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The reproduction of intelligence

Gerhard Meisenberg *

Department of Biochemistry, Ross University Medical, School Picard Estate, Dominica

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ABSTRACT

Although a negative relationship between fertility and education has been described consistently in most countries of the world, less is known about the relationship between intelligence and reproductive outcomes. Also the paths through which intelligence influences reproductive outcomes are uncertain. The present study uses the NLSY79 to analyze the relationship of intelligence measured in 1980 with the number of children reported in 2004, when the respondents were between 39 and 47 years old. Intelligence is negatively related to the number of children, with partial correlations (age controlled) of −.156, −.069, −.235 and −.028 for White females, White males, Black females and Black males, respectively. This effect is related mainly to the *g*-factor. It is mediated in part by education and income, and to a lesser extent by the more "liberal" gender attitudes of more intelligent people. In the absence of migration and with constant environment, genetic selection would reduce the average IQ of the US population by about .8 points per generation.

1. Introduction

The relationship between intelligence and fertility has been investigated since the early years of the 20th century. During the first half of the century, studies in Britain and the United States usually found a negative relationship between IQ and completed family size (Anastasi, 1956; Cattell, 1936, 1937; Dawson, 1932/33), although atypical results were obtained occasionally (Willoughby & Coogan, 1940). These early results were challenged by a series of studies with mainly White middle-class groups in the United States at the time of the baby boom, which reported a negligible or slightly positive relationship between IQ and number of children (Bajema, 1963, 1968; Falek, 1971; Higgins et al., 1962; Waller, 1971). These results were complemented by the observation that subfertility of men in *Who's Who in America* disappeared for cohorts born after 1910 (Kirk, 1957). The conclusion at that time was that dysgenic fertility for intelligence was a temporary phenomenon during the demographic transition when the more intelligent pioneered the use of contraception, but disappeared at a later stage when contraceptive habits had diffused through the entire population (Osborn & Bajema, 1972).

Although these results seemed to make the relationship between intelligence and reproduction a dead issue, studies of cohorts who reproduced after the 1960s again showed the familiar negative relationship. As early as 1978, a negative relationship was observed in married White American women. Remarkably, this negative relationship remained significant even with education and socioeconomic background controlled (Udry, 1978). However, the value of this result is ambiguous because most of the women in this sample (aged 15–44) had not yet completed their childbearing.

More substantial were the findings of Vining (1982, 1986, 1995), who provided evidence for the reemergence of a dysgenic trend among those born after 1935. Vining's conclusions were further supported by Retherford and Sewell (1988, 1989), who found a negative relationship between intelligence at age 17 and number of children at age 35 for a predominantly White sample of high school seniors in Wisconsin. Additional evidence was found in the General Social Survey (van Court & Bean, 1985; Lynn & van Court, 2004), which showed a negative relationship between word knowledge and the number of children. Lynn and

* Tel.: +1767 255 6227.
E-mail address: Gmeisenberg@rossmed.edu.dm.

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van Court (2004) concluded that the relationship had been negative for all cohorts born after 1900, although it was weaker for those born 1920–1929. In these studies, the dysgenic fertility was far stronger in females than males.

The reasons for the negative relationship between intelligence and fertility are not well known. In the Udry (1978) study, the subfertility of highly intelligent women was blamed on their more effective use of reversible contraceptives, whereas Retherford and Sewell (1989) found that the IQ effect was mediated almost entirely by education. Also in the General Social Survey, education is the more powerful predictor of fertility and a likely mediator of the IQ effect (Parker, 2004). However, in this case the only measure of intelligence was a 10-item vocabulary test, and years of schooling may simply be the better measure of intelligence.

The present study investigates the relationship between intelligence and number of children with data from the NLSY79. In this survey, cognitive ability was measured in 1980, when respondents were aged 15–23. The number of children was obtained in 2004, at ages 39–47. Thus we have a cohort of near-complete fertility. Three types of variable were investigated as plausible mediators of IQ effects on fertility: (1) Education and income were chosen because education had been identified as an important mediator in at least two previous studies (Parker, 2004; Retherford & Sewell, 1989). (2) Religious attendance and gender attitudes were investigated based on the hypothesis that intelligent people have less "conservative" and more "liberal" attitudes and values. Liberal or "postmodern" values have been proposed as the driving force in the "second demographic transition," which brought sub-replacement fertility to virtually all advanced postindustrial societies in the last third of the 20th century (Lesthaeghe, 1983, 1995). Finally, marital status was included based on the hypothesis that intelligent people have fewer children because they avoid marriage.

2. Method

Data are from the NLSY79. The publicly available data include both the results of the individual subtests of the ASVAB (Armed Services Vocational Aptitude Battery) and the pre-calculated percentile score on the AFQT (Armed Forces Qualification Test), computed from the arithmetic, word knowledge, paragraph comprehension and mathematics knowledge subtests of the ASVAB. Also available is information about education, family income, religious attendance (but not religious belief), gender attitudes, race, as well as marital status and the number of children born to 2004. The following variables were used below.

2.1. IQ

The percentile scores on the AFQT (1989 revision) were recoded into a normally distributed IQ score. This ASVAB-derived IQ was adjusted for age of testing, and the same was done with each of the ASVAB subtests. Neither IQ nor ASVAB subtests showed evidence for a leveling off in the rising trend even at the oldest ages, and therefore each was age-adjusted with linear regression. Scores extrapolated to age 23 were used because young adult intelligence is more directly relevant than teenage intelligence for behavior during the reproductive age. Scores were adjusted separately for Black males, Black females, White males, White females, other males and other females. This was done because each demographic category has its own rate of age-related change in the 15–23 age range: substantially more in Whites than Blacks, and slightly more in males than females.

2.2. g-factor

g was defined as the unrotated first component from a principal components analysis with the 10 (age-adjusted) ASVAB subtests. This *g*-factor was almost perfectly congruent with the *g*-factor of the measurement model in Fig. 3 ($r = 1.000$).

2.3. Children

The self-reported number of "children ever born" in 2004, when subjects were between 39 and 47 years old. The distribution of number of children was asymmetric (skewness = .774, kurtosis = 1.753 for the combined sample, $N = 5885$). A logarithmic transformation eliminating the skew and most of the kurtosis did not change the results substantially, and therefore results are reported for the untransformed number of children.

2.4. Years married

Years spent in the married state up to age 39. Information about marital status was available on a biannual basis, and each data point was assumed to represent two years of being either married or unmarried.

2.5. Education

Average of the standardized scores of highest grade completed by age 28 and highest degree at age 30. Scores were standardized for all demographic categories combined.

2.6. lgIncome

log-transformed family income, average at ages 28–37.

2.7. Religion

Frequency of religious attendance, average from 1979, 1982 and 2000, recorded on a six-point Likert scale from "not at all" to "more than once a week."

2.8. Gender

Conservative gender attitudes, defined as the first principal component from a two-factor varimax rotation of a set of 8 questions asked in 1979, 1982 and 1987. The four highest-loading items were "A woman's place is in the home, not in the office or shop;" "It is much better for everyone concerned if the man is the achiever outside the home and the woman takes care of the home and family;" "A wife who carries out her full family responsibilities has no time for outside employment;" and "Women are much happier if they stay at home and take care of their children."

