NATIONAL RESEARCH UNIVERSITY
HIGHER SCHOOL OF ECONOMICS

John V.C. Nye, Maksym Bryukhanov,
Sergiy Polyachenko

2D:4D AND LIFETIME EDUCATIONAL OUTCOMES: EVIDENCE FROM THE RUSSIAN RLMS SURVEY

BASIC RESEARCH PROGRAM
WORKING PAPERS

SERIES: ECONOMICS
WP BRP 145/EC/2016

John V.C. Nye[1], *Maksym Bryukhanov*[2], *Sergiy Polyachenko*[3]

2D:4D AND LIFETIME EDUCATIONAL OUTCOMES: EVIDENCE FROM THE RUSSIAN RLMS SURVEY[4]

Is in utero exposure to testosterone (T), measured by the second to fourth digit ratio (2D:4D), associated with lifetime educational attainment? A growing body of work finds exposure to prenatal T to be associated with aggression, physical fitness, performance in computer science, and type of occupation. However, there has not yet been substantial research its relationship with lifetime educational outcomes. Using a large sample drawn from families in Moscow and in the Moscow region from the Russia Longitudinal Monitoring Survey (RLMS-HSE), we observe clear links between measured 2D:4D and the levels of education obtained by men. Statistically significant positive associations between higher 2D:4D (lower prenatal T) and higher levels of education were found, using difference in means analysis and generalized ordered logit (gologit) regressions. These findings were also robust to using a different subsample. Weaker findings were seen for women. Since many of the earlier findings have shown the benefits of higher prenatal T for achievement, the current finding of a negative effect of prenatal T on educational attainment raises interesting issues about the ambiguous effects of prenatal T and the degree to which the traits it promotes interact with different tasks and social contexts.

Keywords: 2D:4D, prenatal testosterone, education, RLMS-HSE, Russia

JEL codes: I15, I21

[1] George Mason University, Fairfax, VA and National Research University - Higher School of Economics, Moscow.

[2] National Research University - Higher School of Economics, Moscow

[3] National Research University - Higher School of Economics, Moscow

[4] The financial support from the Government of the Russian Federation within the framework of the Basic Research Program at the National Research University Higher School of Economics and within the framework of the implementation of the 5-100 Programme Roadmap of the National Research University Higher School of Economics is acknowledged. The authors are grateful to Donald Cox, David Gill, Victor Lavy, Maria Yudkevich, all participants of regular Thursday Research Meeting on Education at Center for Institutional Studies at HSE, participants of RSSIA 2014, 2015 for valuable comments and suggestions.

Introduction

What role does exposure to prenatal hormones play in affecting life outcomes and individual achievement? How many of the observed differences between people are due to specific environmental conditions in the womb? In general, what role do biological considerations play in economic and social outcomes? More specifically, does prenatal hormonal exposure have any effect on individual education attained?

There is now a large body of literature showing that in utero exposure to testosterone and estradiol, proxied by the second to fourth digit ratio (2D:4D), is significantly correlated with different character traits such as confidence, risk-taking, aggressiveness.

We start from the observation that 2D:4D is negatively correlated with foetal testosterone and estradiol (Lutchmaya et al. 2004) and is quite stable over time (Trivers, Manning, and Jacobson 2006). However, the effects are sometimes ambiguous. Among the best known findings is that lower 2D:4D (higher prenatal testosterone) is linearly associated with better performance in computer science (Brosnan et al. 2011), better physical fitness (Hönekopp, T Manning, and Müller 2006) and greater male aggression (Kilduff et al. 2012; Hönekopp and Watson 2011). In some studies a non-linear (quadratic) relationship has been observed. An extensive survey of statistical tests of various functional forms was published by (Valla and Ceci 2011). But broader surveys of the literature have often found mixed results when surveying the consistency of existing findings in the literature. Voracek's(Voracek 2011) preface for the special issue of *Personality and Individual Differences* devoted to 2D:4D noted that robust results were only found for gender differentiated differences in average 2D:4D and for the link between 2D:4D and sporting ability. But much of the existing literature has only recently looked at the possible non-linearity (and non-monotonicity) of prenatal hormonal effects.

As argued by Nye et al. (John V C Nye et al. 2012) and Nye et al. (J V C Nye and Orel 2015), because we have good reason to believe that traits such as confidence or risk-taking or other non-cognitive characteristics are likely to have more positive effects in moderation than at the extremes, we should observe that 2D:4D should exhibit some non-linearity in outcomes, which would have weakened their influence and led to inconsistent findings in literature which only considered first order correlations or linear regressions. Some evidence of nonlinear specifications for these relationships came from the studies of Nye et al. for 2D:4D and grades/test scores (John V C Nye et al. 2012) and for wages (Nye et al. 2014)

In the limited research on the links between 2D:4D, cognitive ability, and academic performance, the results have also been diverse. Given the complex nature of the observed relationship between 2D:4D and cognitive skills, Luxen and Buunk (Luxen and Buunk 2005) studied 44 men and 37 women in order to estimate the potential correlation between 2D:4D and verbal and numerical intelligence and a non-cognitive trait, agreeableness. They found a negative correlation of right hand 2D:4D with numerical intelligence, but a positive correlation between 2D:4D and verbal intelligence. Another dimension of cognitive abilities, spatial abilities, was studied in meta-analyses of Puts et al. (2008) who found a negligible number of significant relationships between 2D:4D and spatial abilities. Beaton et al. (Beaton, Magowan, and Rudling 2012) found a positive correlation between the difference between 2D:4D measures (right 2D:4D minus left 2D:4D) and the memory score for a word order test; no statistically significant relationships between 2D:4D and mental rotation tasks were detected. Similar studies showed links between 2D:4D and cognitive performance (Bosch-Domènech, Brañas-Garza, and Espín 2014; Brañas-Garza and Rustichini 2011) and higher mathematical orientation (Jordan-Steen 2009). Nye et al. (John V C Nye et al. 2012) used a large data set to study the relationship between 2D:4D and student academic performance in Moscow and Manila and found a nonlinear (inverse U) association between 2D:4D and academic performance, but only for females. Other evidence of a non-linear relationship between 2D:4D and academic achievement was documented in the study of Sanchez et al. (2014).

However, to the best of our knowledge, few publications discuss the relationship between 2D:4D and educational attainment, and none with respect to the highest level of education attained. This paper seeks to address this important issue, given the known statistical associations between 2D:4D, aggressiveness and educational performance.

We use an extensive Russian data set to see how prenatal hormonal exposure affects educational attainment and how these effects may differ by gender. 2D:4D positively correlates with male aggression (Butovskaya et al. 2013; A. Z. Shaw et al. 2012; Hönekopp and Watson 2011) but not (or rarely) with female aggression, aggression however negatively correlates with academic performance (Risi, Gerhardstein, and Kistner 2003; Huesmann, Dubow, and Boxer 2009; Dubow, Boxer, and Huesmann 2009; Hinshaw 1992; Cairns, Cairns, and Neckerman 1989; Tremblay et al. 1992)[5], positively correlates with dropping out of school (Cairns, Cairns,

[5] Undoubtedly, indicated literature sources do not completely exhaust the set of findings with respect to aggression. Aggression varies with age and different forms of aggression may contribute to different forms of academic performance, also some studies, documenting negative correlation of aggression with respect to performance, also reveal relative importance of IQ for male competences (Crowell 1987). However, all these facts make empirical analysis of the studied phenomena even more intriguing.

and Neckerman 1989), limiting the ability to successfully continue education after secondary school. Therefore, one can expect positive correlations between male higher 2D:4D and the completed level of education.

In short, our empirical results, presented below, suggest that men with higher 2D:4D (i.e. lower prenatal T) have a better chance of completing higher education.

The rest of the paper is organized as follows. The *methods* section describes our data sets, the sample selection, and predictors; the *results* section presents statistical tests of the differences in means, generalized ordered logit (gologit) regression, and in the *discussion* section we summarize our contribution and its relationship to general cases, describe the model's limitations and suggest directions for future studies.

Methods

In this study, we use data from the Russian Longitudinal Monitoring Survey (RLMS-HSE)[6]. RLMS-HSE is the annual survey conducted jointly by the Higher School of Economics, Demoscope, the Carolina Population Center (University of North Caroline at Chapel Hill) and the Institute of Sociology of the Russian Academy of Science. This is a household-level survey conducted annually in the form of face-to-face interviews of household members drawn from a representative sample of all Russia. In this particular research, we use data of the 20th wave collected in 2011–2012. Our sample consists of adults from Moscow and the Moscow region. There are several advantages of using this sample. It is among the largest used in the studies of this kind and is clearly representative of the population at large. However, one limitation is that it does not represent Russia as a whole, since Moscow and the Moscow region are the biggest and the richest regions in the country. Nonetheless, we still have a cross-section from a large and varied population.

Subjects

Initially 4 333 distinct observations were available regarding the 2D:4D of the right hand, and 4 337 distinct observations were available regarding the 2D:4D ratio of the left hand. Next, individuals who were under 25 years old were excluded from the sample. We selected this lower bound to ensure individuals had completed higher educational degrees by the time of the

[6] http://www.cpc.unc.edu/projects/rlms-hse

interview. Since there is no consensus in the literature as to which hand better represents testosterone exposure in utero or why results are sometimes found for one hand but not the other, we used both left and right hand digit ratios in the analysis.

We also dropped individuals who reported that they had damaged fingers. After these adjustments, there were 3 488 cases of the 2D:4D of the left hand and 3487 for the right (Table A 1). Unfortunately, in our regression analysis the analysed samples shrank significantly after we controlled for predictors

2D:4D

Measurements were taken by a special team of trained assistants, while other information was taken from the RLMS-HSE survey which contains questions regarding an individual's socioeconomic characteristics and family background. The data were anonymised before being provided to the authors for statistical analysis. The finger measurements were taken using electronic callipers. Actual measurements were made from the palmar digital crease to the fingertip of the index and ring fingers. Then measurements were rounded to the nearest millimetre.

According to descriptive statistics (Table A 1) the mean of 2D:4D of the left hand is 0.997 (standard deviation = 0.047), and for right hand 0.998 (standard deviation = 0.047). The survey shows that the mean 2D:4D of the left hand (DL) for males is 0.995 (standard deviation = 0.046; minimum = 0.737; maximum = 1.188), the mean 2D:4D of the right hand (DR) for males is also 0.996 (standard deviation = 0.046; minimum = 0.702; maximum 1.19). The coefficient of correlation between DR and DL is 0.64 (significant at 1%).

Females have slightly higher 2D:4D (lower prenatal T) as expected. For females: the mean DL is 0.999 (standard deviation = 0.048; minimum = 0.765; maximum = 1.368), the mean DR is 0.999 (standard deviation = 0.047; minimum = 0.742; maximum = 1.345). The correlation coefficient of female DR and DL is 0.56 (significant at 1%). The order of female and male 2D:4D are in line with contemporary findings—men have lower ratios. On the other hand, minimums and maximums are rather abnormal, standard deviations are also larger than those found in other 2D:4D studies. The meta-analysis by Voracek (Voracek et al. 2011), and in other studies (Fink, Manning, and Neave 2006; Allaway et al. 2009) the standard deviation of 2D:4D is roughly 0.03. To the best of our knowledge, there is no single way to solve this issue, however some authors recommend exclusion of potential outliers (Hell and Päßler 2011; Peters, Manning, and Reimers 2007; Caswell and Manning 2009). In order to construct the *baseline model*, we deleted observations below the lower and above the upper 2.5 percentiles of the distribution of

each studied finger length and 2D:4D (henceforth *the first procedure of the deletion of outliers*). This procedure is adopted in the literature (Hell and Päßler 2011). The majority of our quantitative predictions concern this baseline model which uses the first procedure of the deletion of outliers. Upon comparison of means and estimation of the baseline gologit regression model we also applied a *second procedure of the deletion of outliers*. Following Peters, Manning, and Reimers (2007) we analysed finger lengths in the interval of 50–100 mm and 2D:4D in the interval of 0.8–1.2 and estimated the same model with the same set of predictors to justify model robustness to the changes in the subsample.

