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2D:4D in Men Is Related to Aggressive Dominance but Not to Sociable Dominance

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It has been shown that a smaller ratio between the length of the second and fourth digit (2D:4D) is an indicator of the exposure to prenatal testosterone (T). This study measured the 2D:4D of men and assessed dominance as a personality trait to investigate indirectly if the exposure to prenatal T is related to a dominant personality later in life. Results showed that men had a more aggressive dominant personality when having a more masculine (lower) 2D:4D, while there was no relationship between sociable dominance and 2D:4D. Findings from this study indicate that it is important to distinguish different forms of dominance since other studies failed to find relationships between dominance and 2D:4D. Aggr. Behav. 38:208–212, 2012.

Keywords: 2D:4D; aggressive dominance; sociable dominance; personality; prenatal testosterone

INTRODUCTION

Exposure to testosterone (T) in utero proliferates the development of male structures and causes masculinization of the central nervous system [Morris et al., 2004]. It has been found that a marker of prenatal exposure to T is the ratio between the length of the second and fourth digit (2D:4D), showing that high exposure to prenatal T is related to lower ratios and that low exposure is related to higher ratios. Indeed, since men experience more exposure to prenatal T than women, men tend to have lower 2D:4D than women [Manning et al., 2000]. Furthermore, it has been shown that higher fetal T exposure is related to a lower 2D:4D in 2-year-old children [Lutchmaya et al., 2004], that lesbians have more masculine, that is, lower ratios [for a meta-analysis see Grimbos et al., 2010], and that sexual dimorphism in 2D:4D is also prevalent in nonhuman primates [Roney et al., 2004]. It has been suggested that the Hox genes are responsible for this relationship between fetal T and 2D:4D [Manning and Wood, 1998] since these genes differentiate digit length as well as stimulate the development of the genitalia [Kondo et al., 1997].

Due to the organizing effect of T on the central nervous system and its influence on digit length development, 2D:4D has been found to be related to several personality traits typically associated with masculinity. For example, a masculine (low) 2D:4D is related to shorter length of intimate relationships in women [Scarbrough and Johnston, 2005], greater courtship display by men [Roney and Maestripieri, 2004], higher sensation seeking in men [Fink et al., 2006], lower agreeableness in men [Luxen and Buunk, 2005], and more openness to experience in both sexes [Lippa, 2006]. However, other studies have found counterintuitive relationships between 2D:4D and masculine traits. For example, a masculine 2D:4D is related to more depression in boys [Vermeersch et al., 2008] and to worse spatial navigation among women (longer platform-finding latency) [Csathó et al., 2001]. Furthermore, a recent study found no relation between

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2D:4D and dominance as a personality trait in either sex [Vermeersch et al., 2008]. Similarly, another study showed no relationship between 2D:4D and social or physical dominance among men [Putz et al., 2004]. These findings suggest that the relationship between 2D:4D and personality is complex [Putz et al., 2004].

A possible cause for these inconsistent results are variations in methodology employed [Putz et al., 2004]. For example, there are many possible ways of defining a dominant personality [Mazur and Booth, 1998]. A dominant personality can at least be separated into two different personality types: sociable dominance and aggressive dominance [Kalma et al., 1993]. Observational as well as self-report data has shown that the two types of dominance are associated with the use of power strategies to influence others [Kalma et al., 1993]. Indeed, there is evidence that people who score high on sociable and aggressive dominance succeed best at getting their preferences represented in a group [Kalma et al., 1993]. However, there are differences between both types of dominance regarding the tactics individuals use to influence others. Aggressively dominant men tend to use a mix between "stating what one wants" and Machiavellian tactics, whereas sociably dominant men expect to be the center of social activity and tend to use reasoning strategies to influence people. Moreover, individuals high in sociable dominance are characterized by a positive attitude toward other people, a central position in groups, a strong need to dominate others in a reasonable way, a solid self-esteem, and an independent and active attitude. In contrast, individuals high in aggressive dominance have a negative attitude toward others, and a strong motivation to realize their own, rather material aims, even at the expense of personal relationships [Kalma et al., 1993].