Interviewer-recorded information about race (Black, White, and "other") was used. These racial categories were rather heterogeneous. "Whites" included 7.1% first-generation immigrants and 24.5% with at least one foreign-born parent. 18.4% of Whites classified their ethnicity as mainly or exclusively Hispanic (e.g., Mexican, Puerto Rican). Blacks included 2.3% first-generation immigrants and 3.8% with at least one foreign-born parent, but only .6% classified themselves as Hispanic. Omitting Hispanics from the "White" group did not substantially change the results, and therefore the analyses were done with Hispanics included. Those classified as "others" (mainly Hispanics and some Asians and Native Americans) were omitted. Thus only those Hispanics that could pass as either "White" or "Black" were included. SPSS software was used for all analyses. All structural equation modeling was done with maximum likelihood estimation using AMOS.

3. Results

3.1. Correlations

The correlations between number of children and several predictors are shown in Table 1. In all four demographic categories, IQ is negatively related to reproductive success. Although of modest magnitude, the relationship is significant in all groups except Black males. It is stronger in females than males, being strongest in Black females and weakest in Black males. Educational outcomes, and highest grade in particular, tend to be slightly more predictive than IQ. This suggests the possibility that predictive effects of IQ are mediated by education. Conservative gender attitudes raise expected fertility for all groups. Also religion raises expected fertility, but this effect is limited to Whites. The pronatalist predictive effect of marriage is stronger in Whites than Blacks, presumably because of a higher rate of non-marital births among Blacks.

Fig. 1 shows the relationships between intelligence and number of children graphically. The patterns differ by group. Whites show the familiar negative relationship, although those with IQ > 130 are slightly more prolific than those with somewhat lower IQ. However, only 41 White females (2%) and 96 White males (5.3%) are in that range. In Black females the relationship is strongly and uniformly negative. However, for Black males the relationship is slightly (but non-significantly) positive up to an IQ of about 95. Only those with IQs above 100 have substantially lower fertility.

Table 1
Correlations (Pearson's *r*) of predictors with the number of children. *Religion* refers to religious attendance, and *Gender attitudes* to "conservative" views. Correlations in excess of about .050 (White groups) or .070 (Black groups) are significant at $p < .05$.

	White ♀	White ♂	Black ♀	Black ♂	Total
IQ	−.162	−.089	−.271	−.049	−.166
Highest grade	−.209	−.087	−.359	−.092	−.186
Highest degree	−.182	−.061	−.324	−.053	−.158
lgIncome	−.027	.058	−.194	.008	−.058
Religion	.125	.137	−.102	−.031	.083
Gender attitudes	.197	.108	.228	.077	.141
Years married	.346	.458	.100	.166	.263
N	1993	1781	902	707	5716

Table 2 shows that the negative relation of ASVAB subtests with the number of children is strongest for academic skills such as word knowledge, paragraph comprehension, science knowledge and mathematics knowledge. The relationships are weaker for tests of technical/vocational knowledge, and weaker still for tests of psychomotor speed.

The extent to which these tests predict reproductive success is related to their *g*-loading, with the most *g*-loaded tests being the best predictors. The *g*-factor, extracted from all 10 ASVAB subtests, is about as predictive as IQ, which is calculated only from the scholastic subtests.

3.2. Causal paths

Possible causal paths were examined with path models in which IQ was allowed to affect the number of children both directly and indirectly through intervening variables. Marriage was investigated because it raises the number of children (Table 1). The hypothesis was that intelligence reduces the likelihood of marriage. Education and income were hypothesized to reduce reproduction especially for women because studying and career tend to conflict with family life (Kemkes-Grottenthaler, 2003). A third set of variables were indicators of "social conservatism," including conservative gender attitudes and churchgoing. The latter was used because measures for religious belief or religious conservatism are not available in the NLSY. The expectation was that high intelligence causes more liberal attitudes (Deary, Batty & Gale, 2008). The relationship of religion with intelligence is more ambiguous. Some older studies found a negative relationship of religiosity with measures of intelligence or education (e.g., Argyle, 1958, p. 93), whereas more recent observations find that education is related positively to religious attendance but negatively to traditional forms of religious belief (Glaeser & Sacerdote, 2008). Both liberal gender attitudes and detachment from religion could conceivably reduce reproduction by de-emphasizing family life.

Initially these three sets of variables were investigated separately for the four demographic categories of White females, White males, Black females and Black males. Marriage was favored by intelligence for Blacks but not Whites. For Blacks, intelligence independently reduced fertility, although it favored marriage. When education and income were the only mediating variables, education reduced reproduction for females and to a lesser extent for males, with variable effects of income. In these models, IQ nevertheless reduced expected reproduction independently of education and income except for Black males. Finally, in models that had religious attendance and conservative gender attitudes as the only intervening variables, liberal gender attitudes mediated a modest portion of the relationship between IQ and number of children. Churchgoing had not a negative, but a slightly positive relationship with IQ for all groups, and churchgoing in turn increased the number of children slightly for Whites but not Blacks.

Fig. 2 shows a complex model combining all intervening variables and all those interactions that were both required for a good model fit and were conceptually meaningful. Error terms are omitted in Fig. 2 except for a correlated error between religious attendance and conservative gender

