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2D:4D digit ratio and its relations to cross-sex and same-sex friendship choices☆

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ABSTRACT

The 2D:4D digit ratio is a sexually differentiating biomarker for prenatal testosterone, which affects structural and functional aspects of individual brain development. Previous studies have shown that 2D:4D is associated with personality traits and aspects of social behavior (e.g., mating). The present study extends this approach to friendship ties as an example of social relationship outcomes. On the basis of the previous finding that 2D:4D is associated with sex drive, we expected men and women to show differential relations between 2D:4D and numbers of cross-sex and same-sex friends. 265 heterosexual adults took part in the study. 2D:4D was differentially related to friendship types for men and women. The hypotheses were partly supported such that male-typed (i.e., low 2D:4D) men had fewer close same-sex friends and larger numbers of general cross-sex friends than female-typed men did. Similarly, female-typed (i.e., high 2D:4D) women showed larger numbers of close same-sex friends than male-typed women did. In summary, the relations between 2D:4D and friendship ties provide further support for the claim that social behavior is affected by prenatal hormone stimulation at least to some extent.

1. Introduction

1.1. Digit ratio as a proxy for prenatal testosterone exposure

Sex hormones such as testosterone evidently influence and shape human behavior (Booth, Granger, Mazur, & Kivlighan, 2006; Hines, 2010). These influences are already beginning to take effect before birth when a fetus is not only receiving nourishment but is also being exposed to fluctuating amounts of sex hormones via its mother's blood. The fetus' sensitivity to these hormones will correspond with the number of matching receptors it has (Zheng & Cohn, 2011). The combination of these factors (i.e., exposure and sensitivity) determines the level of prenatal androgen stimulation (Breedlove, 2010).

As Genazzani, Pluchino, Luisi, and Luisi (2007) and Zheng and Cohn (2011) showed, the development of the size, complexity, and connectivity of the central nervous system (especially the hypothalamus, hippocampus, and limbic system; Christiansen, 2001) is influenced (among other things) by the extent of prenatal androgen stimulation and is considered to be permanent (Genazzani et al., 2007; Hines, 2010).

In this way, the previously undifferentiated fetal brain becomes organized in a sex-specific manner (Christiansen, 2001). Parallel to brain development, androgen sensitivity in the fetus' limbs is also specific. Finger length development has been shown to be associated with androgen receptor activity and hence been implemented in the 2D:4D measure, i.e., the relation between the second to fourth digit (Manning, 2002). In general, higher androgen receptor activity yields increased growth of the fourth digit and thus a lower 2D:4D ratio (Zheng & Cohn, 2011). Both brain development and finger length become permanently organized in a sex-specific manner due to prenatal androgen stimulation. Subsequently, finger length in adults has been discussed as a proxy for prenatal androgen (primarily testosterone) stimulation. Hence, a masculinized finger length ratio (i.e., low 2D:4D) is considered to be indicative of a masculinized brain, with potential consequences for individual personality and behavior (Manning, 2002).

1.2. 2D:4D in relation to individual personality

In the rich and growing literature on 2D:4D, several studies have analyzed its relation to general and specific aspects of personality. Relations with measures of the general structure of personality such as represented by the Big Five or Cattell's 16 Personality Factors (16PF)

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commonly yield weak and often inconsistent findings. For instance, for the Big Five, Fink, Manning, and Neave (2004) found that 2D:4D was positively correlated with neuroticism and negatively correlated with agreeableness, but only for women's right hand 2D:4D. By contrast, when controlling for sex, Lippa (2006) found that 2D:4D only had a negative relation with extraversion and a positive relation with openness to experience. As a third example, using the 16PF, Lindova, Hruskova, Pivonkova, Kubena, and Flegr (2008) found that < 5% of their reported correlations were significant: emotional stability, social boldness, and privateness were correlated only with right hand 2D:4D in women. With these scattered and weak findings, determining how 2D:4D is related to general aspects of personality appears to be an onerous task.

Similarly inconsistent results can be found with regard to specific personality dimensions. 2D:4D in men has been shown to be negatively related to sensation seeking (Fink, Neave, Laughton, & Manning, 2006), physical aggression (Bailey & Hurd, 2005; Hönekopp & Watson, 2011), fairness in negotiations (Eisenegger, Naef, Snozzi, Heinrichs, & Fehr, 2010), masculinity (Neave, Laing, Fink, & Manning, 2003), and (perceived aggressive and social) dominance (Neave et al., 2003; van der Meij, Almela, Buunk, Dubbs, & Salvador, 2012). Again, some studies have been criticized for not providing sufficient statistical power and insufficient replication (Voracek, 2009, 2013) or for generally providing highly inconsistent results (e.g., for sensation seeking; Voracek, Tran, & Dressler, 2010).

