

Human Capital, Biology, and Achievement: The Role of Prenatal T

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Human Capital and Biology

- Human capital and life outcomes
- Most common proxy – education
- But, education is driven by a variety of cognitive and non-cognitive factors
- These same factors are related to other characteristics that matter aside from education
- Biology plus learning and environment

Cognitive vs. Non-cognitive

- The single largest identifiable factor in performance: cognitive ability
- Psychologists use the term g
- This does better than any other single measured factor
- Other factors such as personality characteristics matter, but they have multiple dimensions and not measured consistently

Non-cognitive research in Econ

- Heckman, et al. 2006 summarizes the growing importance of non-cognitive measures for market success (Heckman calls this “character”)
 - Locus of control, Big Five personality dimensions, attitudes towards risk-taking, time preferences, hormonal status all affect differences in achievement and life outcomes
 - But the literature tends to treat these effects as additive and monotonic in effect

Problems of measurement

- All standard measures of iq and personality are influenced to various degrees by social and family environment
- Little agreement by psychologists on dimensions that span personality characteristics
- Less consistency in measurement than g
- We want an index tied to non-cog dimensions but uninfluenced by factors after birth

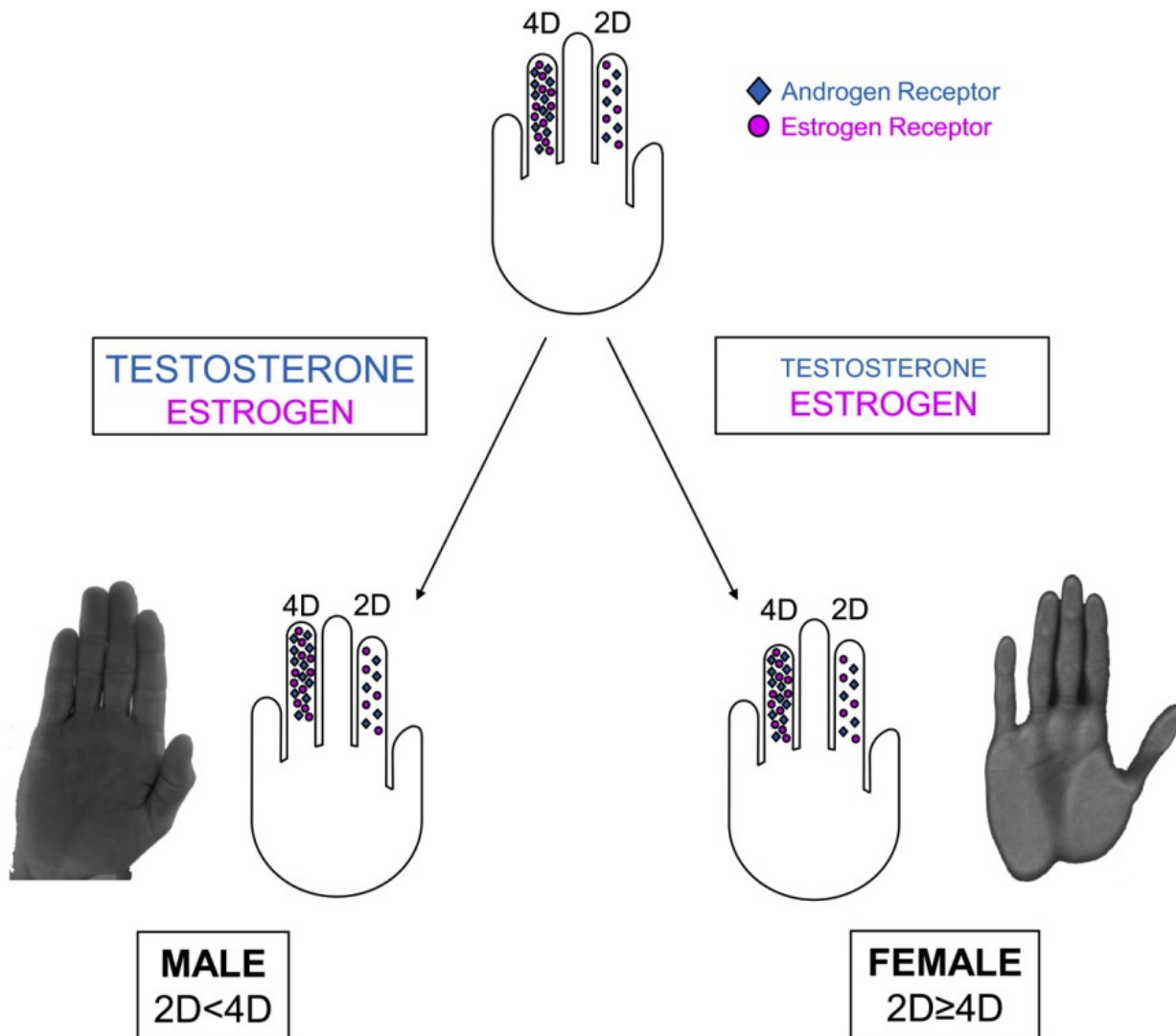
Prenatal Testosterone

- Exposure to **prenatal testosterone (T)** in utero affects secondary sex characteristics, brain development, and cognitive functions
 - Prenatal T inversely correlated with the relative lengths of second and fourth fingers 2D:4D (Manning, et al. 1998; Malas, M. 2006)
 - 2D:4D is sexually dimorphic, even in utero, but distributions overlap
 - 2D:4D affected by both genetics and prenatal environment but not systematically after birth

