Intelligence 46 (2014) 291–299

Contents lists available at ScienceDirect

Intelligence

Why complex cognitive ability increases with absolute latitude

Federico R. León [a,*], Andrés Burga León [b,1]

[a] Universidad San Ignacio de Loyola, Humanities Faculty, Av. La Fontana 550, La Molina, Lima 12, Peru
[b] Ministerio de Educación, Measurement of Educational Quality Unit, Calle del Comercio 193, San Borja, Lima 41, Peru

ARTICLE INFO

Article history:
Received 24 April 2014
Received in revised form 19 July 2014
Accepted 22 July 2014
Available online xxxx

Keywords:
Intelligence
Latitude
Evolution
Cold hypothesis
UV_B radiation theory

ABSTRACT

Evolutionary psychologists attribute the superior IQs of light-skinned populations to genetic imprints left by millenary processes promoted by cold. But a novel theory that explains IQ gains observed across recent generations ascribes them to a latitude → UV_B radiation → vitamin D_3 → parents' sexual hormones → family size → child's intellectual environment → IQ chain of effects. Analyses of 506,347 Peruvian children's math and reading scores from a national census confirmed that complex cognitive ability increases with absolute latitude even under tropical megathermal climates and decreases with high altitude above sea level, birth rate and social development mediate most of the effects, and reading is more strongly influenced than math. The findings weaken the evolutionary cold hypothesis and strengthen the view that contraception has the potential to reduce latitudinal IQ gaps.

1. Introduction

Light-skinned populations attain higher IQ scores than dark-skinned ones (Lynn & Vanhanen, 2002; Rushton & Jensen, 2005; Templer & Arikawa, 2006) and, since they prevail, respectively, in temperate and tropical regions of the world, absolute latitude (AL) accounts for a large part of the cognitive differences observed between nations (Lynn & Vanhanen, 2012). According to the evolutionary cold hypothesis, the predictable harsh winters of temperate regions exerted cognitive demands for survival on humans that resulted in the millenary evolvement of higher levels of intelligence; people at the tropics did not face such challenges or opportunities (Lynn, 1991; Nyborg, 2013; Rushton, 1995). Despite the theoretical, methodological, and political criticism addressed to this racial view (Asendorpf, 2007; Hunt & Sternberg, 2006; Nisbett, 2005; Volken, 2003; Wicherts, Borsboom, & Dolan, 2010; Wicherts, Dolan, & van der Maas, 2010), no competing framework emerged in the field of human intelligence but until very recently: UV_B-radiation theory of latitude's influence on intelligence — URTLII (León, 2012) — attributes the AL–IQ correlations (*r*s) to the decreasing efficacy of skin and retina at fabricating vitamin D_3 with distance from the equator, dependent, in turn, on the decaying availability of UV_B photons from the equatorial line to the poles (Engelsen, Brustad, Aksnes, & Lund, 2005). Since vitamin D_3 activates genes which promote production of estrogen and testosterone (Jones, Strungnell, & DeLuca, 1998; Kinuta et al., 2000), populations at high ALs present lower levels of such sexual hormones in winter (Van Anders, Hampson, & Watson, 2006; Wehr, Pitz, Boehm, März, & Obermayer-Pietsch, 2009), a cause of the seasonality of human births in temperate regions (Cummings, 2007). URTLII explains the lower rate of adolescent pregnancy in the northern than in the southern United States (Finer & Kost, 2011) and smaller total fertility rates of temperate than tropical countries (Bongaarts, 2008) as consequences of the decreasing availability of UV_B photons/vitamin D_3 with proximity to the poles. The resulting smaller families at the coincidentally colder habitats would produce more intelligent children because the cognitive development of the child depends on his/her intellectual stimulation at home. Since this is determined by the average mental age of parents and siblings, it decays with birth order, that is, with family size

* Corresponding author. Tel.: +51 1 3481262.
E-mail addresses: federico.leon@usil.pe (F.R. León), andresburgaleon@gmail.com (A. Burga León).
[1] Tel.: +51 1 992116587.

http://dx.doi.org/10.1016/j.intell.2014.07.011
0160-2896/

(Zajonc & Mullally, 1997); moreover, a child's share in the family's educational resources diminishes with birth order (Booth & Kee, 2009), thus reducing his/her opportunities for acquiring the cognitive improvements brought by formal education (Deary, 2012; Nisbett et al., 2012). Extant between-country IQ–birth rate *r*s, ranging from −0.71 to −0.85 (Lynn & Vanhanen, 2012), are consistent with these postulates. Thus, URTLII explains the Flynn effect, which refers to huge IQ gains seen from one generation to another in more than 30 nations and is interpreted as a result of the challenge of modern technologies (Flynn, 1987) or the impact of better nutrition (Lynn, 1989). In URTLII's perspective, the Flynn effect is due to the increasing use of contraception across societies and consequent reductions in family size (Bongaarts, 2008). The literature also shows that the rhythm of IQ gains is slowing down in nations where modernization began in the 19th century while it accelerates in nations where modernization began during the early to mid-20th century (Nisbett et al., 2012). URTLII accounts for this evidence considering that developed countries started their fertility transition toward smaller families earlier and are ending the transition now (Bongaarts, 2008).