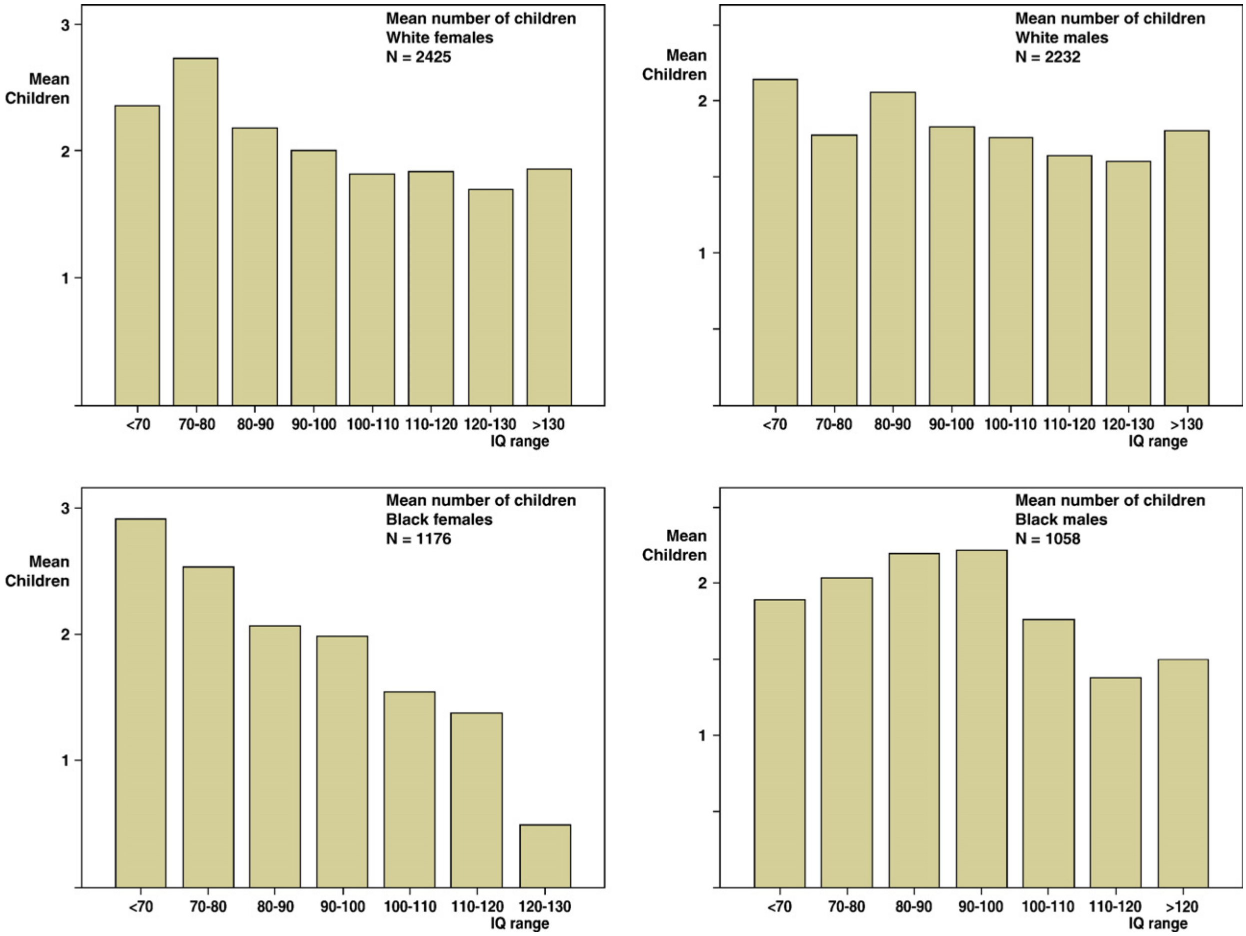

Fig. 1. Relationship between IQ and mean number of children for White females, White males, Black females and Black males.

attitudes. This correlated error represents an unmeasured factor of social conservatism. The regression weights of all error terms were fixed to unity.

The path coefficients in Fig. 2 are for White females. In this model, the most important fertility-reducing effect of IQ is indirect through education and income. A less prominent path leads from IQ to less conservative gender attitudes, both directly and through education, and less conservative gender attitudes lead to fewer children. IQ increases the likelihood of being married, but this effect is offset by the anti-marriage effect of education. As expected, marriage has a strong positive effect on fertility. Table 3 shows the path coefficients for all four groups.

Table 2
Partial correlations (age/cohort controlled) of ASVAB subtests with number of children. Also shown is the correlation of these partial correlations with the *g*-loadings of the subtests. Significance levels are shown only for the correlations with *g*-loadings: *$p < .05$; **$p < .01$.

Subtest	White females	White males	Black females	Black males	*g*-loading of test
1. Science	−.149	−.086	−.201	−.016	.892
2. Arithmetic reasoning	−.114	−.048	−.165	−.023	.861
3. Word knowledge	−.176	−.089	−.209	−.007	.891
4. Comprehension	−.156	−.071	−.176	−.025	.840
5. Numerical operations	−.105	−.011	−.183	.055	.753
6. Coding speed	−.077	−.014	−.171	.038	.689
7. Auto and shop info	−.118	−.041	−.128	.037	.740
8. Math knowledge	−.126	−.062	−.228	−.061	.839
9. Mechanical compreh.	−.109	−.030	−.064	.038	.815
10. Electronics info	−.121	−.079	−.096	−.019	.845
IQ	−.156	−.069	−.235	−.028	
g	−.159	−.067	−.227	.000	
Correlation with *g*-loading	−.763*	−.853**	−.830**	−.586	
N	2425	2232	1176	1058	

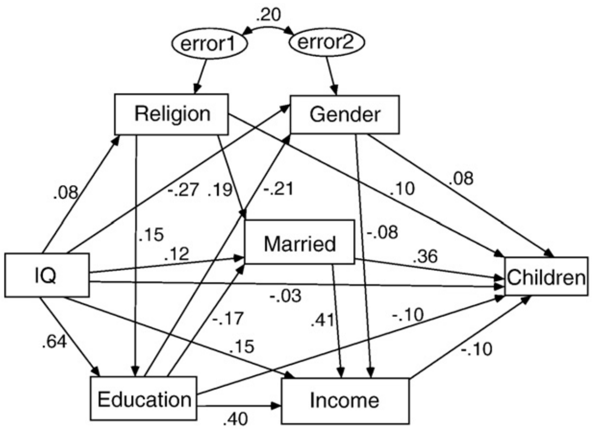

Fig. 2. Path model showing the effects of IQ on the number of children for White females ($N=2057$). Error terms are omitted, except the correlated errors of religion and gender attitudes. *Married*, years married to age 39; *Religion*, frequency of religious attendance; *Gender*, "conservative" gender attitudes; *Income*, log-transformed family income. Significance levels are included in Table 3.

The most important indirect path is through education in females but not males. In this model IQ is closely related to education, which in turn reduces the number of children not only directly, but also by reducing the likelihood of marriage for Whites. Marriage is, however, favored directly by high IQ in all groups, more strongly in females than males and more strongly in Blacks than in Whites. Higher family income is associated with marriage, education and IQ in all groups, and it reduces the number of children in all groups.

Attitudinal factors play a lesser but still significant role. Both high IQ and education are robust predictors of liberal gender attitudes in all four groups, but liberal gender attitudes reduce fertility only to a modest extent. Conservative gender attitudes are also associated with lower family income, most likely because married women who believe that a woman's place is in the home are less likely to work and contribute to the family income. High IQ also associated with religious attendance to a modest extent. Religion in turn raises fertility mildly in Whites but tends to reduce it in Blacks. In this model the standardized direct and indirect effects of IQ on the number of children are −.030 and −.128 for White females, −.069 and −.023 for White males, −.064 and −.204 for Black females, and −.005 and −.056 for Black males.

Multiple-group analysis showed serious deterioration of the model fit when all path coefficients were constrained to be equal between the four demographic categories. For example, cmin/*df* rose from 1.46 to 6.34, TLI declined from .996 to .951, and RMSEA rose from .009 to .031. Therefore the strengths of the causal paths appear to be genuinely different for different demographic groups, and each group should be analyzed separately.

Fig. 3 and Table 4 show a latent variable model with *g* and four group factors, similar to a model published by Deary, Irwing, Der and Bates (2007). The variance of *g* was fixed to 1. The model contains three correlated errors that are not shown in Fig. 3 and Table 4: technical knowledge with psychomotor speed (negative); auto and shop knowledge with mechanical comprehension (positive); and science with electronics info (negative). The negative correlation between the error terms for the latent speed and technical factors is best explained as a

Table 3

Path coefficients in the model of Fig. 2, shown separately for the four demographic categories.