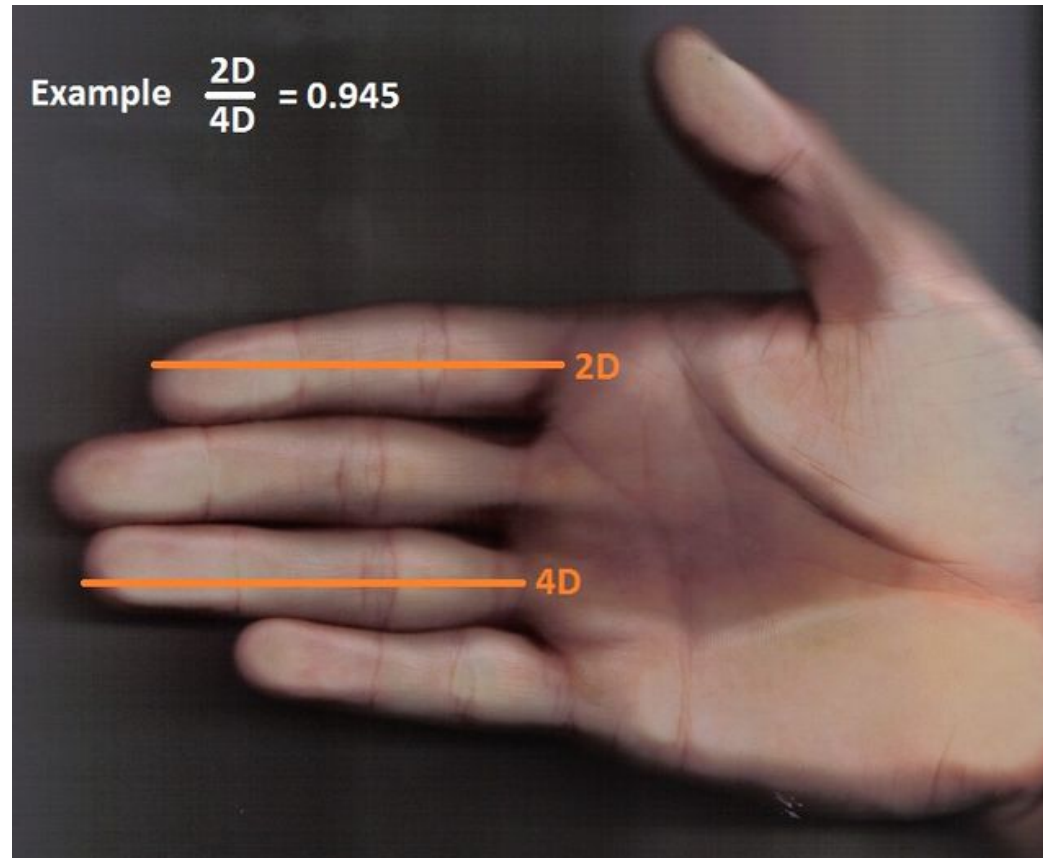
2D4D at HSE and the Center

- Our goal is to undertake systematic analyses of the interaction between various biological markers – including BMI, height, and 2D4D – and a variety of outcome variables that take advantage of access to detailed surveys and RMLS data for Russia
- Main focus has been on 2D4D but we are also looking at attitudes and preferences