Evidence that AL affects income, education and women's domestic power, preference for smaller families, knowledge of family planning and use of contraceptive methods (León, 1984, 1986, 2011, 2012)[2] suggests that not only family size but social development as well mediates the AL–CCA relationship. URTLII predicts additional cognitive effects of AL considering the bodily flow of dopamine, which depends on vitamin D_3 (Cass, Smith, & Peters, 2006; Kesby, Eyles, Bume, & McGrath, 2011): a diminished disposition to studying, with consequences for children's cognitive development, can be assumed to occur with proximity to the equator given the greater attractiveness of playing under the elevated positive mood induced by this neurotransmitter (Siviy, 1998). The theory also predicts negative cognitive effects of altitude above sea level mediated through birth rate, for altitude increases exposure to UV_B photons (Engelsen et al., 2005), thus enhancing production of testosterone (Gonzales, Gasco, Tapia, & Gonzales-Castañeda, 2009). And, since the acquisition of language occurs in the context of early parent–child relationships while math learning is more a matter of schooling, stronger effects are expected on verbal than quantitative skills. Unlike the cold hypothesis, URTLII predicts positive AL–CCA *r*s in any racial or climatological circumstance.

The novel theory has been tested on the basis of student assessments. While scores from IQ tests and student assessments may not be exactly isomorphic within countries, *r*s from .77 to .94 prevail among them (Kaufman, Reynolds, Liu, Kaufman, & McGrew, 2012) and the respective latent traits correlate above .80 (Sonnleitner, Keller, Martin, & Brunner, 2013); this justifies encompassing both into the larger concept of complex cognitive ability (CCA), which has international validity (Rindermann, 2007). León (in press) utilized two data sources: (a) Peru Ministry of Education's reported mean scores per region of education entailing the academic achievements of children in second year of primary instruction (N = 24 regions, math and reading scores averaged) and (b) mean PISA (Programme for International Student Assessment) scores in science among 15 year-old students in various American countries (N = 11 countries). Despite the tiny sample sizes, AL emerged as a consistent determinant of student scores in both studies. According to the Baron and Kenny (1986) mediation analysis model applied to the Peruvian data, AL's influence on student assessment scores was mediated through total fertility rate. Ordinary least squares regression for countries revealed that racial composition disappeared as a determining factor when AL was controlled whereas the influence of latitude remained significant when race was controlled. This article presents the results of a more rigorous and complex test.

2. Method

2.1. Context

Peru is a country in the southern hemisphere extending from 0° 02′ S to 18° 21′ S where 45% of the population are Amerindians whose ancestors arrived from the Northeast Asia more than 14,000 years ago and whose skin is lighter than the African skin and darker than the European skin. Other subpopulations are European-descended (15%) and descendants of African slaves or Chinese or Japanese immigrants (3%); Amerindians, Europeans, and Africans have contributed importantly to the mestizo gene pool (37%) (Putterman & Weil, 2011). Lighter skin is not more prevalent alongside distance from the equator in Peru. Rather, the linguistics literature suggests the opposite: whereas Spanish is the mother tongue of eight out of every 10 Peruvians, Amerindian languages have survived to a greater extent in the south than in the center of the country and are virtually extinct in the north except for circumscribed areas and small and scattered Amazonian tribes (Knapp, 1987).

2.2. Subjects

The data originated in a national census carried out in 2011 by the Peru Ministry of Education that obtained math and reading scores from 506,347 children in 2nd grade of primary instruction, i.e., aged about eight (51% boys, 49% girls). The Ministry yearly evaluates student performance at the national level since 2007; the 2011 census was conducted on November 29 and 30. The Ministry assigns schools of a national listing to specially trained teams of data collectors who travel to the respective sites and give the testing materials to students assembled in groups in classrooms. The Ministry targeted 1769 of the 1837 Peruvian districts (where there were schools with more than five students); Fig. S1[2] and Table S1[2] present relevant information. Of the targeted districts, 1479 satisfied the census' coverage standards (at least 90% of schools accessed and 80% of students tested), 259 did not, and 31 were not reached.

2.3. Measurements

2.3.1. Complex cognitive ability

We submitted the student scores to psychometric analyses. Only two items of the math test and two items of the reading test did not adjust to Rasch models and failed in tests of unidimensionality (see Tables S2–S4).[2] The reliabilities of the

[2] See Online Supplement.