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Prenatal testosterone predicts financial risk taking: Evidence from Latin America

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ABSTRACT

Most research on the relation between steroid hormones and risky behavior has been done for Caucasian populations using 2D:4D. Some articles with ethnically mixed samples were not conclusive. We studied the relation between prenatal exposure to testosterone (T) and financial risk in a Colombian population (89 male, 34 female). Colombian population is the result of miscegenation among Amerindian, Spanish and African groups. Prenatal exposure to T was proxied by 2D:4D and *rel*2 digit ratios. Risk behavior was elicited by the choice of a lottery in a 50%–50% Eckel and Grossman task with actual monetary payoffs. People with higher prenatal T exposure (lower left-hand 2D:4D, *rel*2 ratios) tend to choose more risky lotteries, although the effect is weak and better captured in binary-choice than in ordered-logit models. Results are statistically significant for the left hand but not for the right hand. An increment of one standard deviation in the 2D:4D/*rel*2 of the left hand diminishes the probability of taking the riskier lotteries by 8%/10%.

1. Introduction

Prenatal exposure to testosterone (T) is linked to risky behaviors in several areas such as extreme-sports playing, reckless social behavior (Stenstrom, Saad, Nepomuceno, & Mendenhall, 2011), aggressive behavior in men (Bailey & Hurd, 2005), or sports ability in women (Paul, Kato, Hunkin, Vivekanandan, & Spector, 2006). Studies focusing on financial risk have found mixed results (see Apicella, Carré, & Dreber, 2015 for a review).

The importance of prenatal exposure to T lies in the organizing effects it has in the brain (Arnold & Breedlove, 1985; Brañas-Garza & Rustichini, 2011). Markers for such exposure are the ratio of the second to fourth finger (2D:4D ratio) (Manning, 2002) and the ratio of the second finger to the sum of fingers 2 to 5 (*rel*2) (Loehlin, Medland, & Martin, 2009; Stenstrom et al., 2011). The 2D:4D ratio tends to be negatively correlated to risky economic and financial behavior in Caucasian (Brañas-Garza & Rustichini, 2011; Dreber & Hoffman, 2007; Garbarino, Slonim, & Sydnor, 2011) but not in ethnically heterogeneous samples (Apicella et al., 2008; Sapienza, Zingales, & Maestripieri, 2009; Schipper, 2011, 2012). The same disparity appeared when using *rel*2 (Stenstrom et al., 2011). So far, only one study worked with a non-Caucasian population: 2D:4D was significantly correlated with economic risk for a population of male students from Bangladesh (Sytsma, 2014). There are no studies on the relation between *rel*2 and financial risk with actual monetary payoffs. It has been observed that *rel2* outperforms 2D:4D in several instances (Loehlin et al., 2009; Nepomuceno, Saad, Stenstrom, Mendenhall, & Iglesias, 2016; Stenstrom et al., 2011).

Most of the null effects or non-significant results come from ethnically heterogeneous populations, while most significant results come from homogeneous Caucasian populations. Hence, it is important to identify whether the relation holds for specific non-Caucasian populations, as it is possible that the mixed results arise from the fact that digit ratios are different for different ethnic or national groups (Manning, 2002; Manning & Fink, 2011; Manning, Henzi, & Venkatramana, 2003; Manning, Stewart, Bundred, & Trivers, 2004).

This study tests whether the relation between prenatal T and financial risk aversion holds for a Colombian population. It aims to contribute to the literature in two ways: first, by testing the relation for a non-Caucasian population; secondly, by providing evidence of the relation, using *rel*2 as a proxy for T exposure, with actual monetary payments.

Two key features of the Colombian population are early miscegenation and regional differentiation. Social history, blood-group analysis and mitochondrial DNA studies (Jaramillo Uribe, 1977; Sandoval, de la Hoz, & Yunis, 1993; Yunis & Yunis, 2013) found that the population in this area was the result of miscegenation (genetic admixture) between Spanish, African, and Amerindian people. The mixing process was well advanced by the 18th century (Dueñas Vargas, 1996). High diversity among a few well-defined regions was the result of elements such as the fear of malaria (with larger white presence in the mix in the Andean

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highlands), and the use of slaves in the gold mining areas and plantations (resulting in a larger black weighting in the coastal areas). As a result, the mix between the three groups varied according to the region. There are also some segregated Amerindian communities (e.g. in the Amazonian and the Pacific rainforests) and black communities (e.g. formed by runaway slaves in *palenques*). However, even in these segregated communities, there is evidence of some degree of genetic admixture, such as Caucasian alleles in surviving Amerindian groups (Trachtenberg, Keyeux, Bernal, Rhodas & Erlich, 1996), and Amerindian alleles in black communities (Rodas, Gelvez, & Keyeux, 2003; Trachtenberg, Keyeux, Bernal, Noble & Erlich, 1996). Unlike Argentina or Brazil, Colombia did not receive major immigration flows during the last two centuries. Thus, the Colombian population includes members from regions with different ethnic weightings in their mix, but it is still made up of a long-term hybrid of the three original groups.