Path	White ♀	White ♂	Black ♀	Black ♂
IQ → years married	.118***	.053	.178***	.106*
IQ → education	.638***	.660***	.598***	.578***
IQ → income	.149***	.161***	.204***	.138***
IQ → religion	.081***	.191***	.093**	.062
IQ → gender attitudes	−.266***	−.260***	−.380***	−.389***
Education → income	.395***	.378***	.267***	.277***
Education → years married	.166***	−.125***	−.079	.089
Education → gender att.	−.213***	−.222***	−.195***	−.137***
Religion → education	.150***	.148***	.168***	.180***
Religion → years married	.188***	.164***	.230***	.192***
Gender att. → income	−.076***	−.035	−.089**	−.093**
Years married → income	.411***	.354***	.453***	.461***
IQ → # children	−.030	−.069*	−.064	−.005
Education → # children	−.104***	.019	−.231***	−.066
Income → # children	−.096***	−.082**	−.139***	−.079
Years married → # children	.358***	.466***	.223***	.241***
Religion → # children	.096***	.090***	−.073*	−.051
Gender att. → # children	.084***	.042	.044	.047
Error1 ↔ error2	.203***	.194***	.066	.044
N	2057	1823	933	726
R^2 (children)	.179	.227	.165	.052
Model fit				
cmin	4.0	1.1	3.1	3.4
df	2	2	2	2
TLI	.994	1.003	.993	.986
CFI	.999	1.000	.999	.999
RMSEA	.022	<.001	.024	.032
ECVI	.034	.037	.074	.096

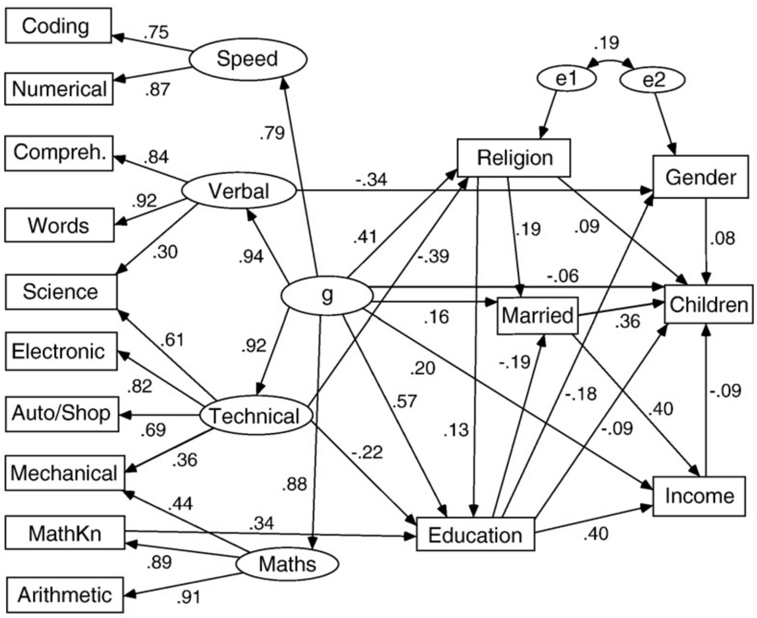

Fig. 3. A model showing the direct and indirect effects of cognitive ability factors on number of children for White females. Most error terms are omitted, including correlated errors in the measurement model. Significance levels are included in Table 4.

gender-typed ability pattern. Males surpass females on the technical knowledge factor by as much as 13.5 IQ points, whereas psychomotor speed is the only ability factor on which females score higher than males: by the equivalent of 1.6 IQ points. When *g* is controlled, a trend for opposite performance in these two ability factors is evident also within each gender. The remaining two correlated errors support the coherence of the somewhat heterogeneous technical knowledge factor.

g is the cognitive ability factor that is related most closely to education, income, marital status and religious attendance, and

Table 4
Path coefficients in the model of Fig. 3, shown separately for the four demographic categories. *MathKn*, mathematics knowledge.

Path	White ♀	White ♂	Black ♀	Black ♂
g → years married	.157***	.102**	.225***	.125**
g → education	.565***	.571***	.743***	.932***
g → income	.196***	.207***	.257***	.232***
g → religion	.406***	.462***	.389**	.097
Verbal → gender att.	−.336***	−.312***	−.424***	−.433***
Technical → education	−.224***	−.239***	−.299**	−.555***
Technical → religion	−.388***	−.310***	−.311*	−.036
MathKn → education	.343***	.336***	.198***	.212***
Religion → education	.129***	.108***	.149***	.169***
Religion → years married	.194***	.162***	.232***	.193***
Education → income	.395***	.363***	.271***	.254***
Education → years married	−.189***	−.154***	−.110**	.076
Education → gender att.	−.183***	−.201***	−.171***	−.117**
Years married → income	.402***	.345***	.440***	.452***
g → # children	−.059*	−.109***	−.087	.045
Education → # children	−.091**	.034	−.222***	−.087
Income → # children	−.091***	−.073**	−.134**	−.088
Years married → # children	.359***	.467***	.225***	.242***
Religion → # children	.094***	.093***	−.074*	−.048
Gender att. → # children	.078***	.032	.038	.061
Error1 ↔ error2	.190***	.197***	.067*	.042
N	2057	1823	933	726
R^2 (children)	.181	.231	.166	.053
Model fit				
cmin	403.4	481.5	162.7	148.6
df	80	80	80	80
TLI	.974	.968	.982	.984
CFI	.982	.978	.988	.989
RMSEA	.044	.052	.033	.034
ECVI	.251	.326	.295	.360

verbal ability is most important for gender attitudes. Independent of *g*, mathematics knowledge is positively and technical knowledge is negatively related to educational attainment. Technical knowledge also opposes the effect of *g* on religious attendance. Direct cognitive ability effects on marital status, gender attitudes, income and number of children are accentuated in the latent variable model compared to the path model.

The paths leading from cognitive ability to number of children are very similar to the model of Fig. 2. Ability is again related to reproduction mainly through education and income, at least in females.

This model should be interpreted with caution because the ability factors are highly correlated. For example, the correlation of *g* is between .929 and .940 with verbal ability and between .859 and .909 with technical knowledge in different demographic categories. Correlations between the group factors range from .503 to .838. One effect of this is that path coefficients (but not significance levels) are inflated when highly correlated ability factors act on an outcome variable with opposite signs, as in the cases of education and religion.

4. Discussion

Using what is arguably the best data set currently available, the results confirm previous reports (Lynn & van Court, 2004; Retherford & Sewell, 1988; Udry, 1978; van Court & Bean, 1985; Vining, 1982, 1986, 1995) about a negative relationship between IQ and number of children in the United States during the last third of the 20th century. Thus the existence of IQ dysgenics can be considered firmly established for this time and place.

