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Examining the effect of prenatal testosterone and aggression on sporting choice and sporting longevity

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ABSTRACT

Digit ratio (2D:4D; a putative correlate of prenatal testosterone) has been reported to be negatively associated with aggression in non-sporting and sporting populations. 2D:4D has previously been suggested to be a potential biomarker for successful competitive performance within boxing football, rugby, athletics, skiing, and gym-based exercises. However, to date no study has attempted to investigate prenatal testosterone levels as a predictor of sporting choice. This study included a sample of both athletes and non-sports people in order to examine associations between prenatal testosterone (2D:4D), aggression, choice of sport (contact vs. non-contact), attainment level, and longevity. 200 male participants completed a self-report measure for aggression followed by providing a hand scan, which was later used to measure 2D:4D using Vernier Calipers. Results showed individuals involved in sport exhibited significantly greater levels of both prenatal testosterone (lower 2D:4D) and physical aggression compared with their non-sporting counterparts. Athletes from contact sports (rugby, football and boxing) were found to have significantly lower 2D:4D and significantly higher levels of physical aggression compared to athletes from non-contact sports (basketball, golf, weight-training, badminton). Additional findings, regarding longevity, showed those exposed to higher levels of prenatal testosterone (low 2D:4D) had been involved in sport for more years compared to those with high 2D:4D, adjusting for age. Findings may contribute to more reliable predictions of sporting selection and longevity. Future studies should look to replicate findings across a greater variety of sports using professional/elite populations.

1. Introduction

There is evidence to suggest that the relative lengths of the second and fourth fingers (2D:4D ratio) correlate negatively with prenatal testosterone (Manning, 2011; Manning, Scutt, Wilson, & Lewis-Jones, 1998; Zheng & Cohn, 2011). There are a considerable number of papers concerned with uncovering links between 2D:4D and aggression (Hönekopp & Watson, 2011). The evidence points to a weak negative correlation between 2D:4D in men, with little in the way of significant associations being found in women (Hönekopp & Watson, 2011). However there are now a growing number of studies showing negative relationships between 2D:4D and 'real-world' measures of aggression, including aggression in non-sporting contexts (Joyce et al., 2013; Schwerdtfeger, Heims, & Heer, 2010) and during sporting contests (Bennett, Manning, Cook, & Kilduff, 2010; Kilduff et al., 2013; Mailhos, Buunk, Del Arca, & Tutte, 2016; Perciavalle et al., 2013). Individuals involved in sport have been shown to exhibit significantly higher levels of aggression (Sønderlund et al., 2014), with aggression being recognised as a potential prerequisite to sporting success, in male-to-male physical competition (Perciavalle et al., 2013; Tamiya, Lee, & Ohtake, 2012). General aggression has been defined as behaviour intended to harm another individual (Archer, 2009). However, in the context of sport, aggression typically refers to a tendency to force actions (Kerr, 2004), directly resulting in the experience of either positive (e.g. a successful tackle or punch) or negative (e.g. a red card or sanction for dangerous behaviour) outcomes. Research has demonstrated a relationship between prenatal (equivocal findings), and circulating, testosterone and levels of psychological and behavioural aggression (Hönekopp, 2011; Perciavalle et al., 2013). Testosterone therefore has been widely acknowledged as a key contributor to higher levels of aggression among males compared to their female counterparts across a variety of cultural, social and ethnic groups (Hönekopp & Watson, 2011). Hönekopp (2011) has suggested that prenatal testosterone has a permanent masculinising effect on human functioning and behaviour. The 2D:4D ratio (relative difference in length between the index and ring fingers) is a putative marker for prenatal testosterone, whereby higher testosterone levels correspond with a relatively longer fourth finger or lower 2D:4D (Hönekopp, 2011; Manning, 2002). 2D:4D is now commonly used as a proxy measure of individual differences in prenatal testosterone exposure due to ease of procurement and reproducibility (Perciavalle et al., 2013).

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Prenatal testosterone (2D:4D) has been shown to be negatively associated with a behavioural measure of aggression, i.e., traffic violations, in males (Schwerdtfeger et al., 2010). Moreover, in a study that included a relatively large sample ($N = 2200$), 2D:4D was negatively associated with verbal and physical aggression in males (Hönekopp, 2011). Elsewhere, Perciavalle et al. (2013) showed that professional soccer players who had been exposed to higher levels of prenatal testosterone were more likely to have committed more playing fouls that resulted in yellow or red cards over the course of a season. The same authors also reported both aggression and prenatal testosterone levels to be significantly greater within the soccer players compared to controls, mirroring the findings of Bennett et al. (2010) within a sample of elite rugby players. Furthermore, Mehİbe, Serkan, Gülsüm, and Fatma (2009) found that secondary school students who were regularly participating in sporting activities recorded significantly higher scores for destructive aggression compared to their non-sporting counterparts. More recently, Mailhos et al. (2016) showed within a sample of junior Uruguayan soccer players the most aggressive (i.e. those awarded one or more red cards) possessed a lower 2D:4D ratio compared to their less-aggressive counterparts.

