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RESEARCH ARTICLE

Children's Personality and Its Contribution to School Grades Inequality: Evidence From Mexico

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ABSTRACT

We explore the relationship between Big-5 Personality Traits and school grades, using a novel survey of state primary school children in Mexico. Linear school fixed-effects estimates controlling for household income, principal caregiver's education, IQ, and personality traits indicate that higher conscientiousness and agreeableness consistently and significantly correlate with high school performance in all subjects, net of child's IQ. A regression-based inequality decomposition shows that a child's personality accounts for 5.1% and 6.5% of the inequality in mathematics for girls and boys, whereas for Spanish, it accounts for 3.9% and 8.0%, respectively. Results are robust to unobservable confounders using Oster bounds.

1 | Introduction

Studies based on the Program for International Student Assessment (PISA) present overwhelming evidence that girls outperform boys in reading, whereas boys marginally outperform girls in mathematics, consistent with a reversal of the education gender gap in recent decades (OECD 2015). As a representative developing country, Mexico offers a unique setting for studying gender differences in academic achievement. In line with other developing countries, girls in Mexico outperformed boys by 11 score points in reading but underperformed boys by 12 score points in math.

One potentially important but under-researched channel for the achievement gender gap is the role of mother's and children's personalities, which might have heterogeneous effects as suggested by Duckworth and Seligman (2006) for gender differences in self-discipline. Since Webb's (1915) pioneering study on the role of "character" in explaining students' academic performance, our understanding of the importance of noncognitive effects is still under-developed largely due to difficulties in measuring personality and challenges in sorting out whether differences in personality across individuals reflect "nature" versus "nurture" variation (Borghans et al. 2008). It was not until the 1990s that the Big-5 Personality Traits (B5PT) model was widely adopted as a consistent personality framework. Studies using B5PT measures have firmly established a robust relationship between academic attainment and B5PT as measured by extroversion (E), agreeableness (A), conscientiousness (C), neuroticism (N), and openness (O) (e.g., Poropat 2009).

An emerging literature is concerned with the extent to which cognitive and noncognitive skills interact with each other at different stages of a child's education production. Cunha and Heckman (2007) introduce a theoretical framework of stage-specific cognitive and noncognitive skill formation that allows

for dynamic complementarities. Subsequent research studies indicate that early childhood interventions could often have stronger effects on personality and other noncognitive skills than on cognitive skills (see, e.g., Heckman, Pinto, and Savelyev 2013; Kliem and Sandner 2021). For analyzing the long-term effects of such interventions, it is therefore important to know how personality and other noncognitive skills affect school outcomes. However, the extent to which cognitive and noncognitive skills contribute to the gender gap in educational achievement during early childhood remains largely unknown.

Despite the advancement on the theoretical front, direct empirical evidence on the interaction of cognitive and noncognitive skills remains thin, as few existing surveys collect all the information needed—including measures of family background and school quality. To bridge the gap, we design a new representative survey of primary-school children and their principal caregivers (PCs) in Mexico, with both cognitive and noncognitive abilities measured with age-appropriate interviewing techniques and adapted for the Spanish language context. This is then individually matched to administrative student grades records for math and Spanish to form the baseline survey of the Aguascalientes Longitudinal Study of Child Development (EDNA) (Miranda et al. 2020).

Specifically, we run a field implementation of the Berkeley Puppet Interview Big Five Questionnaire of Measelle et al. (2005), which is an age-appropriate interviewing technique not requiring strict laboratory conditions and adapted for the Spanish language context. EDNA's Field Puppet Interview-Big Five Questionnaire Test (FPI-BFQ) shows very good reliability for all five dimensions as measured by the omega statistics for the child, with E-omega = 0.87, A-omega = 0.88, C-omega = 0.82, N-omega = 0.82, and O-omega = 0.91 (Peralta et al. 2021).

We focus on studying the relationship of both B5PT and cognitive abilities of primary school pupils with the level and variation of their year-averaged school grades, controlling for household income, PC's education, IQ, and personality traits, as well as school fixed-effects.

Our findings show that a child's conscientiousness (C^C) and agreeableness (A^C) are substantially and significantly correlated with higher grades in all subjects, net of her/his cognitive abilities (IQ^C) as measured by a 18-item colored Raven's progressive matrices (RPM) test.

Further, using a regression-based inequality decomposition approach (Shorrocks 1982; Fields 2003), we show that children's personality traits account for 5.5% of the inequality in school grades for math and 5.1% of the inequality for Spanish in the pooled gender analysis, equivalent to 59% and 65% of the inequality related to differences in children's IQ for math and Spanish, respectively. Personality matters more for boys, whereas IQ matters more for girls. Furthermore, PC's conscientiousness (C^P) has a large positive association with school grades only for boys (both subjects), whereas PC's neuroticism (N^P) has a large negative association only for girls (both subjects). Our results are also robust to potential unobservable confounders using the Oster (2019) bounds.