Also the observation of a stronger relationship in females than males confirms earlier observations (Lynn, 1999; Lynn & van Court, 2004; Retherford & Sewell, 1988; Vining, 1982). This gender gap is possibly of recent origin, since cohorts born before 1930 show virtually the same extent of dysgenic fertility for males and females (Lynn & van Court, 2004). This secular change is in all likelihood related to the massive expansion of post-secondary education in the United States after the 1960s. From 1960 to 1980 alone, the number of college degrees in the United States rose from 477,000 to 1,731,000, and the percentage of these degrees earned by women rose from 34.2% in 1960 to 48.9% in 1980 (US Census Bureau, 2008). Observations on differential reproduction during the 1960s (Bajema, 1963, 1968; Falek, 1971; Higgins et al., 1962; Waller, 1971) show that the earlier expansion of secondary education in the United States (Goldin & Katz, 1999) did not seem to impair the reproduction of educated women to any great extent, but the later expansion of tertiary education did.

The fertility-reducing effect of female education in the United States has been reported with great regularity (Retherford & Luther, 1996; Yang & Morgan, 2003). This effect is not limited to the United States and other developed nations, but is universal in developing countries as well (Goujon & Lutz, 2004; Meisenberg, 2008; Weinberger, 1987). The usual explanation is that most child care is done by mothers rather than fathers, and the career opportunities that education provides are not easily compatible with child care (Kemkes-Grottenthaler, 2003).

It is therefore not surprising that education is the most important mediator of the IQ effect for women in the United States. Similar results have been reported previously (Parker, 2004; Retherford & Sewell, 1989). The advantage of the NLSY is that the IQ was measured between the ages of 15 and 23, when slightly more than half of the respondents were still in school. Therefore the association between IQ and fertility cannot be explained by an effect of education on intelligence. Instead, pre-existing high IQ leads to more education, which in turn leads to fewer children.

To test for a direct effect of intelligence on reproductive outcomes, the more relevant measure would not be IQ during adolescence, but IQ during the reproductive age. Slightly more than half of the respondents in the NLSY continued their schooling after they took the cognitive test, and we know that continued schooling during adolescence raises the IQ. Assuming, based on the results of Ceci (1991) and Winship and Korenman (1997), that each year of schooling adds 2 points to the IQ, the correlation of IQ at age 28 with the number of children would be −.178 for the total sample, rather than −.166 as reported in Table 1. It is therefore difficult to disentangle the effects of schooling from those of intelligence.

The relationship between income and fertility is ambiguous because earnings (measured at ages 28–37) and childbearing occur at the same time. Therefore it is possible that childbearing reduces family income, rather than the reverse. When the income → children arrow in Fig. 2 is reversed, the model fit improves slightly for White males and deteriorates slightly for the other groups. These results are compatible with a bidirectional relationship between income and number of children. It is also possible that having a high income, especially when controlled for IQ and education, is an indicator for materialist and consumerist priorities that compete with a focus on the family.

The greater effectiveness of educated and intelligent people in the use of reversible contraceptives has been proposed as one reason for their lower fertility, based on discrepancies between desired and actual number of children (Lynn, 1999; Udry, 1978). Another possibility is suggested by the observation in Table 1 that highest grade is more predictive than highest degree. Perhaps time spent in school directly competes with time available for family formation.

Also intellectual interests and attitudes that are developed in school can conceivably compete with family-centered interests. This is suggested by the importance of word knowledge for the White groups, since word knowledge correlates with intellectual interests and the habit of reading (Krashen, 1989). Word knowledge is also the ASVAB subtest that is most strongly related to liberal gender attitudes in all demographic groups.

The importance of education as a mediator of the IQ effect explains why the predictive effect of tests correlates with their *g*-loading. Intelligence tests were designed to predict academic ability and vocational training success. Therefore conventional intelligence tests assess those abilities most redundantly that best predict academic and vocational success, and therefore the *g*-factor that is extracted from these tests is predictably a superb predictor for these outcomes. The design of the tests ensures that *g* is the best predictor of school success and job performance, and this is what is most commonly observed (e.g., Schmidt & Hunter, 2004).

Fig. 3 confirms this typical pattern, although it also shows that mathematics knowledge has an incremental positive effect and technical knowledge a negative effect on education. This suggests a certain incompatibility between academic and technical/vocational interests. Still, because *g* is the best predictor of education, any effect of intelligence that is mediated primarily by education is predictably related to *g*. The number of children is one such effect, at least in females.

In addition to education, verbal ability is associated with liberal gender attitudes (Fig. 3). This conforms to an observation by Kemmelmeier (2008), who found conservative gender roles associated with verbal but not mathematical SAT. Liberal gender attitudes, in turn, are associated with low fertility especially in White females. However, this effect is small relative to the path through education and income. The role of religion is more complex. Religious attendance is consistently favored by high IQ or high *g*, although this effect is antagonized to some extent by technical/vocational ability. This does not necessarily mean that intelligent people are more religious. There is evidence that at least some aspects of religious belief are reduced by high intelligence (Argyle, 1958; Clark, 2004). While weak at the individual level, the negative relationship between intelligence and religious belief is strong at the country level (Lynn, Harvey & Nyborg, 2008; Meisenberg, 2004). Glaeser and Sacerdote, (2008) conclude that intelligent people are more likely to go to church because they are more social. In the models of Figs. 2 and 3, religion tends to raise the fertility of Whites both directly and by favoring marriage. However, religion is also associated with more education, which reduces female fertility. A positive effect of religious attendance during adolescence on education has been documented before (Loury, 2004). In the NLSY the correlation of educational attainment is .167 with religious attendance in 1979/82 but only .134 with religious attendance in 2000 ($N=7537$). These observations suggest that the direction of causality is more likely from religion to education rather than the reverse. The small negative association of religious attendance and fertility for Blacks in Tables 1, 3 and 4 is most likely related to their high proportion of religiously disapproved non-marital births.

Tables 3 and 4 also show that in these models the likelihood of being married is increased by IQ and *g*, both directly and, to a lesser extent, indirectly through religious attendance. However, in the White groups this effect is opposed by the anti-marriage effect of education. These results contrast with a British study, which found that never-married women had higher childhood IQs than married women although married men tended to have higher IQs than never-married men (Taylor et al., 2005). In an Afro-Caribbean population, however, high IQ raised the marriage rate for both males and females (Meisenberg, Lawless, Lambert, & Newton, 2006).

Irrespective of the causal paths, differential fertility will affect the intelligence of the next generation. This is inevitable because additive genes and, to a lesser extent, the home environment are important determinants of children's intellectual development (Bartels, Rietveld, Van, Baal & Boomsmaet, 2002; Castro, DeFries & Fulker, 1995). The calculation of the trans-generational effect of differential fertility is based on the selection differential:

$$S = {}^{1}\Big/_{N} \sum_{i=1}^{n} \left(IQi - \overline{IQ}\right) CH_i \Big/ \overline{CH}$$

S	Selection differential
N	Number of cases
IQ_i	IQ of individual
$\overline{IQ}$	Average IQ in sample
CH_i	Children of individual
$\overline{CH}$	Average children in sample.