2D:4D has previously been suggested to be a potential biomarker for successful competitive performance in several sports including skiing (Manning, 2002), and gym-based exercises (Hönekopp, Manning, & Muller, 2006). More recently, 2D:4D studies demonstrated significant associations between greater levels of prenatal testosterone and performance within the sports of athletics (e.g. middle- and long-distance running) (Hönekopp & Schuster, 2010), rugby (Bennett et al., 2010), and football (Perciavalle et al., 2013). Bennett et al. (2010) found that among elite rugby players, the number of tries scored and number of international appearances were both significantly higher in those with lower 2D:4D ratios, after adjusting for playing position and age respectively. Interestingly, low 2D:4D may also be a predictor of success and longevity, with support for this notion found within a group of financial traders (Coates, Gurnell, & Rustichini, 2009). Longevity is a particularly important phenomenon to understand in sport where careers are usually short-lived as a result of physical and or psychological burnout (Burgess, Naughton, & Hopkins, 2012).

However, despite previously reported links between 2D:4D and aggression within studies investigating sporting success (Perciavalle et al., 2013; Tamiya et al., 2012), high levels of prenatal testosterone are not unequivocally synonymous with high rates of reported aggression or aggressive behaviours (Perciavalle et al., 2013). For example, Perciavalle et al. (2013) did not provide evidence of a significant correlation between extraggression and 2D:4D and many of the subscales of their aggression measure demonstrated poor internal consistency. Golby and Meggs (2011) contradicted many of the previous findings by demonstrating that athletes with the lowest 2D:4D ratios, who also competed at the highest levels of sport, self-reported some of the lowest levels of hostility (one of four commonly used sub-scale measures of aggression (Webster et al., 2014)). Therefore, it is evident that further exploration into the association between aggression, sporting success and prenatal testosterone exposure is needed.

Despite previous research (Golby & Meggs, 2011; Tomar & Singh, 2012) using heterogeneous sport samples, these studies failed to report on analysis of differences in psychological characteristics and 2D:4D among athletes competing in different sports (Joyce et al., 2013; Perciavalle et al., 2013). The extant literature has predominantly focused on the association between prenatal testosterone and psychological, physiological and behavioural variables important in sport performance (Bennett et al., 2010; Golby & Meggs, 2011). To the authors' knowledge, no study has attempted to investigate prenatal testosterone levels as a predictor of sporting choice among males. This exploratory study was therefore primarily designed to explore the relationship between 2D:4D and levels of aggression, investigating for inherent differences between sporting groups in order to uncover potential inferences regarding the effect of prenatal testosterone on sporting choice. Specifically, this study focused on the ability of 2D:4D to distinguish between athletes in explicitly aggressive (contact) and non-aggressive (non-contact) sports. It was anticipated that those athletes with low 2D:4D would have selected contact sports over non-contact sports. This hypothesis was partly based on the recent findings of Ribeiro et al. (2016) whom reported increases in levels of testosterone as a response to an aggressive challenge, such as an encounter during a contact sport. This was found to be most significant within low 2D:4D individuals, whom appeared to respond to such a challenge by producing a marked spike in testosterone resulting in an increase in both aggression and strength (Ribeiro et al., 2016). This correlates with the work of Joyce et al. (2013) who found those individuals presenting themselves with a 'boxer's fracture' due to an aggressive-related injury had a statistically significant smaller 2D:4D ratio in comparison to the normal population mean ratio. Additionally, this study looked to investigate prenatal testosterone's potential contributory effect on longevity; it was expected that individuals with the most year's involvement in their sport would report the lowest levels of 2D:4D, thus mirroring the findings of Coates et al. (2009) within their sample of financial traders.

2. Methods

2.1. Participants

The participants in this study were a sample of 200 male collegiate and university students aged 16–30 years ($M_{age} = 20.13$; S.D.: 4.4). 175 participants represented an even split across the following groups: badminton, basketball, golf, weight-training (non-contact sports [$n = 100$]), boxing, football, and rugby (contact sports [$n = 75$]), from all levels of sporting achievement: International/national ($n = 12$), Regional ($n = 110$), Recreational ($n = 53$). A further 25 participants represented a non-sporting group.

2.2. Measures

2.2.1. Aggression

The 12-item Brief Aggression Questionnaire (BAQ) (Webster et al., 2014) provides an overall value of aggression across four sub-scale measures: Physical aggression, Verbal aggression, Anger, and Hostility. Statements are rated on a five point Likert scale, ranging from '1 = extremely uncharacteristic of me' to '5 = extremely characteristic of me'. Webster et al. (2014) showed the BAQ to have strong test-retest reliability and to replicate the Buss-Perry scale; which has acceptable psychometric properties (Buss & Perry, 1992). The measure has previously been shown to demonstrate reliability among contact athletes, non-contact athletes, and non-athletes (LeMieux, McKelvie, & Stout, 2002).

2.2.2. Digit ratio measurement

A portable, digital hand scanner was used to take a copy of participants' right hands. Digit ratio was measured using Vernier Calipers (Fink, Thanzami, Seyde, & Manning, 2006) accurate to 0.01 mm. Kim, Kim, and Kim (2014) reported that the right hand tends to exhibit more robust gender differences, displaying greater sensitivity to prenatal androgens when compared with the left. Digit length was determined by the distance between the metacarpo-phalangeal crease to the fingertip (Bennett et al., 2010), measured by two independent researchers (intra-correlations were 0.99). Digit ratio was calculated by dividing the length of the 2nd digit (index finger) by that of the 4th (Manning & Hill, 2009). Participants who had disclosed previous breaks or dislocations to either digit were excluded from the study due to potential distortions in finger length (Joyce et al., 2013).