphism in second-to-fourth digit ratio and its relation to gender-role orientation in males and females

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### Abstract

It has been proposed that high prenatal androgens, low prenatal estrogens, or both may be associated with a low (i.e., masculine) second to fourth digit (2D:4D) ratio. The aim of the present study was to examine the association between 2D:4D ratio and gender-role orientation. Participants were 423 male and 312 female university students ranging in age from 18 to 36 years. After filling in the Bem Sex-Role Inventory (BSRI), participants' 2D:4D ratios were measured on both hands. While regression analyses failed to indicate a functional relationship between aspects of gender-role orientation and 2D:4D ratio in the female sample, the BSRI-Femininity score was positively related to the left-hand 2D:4D ratio in males. This finding suggests that a more feminine gender-role orientation in men is associated with lower androgen and/or higher estrogen levels in utero. However, our findings also draw attention to difficulties and inconsistencies in the interpretation of 2D:4D data.

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*Keywords:* Second to fourth digit ratio; Gender-role orientation, masculinity; Femininity; Prenatal steroids

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## 1. Introduction

The ratio between the lengths of the second and fourth manual digit (2D:4D ratio) is sexually dimorphic, with males having lower 2D:4D ratios than females (e.g., Manning, 2002; Peters, Mackenzie, & Bryden, 2002). This variation in 2D:4D ratio is thought to reflect the influence of prenatal exposure to testosterone and estrogen (Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, & Manning, 2004; Manning, Scutt, Wilson, & Lewis-Jones, 1998). According to this account, high levels of prenatal testosterone and low levels of prenatal estrogen produce a low (i.e., masculine) 2D:4D ratio. Converging evidence for a functional relationship between prenatal testosterone levels and 2D:4D ratio comes from studies of patients suffering from congenital adrenal hyperplasia (CAH), a condition characterized by prenatal exposure to higher than normal levels of adrenal androgens. In two studies (Brown, Hines, Fane, & Breedlove, 2002; Okten, Kalyoncu, & Yaris, 2002), CAH was associated with lower 2D:4D ratios in male and female patients, although the effect was not consistently observed in both hands. These findings suggest that 2D:4D ratio may represent a retrospective marker of prenatal androgen exposure.

Androgens may also play a major role in the development of gender-typical behavior. Most notably, CAH girls exhibit increased masculine-typical gender role preferences, including childhood toy, game, playmate, and activity preferences (Berenbaum & Hines, 1992; Dittmann et al., 1990; Pasterski, Geffner, Brain, Hindmarsh, & Brook, 2005; Servin, Nordenström, Larsson, & Bohlin, 2003). This relationship between prenatal androgen and childhood gender role behavior represents one of the best-established links between hormone environment and human psychosexual development (Hines, Golombok, Rust, Johnston, & Golding, 2002).

As a consequence of prenatal hormone-determined differentiation of the brain, behaviors, particularly those that are linked to gender, should be associated with 2D:4D ratio as a potential index of prenatal influence of testosterone. Based on such a hypothesized common link of prenatal androgens, Wilson (1983) examined the relationship between 2D:4D ratio and gender-role orientation in women who answered a newspaper survey. His finding that women who reported a lower 2D:4D ratio were more likely to describe themselves as “assertive and competitive” compared to women with higher 2D:4D ratios, was consistent with the notion of a positive relationship between prenatal androgen levels and masculinity.

More recently, Csathó et al. (2003) re-examined Wilson’s (1983) findings. For this purpose, they measured 2D:4D ratios in 46 female university students using a Vernier calliper. Furthermore, for psychometric assessment of gender-role orientation, participants were asked to fill in the Bem Sex-Role Inventory (BSRI; Bem, 1974, 1981a). The BSRI measures masculine and feminine gender roles separately and, at the same time, is able to yield a measure of androgyny. The concept of androgyny represents a framework for interpreting similarities and differences among individuals according to the degree to which they describe themselves in terms of characteristics traditionally associated with men and those associated with women. Csathó et al. (2003) found a negative correlational relationship between 2D:4D ratio and the so-called Androgyny score (Bem, 1974) indicating that women with lower 2D:4D ratios described themselves as more masculine and less feminine while women with higher 2D:4D ratios showed an opposite pattern of self-reported masculinity and femininity. This relationship was reliable for the right hand but not for the left-hand 2D:4D ratio.

The present study was designed to replicate and extend Csathó et al.’s (2003) findings to further elucidate the relationship between 2D:4D ratio and gender-role orientation in humans. Therefore,

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