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Estimating the strength of genetic selection against heritable g in a sample of 3520 Americans, sourced from MIDUS II

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ABSTRACT

The relationship between IQ and completed fertility among a sample of 3520 Americans from MIDUS II (1960's birth cohorts) is examined using a common factor comprised of eight cognitive ability measures, in order to determine the rate of phenotypic IQ loss due to genetic selection. Negative correlations are present in both the male and female subsamples, and are associated with a predicted loss in heritable *g* (*g.h*) of −.262 points per decade, increasing to −1.072 points when the additive effect of mutation accumulation is considered. The ability–fertility associations showed Jensen effects at the level of the whole sample (.167), and also separately for each sex (.185 and .147 for the females and males respectively). The magnitude of the expected *g.h* loss in this cohort due to selection is comparable to that derived from a meta-analysis of disattenuated decadal *g.h* declines from eight US studies (−.44 points per decade; $N = 127{,}389$). There is a Flynn effect in the US amounting to gains of 3.6 points per decade, which are concentrated on more environmentally plastic and specialized sources of ability variance (*s.e*) suggesting co-occurrent socio-ecological specialization with respect to narrower cognitive abilities in the present cohort.

1. Introduction

The *co-occurrence model* (Woodley & Figueredo, 2013) posits that the widely observed secular increases in aggregate phenotypic IQ (the so-called Flynn effect) are concentrated on the environmentally influenced variances associated with specialized mental abilities (*s.e*, Woodley & Figueredo, 2013). Genetic selection effects and other genetic changes (such as accumulating mutations) are by contrast reducing the level of heritable general intelligence (*g.h*). This prediction that different variance components of IQ may be trending on opposing directions is consistent with evidence that despite secular gains on pencil-and-paper IQ tests, there are apparent simultaneous long-term secular losses in population-level cognitive indicators believed to be closely allied to *g* such as *creativity* (per capita rates of macro-innovation and genius; Huebner, 2005; Murray, 2003), *working memory* (digit span backwards; Woodley of Menie & Fernandes, 2015), *processing speed* (simple visual reaction time; Woodley, te Nijenhuis, & Murphy, 2014) and *crystallized ability* (vocabulary usage evaluated using the frequencies of high-difficulty words in lexicographic databases; Woodley of Menie, Fernandes, Figueredo, & Meisenberg, 2015).

The co-occurrence model also predicts that the historically recent environmental enrichments likely responsible for enhancing *s.e* (i.e. industrialization, sanitation, nutrition, medicine, enhanced environmental quality and generalized education) have simultaneously increased the selective pressures against *g.h* (Woodley & Figueredo, 2013).

In the US, IQ has been negatively correlated with reproductive success (measured in terms of completed fertility or sibling numbers) since the beginning of the 20th century (Lynn & van Court, 2004; van Court & Bean, 1985). Proxies for IQ, such as socio-economic status and educational attainment, appear to have been negatively correlated with reproductive success in the West since the early 19th century (Skirbekk, 2009).

Several studies have attempted to determine the degree to which negative ability–fertility correlations should reduce IQ within a population over time, using US samples. This expectation is based on the premise that the heritable components of IQ (such as *g*) should decrease owing to selection. One of the earliest studies into this question was conducted by Lentz (1927) who estimated that IQ should be declining at a rate of −4 points per generation, based on the negative correlation between IQ (evaluated using various group tests) and sibling number in a sample of 4330 US citizens.

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Retherford and Sewell (1988) attempted to estimate the generational decline in 'genotypic IQ', i.e. the heritable variance component of full-scale IQ (*IQ.h*; Woodley & Figueredo, 2013), based on the negative fertility–IQ relationship among a sample of 10,317 US citizens evaluated using the AirCorps aviation qualifying examination. Employing a very low estimate of the additive heritability of IQ (.4) they estimated a decline of −.32 points per generation.

Vining (1995) re-examined a sample of 2196 individuals, tested on a large IQ battery as part of the National longitudinal study of labor market experience that had completed fertility, and predicted declines in *IQ.h* of −.5 points per generation, assuming a parent–child similarity correlation on IQ of .5. An earlier study by Vining (1982) examined a larger subset of this cohort, and found larger declines, however these were attributed to incomplete fertility.

Loehlin (1997) estimated the *IQ.h* loss among a sample of 16,781 Americans at .8 points per generation, utilizing data on educational level and assuming a parent–child similarity of .5.

Lynn (1999) and Lynn and van Court (2004) examined the negative association between IQ and fertility on the WORDSUM test in the General Social Survey. Using a subset ($N = 1645$), Lynn (1999) estimated the generational *IQ.h* loss due to selection at .49 points per generation, assuming an IQ h^2 of .8. Using a larger subset of the GSS ($N = 5885$), Lynn and van Court (2004) estimated the decline at .9 points per generation, assuming an h^2 value of .71.

Meisenberg (2010) and Meisenberg and Kaul (2010) examined the negative ability–fertility relationship in the National Longitudinal Survey of Youth, using the Armed Services Vocational Aptitude Battery. The estimated sample-wide loss due to selection was .8 points per generation, assuming a parent–child similarity of .5.

The most recent estimate of the *IQ.h* loss in the US population comes from Reeve, Lyerly, and Peach (2013), who estimate losses of .83 points per generation, utilizing a sample of 79,734 individuals evaluated using the Project Talent Ability Battery, and assuming an h^2 value of .5.