The exclusion of observations below the lower and above the upper 2.5 percentiles of the distribution of each studied finger length and 2D:4D, shrank the standard deviations and slightly changed mean values of the digit ratios, and they became closer to values more typical in the literature. The mean of both DR and DL becomes 0.998 (standard deviation = 0.03). For females, the coefficient of correlation between DR and DL is 0.558 (significant at 1%), for males it is 0.619 (significant at 1%).

The dependent variable

RLMS-HSE has information about individual academic attainment. The data set shows that 2 172 females and 1 377 males reported their level of education, which is encoded as follows: (1) 0–6 years of school (males 0.58%, females 1.80%); (2) 7–8 years of school (males 3.34%, females 4.74 %); (3) 7–8 years of school and some additional education (males 6.90%, females 3.45%); (4) completed secondary school education (males 30.65%, females 21.96%); (5) completed vocational, professional education (males 19.97%, females 25.28 %); (6) completed a university or higher degree (males 38.56%, females 42.77%).

For computational convenience we merged categories “1”, “2” and “3” to obtain 4 categories for the dependent variable *educational attainment*:

category 1. did not complete secondary school education;
category 2. completed secondary school education;
category 3. completed vocational school, professional education;
category 4. completed university degree or higher academic degrees.

The set of predictors

We followed the literature on educational achievement (Galindo-Rueda and Vignoles 2005; Lauer 2003; Ermisch and Francesconi 2001; Card 1999) and included in our analysis the following additional controls:

- Individual *age*, measured in years (mean = 49 years, standard deviation = 17).
- *Father's higher education*, measured using a dummy variable = 1 if the father has university degree, and 0 otherwise. 29% of fathers have university degrees.
- *Mother's higher education*, measured using a dummy variable = 1 if mother has a university degree, and 0 otherwise. 25% of mothers have university degrees.

Settlement type, where an individual studied at secondary school. RLMS-HSE has information about the following type of settlements: 1) Moscow, Saint Petersburg (a dummy variable *settlement type 1*, 59% of respondents); 2) cities and villages in the Moscow and Saint Petersburg regions (*settlement type 2*, 4%); 3) major cities of regions, capitals of the former USSR republics (settlement type 7%); 4) rayon[7] centres (*settlement type 4*, 6%) ; 5) other towns (*settlement type 5*, 10%); 6) villages, urban settlements (*settlement type 6*, 14%).

Results

First, we estimated a gologit model which is applicable for educational attainment (Galindo-Rueda and Vignoles 2005) on the full sample. This model was estimated using STATA 13 and gologit2—a special code for STATA environment, with the option "robust" for computations of standard errors. To summarise the results: the coefficients for 2D:4D and standard errors of the coefficients are presented Table 1. Detailed regression output is given in Table A 2 and Table A 3.

We add controls simultaneously because 2D:4D ratios may potentially be endogenous for individual and household traits, approximated by variables like age, education or high-school dummies. This procedure may give some insights about sensitivity of the coefficients of 2D:4D.

According to the structure of the regression output (Williams 2006) the first panel compares category 1 (those who did not complete secondary school education) with categories 2,3,4 (those who completed secondary school, vocational school and university respectively), the second panel compares categories 1, 2 with categories 3, 4, and the third panel compares categories 1, 2, 3 with category 4. Positive regression coefficients on the predictors indicate that an increase in these predictors makes it more probable that an individual completes higher level

[7] Administrative geographical units, smaller than regions.

of education. For example, consider the full sample case for males, when we control for 2D:4D only, the coefficient on DL = 3.228 at 10% significance level. The coefficient is positive and this tells us there is a positive association between 2D:4D and the likelihood of completing secondary school, in comparison to uncompleted secondary school. This tendency is also observed at higher levels. For instance, on the third panel, when we control for 2D:4D, age, parental education and include secondary school regional dummies (the settlement type where an individual studied at secondary school) we obtained a DL coefficient of 3.085, at 10% significance level. Its value tells us that there is a positive association between 2D:4D and the probability of completing a university degree or higher academic degrees. We do not see this tendency in the case of females[8]. For male DR, the significance of coefficients is not detected on all panels, using different combinations of controls.

[8] Unfortunately, sometimes computational procedure in the case of females went wrong and produced negative probabilities. For instance, when we estimated regression on the full data set: 1) controlling for all predictors used, using DL, STATA computed 2 negative probabilities for 2 in-sample values; controlling for age and predicting with DR, STATA computed 1 negative case; controlling for all predictors, using DR, STATA computed 2 negative probabilities. Sometimes the quantity of negative cases went up. For instance, 19 negative probabilities were detected, using all controls, predicting educational attainment with DL. We decided to re-estimate regressions for females, using multinomial models, controlling for age, education of parents and high-school regional dummies. Unfortunately, we did not find significant results, using multinomial regressions for women. To save space, we do not provide regression output here.

Table 1 Summary of generalized ordered logit regressions

Controls	Full sample				The first method of deletion of outliers				The second method of deletion of outliers				Index of the panel
	Females		Males		Females		Males		Females		Males		
	DL	DR	DL	DR	DL	DR	DL	DR	DL	DR	DL	DR	
Digit Ratios Only	3.4843**	3.2494**	3.2277*	2.0524	2.2510	5.0461**	6.6736**	6.2213**	3.6392**	2.8032*	3.7177**	2.4277	1-st
	(1.4489)	(1.5158)	(1.6727)	(1.9608)	(2.2993)	(2.4015)	(2.7734)	(2.6325)	(1.5274)	(1.6125)	(1.8033)	(1.9671)	
	1.0525	-0.0037	2.6303**	1.0218	2.0257	1.5766	5.1183***	4.5401**	1.5186	0.3955	2.6709**	1.3710	2-nd
	(0.9940)	(1.0388)	(1.1867)	(1.2609)	(1.5207)	(1.5638)	(1.7634)	(1.8092)	(1.0527)	(1.0554)	(1.2247)	(1.2634)	
	0.6760	1.3944	3.5982***	2.0458	1.3580	2.9474**	5.5133***	5.3085***	1.1969	1.6498*	3.6609***	2.5251*	3-d
	(0.9482)	(0.9920)	(1.2432)	(1.2961)	(1.4105)	(1.4633)	(1.7785)	(1.8632)	(0.9942)	(1.0014)	(1.2639)	(1.2941)	
Digit Ratios, Age	0.5971	0.5382	3.1904*	1.8918	-1.2185	0.5329	6.8050**	5.7945**	0.5897	0.2486	3.7060**	2.2814	1-st
	(1.4371)	(1.2744)	(1.6685)	(1.8971)	(2.2010)	(2.3298)	(2.7807)	(2.6037)	(1.5654)	(1.3376)	(1.7935)	(1.9028)	
	0.6725	-0.5748	2.7658**	1.0980	1.7231	1.0936	5.0916***	4.5495**	1.1237	-0.2107	2.7917**	1.4340	2-nd
	(0.9941)	(0.9988)	(1.1855)	(1.2629)	(1.5244)	(1.5734)	(1.7615)	(1.8029)	(1.0557)	(1.0290)	(1.2238)	(1.2650)	
	0.1289	0.3368	3.8124***	2.1745*	0.4314	2.0063	5.5187***	5.3024***	0.6018	0.5852	3.8546***	2.6368**	3-d
	(0.9617)	(0.9868)	(1.2432)	(1.2916)	(1.4426)	(1.4670)	(1.7807)	(1.8608)	(1.0178)	(1.0009)	(1.2636)	(1.2883)	
Digit Ratios, Age, Education of Father	0.7798	-0.4299	4.3532**	2.8940	-1.2333	1.8928	5.9635*	4.8418	0.8193	-0.4377	4.5882**	2.9278	1-st
	(2.4018)	(2.7381)	(2.0493)	(2.6494)	(3.5893)	(4.5626)	(3.5446)	(3.4330)	(2.4705)	(2.8849)	(2.2423)	(2.6664)	
	-0.4981	-1.0692	3.6291**	2.4506	1.0220	-0.2666	5.4015**	5.5242**	-0.2535	-0.9362	3.6392**	2.7588*	2-nd
	(1.3581)	(1.3277)	(1.4907)	(1.5726)	(1.9771)	(2.1450)	(2.2542)	(2.3284)	(1.3516)	(1.3306)	(1.5565)	(1.5855)	
	-0.9949	-1.0802	3.8739**	3.6461**	-0.8851	1.0946	4.7503**	7.3764***	-0.8619	-0.9736	3.9814**	4.2585***	3-d
	(1.3197)	(1.3196)	(1.5763)	(1.5745)	(1.8893)	(2.0072)	(2.1809)	(2.3121)	(1.3375)	(1.3258)	(1.6065)	(1.6025)	
Digit Ratios, Age, Education of Farther, Education of Mother	0.7109	-0.8660	4.3588**	2.9893	-0.6585	2.1946	5.3789	4.8492	0.6356	-0.8620	4.5931**	3.0479	1-st
	(2.4185)	(2.8042)	(2.0980)	(2.7509)	(3.7115)	(4.7218)	(3.5896)	(3.5800)	(2.5275)	(2.9935)	(2.2980)	(2.7638)	
	-0.2664	-1.0191	3.8604**	2.7218*	1.7712	-0.2477	5.9889***	6.3234***	-0.0692	-0.8900	3.8688**	3.0880*	2-nd
	(1.3774)	(1.3606)	(1.5127)	(1.6124)	(2.0847)	(2.2195)	(2.2679)	(2.3962)	(1.3855)	(1.3702)	(1.5803)	(1.6102)	
	-0.8382	-0.9006	3.9730**	3.8292**	-1.1715	1.5615	5.2349**	7.9591***	-0.7802	-0.7972	4.0698**	4.5633***	3-d
	(1.3291)	(1.3314)	(1.6067)	(1.6189)	(1.9632)	(2.0632)	(2.1948)	(2.3437)	(1.3526)	(1.3395)	(1.6375)	(1.5953)	
Digit Ratios, Age, Education of Farther , Education of Mother Secondary school regional dummies	0.8881	-0.7822	4.2502**	2.7232	-1.2696	2.2323	4.7567	4.1793	0.6645	-0.6707	4.5483*	2.6889	1-st
	(2.4144)	(2.8257)	(2.1344)	(2.7463)	(3.9789)	(4.7674)	(3.7691)	(3.7547)	(2.5905)	(2.9975)	(2.3401)	(2.7851)	
	-0.5845	-1.2166	3.3865**	2.4610	0.8834	-1.0547	5.5467**	6.4108**	-0.3430	-1.0166	3.5457**	2.8176*	2-nd
	(1.4146)	(1.3904)	(1.5780)	(1.6646)	(2.1185)	(2.2617)	(2.3425)	(2.5082)	(1.4235)	(1.3885)	(1.6353)	(1.6697)	
	-0.9564	-0.6819	3.0852*	2.8680*	-1.2124	1.4145	4.2362*	7.6120***	-0.8674	-0.5114	3.2953*	3.6360**	3-d
	(1.3709)	(1.3746)	(1.6976)	(1.6887)	(1.9916)	(2.1179)	(2.2970)	(2.5496)	(1.3922)	(1.3756)	(1.7269)	(1.6993)	

Next, we turn to the baseline model, estimated on the subsample created by the first method of the deletion of outliers. We analysed differences in the means of 2D:4D by educational categories. In particular, we took the difference between the mean of 2D:4D of those individuals who have a university degree or higher academic degrees and of those who do not. Computed differences are shown in Figure 1[9] and means itself are provided in Table A 8–Table A 11.