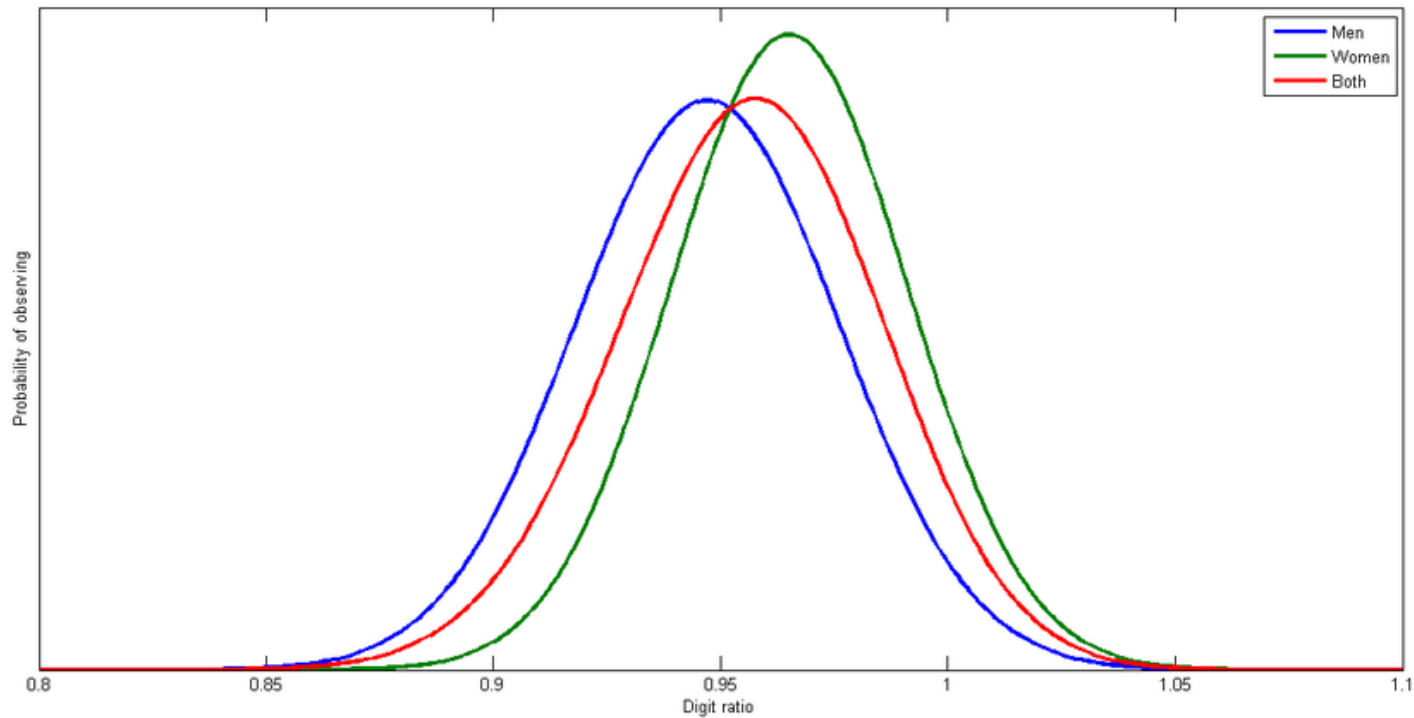
Hormones and digit length



Example: Low 2D4D = High T



Male and Female 2D4D Overlap



2D4D Mechanisms

- Low 2D4D is correlated with testosterone to estradiol levels in utero based on amniocentesis of 33 children (Lutchmaya, et al. 2003)
- Digit effects for animals such as pheasants or mice have been shown to be affected by prenatal androgens (Romano and Leoni, 2006; Zheng and Cohn, 2011)
- Dimorphism of digit ratios occurs in utero

2D:4D Matters

- The 2D:4D ratio has been correlated with both cognitive ability and non-cognitive traits:
 - Musical rank (Sluming and Manning, 2000)
 - Risky behavior (Stenstrom et al. 2010; Apicella 2008) and female aggressiveness (Wilson, 1983)
 - Occupational Preference (Paessler 2010; Sapienza, et al. 2009)
 - Success in bond trading (Coates et al. 2009; Guiso and Rustichini, 2010)
 - GPA/grades in Moscow/Manila (Nye et al. 2012)

2D4D and Educational Success

- Our earliest work at HSE (PLOS One 2012) sampled 900 students at HSE and about 150 students from the Univ. of the Philippines
- For most, but not all departments, female but not male digit ratios were non-linearly correlated (inverse U) with GPA/grades implying an optimal level of prenatal T
- Potential Problem with restriction of range

RMLS survey for Wages, etc.

Need to get a bigger, better sample

We use data from the Russian longitudinal monitoring survey RMLS (similar to GSS)

- Representative sample of population
- Contains data on standard economic measures