We contribute to the literature in education economics and child development in a couple of ways. First, using novel primary data in a developing country context, we show a very substantial relationship between noncognitive skills as measured by B5PT and primary school students' grades, net of children's cognitive skills. Second, our gender disaggregated analysis sheds new light on the differential role of IQ and personality traits in explaining the gender gap in students' educational achievement. For both subjects, the relationship between personality traits and school grades—in agreeableness and conscientiousness in particular—is more pronounced for boys, whereas IQ matters more for girls.

2 | Materials and Methods

2.1 | Data and Key Variables

EDNA is a representative study of over 1000 students in 100 schools who started first grade in 2016 in a public primary school of the state of Aguascalientes, Mexico. More information about EDNA's sample design is available in Miranda et al. (2020).

We exclude observations with missing values on key variables or mis-reported year of birth and children who were grade-retained. The analytic sample has 923 observations. Mothers, grandmothers, and fathers account for 91%, 4.4%, and 2.4% of PCs, respectively. Overall, 55% of PCs have secondary education. Only 7.4% have professional qualifications. Average household income per month is around 5208 pesos. Girls make up 51% of children. Age-within-year is measured in days with reference to the day the cohort entered first grade, such that younger pupils have positive age-within-year values.[1] The Online Appendix contains descriptive statistics.

Our main response variables are school grades in math and Spanish for the 2018/19 academic year, obtained from administrative records of the *Instituto de Educación de Aguascalientes* (IEA) (Aguascalientes Education Institute).[2] The Online Appendix offers a kernel distribution estimate of our response variables.

Children sit exams in math and Spanish every 2 months during the academic year. For analysis, we use year-averaged grades per subject, which has been found to substantially reduce measurement errors (Guskey 2011). To ease interpretation, we standardize our response variables to have a zero mean and standard deviation of one.

Key controls include personality and IQ measures for children and mothers. Child IQ is measured using an 18-item colored RPM test suitable for children between 5 and 11, which is based on pattern recognition and widely used as a non-verbal test of intelligence and abstract reasoning (Raven, Court, and Raven 1998). At each item, a figure with a missing piece is shown, and subjects must choose the piece that completes the pattern. Difficulty increases as the subject progresses from item to item. The 18-item scale achieves a reliability (Cronbach's alpha) of alpha = 0.66 and omega = 0.65, which is below 0.7 but still acceptable.

Adult personality (for the PC) is measured using the Spanish version of B5PT with the alpha statistics for the PC: E-alpha = 0.81,

A-alpha = 0.81, C-alpha = 0.75, N-alpha = 0.79, and O-alpha = 0.81. Finally, PC IQ is measured using a 12-item RPM test.

2.2 | Empirical Methods

We use regression-based decomposition of inequality based on the Fields (2003) and Shorrocks (1982) methods, implemented by Fiorio and Jenkins (2021), to decompose the population inequality of school grades in terms of the components given by the data generating process (DGP).

$$\mathbf{y}_{gist} = \mathbf{x}_{gist}\boldsymbol{\beta} + \delta IQ^{c}_{ist-1} + \theta P^{c}_{ist-1} + c_s + u_{gist}, \tag{1}$$

where $\mathbf{y}_{gist}$ represents the standardized grade (mean zero, sd one) in the g-th subject of the i-th student in the s-th school at time t, with $g = \{\text{Math, Spanish}\}$, $i = 1,\ldots,N$, $s = 1,\ldots,S$, and t represents the 2017/18 and 2018/19 academic years. Similarly, $\mathbf{x}_{gist}$ is a $1 \times K$ vector of explanatory variables, IQ^{c}_{ist-1} and P^{c}_{ist-1} represent child's IQ and personality at time $t-1$, $\boldsymbol{\beta}$ is a $K \times 1$ vector of coefficients, and u_{gist} is a random error. School fixed-effects c_s control for potential unobserved heterogeneity across schools. Notice that our main response variables are measured 1 academic year after children's IQ and personality were measured, and 2 academic years after mother's IQ and personality were measured. Equation (1) is fitted by fixed-effects regression. Standard errors are clustered to allow potential correlation of units at school level.