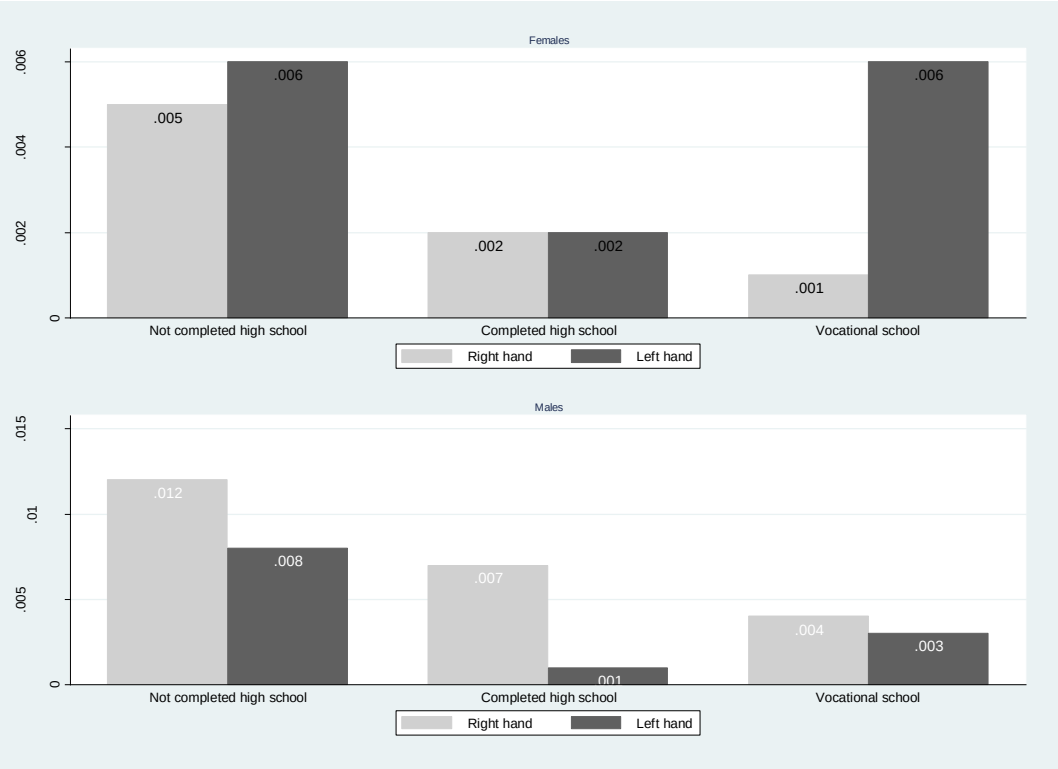

Figure 1 Difference in means of digit ratios by education completed

Next, for each difference we performed a t-test. This shows that for women with higher education the mean 2D:4D of the right hand is significantly higher than for individuals who: (a) did not complete secondary school (at 10% significance level); (b) completed vocational education (at 5% significance level). Other differences in means are statistically insignificant. Males who completed higher education have (in general) larger 2D:4D. For instance, t-tests indicate that males who graduated from institutions of higher education have larger mean 2D:4D on the left hand in comparison to respondents who: (a) did not complete secondary school (at 1% significance level); (b) completed school education only (at 5% significance level). This was

[9] For example, the first couple of bars have corresponding values of differences: 0.03 and 0.07. These differences are computed as follows. The mean of digit ratios (left hand) of females, who have higher education equals 0.99943 (table A2). The mean of digit ratios of females, who did not complete secondary school = 0.99594. Therefore 0.003 is the approximated difference of these two values.

found for the mean 2D:4D of the right hand for those who did not complete secondary school (at 10% significance level). Thus, we obtained evidence that mean values of 2D:4D of more educated males are larger; associations in the case of women are weaker.

The next step of our analysis includes the estimation of the gologit model on this subsample. As Table 1 shows (for details see Table A 4 and Table A 5) that the coefficients of parental education are significant almost in all cases. Now we can observe that the significance of coefficients on 2D:4D of males for both hands on almost all levels, using different sets of controls.

To interpret these regression results more easily, we computed the predicted probabilities of completing a university degree or higher academic degree for different values of 2D:4D of both hands (Table A 12, columns 1–2 are calculated for the left hand and columns 3–4 are computed for the right hand). In order to assign values for predictors, we considered 2 cases. The first case (columns 1, 3) shows respondents who studied at school in rural areas, whose mother and father had no university degrees. The second case (columns 2, 4) represents individuals, who studied at school in Moscow/Saint Petersburg, whose mother and father had university degrees. In both cases age is fixed at the mean value.

Figure 2 shows that the predicted probabilities are rising in 2D:4D of both hands.

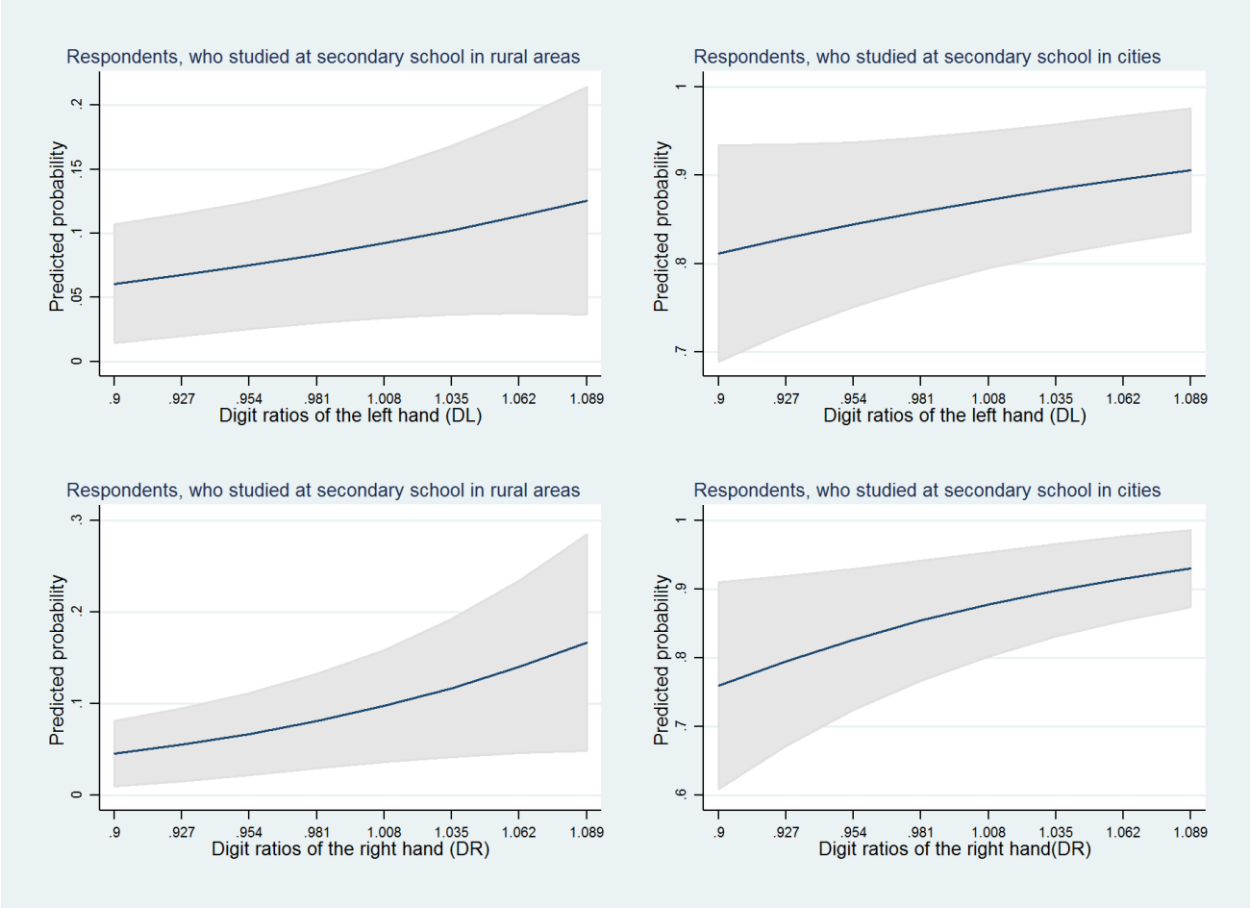

Figure 2 Predicted probabilities of completing higher education degree, males (grey shaded areas represent 95% confidence intervals).

To compute the probabilities, we determined the range for 2D:4D, which vary from 0.8 to 1.19. These values are roughly close to the maximal and to the minimal values of males 2D:4D. For individuals who studied at school in rural areas the estimated probabilities rise from 0.055 to 0.139 (DL), and from 0.053 to 0.614 (DR). For respondents who studied at school in Moscow/Saint Petersburg predicted probabilities of having a university degree increase from 0.621 to 0.821 (DL), from 0.614 to 0.828 (DR). The levels of predicted probabilities are higher in the last case, presumably, because of better academic opportunities in Moscow/Saint Petersburg compared to rural areas; another or additional reason is the higher levels of social capital in Moscow/Saint Petersburg.

We also computed the probabilities for a one standard deviation increase above the mean of 2D:4D. For men who studied at secondary school in rural areas and whose parents have no higher education degrees in rural areas a one standard deviation increase in DL is associated with an increase of probability of having a university-level degree from 0.088 (significant at 1%,

standard error = 0.027) to 0.098 (significant at 1%, standard error 0.031). The size of correlation is greater in the case of the right hand—a one standard deviation increase in DR is accompanied by a probability growth from 0.089 (significant at 1%, standard error = 0.028) to 0.1[10] (significant at 1%, standard error = 0.032). For men who studied at secondary school in Moscow/Saint Petersburg, the estimated probabilities (for DL) increase from 0.734 (significant at 1%, standard error = 0.042) to 0.755 (significant at 1%, 0.042), for DR from 0.736 (significant at 1%, standard error = 0.041) to 0.759[11] (significant at 1%, standard error = 0.043).

The analysis and estimated probabilities indicate that the size of the probability change (due to a change in the value of 2D:4D) is small compared to the changes in probabilities with respect to the fundamental predictors of educational attainment. Specifically, estimates show that (for individuals who studied at school in rural areas, keeping the rest of variables at means) university-level education of both parents makes predicted probabilities of having university-level degree approximately 4.5 times higher (than predicted using DL or DR).

As mentioned earlier, in order to check the robustness of our model to the subsample used, we also applied the method of the exclusion of outliers, used by Peters(Peters, Manning, and Reimers 2007) and the gologit model was estimated again. The results are presented in Table 1 and details are given in Table A 6 and Table A 7. Computations show that predicted probabilities (Table A 13), are also close to each other. Therefore, it can be concluded that the basic predictions produced by these two gologit models are also close.

We noted earlier that in some studies nonlinear associations of 2D:4D and educational outcomes were found (John V C Nye et al. 2012; Sánchez et al. 2014). To check for other possible non-monotonic associations and predictors we squared the 2D:4D and included them in regressions with multiple controls (see Table A 14–Table A 16). However, the regression outputs do not show much consistency across levels of education, the subsample used or with respect to gender. This fact demands further investigations of possible non-monotonic effects of 2D:4D on lifetime educational outcomes and their nature.

[10] In percentage terms (averaged over both hands) this relative increase in estimated probability equals approximately 12% = 100*((0.098-0.088)/ 0.088) + (0.1 - 0.089)/0.089)/2.

[11] In percentage terms (averaged over both hands) this relative increase in estimated probability equals approximately 3% = 100*((0.755-0.734)/0.734 + (0.759 - 0.736)/ 0.736)/2.

Discussion

Our work fills a gap in the literature by connecting empirical evidence of the relationship between 2D:4D and aggression, and documented associations of aggression and academic attainment.

Our results differ from many papers that show higher levels of prenatal T exposure being correlated with different outcome variables for achievement. In this case, higher 2D:4D (indicating lower prenatal T exposure) seems to be positively correlated with educational attainment.

Tests of difference in means and gologit results (using different subsamples) indicate that men who have high 2D:4D also have higher educational attainment. In particular, the test of the difference in means show that male individuals who have larger 2D:4D have higher chances of obtaining higher education, compared to those who completed secondary school only, and to those who did not complete secondary school. This is true for both hands. Predicted probabilities give evidence that (for men) the probability of obtaining a university degree is positively related to 2D:4D of both hands. Specifically, a one standard deviation above the mean of 2D:4D, on average (over both hands) increases this probability by approximately 12% for people who studied at school in rural areas (and had parents without higher education), and by approximately 3% for people who studied at school in Moscow/Saint Petersburg and who had parents with higher education. Therefore, our claim of positive association between 2D:4D and the educational attainment of men is empirically supported.

