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# Evidence of contemporary polygenic selection on the Big *G* of national cognitive ability: A cross-cultural sociogenetic analysis

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ABSTRACT

Country-level total fertility rates (TFR) and cognitive ability are negatively correlated, suggesting the existence of a selection pressure that might be reducing *global G*. Also, the cross-population frequencies of several SNPs have been found to predict cognitive ability between countries. This study applies a cross-cultural sociogenetic approach to explore the role of latent factors among cognitive ability measures and these SNPs in moderating the associations among their indicators and TFR. Using a *G* factor constructed from five measures of cognitive ability, positive moderation is found on the TFR*ability relationship ($\rho = 0.251$ $N = 60.6$ countries). Using a metagene common factor among eight SNPs, positive moderation is also found on the TFR*SNP relationship ($\rho = 0.816$, $N = 18$ countries). An inference of *polygenic selection* for lower *G* is supported by the findings of two multivector co-moderation analyses. When controlled for one another, Human Development Index and metagene frequency both independently predicted TFR ($\beta = -0.339$, and $-0.678$ respectively, $N = 18$ countries). This indicates a joint impact of intelligent fertility control and life history slowing on the distribution of TFR values. Based on these results, polygenic selection might be reducing heritable *G* globally by $-0.253$ points per decade, highlighting the importance of the Flynn effect as a contributor to global development.


## 1. Introduction

The emerging field of *cross-cultural sociogenetics* (Minkov, Blogoev, and Bond, 2015) has led to an abundance of research linking cross-cultural variation in the frequencies of various genes and alleles known or suspected to predict trait variation at the individual differences level, to the cross-cultural distribution of those same traits. Thus far, research in this field has examined the genetic underpinnings of cross-cultural variation in height (Turchin et al., 2012), intelligence and educational attainment (Piffer, 2013, 2015, 2016; Minkov et al., 2015; Minkov, Welzel, and Bond, 2016), life history characteristics and personality (Minkov and Bond, 2015; Minkov et al., 2015), individualism-collectivism (Chiao and Blizinsky, 2010) and subjective wellbeing (Minkov and Bond, 2016). Little attention has been paid to the implications of genetic factors for global patterns of selection operating contemporaneously on these traits however. It is known for example, that substantial differences in total fertility rates (TFR) exist between countries (CIA, 2015). Of particular interest is the observation that these have been found to consistently negatively correlate with country-level differences in cognitive ability (see Lynn and Vanhanen, 2012a, Table 14, p. 231 for an overview of studies). The present study will attempt to establish the role of sociogenetic factors in this relationship utilizing both moderation and regression analyses involving a newly developed cross-cultural genetic index of cognitive ability. These relationships have potentially significant implications for our understanding of the nature of contemporary patterns of phenotypic selection on the future of global cognitive ability.

The introduction is structured as follows; firstly the theoretical and empirical underpinnings of the negative relationship between IQ and fertility, both at the cross-cultural and individual-differences level will be reviewed. Here the *co-occurrence model* as a solution to *Cattell's Paradox*, or the observation that cognitive ability rises over time owing to the Flynn effect, rather than declines, as predicted by genetic selection, will be presented. Secondly, four predictions are made concerning the relationships between cross-cultural sociogenetic factors, TFR and various national-level indicators of cognitive ability.

### 1.1. The global relationship between cognitive ability and total fertility rates

Whilst several studies have demonstrated the existence of negative correlations between national cognitive ability and TFR (Lynn and Vanhanen, 2012a, 2012b), thus far only two studies have attempted to

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determine the degree to which the potential selection pressure stemming from this association should reduce global 'genotypic IQ' (i.e. the heritable variance component of IQ, or *IQ.h*, following abbreviations developed in Woodley and Figueredo, 2013) across generations. Based on a model that factored in the changing rate of population growth from 1950, projected out to 2050, Lynn and Harvey (2008) estimated a global *IQ.h* decline of 0.86 points between 1950 and 2000 (0.17 points per decade), which increases to 1.28 points between 2000 and 2050 (0.26 points per decade). In a second study, Meisenberg (2009) utilized a more sophisticated model in order to estimate the *IQ.h* change among the young, reproductive aged global population (Lynn and Harvey by contrast provide estimates for the change in the total global population). Meisenberg estimated an *IQ.h* decline of 1.31 points per 28-year generation (0.47 points per decade).

What is the origin of this apparent global selection pressure on cognitive ability? Key to understanding this is the *demographic transition*, or the general decrease in fertility, starting in the West during the Industrial Revolution and now present in the majority of the world's countries (Kirk, 1996). The demographic transition has two principal causes:

i) *Intelligent control of fertility*: Among Western populations, in the period leading up to the late 18th century, fitness among those with higher IQ (as indicated by proxies such as social status) was greater relative to those with lower ability (Clark, 2007; Skirbekk, 2008). A major driver of this fitness difference was selective child mortality, which was concentrated among those with lower social status, and (presumably) also lower IQ (Geary, 2000), and was higher than 50% in some Western populations during the Middle Ages (Volk and Atkinson, 2008). This led to a process of *downward social mobility* whereby the reproductive surplus of the high-socioeconomic status stratum came to gradually replace the reproductively failing lower stratum, as indicated by the increasing prevalence across social classes of formerly elite surnames over time (Clark, 2014). The net result of this would have been more intelligent populations that would have been able to make rational trade-offs between factors such as numbers of children and opportunities to increase their economic competitiveness, such as spending years in education (Kanazawa, 2014; Meisenberg, 2009, 2014). This *intelligent family planning* would have reduced the aggregate fertility of higher-ability Western populations relative to lower-ability populations that were less able to solve the evolutionarily novel 'problem' of fertility regulation.