This study examined if 2D:4D is related to a dominant personality. However, our study is novel in that we differentiated a dominant personality into two separate types of dominance: aggressive and sociable dominance. In a sample of healthy men, we examined if exposure to higher prenatal T (operationalized as low 2D:4D) is related to aggressive and sociable dominant personality later in life.

METHODS

Participants

Eighty-four male students from the University of Valencia in Spain, aged 18–29 years (21.2, SEM ± 0.32), participated in this study in exchange for €10. The participants had a mean body mass index of 23.5 (±0.46) and were all Caucasian. Subjective socioeconomic status [Adler et al., 2000] was measured on a scale from 1 (lowest) through 10 (highest) and the participants reported a mean subjective socioeconomic status of 6.6 (±0.09). All potential participants were first interviewed and were asked to complete a questionnaire. Individuals who reported a serious medical or psychological problem or drug abuse were excluded from participation.

Sociable and Aggressive Dominance

Participants completed two questionnaires measuring sociable and aggressive dominance, consisting of ten items for the sociable dominance scale and ten items for the aggressive dominance scale [Kalma et al., 1993]. See Table I for all the items. Both scales are reliable and have been validated using

TABLE I. Factor Loadings of Each Item onto the Rotated Two Factors: Sociable Dominance (SD) and Aggressive Dominance (AD)

Scale	Item	Sociable dominance	Aggressive dominance
SD	I have no problems talking in front of a group	0.74	0.06
SD	At school I found it easy to talk in front of the class	0.73	0.06
SD	No doubt I'll make a good leader	0.62	0.11
SD	I like taking responsibility	0.54	−0.18
SD	I certainly have self-confidence	0.65	0.03
SD	For me it is not hard to start a conversation in a group	0.70	0.06
SD	I am not shy with strangers	0.68	0.29
SD	People turn to me for decisions	0.64	0.01
SD	I generally put people into contact with each other	0.63	0.01
AD	When a person is annoying, I put him in his place	0.08	0.49
AD	If I need something I borrow it from a friend without his approval.	0.05	0.49
AD	I find it important to get my way, even if this causes a row	−0.02	0.69
AD	I find it important to get my way	0.06	0.73
AD	I like it when other persons serve me	0.15	0.60
AD	I quickly feel aggressive with people	−0.11	0.50
AD	I think that achieving my goals is more important than respecting others	−0.14	0.67
—	I can look everybody in the eye, and lie with a straight face	0.48	0.41
—	I can lie without anybody noticing it	0.53	0.41
—	I'd rather be disliked (for being unkind) and that people look down on me (for not achieving my aims)	−0.13	0.08
—	I make smart, sarcastic remarks if people deserve it	0.20	0.28

—, Item removed from final scale scores.

observational data of social interactions [for more details see Kalma et al., 1993]. For every item in the two questionnaires, the participants rated to what extent they agreed with the statements on a scale from 1 (strongly disagree) to 6 (strongly agree). Two participants failed to return these questionnaires.

We performed a principal component factor analysis with varimax rotation and chose a rotated two factor solution based on the scree plot. These factors were *sociable dominance*, which explained 22.78% of the total variance, and *aggressive dominance*, which explained an additional 15.47% of total variance. Scale scores were calculated by averaging those items that had a factor loading of 0.40 or greater on only one of the factors (see Fig. 1). Four items were removed because two items had factor loadings of less than 0.40 and another two items loaded on both factors more than 0.40. The final score for *sociable dominance* consisted of nine items with factor loadings ranging from 0.54 to 0.74 (Cronbach's Alpha of 0.85) and *aggressive dominance* consisted of seven items with factor loadings ranging from 0.49 to 0.73 (Cronbach's Alpha 0.72). The two factors were not significantly correlated ($r_{82} = 0.13$, $P = 0.256$).