A recent psychometric meta-analysis of 10 predicted declines in heritable general intelligence (*g.h*) computed on the basis of the magnitude of the negative ability–fertility correlation in various US and UK samples, and corrected for reliability, validity and heterogeneity, revealed an aggregate decline in *g.h* of −.39 points per decade (−1.37 points per generation), assuming a high-end estimated generational length of 3.5 decades (which would tend to underestimate the rate of decline) and a high heritability (.86) of general intelligence (Woodley of Menie, 2015). In order to estimate the US specific decline, the two UK estimates can be excluded, yielding a meta-analytic estimate of the *g.h* loss due to selection in the US of −.44 points per decade (95% CI = .418 to .426, $N = 127{,}389$, $K = 8$).

In the present analysis, another relatively large and population-representative US dataset (Mid-Life in the United States [MIDUS] II) will be examined for evidence of genetic selection effects on the heritable components of intelligence. An attempt will be made to quantify the degree to which *g.h* should be declining due to the effects of genetic selection and mutation accumulation. Also the data will be examined for the presence of "Jensen effects" (Rushton, 1998), meaning the correlations of observed effects upon specific tests of various cognitive abilities with their common factor loadings. The latter is a test of the co-occurrence model, as it is predicted that the magnitude of genetic selection should be largest when the common factor loading is highest.

2. Methods

MIDUS II (Ryff et al., 2004–2006) constitutes the second wave of data collection involving large-scale longitudinal examination of adult development within the United States. Data collection was completed in 2009 for a full sample of 4963 participants aged between 32 and 84. In MIDUS II, data were collected on several cognitive ability measures as part of the Brief Test of Adult Cognition (BTACT). These include two Recall Tasks (delayed and immediate), Digit Span Backwards, Category Fluency measures, Number Series, Backwards Counting (a measure of processing speed) and measures of Task Switching Efficiency (in milliseconds). Lachman, Agrigoroaei, Tun, and Weaver (2014) identified a hierarchical structure among these measures, with the two Recall Tasks loading on an Episodic Memory common factor, and the others (Digit Span Backwards, Category Verbal Fluency, Number Series, Backwards Counting and the Mixed Switching Task) forming an Executive Functioning common factor. Both factors correlated with one another at .43, indicating the presence of a higher-order *g*-like (Stratum III; Carroll, 1993) common factor among these lower-order factors (Stratum II; Carroll, 1993).

In constructing a phenotypic IQ (*IQ.p*) factor, the seven ability scales employed by Lachman et al. (2014) were utilized (see Lachman et al., 2014 for details concerning these variables). The 12-point Educational Attainment measure was also incorporated into the common factor computed for the present study. Educational attainment serves as a proxy for crystallized ability, as it relates to learned knowledge, and is routinely found to correlate with *g* (e.g. Herrnstein & Murray, 1994).

The first wave of MIDUS data collection was conducted in 1995–1996 on a sample with a minimum age of 25; the second wave (MIDUS II) was conducted in 2004–2006, indicating that the minimum age of continuing participants was 35. To capture completed fertility, we excluded the subset of that cohort aged <41, so that the remainder of the MIDUS II sample had achieved anywhere from 99.8%–100% of their completed fertility, based on 2012 estimates of completed fertility by respondent age cohorts reported by the US Census Bureau (Martin, Hamilton, Osterman, Curtin, & Mathews, 2013). MIDUS II contains an indicator that measures total numbers of children (Variable Code = B1PC2). This variable includes adopted and stepchildren in addition to biological ones, and cannot be disaggregated. Given that adoption is relatively rare, it is unlikely to substantially compromise potential negative ability–fertility correlations in this dataset, therefore it is used in the present analysis, albeit with the caveat that any adopted and stepchildren counted will necessarily function to underestimate the magnitude of the expected negative ability–fertility correlation.

2.1. Estimating the loss in g due to genetic selection

The eight cognitive ability measures from MIDUS II were aggregated into an *IQ.p* common factor using Unit Weighted factor analysis. Unit-weighted common factor scales (Gorsuch, 1983) were estimated as the means of the standardized scores for all non-missing indicators on each factor (Figueredo, McKnight, McKnight, & Sidani, 2000). The common factor loadings on each specific ability are then computed by correlating the standardized ability scores with the Unit Weighted *IQ.p* factor.

The factor structure identified by Lachman et al. (2014) was replicated using Unit Weighted analysis to derive the common factor loadings of each ability scale (Stratum I in Carroll, 1993) on the Semantic Memory and Executive Functioning group factors (Stratum II). Educational Attainment was treated as both a Stratum II (Crystallized Ability) and Stratum I indicator. The loadings of the *IQ.p* factor on each Stratum II ability were calculated also for use in the analyses.

The ability–fertility correlation constitutes the selection differential that predicts the inherited change in *IQ.p* in the following generation. Generation length was estimated at 3.5 decades (Woodley of Menie, 2015). The decline resulting from the negative selection differential was computed case-wise with Equation 1, first developed by Lentz (1927).

$$S = \frac{1}{N}\sum_{i=1}^{N}(X_i = \overline{X})\frac{f_i}{\overline{f}} \quad [1]$$

X and f are the mean *IQ.p* and fertility of the sample, X_i and f_i are the *IQ.p* and fertility of the individual, and N is the sample size. To convert