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The impact of genes, geography, and educational opportunities on national cognitive achievement☆

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ABSTRACT

A debate between Stankov and Lynn has focused on whether national differences in cognitive achievement are primarily a matter of culturally-driven motivation or genetically determined mental ability, measured in terms of IQ. We present evidence showing that a third position is more conclusive: while genetic differences are a driving force behind differences in academic achievement between nations, these genetic differences operate on motivation rather than ability. Indeed, across 53 countries from all continents, 90% of the variance in national cognitive achievement can be explained by: (1) a recently reported national genetic index related to life history strategy; (2) educational opportunities as measured by the education index of the United Nations Development Program, and (3) a geographic variable: Welzel's index for cool water condition. In contrast, neither national wealth (gross domestic product per person), nor socioeconomic inequality (Gini index), nor pathogen prevalence show a significant effect. We explain these findings by combining theoretical propositions about academic achievement from two complementary approaches: life history strategy and the cool water condition.

1. Introduction

The causes of group differences in cognitive achievement are heavily debated. The most controversial issue is whether group-level genetic differences play a significant role. *Learning and Individual Differences* has been involved in this debate, with a focus on a specific issue: whether the superior achievement of East Asians in mathematics is primarily an outcome of culturally-driven motivation (Stankov, 2010) or genetically determined mental ability, operationalized in terms of IQ (Lynn, 2010). Stankov and Lynn present their positions as mutually exclusive: If cognitive achievement is mostly a matter of motivation, there is no need for a genetic explanation because motivation is a cultural phenomenon and culture is acquired through socialization, not through a genetic heritage. Conversely, if cognitive achievement is a matter of some sort of genetically determined brain power, there is no need for a motivational explanation.

In this article we present evidence that supports a third position that does not fully reject or confirm either Stankov's or Lynn's view. Instead, it is a synthesis of some elements of the two positions. More precisely, we find that national differences in cognitive achievement do have a strong genetic component, in accordance with Lynn's position. But, we hypothesize that this genetic component creates societal differences in motivation rather than in mental ability, a position consistent with Stankov's cultural explanation.

2. Evidence for genetic differences in mental ability at the group level

Lynn and Vanhanen (2002, 2006, 2012) argue that there are national differences in mental ability, with a strong genetic component. However, this contention has never been proven convincingly. As far as we know, only four studies show significant correlations between group-level cognitive ability or intellectual achievement on the one hand, and measurable genetic markers at the same level on the other hand. These groups, however, are schools or ethnic groups, not nations. "Correlations" in this case refers to statistical associations between a measure of individual cognitive achievement aggregated to the type of group under study and frequencies of relevant alleles within the same groups.

In the first study of its kind, Beaver and Wright (2011) found a significant correlation between genetic markers and verbal IQ at the level of US schools. So, that study has no implication for any cross-national differences. Piffer (2013) showed an ethnic-level correlation between a statistically extracted genetic factor (by factor-analyzing occurrences

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of genetic markers that are correlated at the ethnic level) and IQ. It is hard to extend Piffer's ethnic analysis to the national level, however, because many ethnic groups in his dataset do not correspond at all to nations, with the possible exception of about 15. Additionally, working with such a small and unrepresentative sample of nations can severely distort the results of a study of associations between nation-level genetic variation and societal outcomes (Eisenberg & Hayes, 2011).

Woodley, Rinderman, Bell, Stratford, and Piffer (2014) reported a significant correlation between microcephalin allele frequencies and ethnic IQ. But the lack of any individual-level association between microcephalin and IQ, acknowledged by those authors, makes their finding unpersuasive. Most recently, Piffer (2015) showed a strong correlation between the prevalence of some alleles and ethnic IQ. However, the usage of the term "country IQ" by this author (also in the title of his article) is misleading because he uses data concerning ethnicities, not nations. Furthermore, Piffer relies on genome-wide association studies of intelligence, a purely statistical approach that does not explain the mechanism of the association between a particular allele and the personality trait or ability that it is presumed to affect.

In sum, we still lack convincing direct evidence that national differences in cognitive performance are related to genetic factors, measurable in terms of national frequencies of relevant polymorphisms that seem to be associated with cognitive ability.

3. Goal and concept of the present study

The goal of this study is to elucidate the relationship between genes and national cognitive achievement on the basis of empirical evidence. As a first step, we explain why it is plausible to expect a cause-and-effect relationship between national genetic patterns and national cognitive achievement. Then, we elaborate this logic, suggesting other potential predictors of national differences in cognitive achievement. We test the relative predictive properties of all these predictors, and then explain our results.

