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Masculinised brain and romantic jealousy: Examining the association between digit ratio (2D:4D) and between- and within-sex differences

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ABSTRACT

We examined the relationship between second-to-fourth digit ratio (2D:4D), a correlate of prenatal testosterone exposure, and distress at sexual versus emotional infidelity in hypothetical scenarios of relationship threat. As predicted, a significant negative association was found between 2D:4D and greater distress at sexual infidelity for the whole sample ($N = 179$, females = 101). While this novel finding supports the view of romantic jealousy as a sexually-dimorphic adaptation, we explore reasons for the relatively weak association and discuss how underlying differences in brain structure could have influenced sex-specific behavioural capacities in romantic jealousy. We suggest a useful direction for future research will be to develop novel methods that facilitate the investigation of implicit emotional, rather than explicit cognitive, processes in response to pair-bond threat.

1. Introduction

While romantic jealousy has historically been viewed in pathological terms, evolutionary psychologists emphasize the utility of romantic jealousy as a basic adaptive mechanism designed to protect the pair-bond and, ultimately, promote reproductive success (Buss, 2000). One influential evolutionary hypothesis states that on account of parental investment theory (Trivers, 1972), males and females evolved distinct jealousy systems as a result of different reproductive challenges (Buss, Larsen, Westen, & Semmelroth, 1992). The "jealousy as a specific innate module" (JSIM) hypothesis (following Harris, 2003) states that males are more sensitive than females to cues of sexual infidelity to prevent cuckoldry, while females are more sensitive than males to cues of emotional infidelity to prevent loss of parental investment. Support for JSIM has been demonstrated at the perceptual and early cognitive level, and in behaviours evoked by jealousy such as mate-guarding and reactions to self-esteem threat (Goldenberg et al., 2003; Kaighobadi, Shackelford, & Buss, 2010; Schutzwohl, 2005; Schutzwohl & Koch, 2004). Furthermore, functional brain activity measured in response to scenarios of emotional versus sexual infidelity suggests that males and females have distinct and separate neuropsychological responses to each infidelity type (Takahashi et al., 2006).

The cornerstone of empirical evidence for JSIM, however, has rested on a dichotomous forced-choice task in which participants choose between sexual or emotional hypothetical infidelity scenarios as to the most distressing. While studies using the forced-choice task have demonstrated significant sex differences in line with JSIM, (Harris, 2003; Madran, 2008), the wide variance in the percentage of males choosing sexual infidelity as more distressing compared with emotional infidelity has been highlighted: In two meta-analyses the percentage ranged from 12% to 76%, with a mean of 46% (Harris, 2003; Madran, 2008). Such choice tasks seem subject to cultural variation and individual differences within sexes (Berman & Frazier, 2005; Murphy, Vallacher, Shackelford, Bjorklund, & Yunger, 2006).

An alternative to JSIM is the social-cognitive account of jealousy (Harris, 2003) which proposes that the long period of human infancy dependence selected for universal rather than sexually-specific mechanisms of jealousy in males and females (see Miller & Fishkin, 1997, for a full account). Accordingly, rather than being an adaptation, any between-sex differences in jealousy occur as a result of proximal mediators, such as threats to the self concept (which differs between- and within-sexes), the influence of cultural norms and diverse sex roles (Hupka, 1991; Salovey & Rothman, 1991; Wood & Eagly, 2002).

The current study sought to identify a biological mechanism that would have been shaped by natural selection and, as expressed through proximate systems, could explain both be-

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tween- and within-sex differences in romantic jealousy. Such a mechanism might lend support to the influence of natural selection on romantic jealousy specifically rather than to the idea of more general learning systems proposed by the social-cognitive account. We conjectured that a biological mechanism resulting in a "masculinised" brain might result in greater distress at sexual rather than emotional infidelity ("sexual jealousy") in both sexes. Given the Takahashi et al. (2006) findings we proposed that such a mechanism could be the male sex hormone, testosterone. Indeed, comparative research supports the status of testosterone as a distal genetic force associated with pair-bond threat as it has been correlated with aggressive behavioural responses to pair-bond threat in macaque males (Rilling, Winslow, & Kilts, 2004).

Testosterone has two direct effects on the brain and behaviour: It has an organisational effect that causes permanent changes in brain structure *in utero*, specifically affecting the hypothalamus, the hippocampus and the amygdale (McCarthy, 2010) and an activational effect post-puberty when circulating testosterone dynamically maintains the prenatally-determined sexually-dimorphic brain structure throughout adulthood (Ahmed et al., 2008).