Another possible channel of association between 2D:4D and educational attainment may be related to risk taking behaviour. There are some studies which establish associations between 2D:4D and risk taking behaviour (Coates, Gurnell, and Rustichini 2009; Hönekopp 2011; Garbarino, Slonim, and Sydnor 2011)), and show relationships between risk aversion and educational attainment (Belzil and Leonardi 2007; Brodaty, Gary-Bobo, and Prieto 2014; K. L. Shaw 1996). However, scientists cannot determine whether investment in education should be viewed as a risky decision or not (Belzil and Leonardi 2007). Unfortunately, given the data set we have, we are unable to judge what factors are more relevant in the revealed relationship—risk, aggression, both, or a different but related characteristic. We are also unable to study correlations of 2D:4D with important variables such as effort and motivation. Therefore, in contrast with our earlier findings (John V C Nye et al. 2012)on grades, men with higher prenatal T are less likely to receive a university level degree indicating a negative effect of prenatal T on educational attainment. And while women in our earlier study (John V C Nye et al. 2012)who

had a close to average amount of prenatal T had the best grades, in this sample, women showed no benefits or costs from higher prenatal T in terms of receiving a university degree.

The contradictory findings in much of the literature point to the complex ways in which the various traits promoted by prenatal T interact with other characteristics depending on the nature of the outcome being studied. In some cases, there may be greater returns to moderation with lower performance at the extremes. In addition, there could be interactions between the promoted traits and the socio-cultural context involved.

Other issues concern the impact of the mother's lifestyle on a child's lifetime academic outcomes. Several studies have documented that maternal smoking during pregnancy (Rizwan, Manning, and Brabin 2007) and body mass index (Sowers et al. 2001) were correlated with testosterone in women, which influences the hormonal levels received by a foetus. However, this concern about the endogeneity of 2D:4D to the prenatal environment and to the family (household) conditions when the child is in utero. We can rule out any post-natal influences on 2D:4D ratios but still need to consider the complex combination of genes and environmental influences prior to birth. The sometimes positive and sometimes negative effect of prenatal T on different outcomes points to the complicated and non-monotonic nature of these hormonal effects on human achievement. It also offers an explanation as to why the earlier literature found contradictory results when small samples were used in more limited circumstances that do not show the full range of possible outcomes.

John V.C. Nye George Mason University Fairfax, VA and National Research University Higher School of Economics, Moscow.

Maksym Bryukhanov National Research University - Higher School of Economics, Moscow

Sergiy Polyachenko National Research University - Higher School of Economics, Moscow

References

Allaway, Heather C, Terri G Bloski, Roger A Pierson, and Marla E Lujan. 2009. “Digit Ratios (2D: 4D) Determined by Computer-Assisted Analysis Are More Reliable than Those Using Physical Measurements, Photocopies, and Printed Scans.” *American Journal of Human Biology* 21 (3). Wiley Online Library: 365–70.

Beaton, Alan A., Sarah V. Magowan, and Nick G. Rudling. 2012. “Does Handedness or Digit Ratio (2D:4D) Predict Lateralised Cognitive Ability?” *Personality and Individual Differences* 52 (5): 627–31. http://www.sciencedirect.com/science/article/pii/S0191886911005733.

Belzil, Christian, and Marco Leonardi. 2007. “Can Risk Aversion Explain Schooling Attainments? Evidence from Italy.” *Labour Economics* 14 (6). Elsevier: 957–70.

Bosch-Domènech, Antoni, Pablo Brañas-Garza, and Antonio M Espín. 2014. “Can Exposure to Prenatal Sex Hormones (2D: 4D) Predict Cognitive Reflection?” *Psychoneuroendocrinology* 43. Elsevier: 1–10.

Brañas-Garza, Pablo, and Aldo Rustichini. 2011. “Organizing Effects of Testosterone and Economic Behavior: Not Just Risk Taking.” Edited by Bruce Cushing. *PloS One* 6 (12). Public Library of Science: e29842. http://dx.plos.org/10.1371/journal.pone.0029842.

Brodaty, Thomas, Robert J Gary-Bobo, and Ana Prieto. 2014. “Do Risk Aversion and Wages Explain Educational Choices?” *Journal of Public Economics* 117. Elsevier: 125–48.

Brosnan, Mark, Victoria Gallop, Nida Iftikhar, and Edmund Keogh. 2011. “Digit Ratio (2D: 4D), Academic Performance in Computer Science and Computer-Related Anxiety.” *Personality and Individual Differences* 51 (4). Elsevier: 371–75.

Butovskaya, Marina, Julija Fedenok, Valentina Burkova, and John Manning. 2013. “Sex Differences in 2D: 4D and Aggression in Children and Adolescents from Five Regions of Russia.” *American Journal of Physical Anthropology* 152 (1). Wiley Online Library: 130–39.

Cairns, Robert B, Beverley D Cairns, and Holly J Neckerman. 1989. “Early School Dropout: Configurations and Determinants.” *Child Development*. JSTOR, 1437–52.

Card, David. 1999. “The Causal Effect of Education on Earnings.” *Handbook of Labor Economics* 3. Elsevier: 1801–63.

Caswell, Noreen, and John T Manning. 2009. “A Comparison of Finger 2D: 4D by Self-Report Direct Measurement and Experimenter Measurement from Photocopy: Methodological Issues.” *Archives of Sexual Behavior* 38 (1). Springer: 143–48.

Coates, John M, Mark Gurnell, and Aldo Rustichini. 2009. “Second-to-Fourth Digit Ratio Predicts Success among High-Frequency Financial Traders.” *Proceedings of the National Academy of Sciences* 106 (2). National Acad Sciences: 623–28.

Crowell, David H. 1987. *Childhood Aggression and Violence*. Springer.

Dubow, Eric F, Paul Boxer, and L Rowell Huesmann. 2009. “Long-Term Effects of Parents' Education on Children's Educational and Occupational Success: Mediation by Family Interactions, Child Aggression, and Teenage Aspirations.” *Merrill-Palmer Quarterly (Wayne State University. Press)* 55 (3). NIH Public Access: 224.

Ermisch, John, and Marco Francesconi. 2001. “Family Matters: Impacts of Family Background on Educational Attainments.” *Economica*. JSTOR, 137–56.

Fink, Bernhard, J T Manning, and Nick Neave. 2006. “The 2nd--4th Digit Ratio (2D: 4D) and Neck Circumference: Implications for Risk Factors in Coronary Heart Disease.” *International Journal of Obesity* 30 (4). Nature Publishing Group: 711–14.

Galindo-Rueda, Fernando, and Anna Vignoles. 2005. “The Declining Relative Importance of Ability in Predicting Educational Attainment.” *Journal of Human Resources* 40 (2). University of Wisconsin Press: 335–53.

Garbarino, Ellen, Robert Slonim, and Justin Sydnor. 2011. “Digit Ratios (2D: 4D) as Predictors of Risky Decision Making for Both Sexes.” *Journal of Risk and Uncertainty* 42 (1). Springer: 1–26.

Hell, Benedikt, and Katja Päßler. 2011. “Are Occupational Interests Hormonally Influenced? The 2D: 4D-Interest Nexus.” *Personality and Individual Differences* 51 (4). Elsevier: 376–80.

Hinshaw, Stephen P. 1992. “Externalizing Behavior Problems and Academic Underachievement in Childhood and Adolescence: Causal Relationships and Underlying Mechanisms.” *Psychological Bulletin* 111 (1). American Psychological Association: 127.

Hönekopp, Johannes. 2011. “Relationships between Digit Ratio 2D: 4D and Self-Reported Aggression and Risk Taking in an Online Study.” *Personality and Individual Differences* 51

(1). Elsevier: 77–80.

Hönekopp, Johannes, John T Manning, and Constanze Müller. 2006. "Digit Ratio (2D: 4D) and Physical Fitness in Males and Females: Evidence for Effects of Prenatal Androgens on Sexually Selected Traits." *Hormones and Behavior* 49 (4). Elsevier: 545–49.

Hönekopp, Johannes, and Steven Watson. 2011. "Meta-Analysis of the Relationship between Digit-Ratio 2D: 4D and Aggression." *Personality and Individual Differences* 51 (4). Elsevier: 381–86.

Huesmann, L Rowell, Eric F Dubow, and Paul Boxer. 2009. "Continuity of Aggression from Childhood to Early Adulthood as a Predictor of Life Outcomes: Implications for the Adolescent-Limited and Life-Course-Persistent Models." *Aggressive Behavior* 35 (2). Wiley Online Library: 136–49.

Jordan-Steen, Maureen. 2009. "Correlation Study between Second/Fourth Digit Ratio, Number of Older Brothers and Mathematics Inclination in Female Pre-Service Teachers." In *Proceedings of the World Congress on Engineering*. Vol. 2.

Kilduff, Liam P, Renato N Hopp, Christian J Cook, Blair T Crewther, and John T Manning. 2012. "Digit Ratio (2D: 4D), Aggression, and Testosterone in Men Exposed to an Aggressive Video Stimulus." *Evolutionary Psychology: An International Journal of Evolutionary Approaches to Psychology and Behavior* 11 (5): 953–64.

Lauer, Charlotte. 2003. "Family Background, Cohort and Education: A French--German Comparison Based on a Multivariate Ordered Probit Model of Educational Attainment." *Labour Economics* 10 (2). Elsevier: 231–51.

Lutchmaya, Svetlana, Simon Baron-Cohen, Peter Raggatt, Rebecca Knickmeyer, and John T Manning. 2004. "2nd to 4th Digit Ratios, Fetal Testosterone and Estradiol." *Early Human Development* 77 (1). Elsevier: 23–28.

Luxen, Marc F, and Bram P Buunk. 2005. "Second-to-Fourth Digit Ratio Related to Verbal and Numerical Intelligence and the Big Five." *Personality and Individual Differences* 39 (5). Elsevier: 959–66.

Nye, John V, Maria Yudkevich, Ekaterina Orel, and Ekaterina Kochergina. 2014. "The Effects of Prenatal Testosterone on Adult Wages: Evidence from Russian RLMS Data and Measured 2D: 4D Digit Ratios." *Higher School of Economics Research Paper No. WP BRP* 71.

Nye, J V C, and E Orel. 2015. “The Influence of Prenatal Hormones on Occupational Choice: 2D: 4D Evidence from Moscow.” *Personality and Individual Differences* 78. Elsevier: 39–42.

Nye, John V C, Gregory Androuschak, Desiree Desierto, Garett Jones, and Maria Yudkevich. 2012. “2D: 4D Asymmetry and Gender Differences in Academic Performance.” *PloS One* 7 (10). Public Library of Science: e46319.

Peters, Michael, John T Manning, and Stian Reimers. 2007. “The Effects of Sex, Sexual Orientation, and Digit Ratio (2D: 4D) on Mental Rotation Performance.” *Archives of Sexual Behavior* 36 (2). Springer: 251–60.

Puts, David A, Michael A McDaniel, Cynthia L Jordan, and S Marc Breedlove. 2008. “Spatial Ability and Prenatal Androgens: Meta-Analyses of Congenital Adrenal Hyperplasia and Digit Ratio (2D: 4D) Studies.” *Archives of Sexual Behavior* 37 (1). Springer: 100–111.

Risi, Susan, Rebecca Gerhardstein, and Janet Kistner. 2003. “Children’s Classroom Peer Relationships and Subsequent Educational Outcomes.” *Journal of Clinical Child and Adolescent Psychology* 32 (3). Taylor & Francis: 351–61.

Rizwan, S, J T Manning, and B J Brabin. 2007. “Maternal Smoking during Pregnancy and Possible Effects of in Utero Testosterone: Evidence from the 2D: 4D Finger Length Ratio.” *Early Human Development* 83 (2). Elsevier: 87–90.

Sánchez, Ángeles, José Sánchez-Campillo, Dolores Moreno-Herrero, and Virginia Rosales. 2014. “2D: 4D Values Are Associated with Mathematics Performance in Business and Economics Students.” *Learning and Individual Differences* 36. Elsevier: 110–16.

Shaw, Allison Z, Michael R Kotowski, Franklin J Boster, and Timothy R Levine. 2012. “The Effect of Prenatal Sex Hormones on the Development of Verbal Aggression.” *Journal of Communication* 62 (5). Wiley Online Library: 778–93.

Shaw, Kathryn L. 1996. “An Empirical Analysis of Risk Aversion and Income Growth.” *Journal of Labor Economics*. JSTOR, 626–53.

Sowers, M F, J L Beebe, D McConnell, John Randolph, and M Jannausch. 2001. “Testosterone Concentrations in Women Aged 25--50 Years: Associations with Lifestyle, Body Composition, and Ovarian Status.” *American Journal of Epidemiology* 153 (3). Oxford Univ Press: 256–64.