To calculate the selection differential for the complete sample, Blacks were given a sample weight of .33 to compensate for their 3-fold oversampling (relative to the US census population) in the NLSY. Results:

Whites ($N=4657$):	$S=-1.27$ points
Blacks (N = 2234):	$S=-1.11$ points
Others ($N=409$):	$S=-1.33$ points
Total sample ($N=7344$):	$S=-1.63$ points

This is the extent to which the IQ would decline in one generation if intelligence was determined only by additive genes and children had the same IQ as their parents. Blacks have a somewhat smaller selection differential than the other groups because of their smaller standard deviation. The selection differential is larger for the total sample than the subgroups because the groups with lower IQ tend to have more children: Blacks (average IQ 85.6) have 2.12 children, Whites (IQ 101.8) have 1.89, and “others” (IQ 88.2) have 2.36 children. Also some individuals without information about race are included in the total. With one-third weighting of Blacks, between-group selection contributes .35 points to the selection differential of the complete sample.

In reality, however, children regress to the (previous) population mean because intelligence is determined not only by additive genes. The response to selection (R) depends on the narrow-sense (additive) heritability h^2:

$$R = Sh^2.$$

With an estimated h^2 of .5, R for the complete sample is approximately −.8 points. This is the value by which the IQ would change in one generation due to genetic selection if the environment remained unchanged across generations. It is broadly similar to prior estimates for the late 20th century United States, which include values of −.35 (Retherford & Sewell, 1988), −.48 (Lynn, 1999), −.5 (Vining, 1995), −.8 (Loehlin, 1997) and −.9 points (Lynn & Van Court, 2004).

The heritability estimate is debatable. One study found an h^2 of .32 for AFQT scores (and .50 for education) in the NLSY (Neiss, Rowe & Rodgers, 2002), based on correlations between full-siblings and half-siblings. However, results produced by this method are inaccurate because the magnitude of the predicted differences between half-sibling and full-sibling correlations is small, and errors due to misassigned paternity are bound to lead to an underestimate of heritability. More importantly, assortative mating most likely resulted in an underestimate of additive genetic effects and overestimate of shared environmental effects in this study. Values for parent–offspring regression are generally close to .5 for general intelligence (DeFries et al., 1976; Scarr & Weinberg, 1977; Vogler & DeVries, 1983; Williams, 1975). Shared environmental effects, which still account for about 20% of the IQ variance at age 11 (Bartels, Rietveld, Van Baal & Boomsma, 2002; Castro, DeFries & Fulker, 1995), virtually vanish by young adulthood (van der Sluis, Willemsen, Geus, Boomsma & Posthuma, 2008). Therefore the bulk of the parent–offspring resemblance for IQ measured at ages 15–23 must be attributed to additive genes rather than shared environment.

Selection against high intelligence has been observed throughout most of the 20th century in Europe and the United States (Cattell, 1936, 1937; Lynn & van Court 2004; Retherford & Sewell, 1988; van Court & Bean, 1985), where it was probably present since the beginning of the fertility transition in the 19th century (Notestein, 1936; Stevenson, 1920). We can estimate that without this selection effect the average intelligence in these countries today would be up to 5 points higher than it is—about as high as the average IQ in China today (Lynn & Vanhanen, 2006), where reproductive differentials still favored wealth, literacy and presumably intelligence in the early part of the 20th century (Lamson, 1935; Notestein, 1938). In pre-industrial societies, fertility usually was highest among the wealthy classes (Clark & Hamilton, 2006; Hadeishi, 2003; Harrell, 1985; Lamson, 1935) and also among the educated, at least in the few studies that included a measure of education (Clark & Hamilton, 2006; Hadeishi, 2003; Lamson, 1935). Although selection against high educational attainment, and presumably high intelligence, is found worldwide today (Meisenberg, 2008; Weinberger, 1987), historically it presents a novel phenomenon.

During the 20th century, the small genetic decline was masked by massive environmental improvements, especially in the educational system, which caused IQ gains on the order of 10 points per generation (Flynn, 1987). This environmental effect was at least ten times greater than the decline predicted from genetic selection, and thus made genetic selection seem irrelevant. However, recent results show that this rising trend, known as the Flynn effect, is either diminishing or reversing in the most advanced societies. A marginal Flynn effect was still observed among children born between 1973 and 1995 in the United States (Rodgers & Wänström, 2007), most recent trends in Britain are ambiguous (Flynn, 2009; Shayer, Ginsburg & Coe, 2007), and military conscripts born after about 1980 in Denmark (Teasdale & Owen, 2008) and Norway (Sundet, Barlaug & Torjussen, 2004) show stagnating intelligence or a slow decline.

We do not know whether the reason for these mixed results is that people in the most advanced societies are approaching the biological limit of their intelligence, but this possibility needs to be taken seriously. If this is the case, future intelligence trends in these countries will be small and erratic on time scales of a few decades, and longer-term trends will be determined by genetic as well as environmental changes. Intelligence trends in the less developed countries will still be dominated by the Flynn effect for much of the 21st century as they are now (Colom, Flores-Mendoza & Abad, 2006; Khaleefa, Abdelwahid, Abdulradi & Lynn, 2008; Meisenberg, Lawless, Lambert & Newton, 2005), despite substantial dysgenic fertility in these countries (Goujon & Lutz, 2004; Meisenberg, 2008; Weinberger, 1987). There are also large fertility differentials between high IQ countries and low IQ countries (Lynn & Harvey, 2008; Meisenberg, 2009), and there is evidence that intelligence and/or education is itself a major reason for low fertility in advanced societies (Meisenberg, 2009).

The implications of the present findings for the United States need to be stated clearly: Assuming an indefinite continuation of current fertility patterns, an unchanging environment and a generation time of 28 years, the IQ will decline by about 2.9 points/century as a result of genetic selection. The proportion of highly gifted people with an IQ higher than 130 will decline by 11.5% in one generation and by 37.7% in one century. Since many important outcomes, including economic wealth (Rindermann, 2008a) and democracy (Rindermann, 2008b), are favored by high intelligence, adverse *long-term* consequences of such a trend would be expected although *short-term* consequences on a time scale of less than one century are negligible.

Favorable environments enhance human intelligence, and high intelligence enables people to create favorable environments. Based on this reasoning, positive intelligence–environment feedback has been offered as an explanation not only for the dynamic nature of the Flynn effect (Dickens & Flynn, 2001), but also for the dynamic growth of intelligence, technology and prosperity in the wake of the industrial revolution (Meisenberg, 2003, 2007). In the past two centuries, this meant that small rises in IQ that were caused by educational and other environmental improvements were translated into even more environmental improvements, which raised the intelligence of the next generation even more.

However, if the cognitive returns on environmental improvements are indeed diminishing in the most advanced societies, small genetically caused declines can entail far larger declines of phenotypic intelligence than predicted by genetic selection alone. This is because a less intelligent population is less able to maintain near-optimal environments, thereby reducing its intelligence even more. For example, small reductions in the average intelligence of educational administrators will result in an increased probability that educational reforms will reduce rather than enhance students' intelligence, and thereby lead to even lower intelligence in the next generation of educational administrators and even greater deterioration of the educational system. Predictions about the future of human intelligence are possible in principle, but require a better understanding of the causal relationships between manifest intelligence, the environmental conditions that are required for its development, and its genetic limitations.

