

## Second to fourth digit ratio and male ability in sport: implications for sexual selection in humans

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### Abstract

Fetal and adult testosterone may be important in establishing and maintaining sex-dependent abilities associated with male physical competitiveness. There is evidence that the ratio of the length of the 2nd and 4th digits (2D:4D) is a negative correlate of prenatal and adult testosterone. We use ability in sports, and particularly ability in football, as a proxy for male physical competitiveness. Compared to males with high 2D:4D ratio, men with low ratio reported higher attainment in a range of sports and had higher mental rotation scores (a measure of visual–spatial ability). Professional football players had lower 2D:4D ratios than controls. Football players in 1st team squads had lower 2D:4D than reserves or youth team players. Men who had represented their country had lower ratios than those who had not, and there was a significant (one-tailed) negative association between 2D:4D and number of international appearances after the effect of country was removed. We suggest that prenatal and adult testosterone promotes the development and maintenance of traits which are useful in sports and athletics disciplines and in male:male fighting. © 2001 Elsevier Science Inc. All rights reserved.

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Darwin (1871) recognised two forms of sexual selection: (a) mate choice, i.e., intersexual selection and (b) competition within a sex, usually male, for resources which facilitate access to mates, i.e., intrasexual selection. Ability in many sports and athletic disciplines may act as a proxy for ability in male–male fighting because they demand good visual–spatial judgement, speed, endurance and strength. Football (“soccer”) is one such sport. Striking

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the ball with foot, head and fist (in the case of goalkeepers) and directing it towards fellow players or the goal requires spatial judgement. Playing competitive football for 90 min is a sustained demonstration of cardiovascular efficiency and a test of speed and sometimes strength. Testosterone, particularly prenatal testosterone, has many extragenital influences (Bardin & Catterall, 1981; McEwen, 1981). Androgens are critical for sexual differentiation of the nervous system and the development of abilities such as spatial judgement (Geschwind & Galaburda, 1985; Kimura, 1996, 1999), and in males the formation of an efficient cardiovascular system (Manning & Bundred, 2000). There is evidence that the ratio between the length of the 2nd and 4th digits (2D:4D) is a correlate of prenatal and adult testosterone concentration because (a) it is lower in males than females (Baker, 1888; Manning, Scutt, Wilson, & Lewis-Jones, 1998; Phelps, 1952); (b) the ratio does not appear to change at puberty and is probably fixed prenatally, perhaps by the end of the first trimester (Garn, Burdi, Babler, & Stinson, 1975; Manning et al., 1998); (c) the waist:hip ratio (a positive correlate of testosterone) of mothers is negatively associated with the 2D:4D ratio of their children (Manning, Trivers, Singh, & Thornhill, 1999); and (d) 2D:4D has been reported to be negatively associated with testosterone in men (Manning et al., 1998).

Low 2D:4D ratios are associated with autism (Manning, Baron-Cohen, Wheelwright, & Sanders, 2001), left-hand preference (Manning, Trivers, Thornhill, & Singh, 2000), male homosexuality (Robinson & Manning, 2000) and male membership of a symphony orchestra (Sluming & Manning, 2000). There is evidence that all these traits are correlated with high prenatal testosterone (Geschwind & Galaburda, 1985; but see also Bryden, McManus, & Bulman-Fleming, 1994). The purpose of this work was to examine the relationship between 2D:4D ratio and sports ability, with particular reference to football.

## **1. Methods**

### *1.1. Study I*

The participants were 128 men recruited from libraries and sports centres. Many were university students. Participants who reported injuries to their 2nd and/or 4th digits were excluded from the study. The length of the right and left 2nd and 4th digits was measured from the crease proximal to the palm to the tip of the digit. Vernier callipers, measuring to 0.01 mm, were used. The 2nd and 4th digits from 50 hands and 50 subjects were measured twice.

Subjects ranked their competitive level in the sport they most regularly practiced on a scale from 1 to 10, with 10 representing international participation (Table 1). This scale has been used to rank middle distance runners and it was shown to correlate with their best times for 800 m (Manning & Pickup, 1998).

### *1.2. Study II*

The subjects were 125 men recruited from libraries, adult education classes and sports centres. The participants were from a variety of educational and socio-economic back-

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