Tremblay, Richard E, Benoit Masse, Donna Perron, Marc LeBlanc, Alex E Schwartzman, and Jane E Ledingham. 1992. "Early Disruptive Behavior, Poor School Achievement, Delinquent Behavior, and Delinquent Personality: Longitudinal Analyses." *Journal of Consulting and Clinical Psychology* 60 (1). American Psychological Association: 64.

Trivers, R, John T. Manning, and A Jacobson. 2006. "A Longitudinal Study of Digit Ratio (2D:4D) and Other Finger Ratios in Jamaican Children." *Hormones and Behavior* 49: 150–56.

Valla, Jeffrey M, and Stephen J Ceci. 2011. "Can Sex Differences in Science Be Tied to the Long Reach of Prenatal Hormones? Brain Organization Theory, Digit Ratio (2D/4D), and Sex Differences in Preferences and Cognition." *Perspectives on Psychological Science* 6 (2). SAGE Publications: 134–46.

Voracek, Martin. 2011. "Special Issue Preamble: Digit Ratio (2D: 4D) and Individual Differences Research." *Personality and Individual Differences* 51 (4). Elsevier: 367–70.

Voracek, Martin, Jakob Pietschnig, Ingo W Nader, and Stefan Stieger. 2011. "Digit Ratio (2D: 4D) and Sex-Role Orientation: Further Evidence and Meta-Analysis." *Personality and Individual Differences* 51 (4). Elsevier: 417–22.

Williams, Richard. 2006. "Generalized Ordered Logit/partial Proportional Odds Models for Ordinal Dependent Variables." *Stata Journal* 6 (1). StataCorp LP: 58–82.

APPENDIX A

Table A 1 Descriptive statistics of the baseline model

	Mean	Standard deviation	Minimum	Maximum	Number of Observations
Digit ratios of the left hand (DL)	0.9974	0.0468	0.7368	1.3676	3488
Digit ratios of the right hand (DR)	0.9978	0.0468	0.7024	1.3455	3487
Educational attainment	2.9518	1.0369	1	4	3549
Age	49.3411	16.8871	25	98	3565
Gender (Male=1)	0.3882	0.4874	0	1	3565
Higher education of father	0.2853	0.4516	0	1	2282
Higher education of mother	0.2505	0.4334	0	1	2503
Settlement type 1	0.5878	0.4923	0	1	3486
Settlement type 2	0.0367	0.1881	0	1	3486
Settlement type 3	0.0740	0.2618	0	1	3486
Settlement type 4	0.0617	0.2406	0	1	3486
Settlement type 5	0.1024	0.3032	0	1	3486
settlement type 6	0.1374	0.3443	0	1	3486

Table A 2 Generalized ordered logit regression output, females, full sample

	(1) Educational attainment b/se	(2) Educational attainment b/se	(3) Educational attainment b/se	(4) Educational attainment b/se	(5) Educational attainment b/se	(6) Educational attainment b/se	(7) Educational attainment b/se	(8) Educational attainment b/se	(9) Educational attainment b/se	(10) Educational attainment b/se
1										
Digit ratios of the left hand (DL)	3.4843**	0.5971	0.7798	0.7109	0.8881					
	(1.4489)	(1.4371)	(2.4018)	(2.4185)	(2.4144)					
Age		-0.0497***	0.0057	0.0084	0.0107		-0.0495***	0.0055	0.0080	0.0103
		(0.0041)	(0.0140)	(0.0147)	(0.0145)		(0.0041)	(0.0142)	(0.0148)	(0.0147)
Education of father			0.9779**	0.1107	0.0500			0.9797**	0.1100	0.0598
			(0.3803)	(0.4285)	(0.4640)			(0.3817)	(0.4269)	(0.4593)
Education of mother				1.9392***	2.3208***				1.9347***	2.3020***
				(0.6692)	(0.8317)				(0.6671)	(0.8288)
Digit ratios of the right hand (DR)						3.2494**	0.5382	-0.4299	-0.8660	-0.7822
						(1.5158)	(1.2744)	(2.7381)	(2.8042)	(2.8257)
Constant	-1.2660	4.4401***	1.8675	1.7615	1.6130	-1.0337	4.4829***	3.0888	3.3617	3.3018
	(1.4390)	(1.5087)	(2.6610)	(2.6982)	(2.6671)	(1.5055)	(1.3430)	(3.0086)	(3.0760)	(3.0723)
2										
Digit ratios of the left hand (DL)	1.0525	0.6725	-0.4981	-0.2664	-0.5845					
	(0.9940)	(0.9941)	(1.3581)	(1.3774)	(1.4146)					
Age		-0.0130***	-0.0065	-0.0019	0.0011		-0.0136***	-0.0067	-0.0021	0.0010
		(0.0030)	(0.0058)	(0.0059)	(0.0062)		(0.0030)	(0.0058)	(0.0059)	(0.0062)
Education of father			1.3639***	0.6999***	0.6444***			1.3601***	0.6896***	0.6326***
			(0.1730)	(0.2108)	(0.2231)			(0.1732)	(0.2098)	(0.2219)
Education of mother				1.3069***	1.2932***				1.3122***	1.2954***
				(0.2437)	(0.2614)				(0.2434)	(0.2613)
Digit ratios of the right hand (DR)						-0.0037	-0.5748	-1.0692	-1.0191	-1.2166

						(1.0388)	(0.9988)	(1.3277)	(1.3606)	(1.3904)
Constant	-0.2959	0.7538	1.3981	0.8843	1.1687	0.7594	2.0297**	1.9796	1.6482	1.8137
	(0.9928)	(1.0186)	(1.3974)	(1.4182)	(1.4567)	(1.0388)	(1.0328)	(1.3727)	(1.4045)	(1.4323)
3										
Digit ratios of the left hand (DL)	0.6760	0.1289	-0.9949	-0.8382	-0.9564					
	(0.9482)	(0.9617)	(1.3197)	(1.3291)	(1.3709)					
Age		-0.0254***	-0.0405***	-0.0384***	-0.0371***		-0.0254***	-0.0406***	-0.0386***	-0.0372***
		(0.0028)	(0.0055)	(0.0055)	(0.0057)		(0.0029)	(0.0055)	(0.0055)	(0.0057)
Education of father			1.4852***	0.9813***	0.9204***			1.4883***	0.9841***	0.9224***
			(0.1390)	(0.1602)	(0.1621)			(0.1392)	(0.1603)	(0.1619)
Education of mother				1.0046***	0.9620***				1.0048***	0.9619***
				(0.1720)	(0.1762)				(0.1717)	(0.1759)
Digit ratios of the right hand (DR)						1.3944	0.3368	-1.0802	-0.9006	-0.6819
						(0.9920)	(0.9868)	(1.3196)	(1.3314)	(1.3746)
Constant	-0.9719	0.8559	2.1772	1.8303	1.9039	-1.6885*	0.6488	2.2701*	1.8987	1.6340
	(0.9481)	(0.9824)	(1.3569)	(1.3701)	(1.4109)	(0.9922)	(1.0139)	(1.3610)	(1.3752)	(1.4194)
Log-likelihood	-2723.0374	-2612.3722	-1429.4636	-1390.8657	-1342.9507	-2717.8522	-2608.9914	-1428.2490	-1389.6752	-1341.7123
Log-likelihood, constant term only	-2725.9650	-2725.9650	-1541.7654	-1526.7968	-1501.1664	-2723.0798	-2723.0798	-1540.3406	-1525.3701	-1499.7447
Wald chi2	5.8305	274.0802	184.4334	204.0737	246.8716	9.8131	288.6240	183.7555	202.8630	245.8082
Prob > chi2	0.1202	0.0000	0.0000	0.0000	0.0000	0.0202	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.0011	0.0417	0.0728	0.0890	0.1054	0.0019	0.0419	0.0728	0.0890	0.1054
Number of observations	2139	2139	1312	1302	1279	2137	2137	1311	1301	1278

Note: * p<0.1, ** p<0.05, *** p<0.01. Robust standard errors. Specifications (5) and (10) include high-school regional dummies

Table A 3 Generalized ordered logit regression output, males, full sample

	(1) Educational attainment b/se	(2) Educational attainment b/se	(3) Educational attainment b/se	(4) Educational attainment b/se	(5) Educational attainment b/se	(6) Educational attainment b/se	(7) Educational attainment b/se	(8) Educational attainment b/se	(9) Educational attainment b/se	(10) Educational attainment b/se
1										
Digit ratios of the left hand (DL)	3.2277*	3.1904*	4.3532**	4.3588**	4.2502**					
	(1.6727)	(1.6685)	(2.0493)	(2.0980)	(2.1344)					
Age		-0.0159**	0.0235**	0.0256**	0.0282**		-0.0160**	0.0235**	0.0254**	0.0283**
		(0.0074)	(0.0114)	(0.0119)	(0.0132)		(0.0074)	(0.0114)	(0.0118)	(0.0132)
Education of father			1.0400***	0.6299*	0.5849			1.0490***	0.6438*	0.5987
			(0.3391)	(0.3698)	(0.3888)			(0.3386)	(0.3678)	(0.3865)
Education of mother				0.7292*	0.7144*				0.7188*	0.7098*
				(0.4021)	(0.4109)				(0.3992)	(0.4062)
Digit ratios of the right hand (DR)						2.0524	1.8918	2.8940	2.9893	2.7232
						(1.9608)	(1.8971)	(2.6494)	(2.7509)	(2.7463)
Constant	-1.0991	-0.3075	-3.0999	-3.1994	-3.1957	0.0649	0.9835	-1.6591	-1.8413	-1.6797
	(1.6582)	(1.7229)	(2.1621)	(2.2334)	(2.2644)	(1.9474)	(1.9338)	(2.7652)	(2.8797)	(2.8796)
2										
Digit ratios of the left hand (DL)	2.6303**	2.7658**	3.6291**	3.8604**	3.3865**					
	(1.1867)	(1.1855)	(1.4907)	(1.5127)	(1.5780)					
Age		0.0074**	-0.0102	-0.0072	-0.0035		0.0070*	-0.0107	-0.0077	-0.0039
		(0.0037)	(0.0068)	(0.0069)	(0.0073)		(0.0037)	(0.0068)	(0.0069)	(0.0073)
Education of father			1.5213***	1.1709***	1.0966***			1.5256***	1.1768***	1.1037***
			(0.1805)	(0.1978)	(0.2029)			(0.1814)	(0.1988)	(0.2043)
Education of mother				0.6600***	0.6081***				0.6587***	0.6153***
				(0.2030)	(0.2104)				(0.2040)	(0.2102)
Digit ratios of the right hand (DR)						1.0218	1.0980	2.4506	2.7218*	2.4610

						(1.2609)	(1.2629)	(1.5726)	(1.6124)	(1.6646)
Constant	-2.2556*	-2.7322**	-3.2274**	-3.6096**	-3.2254**	-0.6584	-1.0590	-2.0394	-2.4616	-2.2878
	(1.1805)	(1.2020)	(1.5157)	(1.5376)	(1.6051)	(1.2561)	(1.2782)	(1.6068)	(1.6409)	(1.6927)
3 Digit ratios of the left hand (DL)	3.5982***	3.8124***	3.8739**	3.9730**	3.0852*					
	(1.2432)	(1.2432)	(1.5763)	(1.6067)	(1.6976)					
Age		0.0103***	-0.0050	-0.0005	-0.0000		0.0098***	-0.0055	-0.0011	-0.0006
		(0.0036)	(0.0071)	(0.0072)	(0.0074)		(0.0036)	(0.0071)	(0.0073)	(0.0074)
Education of father			1.6327***	1.1307***	1.0682***			1.6460***	1.1419***	1.0791***
			(0.1586)	(0.1799)	(0.1873)			(0.1588)	(0.1814)	(0.1886)
Education of mother				0.9973***	0.9882***				1.0006***	0.9920***
				(0.1885)	(0.1968)				(0.1901)	(0.1981)
Digit ratios of the right hand (DR)						2.0458	2.1745*	3.6461**	3.8292**	2.8680*
						(1.2961)	(1.2916)	(1.5745)	(1.6189)	(1.6887)
Constant	-4.0480***	-4.7395***	-4.6580***	-5.0345***	-4.1086**	-2.5031*	-3.0899**	-4.4173***	-4.8727***	-3.8707**
	(1.2399)	(1.2601)	(1.6133)	(1.6458)	(1.7440)	(1.2932)	(1.3061)	(1.6319)	(1.6710)	(1.7392)
Log-likelihood	-1721.6307	-1711.0707	-1085.1458	-1049.9121	-1006.2147	-1725.7357	-1715.5946	-1087.1680	-1051.9189	-1008.2145
Log-likelihood, constant term only	-1726.2623	-1726.2623	-1157.5867	-1133.1605	-1113.8247	-1727.4584	-1727.4584	-1158.6975	-1134.2828	-1114.9440
Wald chi2	9.7780	30.0863	132.1550	144.8687	4052.6961	3.1934	21.9125	129.8487	143.8310	4059.4402
Prob > chi2	0.0206	0.0000	0.0000	0.0000	0.0000	0.3628	0.0013	0.0000	0.0000	0.0000
Pseudo R2	0.0027	0.0088	0.0626	0.0735	0.0966	0.0010	0.0069	0.0617	0.0726	0.0957
Number of observations	1334	1334	912	895	880	1335	1335	913	896	881

