

Finger length measurement

We propose testing the feasibility of measuring the finger-length ratio of respondents' second and fourth digit (2D:4D). 2D:4D has been proposed as a stable marker for prenatal testosterone exposure which in turn has organizational effects on human development and predicts a range of traits and outcomes later in life. Direct measurement of prenatal testosterone is expensive and invasive and can only be done on the embryo. Therefore 2D:4D as an indirect measurement is of potentially high value for researchers interested in human development and the life course. Given stability of 2D:4D as people age, measurement can occur ex-post at any panel wave with yet predictive value for respondents' life course outcomes. Implementing 2D:4D in the Innovation Panel would, to our knowledge, be the first implementation in a nationally representative social survey and enable researchers to evaluate the relative explanatory power and interactions of biological and social factors in determining traits and outcomes.

Recently, the interaction of biological and social factors in determining human behaviour has become a hot topic among evolutionary biologists, psychologists, and lately also social scientists. Recent research in the area, particularly on possible hormone-behaviour interactions, provides the opportunity to disentangle the intricate interplay between nature and nurture and may thereby help overcome the long-thought putative dualism between both. According to the organizational hypothesis in behavioural endocrinology, early exposure to androgens (e.g. testosterone, T) has permanent effects on brain and behaviour (Breedlove 2010, Nelson 2011). **Organizational effects** are permanent effects due to steroid exposure during a sensitive period (prenatal period, possibly to a lesser degree up to puberty). These organizational effects are distinct from **activational effects** of circulating hormone concentrations during adulthood. Although measurement of hormone concentrations in the blood of adults is becoming more frequent in social and medical surveys (including *Understanding Society*), markers for organizational effects of prenatal hormones have not yet been systematically implemented in large-scale representative surveys. Yet, exactly this is important for a full understanding of hormone-behaviour interactions.

Whereas organizational effects link early environment (parental status, stress, economic development) with behavioural outcomes later in life, activational effects orchestrate behaviour in a more immediate way and in response to changes over the life course. The lack of surveys including markers for organizational effects of early hormone exposure may be due to the difficulty and costs associated with direct measurement of prenatal hormone exposure.

Direct measurement is possible through probes of amniotic fluid or of blood from the umbilical cord (Breedlove 2010). Both of these measures are however highly costly and invasive and imply a certain risk for the embryo. In addition there would be a considerable time lag between measuring the embryo's prenatal hormone exposure and outcomes later in life. There is therefore a huge value of indirect measures that can be collected in adulthood. One such indirect measure is 2D:4D (Manning et al. 1998). In recent years, the number of studies on 2D:4D has steadily increased and findings suggest that 2D:4D may be a

stable marker of prenatal steroid hormone exposure that is associated with a variety of health-related, physiological, personality and behavioural traits (Voracek & Loibl 2009).

Despite the novelty of this research area, a small number of meta-analyses and reviews already exist that summarize important findings:

1. Research offers good evidence for the validity of 2D:4D as a marker for prenatal androgen exposure: Research from clinical samples and genetic studies provides strong evidence that 2D:4D is indeed influenced by prenatal androgens (Breedlove, 2010) and a meta-analysis concludes that 2D:4D is not correlated with adult hormone concentrations (Hönekopp et al. 2007). Therefore it is quite clear that 2D:4D measures something else than adult hormone concentrations do.
2. A further meta-analysis shows that there is a stable difference in 2D:4D between men and women, with women having a higher ratio than men on average. There is however also considerable within-sex variation in 2D:4D (Hönekopp & Watson 2010).
3. Several meta-analyses have tested for which kinds of traits related to health, personality, physiology, and behaviour 2D:4D is a stable predictor. The conclusions suggest that 2D:4D is associated with sexual orientation in women but not in men (Grimbos et al. 2010); that there are small effects for men only on aggressive behaviour (Hönekopp & Watson 2011) and risk-taking behaviour (based on our own tentative review of research); that there are small effects on sex-role orientation in men but not in women (Voracek et al. 2011); and that findings on sensation-seeking remain inconclusive (Voracek, Tran, & Dressler 2010).

In sum, it seems that 2D:4D may predict a number of traits, with important differences between the sexes. For many other types of traits the number of studies is not yet sufficient to identify whether 2D:4D is a stable predictor.

So far, 2D:4D has mostly been implemented in non-representative, small samples. An exception to the size is the BBC Internet Study with more than 200,000 respondents (Reimers 2007). But this study is a convenience sample with self-recruitment through the BBC website, it uses exclusively self-measurement of 2D:4D, and does not provide the same quality and detail of information on social context and life histories as the Innovation Panel.

- Implementing it in the Innovation Panel would be highly innovative as it provides the chance to examine 2D:4D in a representative national population and with a large sample size for the first time. This would allow estimating the degree of variation in the population, both between and within the sexes, and would provide for much more detailed subgroup analyses.
- Given that it would be the first implementation in a large-scale nationally representative study, an important goal would be to evaluate the feasibility of this type of data collection in a survey. How high is the consent rate for providing this measurement? How reliable are measures between left and right hand? And how does the data quality differ for respondents surveyed face-to-face (where trained interviewers could take the measurement) from those surveyed via the Web (where respondents would have to measure themselves)?

