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Finger Length Ratio (2D:4D) in Adults with Gender Identity Disorder

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Abstract From early childhood, gender identity and the 2nd to 4th finger length ratio (2D:4D) are discriminative characteristics between sexes. Both the human brain and 2D:4D may be influenced by prenatal testosterone levels. This calls for an examination of 2D:4D in patients with gender identity disorder (GID) to study the possible influence of prenatal testosterone on gender identity. Until now, the only study carried out on this issue suggests lower prenatal testosterone levels in right-handed male-to-female GID patients (MtF). We compared 2D:4D of 56 GID patients (39 MtF; 17 female-to-male GID patients, FtM) with data from a control sample of 176 men and 190 women. Bivariate group comparisons showed that right hand 2D:4D in MtF was significantly higher (feminized) than in male controls, but similar to female controls. The comparison of 2D:4D ratios of biological women revealed significantly higher (feminized) values for right hands of right handed FtM. Analysis of variance confirmed significant effects for sex and for gender identity on 2D:4D ratios but not for sexual orientation or for the interaction among variables. Our results indirectly point to the possibility of a weak influence of reduced prenatal testosterone as an etiological factor in the multifactorially influenced development of MtF GID. The development of FtM GID seems even more unlikely to be notably influenced by prenatal testosterone.

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Introduction

The prediction of hormonal influence as an etiologic factor for the sexual differentiation of the brain and behavior is supported by a large body of research in animals and humans (Cooke, Hegstrom, Villeneuve, & Breedlove, 1998; Migeon & Wisniewski, 1998). Prenatal and perinatal androgen levels were found to play an important organizational role in animal sexual behavior (Baum, 1979) and may well play a crucial role for humans, even if animal studies add only indirect translational insights into the determinants of human sexuality (Gooren, 2006). In this respect, increased prenatal testosterone levels are frequently associated with a contribution to masculinization, whereas decreased levels are to some extent held responsible for feminization (Gooren & Kruijver, 2002). In terms of sexuality, masculinization is supposed to foster the development of a male gender identity and sexual orientation towards women. In contrast, feminization is assumed to pave the way to a female gender identity and sexual orientation towards men.

As experimental laboratory studies on the influence of prenatal testosterone levels on gender identity and sexual orientation can hardly be conducted in human research, investigations mostly rely on "proxy markers". Here, the 2nd to 4th finger length ratio (2D:4D) was suggested to represent prenatal testosterone levels based on the finding that men usually show lower 2D:4D than women (Manning, Scutt, Wilson, & Lewis-Jones, 1998; Peters, Mackenzie, & Bryden, 2002). This difference seems to be more pronounced for the right hand 2D:4D and for right-handed individuals (McFadden et al., 2005; Schneider, Pickel, & Stalla, 2006).

We assume an association between 2D:4D and gender identity in keeping with the hypothesis that the sexually dimorphic 2D:4D might reflect prenatal testosterone levels (Manning et al., 1998) and prenatal testosterone levels might influence the development of gender identity (Gooren, 2006). An association may, therefore, indirectly reflect the impact of possible atypical prenatal testosterone levels on the development of gender identity disorder (GID). GID is the development of a gender identity and gender role that is at variance with morphology of genitals and secondary sex characteristics of the birth sex. Consequentially, lower prenatal testosterone levels represented by feminized (higher) 2D:4D should be found in male-to-female GID patients (MtF) and lower, i.e., masculinized 2D:4D in female-to-male GID patients (FtM).

To date, there is only one report on 2D:4D and GID: Schneider et al. (2006) noted typical female 2D:4D ratios in right-handed MtF compared to a matched number of male and female controls. However, positive findings for 2D:4D differences between MtF and male controls became nonsignificant when all (right and left-handed) subjects were included. This study was conducted without respect to the sexual orientation of GID patients.

When considering sexual orientation, it is worth mentioning that GID patients are frequently subdivided into two classes: homosexual and non-homosexual transsexuals (Blanchard, 1985, 1988, 1989; Smith, van Goozen, Kuiper, & Cohen-Kettenis, 2005), referring to erotic attraction to members of the same or the opposite biological sex, respectively.