Note: * p<0.1, ** p<0.05, *** p<0.01. Robust standard errors. Specifications (5) and (10) include high-school regional dummies

Table A 4 Generalized ordered logit regression output, females, the subsample, obtained by the first procedure of deletion of outliers

	(1) Educational attainment b/se	(2) Educational attainment b/se	(3) Educational attainment b/se	(4) Educational attainment b/se	(5) Educational attainment b/se	(6) Educational attainment b/se	(7) Educational attainment b/se	(8) Educational attainment b/se	(9) Educational attainment b/se	(10) Educational attainment b/se
1										
Digit ratios of the left hand (DL)	2.2510	-1.2185	-1.2333	-0.6585	-1.2696					
	(2.2993)	(2.2010)	(3.5893)	(3.7115)	(3.9789)					
Age		-0.0483***	0.0064	0.0103	0.0107		-0.0480***	0.0075	0.0116	0.0123
		(0.0048)	(0.0169)	(0.0172)	(0.0177)		(0.0051)	(0.0170)	(0.0176)	(0.0179)
Education of father			1.0230**	-0.0061	-0.0598			1.0206**	-0.0354	-0.1092
			(0.4407)	(0.4592)	(0.5184)			(0.4398)	(0.4647)	(0.5184)
Education of mother				2.2610***	2.9253***				2.2840***	2.9404***
				(0.7541)	(1.0502)				(0.7615)	(1.0513)
Digit ratios of the right hand (DR)						5.0461**	0.5329	1.8928	2.1946	2.2323
						(2.4015)	(2.3298)	(4.5626)	(4.7218)	(4.7674)
Constant	0.0750	6.2720***	3.9096	3.0941	3.7813	-2.7033	4.5089*	0.7361	0.1863	0.2290
	(2.2922)	(2.2761)	(3.8686)	(4.0235)	(4.2567)	(2.3866)	(2.4447)	(4.8039)	(5.0031)	(5.0270)
2										
Digit ratios of the left hand (DL)	2.0257	1.7231	1.0220	1.7712	0.8834					
	(1.5207)	(1.5244)	(1.9771)	(2.0847)	(2.1185)					
Age		-0.0112***	-0.0044	0.0002	0.0060		-0.0115***	-0.0045	-0.0003	0.0062
		(0.0035)	(0.0068)	(0.0068)	(0.0073)		(0.0035)	(0.0068)	(0.0068)	(0.0073)
Education of father			1.3293***	0.6409***	0.5639**			1.3098***	0.6057***	0.5146**
			(0.1987)	(0.2246)	(0.2456)			(0.1985)	(0.2260)	(0.2457)
Education of mother				1.3271***	1.3353***				1.3248***	1.3168***
				(0.2556)	(0.2821)				(0.2578)	(0.2800)
Digit ratios of the right hand (DR)						1.5766	1.0936	-0.2666	-0.2477	-1.0547

						(1.5638)	(1.5734)	(2.1450)	(2.2195)	(2.2617)
Constant	-1.1633	-0.2884	-0.1093	-1.1461	-0.3486	-0.7142	0.3546	1.1889	0.8999	1.6032
	(1.5177)	(1.5582)	(1.9974)	(2.1202)	(2.1541)	(1.5601)	(1.6014)	(2.1632)	(2.2324)	(2.2694)
3										
Digit ratios of the left hand (DL)	1.3580	0.4314	-0.8851	-1.1715	-1.2124					
	(1.4105)	(1.4426)	(1.8893)	(1.9632)	(1.9916)					
Age		-0.0243***	-0.0373***	-0.0357***	-0.0337***		-0.0241***	-0.0376***	-0.0361***	-0.0345***
		(0.0032)	(0.0061)	(0.0062)	(0.0065)		(0.0032)	(0.0061)	(0.0062)	(0.0065)
Education of father			1.5524***	1.0359***	0.9403***			1.5563***	1.0400***	0.9496***
			(0.1605)	(0.1832)	(0.1872)			(0.1603)	(0.1825)	(0.1863)
Education of mother				0.9793***	0.9480***				0.9837***	0.9603***
				(0.1925)	(0.2009)				(0.1923)	(0.2008)
Digit ratios of the right hand (DR)						2.9474**	2.0063	1.0946	1.5615	1.4145
						(1.4633)	(1.4670)	(2.0072)	(2.0632)	(2.1179)
Constant	-1.5509	0.6032	2.0273	2.1467	2.1513	-3.1365**	-0.9824	0.0582	-0.5757	-0.4621
	(1.4093)	(1.4665)	(1.9087)	(1.9899)	(2.0127)	(1.4611)	(1.4878)	(2.0256)	(2.0806)	(2.1286)
Log-likelihood	-2134.1649	-2053.5706	-1114.2579	-1084.7317	-1035.3825	-2131.5223	-2054.2079	-1114.5962	-1085.4547	-1035.1144
Log-likelihood, constant term only	-2135.1518	-2135.1518	-1204.7558	-1194.3461	-1173.1319	-2135.1518	-2135.1518	-1204.7558	-1194.3461	-1173.1319
Wald chi2	1.9560	206.5849	145.1253	162.2913	212.7607	7.5217	197.2079	145.8338	162.3549	213.0744
Prob > chi2	0.5816	0.0000	0.0000	0.0000	0.0000	0.0570	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.0005	0.0382	0.0751	0.0918	0.1174	0.0017	0.0379	0.0748	0.0912	0.1176
Number of observations	1710	1710	1045	1037	1019	1710	1710	1045	1037	1019

Note: * p<0.1, ** p<0.05, *** p<0.01. Robust standard errors. Specifications (5) and (10) include high-school regional dummies

Table A 5 Generalized ordered logit regression output, males, the subsample, obtained by the first procedure of deletion of outliers

	(1) Educational attainment b/se	(2) Educational attainment b/se	(3) Educational attainment b/se	(4) Educational attainment b/se	(5) Educational attainment b/se	(6) Educational attainment b/se	(7) Educational attainment b/se	(8) Educational attainment b/se	(9) Educational attainment b/se	(10) Educational attainment b/se
1										
Digit ratios of the left hand (DL)	6.6736**	6.8050**	5.9635*	5.3789	4.7567					
	(2.7734)	(2.7807)	(3.5446)	(3.5896)	(3.7691)					
Age		-0.0170*	0.0316**	0.0301**	0.0345**		-0.0164*	0.0330**	0.0311**	0.0356**
		(0.0089)	(0.0128)	(0.0135)	(0.0151)		(0.0089)	(0.0133)	(0.0140)	(0.0156)
Education of father			1.3153***	1.0765**	0.9943*			1.3484***	1.1061**	1.0325**
			(0.4509)	(0.4967)	(0.5128)			(0.4487)	(0.4897)	(0.5083)
Education of mother				0.3547	0.5321				0.3562	0.5395
				(0.4691)	(0.5065)				(0.4668)	(0.5029)
Digit ratios of the right hand (DR)						6.2213**	5.7945**	4.8418	4.8492	4.1793
						(2.6325)	(2.6037)	(3.4330)	(3.5800)	(3.7547)
Constant	-4.4701	-3.7915	-4.9594	-4.3064	-3.7800	-4.0203	-2.8179	-3.9107	-3.8287	-3.2501
	(2.7505)	(2.7481)	(3.5923)	(3.6673)	(3.7985)	(2.6122)	(2.5899)	(3.5932)	(3.7625)	(3.9287)
2										
Digit ratios of the left hand (DL)	5.1183***	5.0916***	5.4015**	5.9889***	5.5467**					
	(1.7634)	(1.7615)	(2.2542)	(2.2679)	(2.3425)					
Age		0.0079*	-0.0084	-0.0058	-0.0034		0.0081*	-0.0073	-0.0046	-0.0022
		(0.0042)	(0.0077)	(0.0078)	(0.0083)		(0.0042)	(0.0077)	(0.0078)	(0.0083)
Education of father			1.4845***	1.1896***	1.1301***			1.4945***	1.2079***	1.1497***
			(0.2091)	(0.2381)	(0.2397)			(0.2097)	(0.2396)	(0.2427)
Education of mother				0.5395**	0.5056**				0.5332**	0.5046**
				(0.2428)	(0.2444)				(0.2437)	(0.2473)
Digit ratios of the right hand (DR)						4.5401**	4.5495**	5.5242**	6.3234***	6.4108**

						(1.8092)	(1.8029)	(2.3284)	(2.3962)	(2.5082)
Constant	-4.7133***	-5.0534***	-5.0171**	-5.7318**	-5.2406**	-4.1356**	-4.5199**	-5.1880**	-6.1152**	-6.1516**
	(1.7579)	(1.7663)	(2.2492)	(2.2630)	(2.3424)	(1.8025)	(1.8047)	(2.3482)	(2.4117)	(2.5228)
3										
Digit ratios of the left hand (DL)	5.5133***	5.5187***	4.7503**	5.2349**	4.2362*					
	(1.7785)	(1.7807)	(2.1809)	(2.1948)	(2.2970)					
Age		0.0094**	-0.0043	0.0001	-0.0016		0.0095**	-0.0043	0.0001	-0.0016
		(0.0041)	(0.0081)	(0.0082)	(0.0085)		(0.0041)	(0.0081)	(0.0083)	(0.0086)
Education of father			1.5467***	1.0664***	1.0433***			1.5644***	1.0832***	1.0662***
			(0.1820)	(0.2126)	(0.2256)			(0.1824)	(0.2167)	(0.2307)
Education of mother				0.8986***	0.8746***				0.9031***	0.8754***
				(0.2232)	(0.2337)				(0.2266)	(0.2391)
Digit ratios of the right hand (DR)						5.3085***	5.3024***	7.3764***	7.9591***	7.6120***
						(1.8632)	(1.8608)	(2.3121)	(2.3437)	(2.5496)
Constant	-5.9758***	-6.4221***	-5.5279**	-6.2702***	-5.0727**	-5.7690***	-6.2048***	-8.1563***	-8.9959***	-8.4450***
	(1.7772)	(1.7890)	(2.1850)	(2.1990)	(2.3110)	(1.8603)	(1.8646)	(2.3457)	(2.3688)	(2.5766)
Log-likelihood	-1298.7501	-1290.7834	-816.0790	-791.5661	-750.9552	-1299.7907	-1292.0505	-814.7216	-789.9952	-749.0929
Log-likelihood, constant term only	-1304.7007	-1304.7007	-868.7191	-849.8762	-833.7735	-1304.7007	-1304.7007	-868.7191	-849.8762	-833.7735
Wald chi2	12.9592	26.8157	95.1559	101.9754	3470.2519	11.1928	24.6464	99.1496	107.5438	3035.8692
Prob > chi2	0.0047	0.0002	0.0000	0.0000	0.0000	0.0107	0.0004	0.0000	0.0000	0.0000
Pseudo R2	0.0046	0.0107	0.0606	0.0686	0.0993	0.0038	0.0097	0.0622	0.0705	0.1016
Number of observations	1010	1010	688	675	663	1010	1010	688	675	663

Note: * p<0.1, ** p<0.05, *** p<0.01. Robust standard errors. Specifications (5) and (10) include high-school regional dummies

Table A 6 Generalized ordered logit regression output, females, the subsample, obtained by the second procedure of deletion of outliers