Define the inequality statistic as $I(\mathbf{Y})$, whit $\mathbf{Y} = (y_1,\ldots,y_N)'$. Shorrocks (1982) shows that $I(\cdot)$ may be any function of the data. We can interpret Equation (1) in terms of the decomposition of $I(\cdot)$ by factor source with factors $F_1,\ldots,F_{K+1}$ given by

$$F_j = \pi_j w_j; j = 2,\ldots,K, \tag{2}$$

$$F_{K+1} = u. \tag{3}$$

Hence, Equation (1) can be written as

$$y = w_1 + F_1 + \cdots + F_{K+1}. \tag{4}$$

Define the total inequality in terms of its factor sources,

$$I(\mathbf{Y}) = \sum_{j=2}^{k+1} G_j\left(F_j\right), \tag{5}$$

where $G_j(\cdot)$ is the contribution of the j-th factor to total inequality. Hence, the proportional contribution of the j-th factor is

$$g_j = \frac{G_j\left(F_j\right)}{I(\mathbf{Y})}, \tag{6}$$

which Cowell and Fiorio (2011) show can be written as

$$\begin{aligned} g_j = \frac{\sigma(F_j,y)}{\sigma^2(y)} = \pi_j^2\frac{\sigma^2(x_j)}{\sigma^2(y)} + \sum_{h\neq j}^{K}\pi_j\pi_h\rho_{j,h}\frac{\sigma(x_j)\sigma(x_h)}{\sigma^2(y)} \\ +\pi_j\rho_{j,u}\frac{\sigma(x_j)\sigma(u)}{\sigma^2(y)}; j = 2,\ldots,K, \end{aligned} \tag{7}$$

with,

$$g_{K+1} = \frac{\sigma^2(u)}{\sigma^2(y)} + \sum_{j=1}^{K}\pi_j\rho_{j,u}\frac{\sigma\left(x_j\right)\sigma(u)}{\sigma^2(y)}, \tag{8}$$

where $\sigma^2(\cdot) = Var(\cdot)$, $\sigma(\cdot,\cdot) = Cov(\cdot,\cdot)$, and $\rho_{\cdot,\cdot} = Corr(\cdot,\cdot)$. Equations (7) and (8) define the inequality decomposition of y in terms of its factor sources. $\hat{\boldsymbol{\pi}}$ can be fitted by regressing y on $\boldsymbol{x}$ by OLS, including the school fixed-effects in Equation (1).

3 | Results

Table 1 presents fixed-effects regression results for Equation (1). Coefficients can be interpreted as marginal effects in standard deviations. We estimate both pooled and gender-specific specifications. Robustness check specifications are included in the Online Appendix, including one controlling for a child's number of doctor visits in the previous 12 months as a proxy of child's health. In all cases, we find similar results to the ones reported in Table 1.

3.1 | Relationship Between PC and Child's Characteristics With School Grades

We find strong evidence that education/qualifications of the PC, in most cases the mother (hence we use PC and mother interchangeably hereafter), is a strong predictor of the child's academic performance. Increasing mother's qualifications for professional studies is associated with an increment in a child's performance in math by around 0.57 sds, statistically significant at 1%. Similar findings are reported for Spanish. PC's IQ is found to be statistically insignificant.

In terms of mother's personality, a 1-sd increment on a mother's consciousness is related to an increment on her child's performance on math by 0.13 sds (significant at 10%) and on Spanish by 0.16 sds (significant at 5%). These results indicate that organized, self-disciplined, and goal-oriented mothers might be better at helping their children to learn and achieve higher grades at school. On the contrary, neuroticism is associated with lower child performance on math by −0.10 sds (significant at 5%) and on Spanish by −0.12 sds (significant at 5%). Finally, a one-unit increase in household log(income) (an increase of about 6833 Mexican pesos) results in an increment of 0.13 sds on both math and Spanish; both partial correlations are significant at 5%.

In terms of characteristics of the child, girls outperform boys by 0.34 sds in math and 0.45 sds in Spanish. Regarding children's cognitive ability, a one-unit increment in children's IQ has a marginal effect of 0.27 sds on math and 0.24 sds on Spanish. Both partial correlations are significant at 1%.

Moreover, one unit increment in agreeableness has a 0.08-sd marginal effect on math and a 0.10 sds marginal effect on Spanish. Similarly, a 1-sd increment in conscientiousness has a 0.08-sd marginal effect on both (math and Spanish). Both partial correlations are statistically significant at 5%.

In terms of mechanisms, previous research studies on secondary and high school students find that agreeable students like to be friendly and to "fit in." Consequently, they are amenable to instructions and requests from parents and teachers, which leads to surface learning and better school performance (Vermetten, Lodewijks, and Vermunt 2001). Similarly, agreeable students

TABLE 1 | Fixed-effects regressions for school grades in the 2018/19 academic year (ages 8–9).

