Diminished UV radiation enhances national cognitive ability, wealth, and institutions through health and education☆

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Federico R. León

Universidad San Ignacio de Loyola, Av. La Fontana 550, Lima 13, Peru

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ABSTRACT

Rindermann's cognitive capitalism disregards geographic causes of national wealth and postulates that IQ influences wealth through strengthened institutions, whereas a novel biogeographic theory posits that diminished UV radiation, by reducing cell oxidative stress and fatigue, increases industriousness and improves nations' wealth, thus generating favorable conditions for children's intellectual growth. This study tested predictions from both perspectives and also evaluated whether health + education mediates radiation's cognitive and economic effects. Analyses of data sets encompassing 96 countries yielded well-fitted structural equation models upholding the latter hypothesis and showing that radiation directly influences all variables, cognitive ability and income are unrelated, and the former and institutional strength behave as net dependent variables. The findings suggest that what national development requires is healthy and well-educated populations; enhanced cognitive ability, greater wealth, and strong institutions should follow. Geography appears to act on these variables through physiological processes and psychological constructs which deserve greater attention.

1. Introduction

Lynn and Vanhanen (2002, 2006) posited inherited intelligence as a proximate influence on the wealth of nations. Dark-skinned populations, who reside close to the equator, would be poorer than light-skinned ones, who reside close to the poles, owing to millenary evolutionary processes associated with adaptation to climatological and other environmental conditions which differentiated *Homo sapiens* intellectually at higher latitudes (Lynn, 2006). Consistent with economic development research, which dismisses geography as a causal variable and emphasizes institutions as determinants of national wealth (Nunn, 2009), Rindermann's cognitive capitalism disregards geography as a relevant force and places institutional strength as a mediator of cognitive ability's influence on nations' income, albeit specifying that cognitive ability is genetically *and* culturally determined (Rindermann, 2012; Rindermann & Thompson, 2011; Rindermann, Woodley, & Stratford, 2012). Yet, evidence generated over the past few years has produced overwhelming evidence of close relationships existing between geographic and cognitive variables and suggests that it is national wealth that enhances national IQ rather than vice versa.

1.1. UV radiation theory

Complex cognitive ability (CCA), measured by IQ tests and/or

standardized student evaluations of math, reading, and/or science (Rindermann, 2007), increases with distance from the equator across countries (Azam, 2017; León & Burga-León, 2015; Lynn & Vanhanen, 2012). The relationship is also significant across states, provinces, or regions within Italy, Japan, Peru, Russia, Spain, Sudan, and the United States, although not in India and Turkey (León & Hassall, 2017). A theory that CCA depends on UV radiation has been proposed considering that radiation decreases from the equator to the poles (León & Burga León, 2014). The theory not only accounts for the observed latitude-CCA correlations but has also generated evidence that populations residing in the western United States, where UV radiation is stronger, present lower cognitive ability than eastern USA populations (León, 2015); that high altitude above sea level, where UV radiation is greater, impairs CCA (León & Avilés, 2016); and that CCA decreases with proximity to the equator in the United States among White children, whose ancestors' skin evolved to grasp scarce UV photons at higher latitudes (Jablonski & Chaplin, 2010), but not among African Americans and Hispanics, whose skin melanin absorbs and dissipates light (León & Hassall, 2017).

This article builds upon the latter study. León and Hassall took into account that UV radiation causes cell oxidative stress (Meng, Zhang, Zhu, Wang, & Lei, 2009) and, through it, fatigue (Kennedy et al., 2005), possibly reducing industriousness cumulatively through age; since this personality aspect (DeYoung, Quilty, & Peterson, 2007) is relevant to

the creation of wealth and poverty is known to affect cognitive functioning (e.g., Nisbett et al., 2012), the greater poverty closer to the equator would impair CCA. León and Hassall's (2017) explanation has been upheld by an unpublished study showing that a socioeconomic latent variable defined by wealth, education, and employment mediates the effects of UV radiation on CCA in Italy and, without employment, among White children in the United States (León, 2017).

1.2. Study hypotheses

There is a need for worldwide testing of cognitive capitalism's tenets vis-à-vis UV radiation theory. A number of international studies have upheld the postulates that CCA influences wealth through scientific-technological progress and the quality or strength of institutions (Christainsen, 2013; Coyle, Rindermann, & Hancock, 2015; Rindermann, Kodila-Tedika, & Christainsen, 2015). Rindermann and Thompson (2011); Rindermann et al. (2012, 2015) presented structural equation models (SEMs) and saturated path models which supported cognitive capitalism's hypotheses worldwide, but only reported standardized root mean square residual (SRMR) and comparative fit index (CFI). Cognitive capitalism lacks evidence based on more demanding indicators of SEM adjustment, such as χ^2, "the only substantive test of fit for SEM" (Barrett, 2007; p. 815), and root square error of approximation (RMSEA), one of the most informative fit indices and present in virtually all papers that use SEM. Therefore, we tested *Hypothesis 1*: *CCA → institutional strength (IS) → wealth* using such rigorous indicators of model fit, among others. Furthermore, León and Burga-León (2017), utilizing a multiracial sample in the United States, evaluated cognitive capitalism's *CCA → wealth* linkage in the context of UV radiation theory and reported a *radiation → CCA → wealth* SEM that emerged well-fitted in contrast with an unsatisfactory *radiation → wealth → C-CA* one. In the present study, we tested the more specific *Hypothesis 2*: *UV radiation → CCA → IS → wealth*.