	(1) Educational attainment b/se	(2) Educational attainment b/se	(3) Educational attainment b/se	(4) Educational attainment b/se	(5) Educational attainment b/se	(6) Educational attainment b/se	(7) Educational attainment b/se	(8) Educational attainment b/se	(9) Educational attainment b/se	(10) Educational attainment b/se
1										
Digit ratios of the left hand (DL)	3.6392**	0.5897	0.8193	0.6356	0.6645					
	(1.5274)	(1.5654)	(2.4705)	(2.5275)	(2.5905)					
Age		-0.0491***	0.0056	0.0083	0.0106		-0.0491***	0.0053	0.0079	0.0103
		(0.0041)	(0.0139)	(0.0145)	(0.0144)		(0.0041)	(0.0141)	(0.0147)	(0.0146)
Education of father			0.9800***	0.0925	0.0044			0.9750**	0.0841	-0.0055
			(0.3799)	(0.4303)	(0.4702)			(0.3812)	(0.4298)	(0.4694)
Education of mother				1.9575***	2.3490***				1.9582***	2.3445***
				(0.6733)	(0.8387)				(0.6714)	(0.8370)
Digit ratios of the right hand (DR)						2.8032*	0.2486	-0.4377	-0.8620	-0.6707
						(1.6125)	(1.3376)	(2.8849)	(2.9935)	(2.9975)
Constant	-1.4175	4.4127***	1.8291	1.8360	1.8413	-0.5896	4.7529***	3.0990	3.3559	3.1938
	(1.5163)	(1.6359)	(2.7317)	(2.8057)	(2.8506)	(1.6040)	(1.4018)	(3.1556)	(3.2706)	(3.2526)
2										
Digit ratios of the left hand (DL)	1.5186	1.1237	-0.2535	-0.0692	-0.3430					
	(1.0527)	(1.0557)	(1.3516)	(1.3855)	(1.4235)					
Age		-0.0127***	-0.0059	-0.0014	0.0015		-0.0132***	-0.0060	-0.0016	0.0014
		(0.0030)	(0.0059)	(0.0059)	(0.0062)		(0.0030)	(0.0059)	(0.0059)	(0.0062)
Education of father			1.4004***	0.7479***	0.6993***			1.3989***	0.7388***	0.6902***
			(0.1757)	(0.2157)	(0.2283)			(0.1759)	(0.2145)	(0.2267)
Education of mother				1.2681***	1.2489***				1.2749***	1.2518***
				(0.2453)	(0.2630)				(0.2449)	(0.2627)
Digit ratios of the right hand (DR)						0.3955	-0.2107	-0.9362	-0.8900	-1.0166

						(1.0554)	(1.0290)	(1.3306)	(1.3702)	(1.3885)
Constant	-0.7482	0.3009	1.1315	0.6727	0.9111	0.3720	1.6571	1.8230	1.5030	1.5948
	(1.0504)	(1.0801)	(1.3887)	(1.4248)	(1.4633)	(1.0549)	(1.0620)	(1.3749)	(1.4132)	(1.4293)
3										
Digit ratios of the left hand (DL)	1.1969	0.6018	-0.8619	-0.7802	-0.8674					
	(0.9942)	(1.0178)	(1.3375)	(1.3526)	(1.3922)					
Age		-0.0250***	-0.0402***	-0.0381***	-0.0367***		-0.0251***	-0.0403***	-0.0383***	-0.0368***
		(0.0028)	(0.0055)	(0.0055)	(0.0057)		(0.0029)	(0.0055)	(0.0055)	(0.0057)
Education of father			1.5018***	0.9980***	0.9359***			1.5067***	1.0030***	0.9406***
			(0.1398)	(0.1612)	(0.1630)			(0.1400)	(0.1612)	(0.1628)
Education of mother				0.9928***	0.9516***				0.9930***	0.9517***
				(0.1721)	(0.1764)				(0.1718)	(0.1760)
Digit ratios of the right hand (DR)						1.6498*	0.5852	-0.9736	-0.7972	-0.5114
						(1.0014)	(1.0009)	(1.3258)	(1.3395)	(1.3756)
Constant	-1.4855	0.3725	2.0334	1.7626	1.8020	-1.9389*	0.3890	2.1517	1.7843	1.4482
	(0.9936)	(1.0380)	(1.3731)	(1.3919)	(1.4295)	(1.0015)	(1.0274)	(1.3667)	(1.3826)	(1.4192)
Log-likelihood	-2698.4541	-2590.8460	-1420.2816	-1382.6169	-1333.9520	-2698.0187	-2590.9686	-1420.2873	-1382.6404	-1333.9385
Log-likelihood, constant term only	-2701.5398	-2701.5398	-1533.1370	-1518.1611	-1492.5486	-2701.5398	-2701.5398	-1533.1370	-1518.1611	-1492.5486
Wald chi2	5.9076	267.0128	184.5987	202.7915	246.9398	6.7064	269.0797	184.4922	201.9166	246.1988
Prob > chi2	0.1162	0.0000	0.0000	0.0000	0.0000	0.0819	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.0011	0.0410	0.0736	0.0893	0.1063	0.0013	0.0409	0.0736	0.0893	0.1063
Number of observations	2122	2122	1305	1295	1272	2122	2122	1305	1295	1272

Note: * p<0.1, ** p<0.05, *** p<0.01. Robust standard errors. Specifications (5) and (10) include high-school regional dummies

Table A 7 Generalized ordered logit regression output, males, the subsample, obtained by the second procedure of deletion of outliers

	(1) Educational attainment b/se	(2) Educational attainment b/se	(3) Educational attainment b/se	(4) Educational attainment b/se	(5) Educational attainment b/se	(6) Educational attainment b/se	(7) Educational attainment b/se	(8) Educational attainment b/se	(9) Educational attainment b/se	(10) Educational attainment b/se
1										
Digit ratios of the left hand (DL)	3.7177**	3.7060**	4.5882**	4.5931**	4.5483*					
	(1.8033)	(1.7935)	(2.2423)	(2.2980)	(2.3401)					
Age		-0.0153**	0.0233**	0.0254**	0.0284**		-0.0154**	0.0234**	0.0253**	0.0284**
		(0.0074)	(0.0114)	(0.0118)	(0.0133)		(0.0075)	(0.0114)	(0.0119)	(0.0133)
Education of father			1.0407***	0.6251*	0.5737			1.0478***	0.6369*	0.5879
			(0.3392)	(0.3696)	(0.3875)			(0.3389)	(0.3672)	(0.3843)
Education of mother				0.7401*	0.7389*				0.7304*	0.7372*
				(0.4018)	(0.4126)				(0.3984)	(0.4072)
Digit ratios of the right hand (DR)						2.4277	2.2814	2.9278	3.0479	2.6889
						(1.9671)	(1.9028)	(2.6664)	(2.7638)	(2.7851)
Constant	-1.5817	-0.8454	-3.3298	-3.4310	-3.5043	-0.3058	0.5664	-1.6932	-1.9014	-1.6563
	(1.7861)	(1.8372)	(2.3277)	(2.4055)	(2.4461)	(1.9527)	(1.9332)	(2.7753)	(2.8849)	(2.9055)
2										
Digit ratios of the left hand (DL)	2.6709**	2.7917**	3.6392**	3.8688**	3.5457**					
	(1.2247)	(1.2238)	(1.5565)	(1.5803)	(1.6353)					
Age		0.0073**	-0.0105	-0.0076	-0.0042		0.0071*	-0.0106	-0.0076	-0.0041
		(0.0037)	(0.0068)	(0.0069)	(0.0073)		(0.0037)	(0.0068)	(0.0069)	(0.0073)
Education of father			1.5127***	1.1586***	1.0845***			1.5104***	1.1565***	1.0841***
			(0.1806)	(0.1979)	(0.2035)			(0.1814)	(0.1988)	(0.2048)
Education of mother				0.6647***	0.6085***				0.6667***	0.6191***
				(0.2029)	(0.2109)				(0.2039)	(0.2108)
Digit ratios of the right hand (DR)						1.3710	1.4340	2.7588*	3.0880*	2.8176*

						(1.2634)	(1.2650)	(1.5855)	(1.6102)	(1.6697)
Constant	-2.2943*	-2.7529**	-3.2225**	-3.6019**	-3.3585**	-1.0025	-1.3933	-2.3444	-2.8256*	-2.6326
	(1.2185)	(1.2377)	(1.5753)	(1.5987)	(1.6580)	(1.2584)	(1.2785)	(1.6179)	(1.6375)	(1.6970)
3 Digit ratios of the left hand (DL)	3.6609***	3.8546***	3.9814**	4.0698**	3.2953*					
	(1.2639)	(1.2636)	(1.6065)	(1.6375)	(1.7269)					
Age		0.0103***	-0.0055	-0.0011	-0.0009		0.0100***	-0.0058	-0.0015	-0.0012
		(0.0036)	(0.0071)	(0.0072)	(0.0074)		(0.0036)	(0.0071)	(0.0073)	(0.0074)
Education of father			1.6196***	1.1126***	1.0485***			1.6291***	1.1171***	1.0546***
			(0.1589)	(0.1803)	(0.1882)			(0.1589)	(0.1813)	(0.1891)
Education of mother				1.0026***	0.9923***				1.0137***	1.0026***
				(0.1886)	(0.1975)				(0.1901)	(0.1988)
Digit ratios of the right hand (DR)						2.5251*	2.6368**	4.2585***	4.5633***	3.6360**
						(1.2941)	(1.2883)	(1.6025)	(1.5953)	(1.6993)
Constant	-4.1062***	-4.7798***	-4.7393***	-5.1039***	-4.2833**	-2.9756**	-3.5534***	-5.0085***	-5.5864***	-4.6097***
	(1.2605)	(1.2787)	(1.6398)	(1.6729)	(1.7703)	(1.2913)	(1.3015)	(1.6583)	(1.6492)	(1.7500)
Log-likelihood	-1712.6158	-1702.4898	-1081.3821	-1046.0376	-1001.9992	-1715.0958	-1705.2487	-1081.9166	-1046.3163	-1002.6716
Log-likelihood, constant term only	-1717.5064	-1717.5064	-1152.8126	-1128.3866	-1109.0594	-1717.5064	-1717.5064	-1152.8126	-1128.3866	-1109.0594
Wald chi2	10.1074	29.5783	129.9453	142.9787	4028.5530	4.6051	22.8611	128.6178	143.0427	4052.1626
Prob > chi2	0.0177	0.0000	0.0000	0.0000	0.0000	0.2031	0.0008	0.0000	0.0000	0.0000
Pseudo R2	0.0028	0.0087	0.0620	0.0730	0.0965	0.0014	0.0071	0.0615	0.0727	0.0959
Number of observations	1328	1328	908	891	876	1328	1328	908	891	876

Note: * p<0.1, ** p<0.05, *** p<0.01. Robust standard errors. Specifications (5) and (10) include high-school regional dummies

Table A 8 Mean values of DL by educational attainment, females. The subsample, obtained by the first procedure of deletion of outliers.

	Mean	Standard deviation	Number of observations
Uncompleted secondary school	0.9943923	0.0470138	181
Completed school education	0.9972501	0.0476001	406
Completed vocational, professional education	0.9978766	0.0421349	471
Completed university degree or higher degrees	0.9993214	0.0426859	846
Total	0.9980538	0.0440562	1904
N	1904		

Table A 9 Mean values of DL by educational attainment, males. The subsample, obtained by the first procedure of deletion of outliers.

	Mean	Standard deviation	Number of observations
Uncompleted secondary school	0.9893208	0.0405153	118
Completed school education	0.9948966	0.0432867	329
Completed vocational, professional education	0.9972439	0.0432997	226
Completed university degree or higher degrees	1.0001598	0.040063	426
Total	0.9973781	0.0419026	1099
N	1099		

Table A 10 Mean values of DR by educational attainment, females. The subsample, obtained by the first procedure of deletion of outliers.