Herein we measured a putative indicator of prenatal testosterone, the ratio between the second and fourth digit (2D:4D), and examined its association with sexual jealousy. This ratio is lower in males than females, allegedly on account of the difference in prenatal testosterone exposure (Manning, Scutt, Wilson, & Lewis-Jones, 1998), and has been linked to specific behavioural traits in humans and non-human primates in a wide-ranging literature (Nelson & Shultz, 2010; Voracek & Loibl, 2009). Behavioural associations with lower 2D:4D generally reflect sexually-selected, masculinised psychological capacities, for instance, promiscuity, conflict-related behaviour, adventure- and sensation-seeking have been reported in females (Clark, 2004; Hampson, Ellis, & Tenk, 2008; Voracek & Schicker, 2010) while aggression, sporting competitiveness and dominance have been reported in males (Bailey & Hurd, 2005b; Manning & Taylor, 2001; Neave, Laing, Fink, & Manning, 2003).

We predicted that if between-sex differences in romantic jealousy have been influenced by natural selection in accord with JSIM, low 2D:4D (i.e. a masculinised brain structure) would be negatively associated with sexual jealousy.

2. Method

2.1. Participants

The 179 participants comprising 101 females (mean age 19.8 ± 2.0 years) and 78 males (mean age 20.9 ± 2.6 years) were heterosexual undergraduate and postgraduate students at an UK university and all had previous experience of a committed adult romantic relationship (mean relationship duration 24.5 ± 24.2 months). The study was approved by the University's Faculty of Science Human Research Ethics Committee.

2.2. Procedure

2.2.1. 2D:4D measurement

A Canon LIDE100 scanner (optical resolution 2400 × 4800 dpi) was used to acquire digital images of the ventral surfaces of both hands. The measurement tool in Adobe Photoshop CS4 extended (Version 11) measured the scanned images of the second and fourth digits from the finger tip to the most proximal basal crease. Four measurements were recorded for each digit (two from tip to basal crease and two from basal crease to tip) and a mean length calculated for each digit. 2D:4D ratios were calculated by dividing the mean length of the second digit by the mean length of the fourth digit.

2.2.2. Relationship prime

To add ecological validity to the act of judging distress in response to scenarios of hypothetical infidelity, participants received a five-minute relationship prime prior to completion of the sexual jealousy measure. Following Diamond, Hicks, and Otter-Henderson (2006) participants were asked to provide written responses to three relationship-related questions regarding their current or previous romantic relationship, e.g. *Think about your relationship with your boyfriend and list five adjectives or phrases that describe the relationship for you. For example, "I can talk to him about anything", "he's jealous of my friends"*.

2.2.3. Sexual jealousy

Participants were presented with four hypothetical infidelity scenarios (Buss et al., 1992) and asked to choose which they would find more distressing, the sexual or the emotional aspects of the infidelity (Table 1). Following Murphy et al. (2006), responses indicating greater distress at sexual infidelity were scored with "1" and responses indicating greater distress at emotional infidelity were scored with "0" and a sexual jealousy score was calculated as the sum of the responses to the four infidelity scenarios. Thus, sexual jealousy score ranged from 0 (if the participants selected emotional infidelity as more upsetting than sexual infidelity for all four scenarios) to 4 (if the participants selected sexual infidelity as more upsetting than emotional infidelity for all four scenarios).

3. Results

3.1. Sexual jealousy

Males revealed a higher mean sexual jealousy score compared with females (1.8 ± 1.4 vs. 0.7 ± 1.0, $t(177) = -5.78$, $p < .001$, $d = .90$). A breakdown of the responses for each of the four hypothetical questions by sex is presented in Table 1. A Chi-square comparison confirmed a significant difference between males and females in distress at sexual versus emotional infidelity ($\chi^2(1) = 6.591$, $p = 0.037$, Cramer's $V = .192$). Cronbach's α was .69.

3.2. 2d:4d

Consistent with previous literature, the mean male 2D:4D was lower than the mean female 2D:4D in both hands (left: $t(177) = 4.563$, $p < .001$, $d = .70$; $M_{male} = .956 \pm .031$ vs. $M_{female} = .977 \pm .029$) and (right: $t(177) = 3.828$, $p < .001$, $d = .57$; $M_{male} = .956 \pm .032$, $M_{female} = .973 \pm .028$). As expected, right and left 2D:4D were correlated in males ($r(78) = .843$, $p < .001$) and in females ($r(101) = .690$, $p < .001$). While a paired-samples t-test revealed right 2D:4D was significantly lower than left 2D:4D in females ($t(100) = 2.007$, $p = .047$), there was no difference between right and left 2D:4D in males ($t(77) = .396$, $p = .69$).

3.3. 2D:4D and sexual jealousy

There was a significant negative relationship between 2D:4D (i.e. high prenatal testosterone) in both hands and sexual jealousy for the whole sample (left hand: $r_s = -.152$, $p = .042$; right hand: $r_s = -.184$, $p = .014$). There was no association between 2D:4D and sexual jealousy for males or females independently ($p > .264$).

In order to explore whether the relationship between 2D:4D and sexual jealousy was an independent effect, we performed a multiple regression analysis on sexual jealousy using the stepwise method with 2D:4D left and 2D:4D right (Block One) and participant sex (Block Two) entered as predictor variables (Table 2). The analysis revealed there was no independent effect of 2D:4D on sexual jealousy when controlling for sex.