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Population Differences in Finger-Length Ratios: Ethnicity or Latitude?

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The relative length of the second and fourth fingers (the 2D:4D ratio) has been taken to be an indicator of prenatal exposure to testosterone, and hence possibly relevant to sexual orientation and other sex-differentiated behaviors. Studies have reported a difference in this ratio between Caucasian males in Britain and in the U.S.: higher average 2D:4D ratios were obtained in Britain. This raises the question of whether differences among different Caucasian gene pools were responsible or whether some environmental variable associated with latitude might be involved (e.g., exposure to sunlight or different day-length patterns). This question was explored by examining 2D:4D ratios for an Australian adolescent sample. The Australians were predominantly of British ancestry, but lived at distances from the equator more like those of the U.S. studies. The Australian 2D:4D ratios resembled those in Britain rather than those in the U.S., tending to exclude hypotheses related to latitude and making differences in gene pools a plausible explanation.

KEY WORDS: 2D:4D ratio; finger lengths; masculinization; ancestry; latitude.

INTRODUCTION

The ratio of the lengths of the second and fourth digits of the hand (the 2D:4D ratio) has received considerable attention as a possible marker of the prenatal effects of androgen on the developing fetus. Men average lower on this measure than women. Various associations with other variables and conditions that differ by sex have been reported (reviewed in Manning, 2002). There is also some direct evidence. Women with congenital adrenal hyperplasia (CAH), a result of excessive prenatal exposure to androgens, have been reported to have lower (more masculine) 2D:4D ratios than controls (Brown, Hines, Fane, & Breedlove, 2002; Ökten, Kalyoncu, & Yaris, 2002; see also Buck, Williams, Hughes, & Acerini, 2003, for a nonreplication). In another approach, higher androgen/estrogen ratios in amniotic fluid, obtained prenatally, were associated with lower 2D:4D ratios of the same individuals measured at age two, in a combined sample of the two sexes (Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, & Manning, 2004). The results for testosterone alone were in the same direction, but of only borderline statistical significance with the sample size of 33 cases.

Several studies have examined the 2D:4D ratio in heterosexual and homosexual adults, because variation in sexual orientation has sometimes been attributed to atypical prenatal androgen exposure. Some inconsistencies between the outcomes of studies carried out in Britain and the U.S. were clarified in a joint reanalysis of the data from five studies (McFadden et al., 2005), which led to the conclusion that the primary differences between the two countries were between the heterosexual groups, not among the homosexuals. Heterosexual males (i.e., the bulk of the male population) tended to have lower 2D:4D ratios in the U.S. studies than in the British studies. These differences were for group averages—individual males in either country and of either sexual orientation varied

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substantially in their 2D:4D ratios. This variation was similar in the different groups, i.e., within-group *SD*s were comparable.

For the four studies for which information on ethnicity was available, the basic comparisons were restricted to individuals who identified themselves as White or Caucasian, because average 2D:4D ratios are known to vary with ethnicity (Manning, 2002). However, different Caucasian populations have also shown differences in 2D:4D ratios; for example, the English have relatively high 2D:4D ratios, whereas the Finns appear to have relatively low ones (Manning, 2002, Fig. 1.7). In this article, we focus on the four Caucasian male heterosexual samples from the reanalysis—two of them from Britain, with relatively high average 2D:4D ratios, and two from the U.S., with relatively low ratios. We also report female data for comparison.

McFadden et al. (2005) offered a number of speculations about possible causes of the difference in the 2D:4D ratio between the general male populations of the U.S. and Britain (as well as for why these might not be relevant to females and homosexuals). Obviously, genetic subpopulation differences might be involved. However, the two British studies were conducted among individuals who, for the most part, had spent their pre- and postnatal lives at much higher latitudes than the subjects in the two U.S. studies (conducted in Texas and Southern California). Thus, one possibility was that the observed differences might somehow be related to latitude (or to some environmental variable that varies systematically with latitude, such as day-length patterns or exposure to sunlight). The basis for a possible relationship of finger-lengths to latitude is largely speculative, but the pattern of day lengths varies with latitude, and day length is known to function widely in the plant and animal kingdoms in the regulation of growth and reproduction (Schultz & Kay, 2003). It is apparent that latitude cannot be the whole story—it would not account for the low 2D:4D ratios among Finns, for example—but it still might be a factor in the British–U.S. difference.

Recently, data on finger-length ratios were obtained for a sample of adolescents from Australia. Australians live at distances from the equator much more comparable to those of Texas and Southern California than Britain. Do their 2D:4D ratios look like those in the U.S., as one would expect if latitude-related variables were important, or like those of Britain, from which most of their ancestors came? Finger-lengths were measured for a sample of adolescent twins in a study being carried out for other purposes (Wright & Martin, 2004).

METHOD

Participants

The Australian sample consisted of twin pairs and some of their siblings of similar ages, mainly recruited from schools in South East Queensland, with a few via word of mouth and other sources. The subjects were predominantly Caucasian in ancestry: 68.3% of their great-grandparents were British, or Australians of British descent; a further 18.9% came from other Caucasian populations in Europe and the Middle East; 2.8% were of other ethnicities; and 10% were of unknown ethnicity. (We will report results for the entire sample, and for a subsample having at least seven of eight great-grandparents of British origin.) The Australian subjects were mostly younger than those in the U.S. studies (the majority of whom were college students), and these in turn were mostly younger than the British, who were mixed adult groups. However, 2D:4D ratio did not vary notably by age within the British and U.S. samples (McFadden et al., 2005), nor did it in the Australian sample, where the correlation with age was .06 and −.04 for right and left hands, respectively. Nor is there any particular *a priori* reason to suspect that twin status would be related to 2D:4D. It was possible to check this last assumption by comparing the 2D:4D ratios of the 1,097 individuals who were twins to 230 nontwin siblings measured in the study. For females, no significant differences in 2D:4D ratios were found for either hand. For males, the twins had slightly higher 2D:4D ratios, but the difference was statistically significant only for the left hand, $t(518) = 2.60$, $p = .01$.

Measures

Finger-length measurements in the Australian sample were made from photocopies taken at the time of a visit to the laboratory or sent in at a later time by mail. The measurements in three of the four U.S. and British studies were made from photocopies and the fourth (in Texas) from digital scans.

RESULTS

Males

Table I presents means and *SD*s for 2D:4D ratios in the Australian, British, and U.S. samples. Also given is the latitude of the city in which the study was based. Of course, not all of the individual subjects in these studies

Table I. Mean 2D:4D Ratios for Males From Australia, Britain, and the United States

			2D:4D ratio			
			Left hand		Right hand	
Sample	*N*	Latitude	*M*	*SD*	*M*	*SD*
Australia						
Brisbane	518	27°29′ S	.971	.034	.965	.033
(British ancestry)	233		.972	.034	.965	.031
Britain						
London	105	51°32′ N	.965	.034	.968	.034
Liverpool	170	53°25′ N	.974	.035	.972	.034
United States						
Austin, TX	57	30°17′ N	.951	.028	.957	.031
Fullerton, CA	458	33°52′ N	.964	.032	.949	.035

Note. *N*, number of individuals. Data for British and U.S. samples from McFadden et al. (2005). All samples heterosexual or unselected males, predominantly Caucasian. British ancestry means that at least seven of eight great-grandparents were British or Australians of British descent. Cities given are headquarters of the various studies.

grew up in the particular locales in which the studies were carried out. However, most of the subjects from Texas, Southern California, and Australia (and their mothers) may be presumed to have been exposed to conditions characteristic of lower latitudes than did most of those taking part in the British studies.

The Table I data suggest that the Australian 2D:4D ratios are like those found in the British studies and unlike those observed in the U.S. The mean Australian ratio of .968 falls near the center of the range of those observed in the two British studies (.965–.974), and outside the range of U.S. study means of .949–.964. The standard errors of the mean ratios for the Australian study were approximately ($.034/\sqrt{518} = .0015$), so the differences from the typical U.S. study values are highly unlikely to be the result of chance. Taken together, the results suggest that conditions associated with distance from the equator, such as patterns of day length, average temperatures, or sun exposure, are unlikely to explain the U.S.–British difference in average 2D:4D ratios. If we restrict the comparison to subjects of predominantly British ancestry in the Australian sample (second row in the table), the results remain essentially unchanged.

Females

For comparison, Table II presents corresponding data for females. Only one British sample was available, as the Liverpool study included only males. Consistent with many previous studies, women had higher average 2D:4D ratios than males. The difference between U.S. and British studies that was observed for males was not evident in females. The Australian adolescent girls had similar 2D:4D ratios to the other groups, perhaps slightly on the high side.

Table II. Mean 2D:4D Ratios for Females From Australia, Britain, and the United States

			2D:4D ratio			
			Left hand		Right hand	
Sample	*N*	Latitude	*M*	*SD*	*M*	*SD*
Australia						
Brisbane	575	27°29′ S	.983	.033	.982	.031
(British ancestry)	280		.982	.030	.982	.032
Britain						
London	97	51º32′ N	.975	.030	.974	.030
United States						
Austin, TX	56	30º17′ N	.966	.029	.975	.033
Fullerton, CA	598	33º52′ N	.974	.034	.963	.033

Note. *N*, number of individuals. Data for British and U.S. samples from McFadden et al. (2005). All samples heterosexual or unselected females, predominantly Caucasian. British ancestry means that at least seven of eight great-grandparents were British or Australians of British descent. Cities given are headquarters of the various studies.

For both males and females, differences between left and right hands showed no obvious overall pattern. Such differences are not always statistically negligible (McFadden et al., 2005), but the observed interactions tend to be complex.

DISCUSSION

Two explanations for the difference in average male 2D:4D ratios between the U.S. and Great Britain—namely, different gene pools, or environmental factors associated with latitude—were compared using a sample of Australian adolescents. The former explanation was favored. In terms of the distance they lived from the equator, the Australians were much more similar to the U.S. samples than to the samples from Britain, yet they resembled the latter, not the former, in 2D:4D ratios.

This does not eliminate the possibility that some factor or factors in the environment might be responsible for the difference in males' 2D:4D ratio between U.S. and British populations, but it surely narrows the search for such factors. Presumably, factors of this sort would have to act via the mother and affect conditions for the fetus, because sex differences in 2D:4D ratios are present from an early age (Manning, 2002), and 2D:4D ratios are related to prenatal testosterone levels (Lutchmaya et al., 2004).

The results may render more plausible the notion that 2D:4D ratios (or prenatal testosterone levels, or both) may reflect genetic differences between populations. The Australians had the majority of their genes from British ancestors, and thus their similarity to the British samples would not be surprising. The U.S. Caucasian samples would have had some British ancestry, but would have inherited many of their genes via immigrants from other populations in Western and Eastern Europe and Scandinavia.

Is it plausible that genes affecting the 2D:4D ratio, if they exist, would fail to have differential effects on the 2D:4D ratios of females and prospectively homosexual males? To the extent that prenatal testosterone levels are involved in the determination of the male phenotype and its eventual sexual orientation, such hypotheses would seem to be worth considering. Clearly, however, much more detailed research will be required to render this more than a theoretical possibility. Such research would be especially convincing if it could address the underlying physiological mechanisms directly. Being able to rule out a fairly broad category of possible causal mechanisms, those varying with latitude, may be of help in guiding the search. If growth patterns differ across groups, the measurement of other finger-length ratios besides 2D:4D could also be informative.

Given that the relationship of 2D:4D to other variables is often unstable over different studies (e.g., Putz, Gaulin, Sporter, & McBurney, 2004), and that some relationships to latitude might be nonlinear (e.g., the low ratios of the Finns mentioned in the Introduction), replication of the present results in further samples is desirable. However, so far as they go, the present results support genetic differences rather than latitude-related environmental variables as an explanation of population differences in finger-length ratios.

In any case, in studies involving finger-length ratios, differences among populations and subpopulations should always be taken into account; indeed, they may provide important clues in such investigations.

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