Most participants in the study come from the Colombian midlands. According to blood group and mitochondrial DNA studies, this population is hybrid (mestizo) with mainly Amerindian and Spanish ancestors, with <4% of black ancestry (Rodas et al., 2003; Yunis & Yunis, 2013). Thus, the midland population can be considered as ethnically homogeneous.

As a result of extended miscegenation, identification of ethnic origin is not possible short of making genetic tests, and even then most cases would not have a single answer (black, white, or Amerindian), but rather would identify the particular mix for that individual. In addition, questions about an individual's ethnicity are misleading in this kind of society (Parra et al., 2003; Telles, 2004). Instead, given regional differentiation, we approached the question by using the town of birth of the participants. We made the tests for the whole sample and for the subsample of people born in the midland area. Thus, we had a whole sample drawn from a Colombian population mixed in various degrees and a subsample from a population with mainly white and Amerindian origin.

2. Materials and methods

2.1. Participants

In all, 125 economics students in their third or final year at the National University of Colombia, Bogota, taking a Research Methodology course between January 2015 and June 2016 were enrolled. One who declined to participate and another one with a broken finger were excluded. Of the 123 who actually participated, 89 were men and 34 were women, ranging in age between 18 and 21 years. All subjects were informed that they would be involved in a study on the role of physiological and social factors on decision making, that participation was voluntary and that anyone could leave the study at any time they wanted, no questions asked. They all signed a written consent before participation.

2.2. Procedure

Subjects filled out a demographic questionnaire, then the risk aversion measurement was taken, their hands were photocopied, and the payments were made at the end.

Apicella et al. (2008) found that circulating T is associated with risk-taking. In order to control for circadian variations in circulating T, all procedures were performed in the afternoon, between 2:00 pm. and 5:00 pm.

We measured financial risk aversion by means of the Binswanger (1980) and Eckel and Grossman (2002) 50%–50% procedure in the version previously adapted for the Colombian population by Attanasio, Barr, Cardenas, Genicot, and Meghir (2012) (Table 1).

Subjects faced 6 different lotteries (Table 1), all of them with 50%–50% probabilities. Lottery 1 had no risk (sure payoff), and the risk increased with the number of the lottery. The subject chose one lottery among them to actually be played, and received the payoff from the gamble in cash at the end of the session. After choosing the lottery, the subject moved to a different room where the palms of her hands were photocopied. After her return, she would toss a coin and receive the payoff.

At a different stage, two assistants without knowledge of the hypothesis measured the fingers on the photocopies with a ruler, from the midpoint of the bottom crease to the fingertip. Measurements were independently taken by each assistant and later compared. The intraobserver repeatabilities of the measurements were assessed with intraclass correlation coefficient (ICC) type one, employing a two-way mixed effects model with absolute agreement. If the difference in measurements for the same finger was >1 mm or there were incongruences (e.g. little larger than middle finger), the measurement was repeated and we chose the median of the three. We then checked for consistency of the data confirming the D2 < D3 > D4 > D5 inequalities for each hand. When we failed to find the expected inequalities (in 4 cases), we again measured the fingers involved to solve the discrepancy.

Prenatal exposure to T was proxied by 2D:4D (index/ring finger ratio) and *rel*2 (index/sum of index, middle, ring and little fingers ratio). Each measurement was normalized with respect to the population data, hence regression results can be interpreted as the effects of a standard deviation change in the finger ratio.

We followed the approach of Garbarino et al. (2011), who ran an ordered model for six lotteries, and OLS and probit for low-risk (lotteries 1–3) and high-risk (lotteries 4–6) groups, with the idea of checking that results were robust to changes in the statistical specification. We introduced two adjustments to this methodology. 1) We worked with logit models, which are equivalent to probit ones but easier to interpret. 2) We tested for the implicit assumption of ordered models that all coefficients of the independent variable have the same value (Fullerton & Xu, 2012), i.e. that the magnitude of the T effect is the same regardless of the level of risk aversion, which would be a strong assumption. When the assumption did not hold, we ran a generalized order logit instead.

The regressions were run separately for the whole sample and for the subsample, including a sex dummy (1 for women). All procedures were carried out in Stata. The procedure for the generalized ordered model was gologit2.

We identified the midland sample as comprised of people born within 150 kms of Bogota, or in the current departments of Cundinamarca and Boyaca, i.e. the plateau and foothills of the central part of the Eastern Andes.

3. Results

3.1. Repeatability of measurements

We calculated the measurement repeatability among observers for each digit (ICC > 0.97 in all cases, with no 95% confidence interval

Table 1
Lotteries' payoffs.

Lottery	Low payoff COP	High payoff COP	Expected value COP	Standard deviation COP	Risk aversion
1	3000	3000	3000	0	Extreme
2	2700	5700	4200	2121	High
3	2400	7200	4800	3394	Medium
4	1800	9000	5400	5091	Moderate
5	1000	11,000	6000	7071	Somewhat neutral
6	0	12,000	6000	8485	Neutral-negative