	All sample		Girls		Boys	
	Math	**Spanish**	**Math**	**Spanish**	**Math**	**Spanish**
			Principal caregiver characteristics			
Age	0.006	0.004	0.003	0.001	0.011*	0.008
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
Female	0.348*	0.145	0.244	−0.047	0.734***	0.567**
	(0.18)	(0.16)	(0.25)	(0.21)	(0.26)	(0.28)
ED^P: None	−0.034	−0.298	0.201	−0.048	−0.641***	−0.763***
	(0.18)	(0.19)	(0.25)	(0.26)	(0.24)	(0.25)
ED^P: Primary	−0.221**	−0.218**	−0.074	−0.195*	−0.438***	−0.312**
	(0.09)	(0.09)	(0.12)	(0.12)	(0.16)	(0.15)
ED^P: Preparatory	0.235***	0.252***	0.358***	0.327***	0.087	0.109
	(0.09)	(0.09)	(0.12)	(0.12)	(0.14)	(0.15)
ED^P: Technical	0.288*	0.274	0.417*	0.416	0.604*	0.592*
	(0.16)	(0.18)	(0.24)	(0.27)	(0.35)	(0.35)
ED^P: Profesional	0.570***	0.487***	0.33	0.249	0.670***	0.572***
	(0.13)	(0.13)	(0.27)	(0.21)	(0.18)	(0.19)
IQ^P	−0.027	−0.006	0.056	0.041	−0.084*	−0.076
	(0.03)	(0.03)	(0.05)	(0.05)	(0.05)	(0.05)
Household log(income)	0.126**	0.135**	0.089	0.055	0.210**	0.277***
	(0.06)	(0.06)	(0.09)	(0.08)	(0.10)	(0.10)
E^P	0.045	0.004	0.038	0.028	0.055	−0.053
	(0.07)	(0.07)	(0.10)	(0.10)	(0.10)	(0.10)
A^P	−0.069	−0.053	−0.038	−0.05	−0.013	0.051
	(0.08)	(0.08)	(0.11)	(0.12)	(0.12)	(0.12)
C^P	0.131*	0.163**	−0.018	0.013	0.289***	0.298***
	(0.07)	(0.07)	(0.10)	(0.11)	(0.11)	(0.11)
N^P	−0.098**	−0.117**	−0.136**	−0.173***	−0.113	−0.11
	(0.05)	(0.05)	(0.05)	(0.06)	(0.08)	(0.08)
O^P	−0.108*	−0.073	−0.045	−0.015	−0.254**	−0.176*
	(0.06)	(0.06)	(0.09)	(0.09)	(0.10)	(0.10)
			Child's characteristics			
Female	0.336***	0.449***				
	(0.06)	(0.06)				
Age within year	−0.001**	−0.000*	−0.001**	−0.001**	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
IQ^C	0.271***	0.247***	0.314***	0.289***	0.197***	0.181***
	(0.03)	(0.03)	(0.04)	(0.04)	(0.05)	(0.05)
E^C	0.037	0.026	0.008	−0.016	0.056	0.031
	(0.04)	(0.04)	(0.05)	(0.05)	(0.06)	(0.06)
A^C	0.081**	0.095**	0.050	0.055	0.130**	0.164***
	(0.03)	(0.04)	(0.06)	(0.06)	(0.05)	(0.06)
C^C	0.078**	0.084**	0.087	0.050	0.090**	0.134***
	(0.03)	(0.04)	(0.05)	(0.06)	(0.05)	(0.05)

(Continues)

TABLE 1 | (Continued)

	All sample		Girls		Boys	
	Math	**Spanish**	**Math**	**Spanish**	**Math**	**Spanish**
N^C	−0.016	−0.013	−0.04	−0.057	−0.057	−0.029
	(0.04)	(0.04)	(0.05)	(0.05)	(0.06)	(0.06)
O^C	0.054	0.024	0.073	0.062	−0.022	−0.054
	(0.03)	(0.03)	(0.06)	(0.05)	(0.05)	(0.05)
School fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	923	923	471	471	452	452
No. of clusters	135	135	132	132	128	128
ρ	0.25	0.23	0.32	0.32	0.37	0.32

Note: Marginal effects reported with clustered robust standard errors at school level written in parenthesis. Principal caregiver's controls: Age, sex, education, log household income. Child's controls: Age within year. All specifications include school FEs.
*10% significant. **5% significant. ***1% significant.

TABLE 2 | Regression-based decomposition of the inequality in pupils' school grades by sex.