Measurement of 2D:4D

Both hands of the participants were scanned with a Canon Scan 8600F and images were saved as a JPG file with a resolution of 96 dpi, 24 bit color depth and a size of 3,508 × 2,552 pixels. Before measuring finger length, the color of the image was adjusted with the level tool of Adobe Photoshop to make the greaves more clearly visible in the image. The second and fourth digit finger lengths were measured independently by two observers with the measurement tool of Adobe Photoshop by zooming in on the ventral proximal creases at the base of the digit. When the difference between the measurements of both observers was greater than three standard deviations the measurement of that particular finger was repeated. Intraclass coefficients for average measurements were used to calculate interobserver reliability. For all finger measurements the interobserver reliability ranged from 0.979 to 0.992 (Mean = 0.986, SEM = ±0.003). To calculate the 2D:4D for each hand the length of the index finger was divided by the length of the ring finger. The 2D:4D of both hands were averaged to obtain an average 2D:4D. Both hands from two participants and another participant's left hand were not correctly scanned and could therefore not be measured.

RESULTS

We calculated Pearson correlations to investigate if aggressive and sociable dominance were related to the average 2D:4D and the 2D:4D of the right and left hand. Results showed that an average lower 2D:4D was related to a higher aggressive dominance personality ($r_{79} = -0.23$, $P = 0.046$) but was not related to sociable dominance, $r_{79} = -0.09$, $P = 0.446$, see Fig. 1). Results were similar when controlling for social economic status and age (aggressive dominance: P^r (75) = −0.23, $P = 0.047$, sociable dominance, P^r (75) = −0.09, $P = 0.416$).

Looking at each hand separately, we found that the right hand 2D:4D was significantly negatively correlated to an aggressive dominant personality ($r_{80} = -0.23$, $P = 0.038$), whereas this relationship was only marginally significant for the left hand 2D:4D ($r_{79} = -0.19$, $P = 0.092$). There were no significant relationships between sociable dominance and the 2D:4D of both hands (all $P \geq 0.206$). Furthermore,

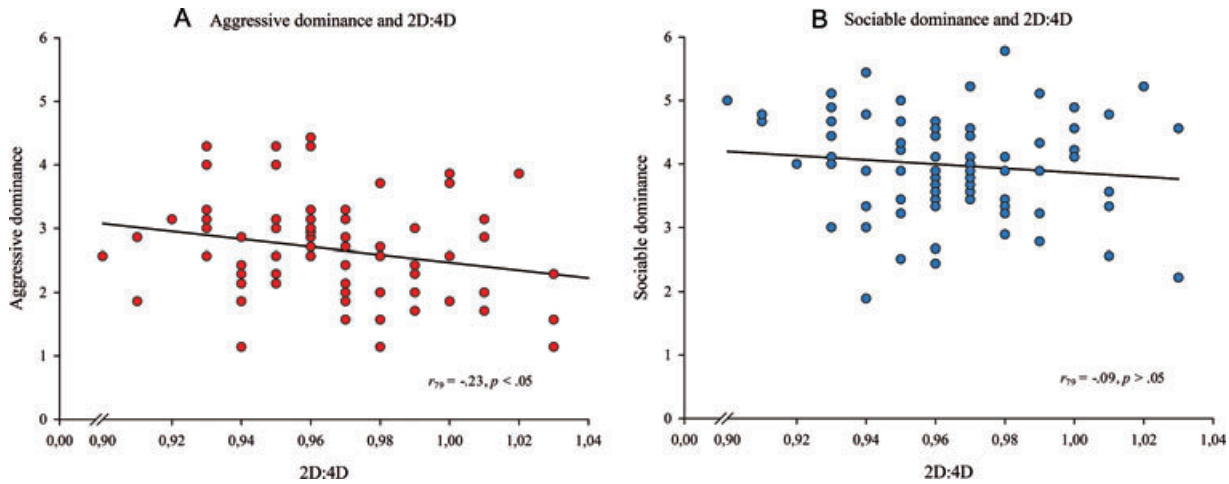

Fig. 1. The relationship between participant's average 2D:4D and their scores on aggressive dominance (A) and sociable dominance and (B) questionnaire.

the dominance scales were not related to fluctuating asymmetry as measured by the difference between the right and left hand 2D:4D (all $P \geq 0.115$).