References

Anastasi, A. (1956). Intelligence and family size. *Psychological Bulletin*, *53*, 187—209.
Argyle, M. (1958). *Religious behaviour*. London: Routledge & Kegan Paul.
Bajema, C. J. (1963). Estimation of the direction and intensity of natural selection in relation to human intelligence by means of the intrinsic rate of natural increase. *Eugenics Quarterly*, *10*, 175—187.
Bajema, C. J. (1968). Relation of fertility to occupational status, IQ, educational attainment, and size of family of origin: A follow-up study of a male Kalamazoo public school population. *Social Biology*, *15*, 198—203.

Bartels, M., Rietveld, M. J. H., Van Baal, G. C. M., & Boomsma, D. I. (2002). Genetic and environmental influences on the development of intelligence. *Behavior Genetics*, *32*, 237−249.

Castro, S. D., DeFries, J. C., & Fulker, D. W. (1995). Multivariate genetic analysis of Wechsler intelligence scale for children-revised (WISC-R) factors. *Behavior Genetics*, *25*, 25−32.

Cattell, R. B. (1936). Is national intelligence declining? *Eugenics Review*, *28*, 181−203.

Cattell, R. B. (1937). *The fight for our national intelligence.* London: P. S. King & Son.

Ceci, S. J. (1991). How much does schooling influence general intelligence and its cognitive components? A reassessment of the evidence. *Developmental Psychology*, *27*, 703−722.

Clark, R. (2004). Religiousness, spirituality, and IQ: Are they linked? Explorations.*An Undergraduate Research Journal*, 35−46 retrieved Dec. 15, 2008 from: http://undergraduatestudies.ucdavis.edu/explorations/2004/clark.pdf

Clark, G., & Hamilton, G. (2006). Survival of the richest: The Malthusian mechanism in pre-industrial England. *Journal of Economic History*, *66*, 707−736.

Colom, R., Flores-Mendoza, C. E., & Abad, F. J. (2006). Generational changes on the Draw-a-Man Test: A comparison of Brazilian urban and rural children tested in 1930, 2002 and 2004. *Journal of Biosocial Science*, *35*, 33−39.

Dawson, S. (1932/33). Intelligence and fertility. *British Journal of Psychology*, *23*, 42−51.

Deary, I. J., Irwing, P., Der, G., & Bates, T. C. (2007). Brother–sister differences in the *g* factor of intelligence: Analysis of full, opposite-sex siblings from the NLSY1979. *Intelligence*, *35*, 451−456.

Deary, I. J., Batty, G. D., & Gale, C. R. (2008). Bright children become enlightened adults. *Psychological Science*, *19*, 1−6.

DeFries, J. C., Ashton, G. C., Johnson, R. C., Kuse, A. R., McClearn, G. E., Mi, M. P., Rashad, M. N., Vandenberg, S. G., & Wilson, J. R. (1976). Parent–offspring resemblance for specific cognitive abilities in two ethnic groups. *Nature*, *261*, 131−133.

Dickens, W. T., & Flynn, J. R. (2001). Heritability estimates versus large environmental effects: The IQ paradox resolved. *Psychological Review*, *108*, 346−369.

Falek, A. (1971). Differential fertility and intelligence: Current status of the problem. *Social Biology*, *18*, S50−S59.

Flynn, J. A. (1987). Massive IQ gains in 14 nations: What IQ tests really measure. *Psychological Bulletin*, *101*, 171−191.

Flynn, J. R. (2009). Requiem for nutrition as the cause of IQ gains: Raven's gains in Britain 1938–2008. *Economics and Human Biology*, *7*, 18−27.

Glaeser, E. L., & Sacerdote, B. I. (2008). Education and religion. *Journal of Human Capital*, *2*, 188−215.

Goldin, C., & Katz, L. F. (1999). Human capital and social capital: The rise of secondary schooling in America, 1910–1940. *Journal of Interdisciplinary History*, *29*, 683−723.

Goujon, A., & Lutz, W. (2004). Future human capital: population projections by level of education. In W. Lutz W. C. Sanderson & S. Scherbov (Eds.), *The end of world population growth in the 21st century. New challenges for human capital formation and sustainable development* (pp. 121−157). London: Earthscan.

Hadeishi, H. (2003). Economic well-being and fertility in France: Nuits, 1744–1792. *Journal of Economic History*, *63*, 489−505.

Harrell, S. (1985). The rich get children: Segmentation, stratification, and population in three Chekiang lineages, 1550–1850. In S. B. Hanley & A. P. Wolf (Eds.), *Family and population in East Asian history* (pp. 81−109). Stanford (CA): Stanford University Press.

Higgins, J. V., Reed, E. W., & Reed, S. C. (1962). Intelligence and family size: A paradox resolved. *Eugenics Quarterly*, *9*, 84−90.

Kemkes-Grottenthaler, A. (2003). Postponing or rejecting parenthood? Results of a survey among female academic professionals. *Journal of Biosocial Science*, *35*, 213−226.

Kemmelmeier, M. (2008). Is there a relationship between political orientation and cognitive ability? A test of three hypotheses in two studies. *Personality and Individual Differences*, *45*, 767−772.

Khaleefa, O., Abdelwahid, S. B., Abdulradi, F., & Lynn, R. (2008). The increase of intelligence in Sudan 1964–2006. *Personality and Individual Differences*, *45*, 412−413.

Kirk, D. (1957). The fertility of a gifted group: A study of the number of children of men in Who's Who. In Milbank Memorial Fund. *The nature and transmission of the genetic and cultural characteristics of human populations* (pp. 78−98). New York: Milbank Memorial Fund.

Krashen, S. (1989). We acquire vocabulary and spelling by reading: Additional evidence for the input hypothesis. *Modern Language Journal*, *73*, 440−464.

Lamson, H. D. (1935). Differential reproduction in China. *Quarterly Review of Biology*, *10*, 308−321.

Lesthaeghe, R. (1983). A century of demographic and cultural change in Western Europe: An exploration of underlying dimensions. *Population and Development Review*, *9*, 411−435.

Lesthaeghe, R. (1995). The second demographic transition in Western countries: An interpretation. In K. O. Mason & A. -M. Jensen (Eds.), *Gender and family change in industrialized countries* (pp. 17−62). Oxford: Clarendon Press.

Loehlin, J. C. (1997). Dysgenesis and IQ. What evidence is relevant? *American Psychologist*, *52*, 1236−1239.

Loury, L. D. (2004). Does church attendance really increase schooling? *Journal for the Scientific Study of Religion*, *43*, 119−127.

Lynn, R. (1999). New evidence for dysgenic fertility for intelligence in the United States. *Social Biology*, *46*, 146−153.

Lynn, R., & Harvey, J. (2008). The decline of the world's IQ. *Intelligence*, *36*, 112−120.