With regard to finger length ratio and sexual orientation, masculinized (i.e., lower) 2D:4D ratios were associated with sexual orientation towards females, whereas higher 2D:4D, i.e., feminized values, implicate sexual orientation towards men. Hence, in homosexual individuals opposite sex 2D:4D ratios were suggested, i.e., feminized (higher) 2D:4D values in gay males compared with heterosexual males and masculinized (lower) 2D:4D in lesbians compared to heterosexual females (Manning, Churchill, & Peters, 2007). However, research on the association between 2D:4D and human sexual orientation has led to rather inconsistent results. The 2D:4D of gay males has been described as hypermasculinized (lower) in some reports or hypomasculinized (higher) in other studies (Lippa, 2003; Manning et al., 2007; McFadden et al., 2005; McFadden & Shubel, 2002; Rahman & Wilson, 2003; Robinson & Manning, 2000; Voracek, Manning, & Ponocny, 2005; Williams et al., 2000). The correlation between sexual orientation and 2D:4D in women seems more consistent. In most studies, lesbians exhibited a more masculinized (lower) 2D:4D than heterosexual women (Kraemer et al., 2006; McFadden & Shubel, 2002; Rahman & Wilson, 2003; Williams et al., 2000) compared to heterosexuals. It is perhaps worth noting that Lippa (2003) and Manning et al. (2007)

could not confirm this finding. Additionally, Brown, Finn, Cooke, and Breedlove (2002) noted on the issue that increased early androgen exposure might plays a role in some cases of female homosexuality, but that the sexual orientation of "femme" lesbians is unlikely to have been influenced by early androgens.

Our analysis of 2D:4D will allow for both possibly testosterone influenced variables, the gender identity and the sexual orientation of the participants. In the current study, 2D:4D served as a proxy measure of prenatal testosterone levels. The purpose of our study was primarily the evaluation of 2D:4D in GID patients (MtF and FtM) in comparison with a large control sample and secondly the examination of interaction effects of gender identity and sex by controlling for sexual orientation. We sought to confirm the findings of different 2D:4D of MtF and FtM individuals in comparison to male and female controls, whereas MtF ratios were assumed to be similar to those of female controls and vice versa for FtM. We expected a correlation between testosterone influence (2D:4D) and gender identity independent of sexual orientation effects.

Method

Participants

Patients who met the diagnostic criteria of GID according to DSM-IV were asked to participate in the study. In 2004–2005, we collected data on 2D:4D from 56 GID patients (39 MtF, age M = 39.9 years; SD = 13.5 and 17 FtM, age M = 30.7 years; SD = 11.0) who had been referred consecutively or who were already in treatment at our Gender Identity Unit. Only one eligible patient refused to participate.

The Gender Identity Unit at the University Hospital of Zurich is one of two sex reassignment centers providing comprehensive treatment for GID in the German speaking part of Switzerland. In contrast to other European countries, Switzerland has no special legislation regulating the change of name and personal status but the assessment and treatment of GID is practiced according to German Standards of Care (Becker et al., 1997; Hepp & Buddeberg, 1999).

Our control group came from a study of a sample of 366 volunteers (176 males, 190 females aged 18–65 years). In order to obtain a typical sample, we conducted a cross-sectional study in the shopping mall at Zurich main station (Switzerland). Passersby were asked to participate and 366 volunteers agreed; the mean age was 37.3 years (SD = 12.2) for males and 35.0 years (SD = 11.9) for females. The age difference between the two groups was not statistically significant.

The study was approved by the Ethics Committee of the canton of Zurich. Participants were informed verbally and

given a handout explaining the study. Written informed consent was obtained from all participants.

Procedure

Participants' left and right hands were photocopied using a standard copy machine. They were asked to place their palms on the glass surface of the photocopier with their fingers together but in a relaxed position (Robinson & Manning, 2000).

Handedness was assessed by asking participants the following question: "Do you consider yourself to be right-handed or left-handed?"

We assessed sexual orientation by asking participants to rate sexual fantasies ("Please rate on the following scale your sexual fantasies towards..."), attraction ("Please rate on the following scale how intensely you are sexually attracted to..."), and activity ("Please rate on the following scale how sexually active you are with...") on Likert scales, ranging from 1 (male) to 9 (female), whether, according to their view, these sexual attributes were directed towards the male or female gender ("life-time"). The results were summed up to a global score of sexual orientation, encompassing values from 3 to 27. When calculating the data, we inverted the females' results to make them comparable to the men's. The cut-off value of homosexuality was defined as 11; higher global scores indicated non-homosexual orientation. The proportion of homosexual individuals was 38.5% (15/39) in MtF, 82.4% (14/17) in FtM, 7.4% (13/176) in male, and 1.1% (2/190) in female controls.

