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# Dysgenic fertility for intelligence and education in Taiwan

Hsin-Yi Chen[a,*], Yung-Hua Chen[b], Yung-Kun Liao[c], Hsin-Ping Chen[d], Richard Lynn[e]

[a] Department of Special Education, National Taiwan Normal University, Taipei, Taiwan, ROC
[b] Chinese Behavioral Science Corporation, Taiwan, ROC
[c] Department of Special Education, National Dong-Hwa University, Hualien, Taiwan, ROC
[d] Department of Economics, National Chengchi University, Taipei, Taiwan, ROC
[e] University of Ulster, Coleraine, Ireland

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ABSTRACT

This study investigated the current trend of dysgenic fertility in Taiwan. Data on 680 adults aged 35 to 90 years from the Taiwan WAIS-IV norming sample and 980 children aged 2.5 to 7 years from the Taiwan WPPSI-IV norming sample were examined to investigate the relationships between intelligence, education, and fertility. Results revealed that education and intelligence were negatively correlated with fertility, and that the correlations were stronger for females. The genotypic intelligence is estimated to decline by approximately 1.19 IQ points per generation and the decline is much stronger for the younger adult cohort (1.46 IQ points) than for the older adult cohort (1.02 IQ points).

## 1. Introduction

Eighty years ago, Runquist (1936) reported a secular increase in intelligence. In the decades that followed, numerous studies reported similar findings across various samples and countries (Lynn, 2013). In 1984, Flynn (1984) reported an average gain of 0.3 IQ points per year based on his examination of 18 U.S. studies from 1932 to 1978. This approximately 3-point-per-decade average increase in IQ has been confirmed by recent meta-analyses (Pietschnig & Voracek, 2015; Trahan, Stuebing, Fletcher, & Hiscock, 2014). Additionally, on the basis of 271 independent samples from 31 countries over more than one century (1909–2013), Pietschnig and Voracek (2015) reported that IQ gains vary according to domain, are stronger for adults than for children, and have decreased in recent decades.

The Flynn effect is currently slowing. Many studies have reported an increase in IQ; for example, reports from the United States (Flynn, 2012; Flynn & Weiss, 2007), the Commonwealth of Dominica (Meisenberg, Lawless, Lambert, & Newton, 2005, 2006), Germany, and Korea have continued to show gains. However, recent evidence has begun to reveal that the Flynn effect has reversed in a few countries (Dutton, van der Linden, & Lynn, 2016). Static or declining trends have been observed in Great Britain, France, Netherlands, Australia, