

Latitude, Digit Ratios, and Allen's and Bergmann's Rules: A Comment on Loehlin, McFadden, Medland, and Martin (2006)

Peter L. Hurd · Sari M. van Anders

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In a recent article in this *Journal*, Loehlin, McFadden, Medland, and Martin (2006) investigated the relationship between latitude and digit ratio (2D:4D) first commented upon by Manning (2002). Manning suggested that inter-ethnic differences in mean digit ratio were a function of latitude, with populations at intermediate latitudes having the highest digit ratios and those at the equator and at high latitudes having the lowest. This trend was seen in the populations studied in Manning et al. (2000) (see Fig. 1, left panel). Higher digit ratios appeared to be more common at intermediate latitudes. However, the data collected by Loehlin et al. do not appear to fit this trend (Fig. 1, right panel).

Latitude has long been thought to influence the evolution of body shape. Modern humans follow Allen's rule: populations in colder climates have relatively shorter limbs and relatively shorter distal segments within limbs (Roberts, 1978; Ruff, 1994, 2002). Another sexually dimorphic trait showing robust latitudinal variation is height. In accordance with Bergmann's rule, body size increases as mean annual temperature decreases, resulting in larger mean height at higher latitudes (Katzmarzyk & Leonard, 1995; Roberts, 1978; Ruff, 1994). This suggests that the inter-ethnic variation attributed to latitude may not be due to such factors that vary as a direct consequence of latitude, such as day length (Loehlin et al., 2006; Manning, 2002), but may instead reflect inter-ethnic variation in the morphological traits associated with latitude due to Allen's and Bergmann's rules, such as height.

Like digit ratio, height has been suggested to reflect physical masculinization. Women's height correlates negatively with maternal tendencies and positively with importance of, and competitiveness in, career (Deady & Law Smith, 2006). Height is also positively correlated with perceptual-verbal ability (in women) and mental rotation ability (in both men and women) (Tan, Okyan, Albayrak, & Akgun, 2003). Note, however, that since women's mean perceptual-verbal ability scores are higher than men's mean scores, the correlation in women runs counter to the expected relationship if variation in height and perceptual-verbal ability are assumed to be caused by the same factors across sexes. Height and IQ scores show a positive correlation within populations (Humphreys, Davey, & Park, 1985; Teasdale, Srensen, & Owen, 1989; Tuvemo, Jonsson, & Persson, 1999). While some research points towards environmental factors as the common cause behind this correlation (Abbott et al., 1998; Teasdale et al., 1989), at least one behavioral genetic study found that the correlation was due entirely to common genetic factors (Silventoinen, Posthuma, van Beijsterveldt, Bartels, & Boomsma, 2006).

As depicted in Fig. 2, a crude analysis of the mean digit ratios of the populations studied in Manning et al. (2000) and Loehlin et al. (2006) and mean stature for the different nations sampled shows a suggestive relationship between mean height and digit ratio after controlling for sex, $r = -0.49$, $p = .053$, $df = 14$. When plotted against mean national stature, the Finns no longer appeared as an outlier from a linear relationship as they did when plotted against latitude (Fig. 1, left panel). Note that over 90% of the Finnish population are Uralic-descended ethnic Finns (for a review of population genetic studies of this population, see Kere, 2001).

While both stature and digit ratio are sexually dimorphic, and appear to covary across ethnic groups, it is clear that the digit ratio vs. stature regression lines for each sex has a

P. L. Hurd (✉)
Department of Psychology, University of Alberta,
Edmonton, Alberta T6G 2E9, Canada
e-mail: phurd@ualberta.ca

S. M. van Anders
Department of Psychology, Simon Fraser University,
Burnaby, British Columbia, Canada

different intercept. This implies no single factor is responsible for both the sexual dimorphism and inter-group variation in these traits.

Latitude effect may not be completely independent of the hypothesized organizational effects of testosterone. Sex ratios appear to be influenced by circulating hormone levels in the parents around the time of conception (James, 2004) and sex ratios at birth appear to be male-biased towards the equator and relatively male-biased at high latitudes (Grech, Savona-Ventura, Vassallo-Agius, 2002). Regardless, any link between organizational testosterone and stature on the one hand and digit ratio on the other, and inter-ethnic variation in all three physical traits, requires further investigation. We suggest that much of the variance in digit ratio attributable to latitude is actually due to an allometric relationship between body size and digit ratio across populations.

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