ii) *Life history speed slowing*: Reductions in factors that cause mortality, such as parasite stress, inadequate nutrition and both intra and inter-group conflict, driven by innovations stemming from rising IQ in Western populations, would have increased social stability (Pinker, 2011). These signals of environmental stability may have encouraged developmental life history speed slowing (i.e. the development of a more K-type life history strategy), which is characterized by the allocation of time and energy into somatic maintenance, the development of lower time preferences and into parenting, rather than into mating (Ellis, Figueredo, Brumbach, and Schlomer, 2009). This would have resulted in reductions in fertility (i.e. fewer numbers of better looked after children), coupled with increases in factors such as body-mass and longevity (Mace, 2000). Increases in standards of living throughout the world might also account for why similar fertility patterns have spread into developing countries (Caldwell, 2001). Nevertheless, adaptive genetic differences in life history strategy between populations (Minkov and Bond, 2015; Rushton, 2000) likely impose limits on the degree to which life history can slow developmentally in response to enhanced environmental stability, which accounts in part, for the persistence of the negative correlations between cognitive ability and TFR between countries, where the latter can be taken as an indicator of life history strategy at the cross-cultural level (Meisenberg and Woodley, 2013; Templer, 2008).

The negative correlation between TFR and cognitive ability measures at the cross-cultural level mirrors the existence of negative associations between these and completed fertility at the individual differences level. These negative associations appear to have been present in many Western countries since the early 1800′s, when wealth/income, occupation/social class and education are utilized as proxies for cognitive ability (Skirbekk, 2008). Presently, these negative associations appear to be nearly worldwide in extent (Lynn, 2011; Meisenberg, 2008; Skirbekk, 2008). Despite the fact that in the West, the demographic transition involved falling fertility levels across socio-economic groups (Kirk, 1996), the impact on the relative fitness of those with high levels of *IQ.h* appears to have been greater than on those with low levels. This was likely a consequence of reduced infant mortality (which fell to <1% in the 20th century; Volk and Atkinson, 2008), stemming from reductions in disease, violence and improvements in nutrition, increasing the overall proportion of children surviving to reproductive age born among those with lower *IQ.h*, coupled with more intensive fertility regulation among those with higher levels, in response to the ever more extensive use of contraceptives and the increasing prevalence of opportunities to delay fertility afforded by further education and longer work hours (Lynn, 2011; Meisenberg, 2010).

It has been estimated that within the UK and US, the selection pressure stemming from the negative IQ-fertility relationship should have reduced heritable general intelligence (i.e. the heritable variance component associated specifically with the *g* factor variance in IQ tests; *g.h*; Woodley and Figueredo, 2013) by around 0.39 points per decade (Woodley of Menie, 2015).

It is important to note that these long-term within and between population selection trends are additive and imply substantial global *IQ.h* losses throughout the 20th century, especially after the second half of the 20th century, when the within-population correlations between fertility and cognitive ability proxies, such as education, became negative for the majority of the world's regions (Skirbekk, 2008). Despite this, measured IQ has actually *risen* throughout the world in this time period at a rate of three points per decade (Pietschnig and Voracek, 2015), this phenomenon having been termed the Flynn effect (Herrnstein and Murray, 1994). Per capita wealth has also been increasing in this period (Maddison, 2007). The Flynn effect is therefore paradoxical, as phenotypic IQ, or measured IQ resulting from both genetic and environmental influences (abbreviated to *IQ.p*; Woodley and Figueredo, 2013) appears to have been rising, when in fact it should have been decreasing – this anomaly was even termed *Cattell's Paradox* (Higgins, Reed, and Reed, 1962), after the psychometrician Raymond B. Cattell, who was vocal in predicting IQ decline due to the low fertility of high-*IQ.p* individuals, yet was among the first to observe the Flynn effect in attempts to test this prediction (Cattell, 1936, 1950).

### *1.2. The co-occurrence model*

A solution to *Cattell's Paradox* is the *co-occurrence model*, which is based on the prediction that genetic selection reduces only *g.h*, whereas environmental improvements boost the levels of the environmentally sensitive variance component of specialized abilities (termed *s.e* by Woodley and Figueredo, 2013, after Spearman's [1904] use of the shorthand '*s*' to collectively denote the non-*g* variance components of each mental ability). Consistent with this prediction, studies using the method of correlated vectors to determine the degree to which the *g* loading of subtests moderates their association with other variables, routinely demonstrate that more *g*-loaded ability measures are not only more heritable (for a review of findings, see: Voronin, te Nijenhuis, and Malykh, 2015), but also negatively correlate more strongly with fertility (Wang, Fuerst, and Ren, 2016; Peach, Lyerly, and Reeve, 2014; Woodley