Measures

The length of the second and fourth finger of each hand was measured on the copy from the basal crease of the finger to the tip. We used a Vernier calliper for taking the measurements, measuring to the nearest 0.01 mm. The finger ratio was calculated by dividing the length of the second finger by that of the fourth (Robinson & Manning, 2000). Independent measurements were taken by two authors (B.K. and T.N.), who were masked to the participants' sex and gender identity; interrater reliability 2D:4D was $r = 0.89$ for the right and $r = 0.89$ for the left hand.

Data Analysis

Group differences in our control sample were analyzed by two-tailed t-tests. Between GID patients and controls, group differences were analyzed with t-tests and Mann–Whitney-tests. Analysis of variance (ANOVA) was used to assess interaction effects for sex, gender identity, and sexual orientation on 2D:4D ratios. Statistical analyses were performed using SPSS 12 for Windows.

Results

Figure 1 shows the mean 2D:4D ratios for the left hand and for the right hand as a function of group. MtF differed significantly from male controls ($U = 2{,}645$, $p = .025$), showing feminized 2D:4D values, whereas no significant difference was found between left hand 2D:4D of MtF and male controls ($U = 3{,}134$, $p = .397$). Compared to female controls, no significant difference was found for FtM right hand 2D:4D ($U = 1{,}407.5$, $p = .381$) and left hand 2D:4D ($U = 1493$, $p = .606$).

Our study sample included 46 right-handed GID patients (82.1%): 33 (84.6%) MtF and 13 (76.5%) FtM (no information about handedness was available from 1 FtM). In keeping with the result for the whole group, 2D:4D of the right hand of right-handed MtF was significantly higher than the ratio in right-handed male controls ($U = 1{,}984$, $p = .048$). In addition, right-handed FtM patients also showed higher 2D:4D ratio (right hand) than female controls ($U = 737$, $p = .048$).

In our control sample, men and women differed significantly with respect to their 2D:4D ratios, right hand, $t(364) = -5.56$, $p < .001$; left hand, $t(364) = -4.10$, $p < .001$, and in women, lesbian sexual orientation correlated with lower (masculinized) 2D:4D ratios on the right hand ($r = .25$) and the left hand ($r = .21$). 2D:4D ratios for right and left hand of MtF, FtM, and controls are presented in Table 1.

In order to explore the effect of sexual orientation on 2D:4D ratio, we conducted a 2 (Group: homosexual versus non-homosexual) × 2 (Hand: right versus left) analysis of variance (ANOVA) in the MtF group (analyses were not conducted on FtM due to the small sample size). In a preliminary analysis, age showed no effect on 2D:4D; therefore, age was not controlled. Results showed no significant effects for sexual orientation, $F(1, 35) < 1$, $\pi^2 = .016$ (see Table 1).

Discussion

In spite of growing evidence of the influence of prenatal sex hormone levels on sexually dichotomous traits of the adult human brain, we found only one study focusing on 2D:4D and gender identity. Schneider et al. (2006) compared 63 MtF and 43 FtM to 65 female and 58 male controls with respect to their 2D:4D as proxy marker for prenatal testosterone levels. By examining the whole sample (right and left-handed individuals), they could detect no significant 2D:4D differences between GID patients and their biological sex comparison group. However, a comparison between right-handed individuals showed that the right-hand 2D:4D in MtF was significantly higher than in control males but similar to that observed in control females. In FtM, they found no significant differences in 2D:4D relative to female controls. Sexual orientation was not taken into consideration in that study.