DISCUSSION

This study showed that masculine (low) 2D:4D is related to a higher aggressive dominant personality. No relationship was found between sociable dominance and 2D:4D. These results suggest that among men, exposure to prenatal T is positively associated with a more self-reported aggressive dominant personality in later life. This complements findings that link aggressiveness with high levels of prenatal T, since it has been shown that girls with an opposite sex twin (i.e., high prenatal T levels) are more prone to aggressive behavior than girls with a same sex twin (i.e., low prenatal T levels) [Cohen-Bendahan et al., 2005]. Furthermore, it has been shown that masculine 2D:4D ratios are related to higher trait aggressiveness [Bailey and Hurd, 2005]. Our findings also complement findings that show that a masculine 2D:4D is related to the expression of dominant behaviors in other primates. Indeed, it has been shown that among rhesus macaques (*Macaca mulatta*) a masculine (low) 2D:4D is related to higher female rank [Nelson et al., 2010]. Of interest is that we found a stronger relationship between 2D:4D and aggressive dominance for the right hand than for the left hand. This complements findings by Williams and Pepitone (2000), since they found a greater sex difference in 2D:4D for the right hand than for the left hand. These last results combined with the results from this study suggest that right hand 2D:4D is more sensitive to fetal androgens than the left hand.

However, our findings contradict other findings in the literature and it seems that mixed findings are rather the rule than the exception [Putz et al., 2004]. For example, our findings differ from the results shown by Vermeersch et al. (2008), since they did not find a relationship between a dominant personality and 2D:4D. It appears that in their study they measured one broad form of dominance, whereas we divided dominance into two separate components; a more friendly kind of dominance (sociable dominance) and a more antisocial kind of dominance (aggressive dominance). The questions used by Vermeersch et al. (2008) seem to tap a combination of both types of dominance that may have obscured the relationship between aggressive dominance and 2D:4D. Our results partially confirm results found by Putz et al. (2004) as they also did not find any relationship between 2D:4D and social dominance, which seems similar to sociable dominance as assessed in the present study. Furthermore, they also did not find a relationship between physical dominance and 2D:4D. Physical dominance, as proposed by Putz et al. (2004), measures physical aggressive tactics to achieve dominance, which is different from the aggressive dominance scale we used since we measured nonphysical tactics to achieve dominance.

Apart from a different methodology in measuring dominance, there may also be another explanation for these divergent results. According to Putz et al. (2004), it may be that the development of some traits and finger digit differentiation do not occur around the same time. Consequently, fetal hormonal levels that influence the development of these traits will be unrelated to the hormonal levels around finger digit differentiation. This difference in development timing might be the reason why we found that 2D:4D is related to aggressive dominance and not to sociable dominance. It could be that a predisposition to form an antisocial dominant personality later in life is developed around the same time as finger digit length differentiation, whereas development timing is not the same for sociable dominance and 2D:4D.

For the development of aggressive and sociable dominance probably some brain structures are more important than others. For the onset of an aggressive dominant personality the amygdala is likely a key structure, since the amygdala is essential for moral socialization through instrumental learning and aversive conditioning. In support of this interpretation, instrumental aggression, and antisocial behavior are related to an impaired amygdala functioning [Blair, 2004]. The brain structures relevant for the development of sociable dominance are most likely the anteroventral striatum and the rostral anterior cingulate cortex, since these structures are related to social reward processing and cooperation [Rilling et al., 2002].

This study adds more evidence to the idea that exposure to T in a developing fetus can have an impact on its personality later in life. We showed an association between a low 2D:4D and an aggressive dominant personality in men that suggests that these men may have a more masculinized central nervous system.

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