1.3. 2D:4D in relation to social outcomes

One might conclude that the influences of prenatal testosterone stimulation on personal behavior style are generally weak because there is too much short-term intra-personal variability, whereas there might be considerably less variability in other kinds of outcome measures, for example, social outcomes like number of sexual partners, social network size, or number of children (Hönekopp, Voracek, & Manning, 2006; Kovářík et al., 2017; Manning & Fink, 2008). For instance, Voracek, Dressler, and Manning (2007) found indications of assortative mating because 2D:4D showed correlations between husbands and wives. Although the authors discussed their findings critically with regard to potential mediators, their present results were consistent for left hand and right hand 2D:4D, with each showing correlations of around 0.20 between husbands and wives.

Further supporting the relevance of 2D:4D in social relations, Moskowitz, Sutton, Zuroff, and Young (2015) showed that men with low 2D:4D were more agreeable and less quarrelsome when interacting with women than with men. By the same token, Hönekopp et al. (2006) analyzed heterosexual men's number of sex partners and found a negative correlation with 2D:4D. Men with higher prenatal testosterone were therefore more likely to have had a larger number of sexual partners. Both results imply that men with a low 2D:4D ratio might prefer cross-sex interactions more than men with a high 2D:4D ratio. A possible interpretation might be based on the finding that (circulating) testosterone is associated with sex drive (extensive review by Schiavi & White, 1976). Again, there are findings that support this (Bremer, 1954; Corona & Maggi, 2010; Davis & Braunstein, 2012) and that oppose it (Aromäki, Lindman, & Eriksson, 2002; Brown, Monti, & Corriveau, 1978). For the relation between sex drive and 2D:4D, Schwarz, Mustafic, Hassebrauck, and Jorg (2011) found a negative correlation in men between 2D:4D and short-term relationship orientation, which "seems to be closely related to the lust dimension, both implying a desire for sexual variety and probably correlating with the level of androgens" (p. 566) but did not find a direct relation with sex drive. However, Manning and Fink (2008) were able to find a negative correlation between 2D:4D and sex drive in men and a positive correlation in women. This indicates that prenatal testosterone stimulation potentially enhances men's sex drive and reduces women's.

Focusing on the relation between 2D:4D and nonsexual relationships, Kovářík et al. (2017) analyzed 2D:4D in relation to social integration. Low 2D:4D men but not women tended to interconnect wider networks, meaning that even the friends of their friends tended to know either other. Low 2D:4D women but not men tended to form local, embedded, and centralized social structures, described by the authors as networks of trust and cooperation. These findings imply two important differentiations. First, high and low 2D:4D men and women show highly different relational patterns. And second, there appear to be differential processes for different levels of social closeness. Therefore, narrow networks with closely tied relationships (e.g., relatives, close friends) need to be differentiated from wider networks with weaker relationships (e.g., more remote friends, acquaintances).

So far, previous research on the relations between prenatal testosterone stimulation and social behavior outcomes has focused on mating, sexual partners, and general social networks. However, relations between prenatal testosterone and friendship choices have not yet received visible attention, although the significance of friends as part of a person's social life has often been demonstrated (Diener & Seligman, 2002; Harris & Vazire, 2016). The present study contributes to closing this gap by analyzing the influence of prenatal testosterone stimulation (2D:4D) on friendship choices in adults.

1.4. Hypotheses

On the basis of previous findings, we expected outcomes of friendship choices to covary with prenatal testosterone stimulation. It has been shown that (a) male-typed (i.e., lower) 2D:4D has been found to be associated with a higher sex drive in men and a lower sex drive in women, and (b) higher sex drive leads to larger numbers of cross-sex interactions. Therefore, with regard to friendship choices, we expected to find that 2D:4D would be negatively associated with number of cross-sex friends in men and positively associated with number of cross-sex friends in women. Conversely, we expected to find that 2D:4D would be positively associated with number of same-sex friends in men and negatively associated with number of same-sex friends in women. With respect to the differentiation between close friends and more remote or general friends, we expected differential result patterns. However, because this differentiation has not yet been incorporated into many studies, this issue remained exploratory in this study.

2. Method

2.1. Sample and procedure

The sample consisted of 265 students (77.4% women) from different fields of study recruited on two campuses in Germany. Their mean age was 22.4 years (SD = 2.8), ranging from 18 to 31. 60.8% reported being in a relationship. The dependent variables (numbers of friends) did not differ between participants who reported being in versus not being in a relationship (all ts < 1.74, all ps > 0.082). Sexual orientation was assessed on an 11-point Likert scale ranging from 1 (*heterosexual*) to 11 (*homosexual*) with the midpoint 6 = *bisexual/ambivalent*. The present sample was selected to include only unambivalently heterosexual participants (M = 1.84, SD = 1.88).

Participants were asked to report their numbers of friends (see Measures) on a paper-and-pencil survey. Afterward, both their hands were scanned (see Measures).

2.2. Measures

2.2.1. Numbers of friends

Participants were first asked to think about their male and female friends. Then they were asked to think about which friends they consider to be close friends and which general friends. Close friends were then described as people one sees often and shares intimate information with. General friends were described as people with whom one meets