Fig. 1 2D:4D ratios for the left and right hand in male controls, MtF, FtM, and female controls. Columns indicate means and error bars show the SD
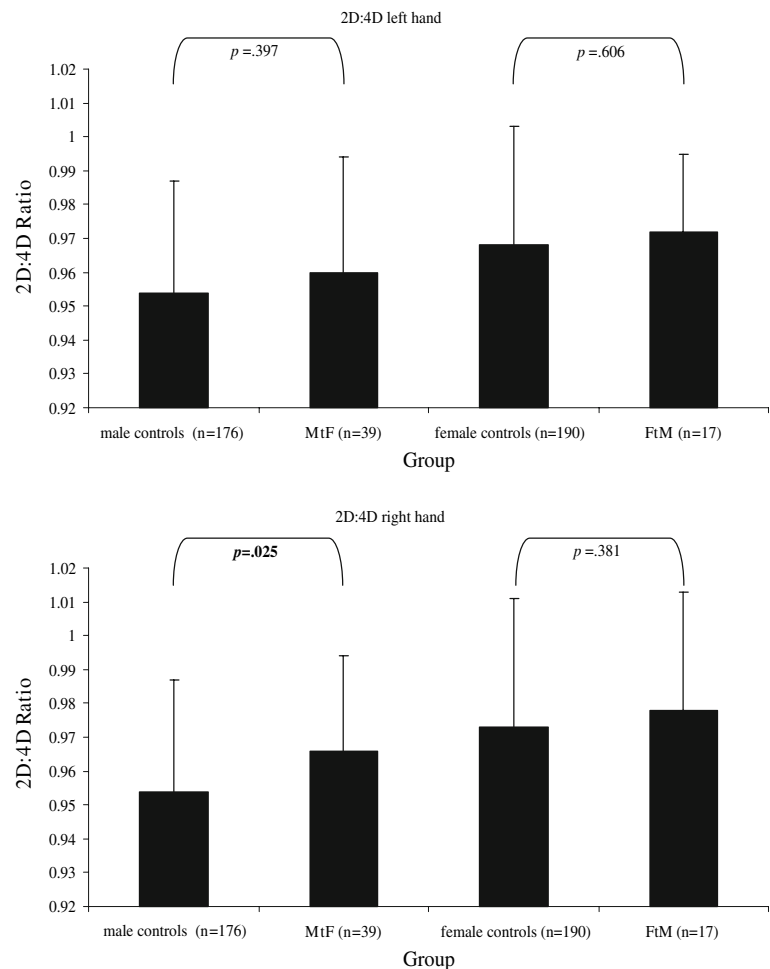
Table 1 2D:4D ratios for right and left hand of MtF, FtM, and controls (homosexuals and non-homosexuals)

	Males (n = 176)		MtF (n = 39)		Females (n = 190)		FtM (n = 17)	
	Homosexuals (n = 13)	Non-homosexuals (n = 163)	Homosexuals (n = 15)	Non-homosexuals (n = 24)	Homosexuals (n = 2)	Non-homosexuals (n = 188)	Homosexuals (n = 14)	Non-homosexuals (n = 3)
Right hand 2D:4D								
M	.959	.954	.961	.970	.912	.974	.982	.960
SD	.041	.032	.028	.027	.025	.033	.033	.047
Left hand 2D:4D								
M	.951	.954	.954	.963	.900	.970	.976	.955
SD	.036	.033	.032	.036	.017	.035	.023	.016

In keeping with our hypothesis of prenatally atypical testosterone level induced masculinization in FtM and lesbians and feminization in MtF and gay males, we expected significant differences between 2D:4D in MtF and male controls and between FtM and female controls. In common with other studies in the field of GID, we were able to study only a relatively small sample due to the low prevalence of GID.

In accordance with our hypothesis, our data revealed a significant 2D:4D difference between MtF and male controls for the right hand, i.e., 2D:4D of MtF of our sample was significantly higher than that of male controls (approaching female controls). In somatic traits that differ between the sexes, there is a tendency for the male form of the trait to be most strongly expressed on the right side of the body (Tanner, 1990). Testosterone influence might, therefore, be

particularly visible on right hands as shown in our results. However, we obtained null findings for FtM with respect to 2D:4D of the right or left hand and female controls. Interestingly, we found the highest (i.e., feminized) 2D:4D values in FtM on a descriptive level, even reaching significance for the right hands of right handed FtM, contradicting our hypothesis of a testosterone induced masculinization of FtM.

Additionally, in an analysis of variance no significant effect on 2D:4D was found for sexual orientation of MtF, i.e., prenatal testosterone might be negligible for the development of sexual orientation in MtF.

As expected, our results suggest some impact of prenatal testosterone levels on the development of GID in males, i.e., reduced prenatal testosterone levels represented by high (feminized) 2D:4D. Contradicting our expectation, FtM showed higher ("hyper"-feminized) 2D:4D values, also indicating lowered testosterone levels prenatally. Our, in part, conflicting results tend to rebut a simple testosterone-based explanation of gender identity development, particularly in FtM. However, lowered prenatal testosterone levels seem to play a role in the development of GID in both sexes. In general, our findings pave the way for speculation about timing of critical periods for the effects of sex hormones on gender identity, sexual orientation, and 2D:4D and strengthen the suggestion of a multifactorial etiology of gender identity and GID. We speculate that testosterone might consolidate one's gender identity, and that reduced prenatal levels might facilitate the development of GID.

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