- A longitudinal survey like the Innovation Panel has a depth of information on social status, occupational, and family histories, and regional variation of contextual factors that is unprecedented in 2D:4D research and would allow studying the interaction of context and hormonal influences on behaviour.
- The multi-dimensional nature of information collected in the Innovation Panel could also help organize dispersed findings from small, one-dimensional studies. For example, certain traits like occupational choice, personality, or risk-taking, which have all found to be associated with 2D:4D independently, may themselves be highly inter-dependent.
- Possibly differences in 2D:4D only become relevant in certain contexts. Life history theory predicts that different strategies (with regard to status acquisition, mating and reproduction) are optimal depending on environmental conditions (Shanahan, Mortimer & Shanahan 2003), including a person's position in the status hierarchy, exposure to competition and stress: Effects of 2D:4D on single behavioural traits may be small, but since many such traits and behavioural instances together shape the life course, effects might be larger in predicting overall characteristics of life trajectories (e.g. its degree of discontinuity).
- Previous research that has examined the associations of 2D:4D with outcomes like aggression, risk-taking, or sensation seeking have mainly been carried out in lab settings. Studying 2D:4D in the context of detailed and high-quality data on social context would allow assessing the external validity of the associations found in lab studies.
- Empirical evidence suggests furthermore a direct association between 2D:4D and certain life-course related outcomes, like number of partners (Hönekopp, Voracek & Manning 2006), offspring sex ratios (Manning 2002) and occupational choice (Voracek, Pum, & Dressler 2010).
- If the 2D:4D ratio of youth (10-15 year-olds) in the Innovation Panel could also be measured, this would allow the assessment of inter-generational transmissions of organizational effects, which could contribute to explaining inter-generational correlations in outcomes and behaviours and would be a completely novel angle compared to existing research.

Researchers will use the data to examine several of the many potential contributions already outlined that would be possible with 2D:4D measures in the Innovation Panel:

- To assess the feasibility of collecting 2D:4D measures in a general population survey, we will compare the quality of measurements (in terms of item missing rates, consistency between right and left hand, and predictive power for traits and outcomes) between measurements taken by interviewers in the face-to-face survey, and measurements taken by respondents themselves in the web survey.
- To examine the population distribution in 2D:4D we will examine the impact of variation in parental social status and, if possible, the regional socioeconomic context at the place and the time of birth, both between and within the sexes. Are 2D:4D differences higher for individuals born under adverse and more unequal conditions? This is implicit in life history theory but has not been tested with population-level data.

- Another important goal will be to publish an assessment of the relative explanatory potential of biological and social factors. For this purpose, we will test whether 2D:4D affects overall life-history strategies. Specifically, we will test whether more masculinized digit ratios (both in men and women) are associated with a higher degree of discontinuity, for example in education, labour market or family histories, and whether this association persists after controlling for standard sociological explanations such as own and parental social status or family disruption in the family of origin. Furthermore, we will assess whether differences in 2D:4D ratios predict differences in the timing of peoples' partnership and fertility behaviours, such as the timing of first cohabitation, marriage, or childbirth. We will test these effects separately for women and men as previous research suggests differences between the sexes. Given that previous 2D:4D research largely relies on bivariate associations, there is huge value for conducting multivariate analyses that control 2D:4D and a range of social explanatory factors simultaneously.
- To test for inter-generational transmission of 2D:4D we would test the correlations between measures for mothers/fathers and their children living in the same household (aged 10 and older) [child finger length measurement in IP7]. We would further test whether there are associations in traits and outcomes between parents and children, for example in their risk preferences, and whether these persist after controlling for the parent's and child's 2D:4D ratios. Furthermore, and to the degree this is possible with the data, we will examine whether the 2D:4D correlation between parents and their children is moderated by differences in social conditions during the time of their respective births.

Implementing 2D:4D in the Innovation Panel would provide data for a large number of possible studies on a variety of life-course related outcomes. The researchers who submitted the finger length proposal envisage initially writing research papers on the following topics:

- An evaluation of the feasibility of collecting 2D:4D measures in studies of the general population using face-to-face or web surveys.
- A descriptive analysis of the impact of variation in parental social status and regional socioeconomic context at the time of birth on the variation in 2D:4D, both between and within the sexes.
- An analysis of the effect of 2D:4D versus social factors on overall life-history outcomes to assess the relative importance of social and biological explanatory factors. This will provide material for at least one, but likely several, publications – one for each domain of substantive interest (e.g., one of family-related issues, one on status and occupational choice).
- A descriptive analysis of associations in 2D:4D between generations, and whether these explain associations in traits or outcomes between generations. Potential outlets for these studies are high-impact biosocial journals such as *PLoS ONE*, *Behavioral and Brain Sciences*, or the *Journal of Biosocial Science*. Given the innovative character of the topic within sociology, publishing some of the results in top sociological journals like the *American Journal of Sociology* may be possible as well.