We must point out at the start that we have not discovered, and will not be discussing, genes that directly affect cognitive ability, for instance by directly contributing to the development of a better working brain, however defined. Such genes, if they exist, may be relevant in an analysis of individual differences in cognitive ability. Yet our analysis is at the societal, not the individual level. Associations at the societal level are not necessarily a sum of individual-level associations (Leung & Bond, 2007). For instance, national differences in murder and robbery rates seem to be best explained in terms of differences in socioeconomic inequality as well as adolescent fertility (Minkov, 2011, 2013, citing a rich literature in that domain), yet neither of these variables is a predictor at the individual level.

In this study, we start from a novel proposition concerning societal differences in cognitive achievement: our hypothesis is that these differences may be best explained as a function of differences in motivation in the educational domain. We define motivation in that domain as a willingness to make sustained efforts for the acquisition of knowledge and skills in cognitively demanding areas, such as mathematics and science, even though these efforts do not necessarily bring tangible short-term benefits. This type of motivation for educational achievement may be partly an innate individual characteristic, driven by specific genes.

Societies that have a higher prevalence of genetic variants that contribute to such motivation will have higher cognitive achievement for a variety of reasons. The individual motivation of students matters, but so does the motivation of teachers, policy-makers, and of course peers and parents, to produce beneficial social environments in which students achieve good results. Thus, societal motivation is a complex phenomenon, not to be equated solely with the sum of the motivations of all individual students.

Comparing motivation for education at the national level is known to be a difficult exercise. Minkov (2008) discusses the results of the 2003 edition of the Program for International Student Assessment (PISA) study when students across some 50 countries were asked whether they agreed with the following statements: "I would like to be the best in my class in Mathematics" (question 37a) and "In Mathematics I always try to do better than the others in my class" (question 37g). At the national level, agreement with these statements was correlated negatively, not positively, with national achievement in mathematics and the other academic domains studied by PISA. Minkov (2008) explains these results in terms of Dweck (2007) theory, according to which, statements of this type reflect a need for admiration from others rather than a genuine interest in making a sustained effort in mathematics.

An original study of motivation for education, albeit across only 14 countries, was reported by Noorderhaven and Tidjani (2001). Those authors designed a questionnaire consisting of items suggested by African social scientists and gave it to 1100 university students from Cameroon, Ghana, Senegal, Tanzania, and Zimbabwe, to white students in South Africa, and to students in Belgium, Germany, the United Kingdom, Guyana, Hong Kong, Malaysia, the Netherlands, and the United States. The authors reported a nation-level factor, underpinned by several items, two of which were, "Wisdom is more important than knowledge" and "Wisdom comes from experience and time, not from education". Although the small number of nations in that study precludes a convincing nation-level statistical analysis, it is interesting to note that it was the African countries that yielded the highest average agreement with these statements, whereas the Asian countries yielded the lowest. This finding, suggesting that education has a relatively higher priority in East Asia but a relatively lower priority in Africa, is consistent with well-known differences in educational achievement between Africa, Europe, and Asia, even after controlling for national wealth.

3.1. Potential genetic contributors to national differences in cognitive achievement

Minkov and Bond (2015) and Minkov, Blagoev, and Bond (2015) have reviewed a wide range of individual-level studies that associate genetic polymorphisms in the androgen receptor gene (AR), the D4 subtype of the dopamine receptor gene (DRD4), and the 5-HTTLPR (5-hydroxytryptamin; 5HT) transporter-linked polymorphic region of the serotonin transporter gene, SLC6A4 (solute carrier gene family 6: sodium-and chloride-dependent neurotransmitter transporter family, member 4). These studies suggest that specific alleles of each of the three genes are associated with several aspects of life history strategy (LHS).

LHS theory explains differences in the allocation of an individual's total bioenergetic and material resources between somatic effort (devoted to the survival of the individual) and reproductive effort (devoted to the production of offspring), as well as between parenting effort (devoted to the survival of offspring) and mating effort (devoted to obtaining and retaining sexual partners) (Figueredo et al., 2005). A focus on somatic and parenting effort is known as slow LHS, whereas an emphasis on reproductive and mating effort is known as fast LHS. At the national level, faster LHS is associated with, and operationalized in terms of, violent crime statistics, adolescent fertility, and prevalence of sexually transmitted diseases versus cognitive ability or achievement (Meisenberg & Woodley, 2013; Minkov, 2011; Templer, 2008; Woodley & Fernandes, 2014).

Specifically, the allelic differences that we discuss in this study have been linked to particular expressions or facets of fast LHS: risk acceptance, impulsivity, poor decision-making in specific circumstances, delinquency, violent offending, and mating competition (see literature review in Minkov & Bond, 2015). Minkov and Bond (2015) found that the three national prevalence indices of these alleles are strongly inter-correlated. Factor-analyzed, they yield a strong single factor which those authors called the "life-history strategy genetic factor" (LHSGF). In a regression model with 48 countries from all inhabited