- 2D:4D measured for over 1000 families from the RMLS in the Moscow and Moscow region

Working Age Adults

- Starting from a sample of about 2500 individuals (male and female)
- 58% Female; 42% Male due to sex ratio imbalance in Russia
- Focused on those with jobs and of adult working age 25 to 60 to exclude students and retired as well as those with finger injury we get 1746 individuals (981 and 765, sometimes less with missing variables)

Standard Mincer Type Regressions

Estimate the effects of 2D:4D on wages with and without education controls (and for age)

$$\gamma = \beta_1 + \beta_2 \text{Edu} + \beta_3 \text{Age} + \beta_4 \text{Age}^2 + \varepsilon$$

$$\gamma = \beta_1 + \beta_2 \text{Edu} + \beta_3 \text{Age} + \beta_4 \text{Age}^2 + \beta_5 \text{DR} + \beta_6 \text{DR}^2 + \varepsilon$$

$$\gamma = \beta_1 + \beta_5 \text{DR} + \beta_6 \text{DR}^2 + \varepsilon$$

Left 2D:4D on average yearly wage

VARIABLES	(1) Female	(2) Male
dl	785,304*** (296,446)	634,860 (516,937)
dl2	-404,100*** (147,701)	-321,662 (253,974)
Constant	-355,291** (148,491)	-276,468 (262,538)
Observations	981	765
R-squared	0.008	0.002

Robust standard errors in parentheses

***** p<0.01, ** p<0.05, * p<0.1**

Left 2D:4D on wages with controls

VARIABLES	(1) Female	(2) Male
dl	586,938** (282,192)	628,581 (531,059)
dl2	-301,179** (140,521)	-326,539 (261,189)
age	1,296** (550)	3,380.243*** (729)
age2	-16** (6.4)	-42*** (8.6)
educ	1,609*** (170)	2,085*** (241)
Constant	-314,076** (144,383)	-365,622 (274,982)
Observations	976	759
R-squared	0.082	0.107