	All sample		Girls		Boys	
	Math	**Spanish**	**Math**	**Spanish**	**Math**	**Spanish**
Residual	**56.8**	**57.3**	**48.6**	**48.5**	**44.1**	**47.6**
	Total contribution of key characteristics					
PC education	5.3	5.4	4.9	5.7	7.5	6.6
PC personality	1.1	1.3	1.2	1.3	1.3	1.4
Child IQ	9.3	7.9	13.2	11.6	5.9	5.3
Child personality	5.5	5.1	5.1	3.9	6.5	8.0
	Total contribution of mother and child characteristics					
PC characteristics	7.6	7.9	7.5	8.0	11.2	11.1
Child characteristics	15.4	13.4	19.7	16.5	12.7	13.4

Note: Regression-decomposition of inequality based in Fields (2003) and Shorrocks (1982) methods.

are likely to adopt values the community perceives as desirable and to procrastinate less (Lubbers et al. 2010). Similarly, conscientious individuals have a tendency for being self-disciplined, careful, and diligent, characteristics that are all valuable for good academic performance (Bidjerano and Dai 2007).

Table 1 also presents results for girls and boys separately. We find that mother's conscientiousness has a significant positive relationship with school grades only for boys, and neuroticism has a significant negative relationship only for girls.

3.2 | Contribution of PC and Child's Characteristics to School Grade Inequality

Table 2 presents results of decomposing the inequality in school grades for math and Spanish for pooled and gender-specific specifications. The first row shows that just over half of the total inequality in standardized mean grades remains unexplained for all subjects, even with our unusually rich set of controls.

We find that PC's education explains about 5.3% of the inequality in school grades in math and 5.4% in Spanish. This is a relatively large contribution to inequality when compared to the contribution of the PC's personality traits, which only explain 1.1% of the inequality in math and 1.3% in Spanish.

A child's IQ is the largest contributor to grade inequality across all subjects, explaining 9.3% of the inequality in math and 7.9% of the inequality in Spanish. Moreover, children's personality traits explain about 5.5% of the inequality in math and 5.1% of the inequality in Spanish.

Overall, the PC's characteristics, including household income, sum up to a total contribution of 7.6% to the inequality in math and 7.9% to the inequality in Spanish. Although the contribution of PC's characteristics is important, the contribution of children's characteristics is about twice as important in all subjects.

Decomposing inequality in school grades for girls and boys separately, we find that the overall contribution of personality relative to IQ is 110% (math) and 151% (Spanish) for boys, whereas

it is only 39% (math) and 34% (Spanish) for girls. Hence, the contribution of children's personality to inequality in school grades is remarkably different by gender.

4 | Summary and Conclusions

Allowing for a rich set of control variables, including school fixed-effects, we present indicative evidence of the relationship between a child's personality traits and his/her school grades at the early stage of compulsory education in a developing country setting through agreeableness and conscientiousness, especially for boys. Further, children's personality traits are shown to be major factors contributing to the variation in academic performance of children aged 8. The association is relatively large, equivalent to 59% and 65% of child's IQ for math and Spanish, respectively. Children's personality contribution to school grade inequality is as large as that of the education of the PC for math and Spanish.

Although our results are robust to potential unobservable confounders using the Oster (2019) bounds (see Online Appendix), we caution against a causal interpretation as potential unobserved time-varying factors may affect both noncognitive skills and educational outcomes. Nevertheless, the strongly gendered patterns of the associations between children's grades and their noncognitive skills after accounting for a rich set of controls, including IQ and school fixed-effects, are novel and could inspire further research on this important topic.

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Ethics Statement

EDNA baseline survey did not have IRB approval because CIDE did not have an IRB at the time of data collection. Despite lacking IRB review, EDNA's research team followed the best international ethical practices, including requesting principal caregivers to sign an informed consent form.

Consent

Principal caregivers signed an informed consent form—a copy of the form can be obtained from the corresponding author. Parental permision for the pupil's interview at school was requested in writing. For children, the consent of the participant was verbally requested before starting the interview.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data and Stata do-files for replication can be obtained from the authors upon request.

Endnotes

[1] In Mexico, children enter first grade the year they turn 6, and the academic year begins at the end of August. As a consequence, all children in our sample were born in 2010, and the cohort entered 1st grade on August 22, 2016. Age-within-year measures a child's age, in days, relative to August 22. A child born on August 22 has age-within-year = 0, whereas one born on January 1 has age-within-year = −234 and one born on December 31 has age-within-year = 131. This continuous measure of relative age is a strong predictor of children's school achievement throughout primary and secondary school (Crawford et al. 2014).

[2] Grades are school and class-specific.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.