Since León's (2017) findings in Italy and among White children in the United States need replication between nations, we tested here *Hypothesis 3*: *UV radiation → wealth + education → CCA → IS* across countries. Moreover, Author's formulation admits alternatives. The free radicals associated with cell oxidative stress have been implicated in the pathology of several human diseases, including atherosclerosis, cancer, malaria, rheumatoid arthritis, and neurodegenerative diseases (Aruoma, 1998). Rate of disease has been shown to impair CCA (Daniele & Ostuni, 2013), assumedly because the immunological system competes for energy with the developing brain of the child (Eppig, Fincher, & Thornhill, 2011). Disease is also likely to cause desertion from school, impoverish educational achievements, and deteriorate worker productivity. Since health + education can be expected to mediate the effects of UV radiation on CCA, institutional strength, and wealth, the study tested *Hypothesis 4*: (*UV radiation → health + education → wealth → IS*) + (*health + education → CCA → IS*).

2. Method

2.1. Countries

The countries or territories selected for the present study are those whose intelligence scores were derived from IQ test scores and/or scores from standardized student evaluations in Rindermann's (2007) standardization in 194 countries. That is, the study ignores the 66 countries or territories for which Rindermann estimated intelligence scores based on national indicators of school attendance. Of the 128 countries with intelligence measurements, 32 lacked UV radiation data. Table S1 in Supplementary online material presents the final list of 96 countries, per continent.

2.2. Measurements

2.2.1. Geo-climatic variables

UV radiation measurements were obtained by Thomas Barnebeck Andersen (University of Southern Denmark), Carl-Johan Dalgaard (University of Copenhagen), and Pablo Selaya (Harvard University), who calculated 1990 and 2000 radiation levels per country using NASA's satellite-based UV Index values per geographic grid of 1 degree latitude × 1 degree longitude and offered an average of the two years. Measurements of temperature were not included in the present study considering León (2017) and León and Hassall's (2017) demonstration that this variable correlates negatively with intelligence only by virtue of its correlation with UV radiation.

2.2.2. CCA scores

Rindermann (2007) called "general complex cognitive ability" (CCA) a *g* factor that explained 94–95% of the variance in standardized student evaluations and intelligence tests across nations. The IQ test scores came from the Lynn and Vanhanen collection, which included published and unpublished results in 113 countries, mainly based on various forms of the Progressive Matrices Test and the Wechsler Intelligence Scale for Children. Others were scores from various PISA (Program for International Student Assessment), TIMSS (Trends in International Mathematics and Science Study), and PIRLS (Progress in International Reading Literacy Study) rounds of student assessments involving mathematics, reading, and science tasks. In the processing and integration of the data, Rindermann considered participation rates and conditions as well as age of participants and year of data collection and made adjustments and aggregations that produced standardized CCA scores per nation in IQ metrics.

2.2.3. Institutional indicators

Three institutional indicators were utilized here. Two of them, pertaining to 1996–2002, were selected from the governance indicators developed by the Global Governance Department and Development Research Group of the World Bank. Rule of law "measures the extent to which agents have confidence in and abide by the rules of society. These include perceptions of incidence of crime, the effectiveness and predictability of the judiciary, and the enforceability of contracts" (Kaufman, Kraay, & Mastruzzi, 2003, p. 4). Government effectiveness combines "the quality of public service provision, the quality of the bureaucracy, the competence of civil servants, the independence of the civil service from political pressures, and the credibility of the government's commitment to policies" (p. 3). The opinions were obtained from 25 sources in 18 organizations. These included international organizations, political and business risk-rating agencies, think-tanks, and non-governmental organizations. The data were aggregated and developers set margins of error. The third institutional variable was economic freedom, based on hard data and opinions obtained by the Heritage Foundation (O'Driscoll, Feulner, & O'Grady, 2003). It shares a few items with rule of law. Its components include property rights, freedom from corruption, fiscal freedom, government spending, and business, labor, monetary, trade, investment, and financial freedom. Since in the original scale the greater the freedom the lower the score, scores were multiplied by −1.

2.2.4. Per capita income

UNDP (2011) reported per capita national incomes per country with 2005 dollar purchasing power based on data from the World Bank, International Monetary Fund, United Nations Statistics Division, and United Nations Department of Economics and Social Affairs. Income was subjected to a natural log transformation as is customary in econometric research.

2.2.5. Health and education

Like income, these variables are components of the Human