Lynn, R., & van Court, M. (2004). New evidence of dysgenic fertility for intelligence in the United States. *Intelligence*, *32*, 193−201.

Lynn, R., & Vanhanen, T. (2006). *IQ and global inequality.* Augusta (GA): Washington Summit.

Lynn, R., Harvey, J., & Nyborg, H. (2008). Average intelligence predicts atheism rates across 137 nations. *Intelligence*, *37*, 11−15.

Meisenberg, G. (2003). IQ population genetics: It's not as simple as you think. *Mankind Quarterly*, *44*, 185−209.

Meisenberg, G. (2004). Talent, character, and the dimensions of national culture. *Mankind Quarterly*, *45*, 123−168.

Meisenberg, G. (2007). *In God's image. The natural history of intelligence and ethics.* Brighton: Book Guild.

Meisenberg, G. (2008). How universal is the negative correlation between education and fertility? *Journal of Social, Political & Economic Studies*, *33*, 205−227.

Meisenberg, G. (2009). Wealth, intelligence, politics and global fertility differentials. *Journal of Biosocial Science*, *41*, 519−535.

Meisenberg, G., Lawless, E., Lambert, E., & Newton, A. (2005). The Flynn effect in the Caribbean: Generational change of cognitive test performance in Dominica. *Mankind Quarterly*, *46*, 29−69.

Meisenberg, G., Lawless, E., Lambert, E., & Newton, A. (2006). The social ecology of intelligence on a Caribbean island. *Mankind Quarterly*, *46*, 395−433.

Neiss, M., Rowe, D. C., & Rodgers, J. L. (2002). Does education mediate the relationship between IQ and age of first birth? A behavioural genetic analysis. *Journal of Biosocial Science*, *34*, 259−275.

Notestein, F. W. (1936). Class differences in fertility. *Annals of the American Academy*, *188*, 26−36.

Notestein, F. W. (1938). A demographic study of 38,256 rural families in China. *Milbank Memorial Fund Quarterly*, *16*, 57−79.

Osborn, F., & Bajema, J. (1972). The eugenic hypothesis. *Social Biology*, *19*, 337−345.

Parker, M. P. (2004). Intelligence and dysgenic fertility: Re-specification and reanalysis. *Chrestomathy: Annual Review of Undergraduate Research at the College of Charleston*, *3*, 167−181.

Retherford, R. D., & Luther, N. Y. (1996). Are fertility differentials by education converging in the United States? *Genus*, *52*, 13−37.

Retherford, R. D., & Sewell, W. H. (1988). Intelligence and family size reconsidered. *Social Biology*, *35*, 1−40.

Retherford, R. D., & Sewell, W. H. (1989). How intelligence affects fertility. *Intelligence*, *13*, 169−185.

Rindermann, H. (2008). Relevance of education and intelligence at the national level for the economic welfare of people. *Intelligence*, *36*, 127−142.

Rindermann, H. (2008). Relevance of education and intelligence for the political development of nations: Democracy, rule of law and political liberty. *Intelligence*, *36*, 306−322.

Rodgers, J. L., & Wänström, L. (2007). Identification of a Flynn effect in the NLSY: Moving from the center to the boundaries. *Intelligence*, *35*, 187−196.

Scarr, S., & Weinberg, R. A. (1977). Intellectual similarities within families of both adopted and biological children. *Intelligence*, *1*, 170−191.

Schmidt, F. L., & Hunter, J. (2004). General mental ability in the world of work: Occupational attainment and job performance. *Journal of Personality and Social Psychology*, *86*, 162−173.

Shayer, M., Ginsburg, D., & Coe, R. (2007). Thirty years on — A large anti-Flynn effect? The Piagetian test *Volume & Heaviness* norms 1975–2003. *British Journal of Educational Psychology*, *77*, 25−41.

Stevenson, T. H. C. (1920). The fertility of various social classes in England and Wales from the middle of the nineteenth century to 1911. *Journal of the Royal Statistical Society*, *83*, 401−432.

Sundet, J. M., Barlaug, D. G., & Torjussen, T. M. (2004). The end of the Flynn effect? A study of secular trends in mean intelligence test scores of Norwegian conscripts during half a century. *Intelligence*, *32*, 349−362.

Taylor, M. D., Hart, C. L., Smith, G. D., Whalley, L. J., Hole, D. J., Wilson, V., & Deary, I. J. (2005). Childhood IQ and marriage by mid-life: The Scottish Mental Survey 1932 and the Midspan studies. *Personality and Individual Differences*, *38*, 1621−1630.

Teasdale, T. W., & Owen, D. R. (2008). Secular declines in cognitive test scores: A reversal of the Flynn effect. *Intelligence*, *36*, 121−126.

Udry, J. R. (1978). Differential fertility by intelligence: The role of birth planning. *Social Biology*, *25*, 10−14.

US Census Bureau (2008). 2008 Statistical abstract. Retrieved 24 November 2008 from http://www.census.gov/compendia/statab/cats/education/higher_education_degrees.html

van Court, M., & Bean, F. D. (1985). Intelligence and fertility in the United States: 1912–1982. *Intelligence*, *9*, 23−32.

van der Sluis, S., Willemsen, G., de Geus, E. J. C., Boomsma, D. I., & Posthuma, D. (2008). Gene–environment interaction in adults' IQ scores: Measures of past and present environment. *Behavior Genetics*, *38*, 348−360.

Vining, D. R. (1982). On the possibility of the reemergence of a dysgenic trend with respect to intelligence in American fertility differentials. *Intelligence*, *6*, 241−264.

Vining, D. R. (1986). Social versus reproductive success: The central theoretical problem of human sociobiology. *Behavioral and Brain Sciences*, *9*, 167−216.

Vining, D. R. (1995). On the possibility of the reemergence of a dysgenic trend with respect to intelligence in American fertility differentials: An update. *Personality and Individual Differences*, *19*, 259−263.

Vogler, G. P., & DeFries, J. C. (1983). Linearity of offspring–parent regression for general cognitive ability. *Behavior Genetics*, *13*, 355−360.

Waller, J. H. (1971). Differential reproduction: Its relation to IQ test score, education, and occupation. *Social Biology*, *18*, 122−136.

Weinberger, M. B. (1987). The relationship between women's education and fertility: Selected findings from the World Fertility Surveys. *International Family Planning Perspectives*, *13*, 35−46.

Williams, T. (1975). Family resemblance in abilities: The Wechsler scales. *Behavior Genetics*, *5*, 405−410.

Willoughby, R. R., & Coogan, M. (1940). The correlation between intelligence and fertility. *Human Biology*, *12*, 114−119.

Winship, C., & Korenman, S. (1997). Does staying in school make you smarter? The effect of education on IQ in *The Bell Curve*. In B. Devlin S. E. Fienberg D. P. Resnick & K. Roeder (Eds.), *Intelligence, genes, and success. Scientists respond to the Bell Curve* (pp. 229−234). New York: Springer.

Yang, Y., & Morgan, S. P. (2003). How big are educational and racial fertility differentials in the U.S.? *Social Biology*, *50*, 167−187.