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Results

- Women's 2D:4D ratios show strong non-linear correlations with their yearly wages
- The inverted U shape shows a peak in earnings near the average 2D:4D ratio for the sample
- Women with very high or very low exposure to prenatal T have lower salaries
- Few to no significant results for men BUT the coefficients for men are quite similar which is suggestive

2D:4D and Education

- Because prenatal T influences education (as is clear from other work and from regressions with this sample), controlling for schooling will **lower** the coefficients on 2D:4D.
- Nonetheless, despite the fact that such controls underestimate 2D:4D's effects, the coefficients on female 2D:4D remain significant even with education controls

Further Discussion

- We don't entirely understand why these non-cognitive components are rewarded and exactly how they relate to other measures of personality
- There is almost certainly an important role for risk-taking and confidence as known in the lit
- What is the mechanism for these effects?
Prenatal T interact and cultural expectations?

Nonlinearity and digit ratios

- One simple way to think of this is that lower 2D4D ratios are correlated with both health/g (because of the role of nutrition) and testosterone exposure/responsiveness
- Greater health/high g is usually monotonically positive for life outcomes
- But greater T exposure is non-linear – bad for both low and high T
- Net effect depends on relative importance

Ongoing Research

- To understand more fully the role of prenatal T on outcomes and behavior, we are exploring other links in the data set
- We examine the links to be found between prenatal T and various economic and behavioral outcomes
- We also consider whether the weaker effects for men are due to outliers adding noise or greater restriction of range due to sample issues for salary effects

Other related work at HSE

- Nye and Orel 2015 also find that women in stereotypically masculine professions have lower 2d4d (higher T) than average especially when comparing jobs such as law or management vs. secretaries and janitorial work
- This improves upon earlier work wherein samples were drawn from online surveys (Manning et al., 2010) or were based on stated job preferences rather than actual career choice (Hell and Paessler, 2011.)

Tentative RMLS findings

- Most of the robust effects seem to be for women not men though there are a few significant male correlations
- For questions relating to consumption of alcohol we find a U shaped relationship for women not men implying higher consumption for women at the two extremes
- For health, education, and outcomes tied to income or status, there is an inverted U for women and only rarely for men

Further Research

- We are beginning a collaboration with Yulia Kovas of Univ of London to examine 2D:4D and other variables for a large twin study of 3 regions in Russia
- Education variables seem to be tied to 2D4D but the links are different for high or low edu
- **High T often explains higher edu attainment but within group lower T corresponds to higher grades suggesting strong non-linearity**

Other Important Lab Work

- 2D4D and market preferences – This includes the importance of education's correlation with pro-market attitudes even for those who were totally educated in Soviet times. Results are consistent for both Russia and the Ukraine.
- Comparisons by major with leading work by Miles Kimball for the United States
- Joint work with a team at GMU to compare the edu-market liberalism link for all of Europe

Persistence of Elites

- New project to study how persistent elite representation in higher education is by looking at three groups – nobility, Jews, and ethnic Germans and their admission to Moscow State University in 1910 vs. 2013
- Jointly with Greg Clark based on his methods in *The Son Also Rises*
- Uses name frequencies and looks at the overrepresentation of rarer minority names

Conclusion

- 2D4D linked to many life outcomes
- T's influence on income and education may affect all existing estimates of these factors in the literature
- We need to find out the tradeoffs, especially where gender norms are significant.
- We need better information on what it means biologically, especially left vs. right.
- We don't understand cultural interactions

Special Features of HSE Work

- Large samples with wide variation - RMLS
- Detailed information about some groups (students)
- Ability to compare with different nations (Russia vs. Philippines)
- Potential for twin studies in the future
- Potential to combine surveys with psychological studies and experiments
- Future collaboration with Psychology Dept

Additional Slides