	Mean	Standard deviation	Number of observations
Uncompleted secondary school	0.9942266	0.0472726	181
Completed school education	0.9990947	0.0463927	406
Completed vocational, professional education	0.9951165	0.0421389	471
Completed university degree or higher degrees	1.000062	0.0400308	846
Total	0.9983257	0.0427335	1904
N	1904		

Table A 11 Mean values of DR by educational attainment, males. The subsample, obtained by the first procedure of deletion of outliers

	Mean	Standard deviation	Number of observations
Uncompleted secondary school	0.9909249	0.0465755	118
Completed school education	0.997973	0.0422924	329
Completed vocational, professional education	0.9966105	0.0418531	226
Completed university degree or higher degrees	0.9994134	0.0411657	426
Total	0.9974944	0.0422687	1099
N	1099		

Table A 12 Predicted probabilities, males. The subsample, obtained by the first procedure of deletion of outliers.

Digit ratios	(1)	(2)	(3)	(4)
.8	0.0545**	0.621***	0.0531**	0.614***
	(2.11)	(5.91)	(2.17)	(5.95)
.83	0.0587**	0.640***	0.0575**	0.634***
	(2.32)	(7.03)	(2.38)	(7.11)
.86	0.0632**	0.658***	0.0623***	0.654***
	(2.55)	(8.45)	(2.61)	(8.60)
.89	0.0681***	0.675***	0.0675***	0.673***
	(2.78)	(10.25)	(2.84)	(10.47)
.92	0.0733***	0.692***	0.0730***	0.691***
	(3.00)	(12.43)	(3.05)	(12.73)
.95	0.0788***	0.709***	0.0790***	0.709***
	(3.17)	(14.82)	(3.20)	(15.15)
.98	0.0848***	0.725***	0.0855***	0.726***
	(3.27)	(16.90)	(3.26)	(17.11)
1.01	0.0911***	0.740***	0.0923***	0.743***
	(3.26)	(17.95)	(3.22)	(17.96)
1.04	0.0979***	0.755***	0.0997***	0.759***
	(3.16)	(17.74)	(3.09)	(17.60)
1.07	0.105***	0.770***	0.108***	0.774***
	(2.99)	(16.74)	(2.91)	(16.57)
1.1	0.113***	0.783***	0.116***	0.789***
	(2.79)	(15.50)	(2.71)	(15.39)
1.13	0.121***	0.797***	0.125**	0.802***
	(2.58)	(14.34)	(2.51)	(14.33)
1.16	0.130**	0.809***	0.135**	0.816***
	(2.38)	(13.38)	(2.32)	(13.45)
1.19	0.139**	0.821***	0.145**	0.828***
	(2.20)	(12.60)	(2.15)	(12.77)
N	721	721	721	721

z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Columns 1-2 reflect digit ratios of the left hand, columns 3-4 reflect digit ratios of the right hand.

Table A 13 Predicted probabilities, males (subsample, according to the second outliers deletion procedure). The subsample, obtained by the second procedure of deletion of outliers.

Digit ratios	(1)	(2)	(3)	(4)
.8	0.0457**	0.587***	0.0439**	0.574***
	(2.35)	(6.22)	(2.42)	(6.25)
.83	0.0503**	0.611***	0.0487***	0.600***
	(2.56)	(7.44)	(2.63)	(7.53)
.86	0.0552***	0.634***	0.0540***	0.626***
	(2.78)	(9.00)	(2.84)	(9.15)
.89	0.0606***	0.656***	0.0598***	0.651***
	(3.00)	(10.98)	(3.05)	(11.21)
.92	0.0664***	0.678***	0.0663***	0.676***
	(3.19)	(13.38)	(3.22)	(13.68)
.95	0.0729***	0.700***	0.0733***	0.699***
	(3.33)	(16.05)	(3.34)	(16.35)
.98	0.0798***	0.720***	0.0811***	0.721***
	(3.40)	(18.46)	(3.38)	(18.67)
1.01	0.0874***	0.739***	0.0896***	0.743***
	(3.38)	(19.90)	(3.35)	(19.98)
1.04	0.0956***	0.758***	0.0989***	0.763***
	(3.29)	(20.09)	(3.24)	(20.13)
1.07	0.104***	0.776***	0.109***	0.782***
	(3.14)	(19.40)	(3.09)	(19.53)
1.1	0.114***	0.792***	0.120***	0.800***
	(2.96)	(18.38)	(2.92)	(18.69)
1.13	0.124***	0.808***	0.132***	0.817***
	(2.77)	(17.38)	(2.74)	(17.89)
1.16	0.136***	0.823***	0.145**	0.833***
	(2.59)	(16.55)	(2.57)	(17.25)
1.19	0.148**	0.837***	0.159**	0.848***
	(2.42)	(15.92)	(2.42)	(16.80)
N	876	876	876	876

z statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Columns 1-2 reflect digit ratios of the left hand, columns 3-4 reflect digit ratios of the right hand.

Table A 14 Generalized ordered logit regression output, quadratic form, full sample

	(1) Educational attainment b/se	(2) Educational attainment b/se	(3) Educational attainment b/se	(4) Educational attainment b/se
1				
Digit ratios of the left hand (DL)	-21.7080		-73.9577	
	(85.3445)		(64.4729)	
Digit ratios of the left hand squared (DL2)	11.2558		39.5678	
	(41.9751)		(32.4023)	
Digit ratios of the right hand (DR)		47.6893		49.9223
		(60.5097)		(74.5398)
Digit ratios of the right hand squared (DR2)		-23.9990		-23.7002
		(30.2106)		(37.8023)
Constant	12.9676	-21.1203	35.3571	-25.1042
	(43.3869)	(30.3037)	(32.0362)	(36.6252)
2				
Digit ratios of the left hand (DL)	101.1503***		54.3408	
	(34.1581)		(41.9353)	
Digit ratios of the left hand squared (DL2)	-50.5049***		-25.3623	
	(16.9885)		(20.8978)	
Digit ratios of the right hand (DR)		84.6842**		24.7727
		(34.2657)		(34.4944)
Digit ratios of the right hand squared (DR2)		-42.6643**		-11.1177
		(17.0476)		(17.2063)
Constant	-49.9470***	-41.3302**	-28.7519	-13.4425
	(17.1575)	(17.2185)	(21.0309)	(17.2684)
3				
Digit ratios of the left hand (DL)	89.1939**		43.9621	
	(41.3021)		(55.0075)	
Digit ratios of the left hand squared (DL2)	-44.7638**		-20.3557	
	(20.6199)		(27.3928)	
Digit ratios of the right hand (DR)		126.4522***		0.4822
		(36.0204)		(34.6217)
Digit ratios of the right hand squared (DR2)		-63.0794***		1.0896
		(17.8262)		(17.2549)
Constant	-43.3738**	-62.2608***	-24.5794	-2.5845
	(20.6601)	(18.1854)	(27.5976)	(17.3576)
Log-likelihood	-1336.9528	-1334.7368	-1004.0701	-1007.6486

Log-likelihood, constant term only	-1501.1664	-1499.7447	-1113.8247	-1114.9440
Wald chi2	253.7872	253.3575	3575.2441	4305.4290
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.1094	0.1100	0.0985	0.0962
Number of observations	1279	1278	880	881

Note: * p<0.1, ** p<0.05, *** p<0.01. Robust standard errors. Specifications 1 and 2 represent regressions for females, 3 and 4 represent regressions for males, all regressions control for parental education, age , high-school regional dummies

Table A 15 Generalized ordered logit regression output, quadratic form, full sample. The subsample, obtained by the first procedure of deletion of outliers.

	(1) Educational attainment b/se	(2) Educational attainment b/se	(3) Educational attainment b/se	(4) Educational attainment b/se
1				
Digit ratios of the left hand (DL)	-367.0695		-315.1511	
	(269.2198)		(213.0444)	
Digit ratios of the left hand squared (DL2)	182.8623		160.8369	
	(135.6268)		(106.7872)	
Digit ratios of the right hand (DR)		88.4577		-225.5660
		(177.8369)		(230.3707)
Digit ratios of the right hand squared (DR2)		-43.0027		115.3974
		(88.3193)		(115.4559)
Constant	186.6016	-42.9574	155.0851	110.9874
	(133.4750)	(89.5686)	(106.1978)	(114.9252)
2				
Digit ratios of the left hand (DL)	48.7031		27.1139	
	(101.9083)		(111.1342)	
Digit ratios of the left hand squared (DL2)	-23.8696		-10.5827	
	(50.6869)		(55.7616)	
Digit ratios of the right hand (DR)		143.4711		286.1707**
		(105.1344)		(129.6659)
Digit ratios of the right hand squared (DR2)		-72.1416		-139.8916**
		(52.3645)		(65.0636)
Constant	-24.2473	-70.7310	-16.2011	-145.8657**
	(51.1766)	(52.7584)	(55.3564)	(64.5529)
3				
Digit ratios of the left hand (DL)	124.9689		130.7950	
	(92.2828)		(104.9759)	
Digit ratios of the left hand squared (DL2)	-62.8886		-63.1534	
	(45.9797)		(52.5129)	
Digit ratios of the right hand (DR)		106.6736		387.0394***
		(102.0774)		(141.4947)
Digit ratios of the right hand squared (DR2)		-52.5130		-189.3443***
		(50.8631)		(70.7955)
Constant	-61.0534	-53.1505	-68.4061	-198.3090***

	(46.2440)	(51.1854)	(52.4244)	(70.6251)
Log-likelihood	-1032.8949	-1034.0671	-748.8243	-742.8252
Log-likelihood, constant term only	-1173.1319	-1173.1319	-833.7735	-833.7735
Wald chi2	222.6487	213.6393	2735.1659	2513.1992
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.1195	0.1185	0.1019	0.1091
Number of observations	1019	1019	663	663

Note: * p<0.1, ** p<0.05, *** p<0.01. Robust standard errors. Specifications 1 and 2 represent regressions for females, 3 and 4 represent regressions for males, all regressions control for parental education, age , high-school regional dummies

Table A 16 Generalized ordered logit regression output, quadratic form, full sample. The subsample, obtained by the second procedure of deletion of outliers

	(1) Educational attainment b/se	(2) Educational attainment b/se	(3) Educational attainment b/se	(4) Educational attainment b/se
1				
Digit ratios of the left hand (DL)	-8.0208		-62.9674	
	(93.2827)		(76.7248)	
Digit ratios of the left hand squared (DL2)	4.4103		34.0014	
	(46.1310)		(38.4488)	
Digit ratios of the right hand (DR)		59.3934		71.9218
		(64.0049)		(74.4218)
Digit ratios of the right hand squared (DR2)		-29.8390		-34.7938
		(32.0366)		(37.7272)
Constant	6.1303	-26.9731	29.9405	-35.9975
	(47.1376)	(31.9664)	(38.2270)	(36.5977)
2				
Digit ratios of the left hand (DL)	114.2449***		46.6446	
	(35.3537)		(44.9335)	
Digit ratios of the left hand squared (DL2)	-57.0368***		-21.4679	
	(17.6086)		(22.3815)	
Digit ratios of the right hand (DR)		74.9242**		55.6117
		(35.8000)		(38.0415)
Digit ratios of the right hand squared (DR2)		-37.7577**		-26.4147
		(17.8340)		(18.9545)
Constant	-56.5112***	-36.5088**	-24.9389	-28.9378
	(17.7288)	(17.9654)	(22.5407)	(19.0684)
3				
Digit ratios of the left hand (DL)	120.8718***		36.1256	
	(38.5464)		(55.8564)	
Digit ratios of the left hand squared (DL2)	-60.6790***		-16.3582	
	(19.2067)		(27.8151)	
Digit ratios of the right hand (DR)		124.3916***		46.4167
		(36.7682)		(39.0547)
Digit ratios of the right hand squared (DR2)		-61.9862***		-21.4114
		(18.2113)		(19.3249)
Constant	-59.1182***	-61.3152***	-20.7173	-25.9293

	(19.3169)	(18.5477)	(28.0235)	(19.7215)
Log-likelihood	-1326.9922	-1327.6007	-1000.6815	-1001.5317
Log-likelihood, constant term only	-1492.5486	-1492.5486	-1109.0594	-1109.0594
Wald chi2	256.0841	254.1809	3588.6821	4196.1241
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.1109	0.1105	0.0977	0.0970
Number of observations	1272	1272	876	876

Note: * p<0.1, ** p<0.05, *** p<0.01. Robust standard errors. Specifications 1 and 2 represent regressions for females, 3 and 4 represent regressions for males, all regressions control for parental education, age , high-school regional dummies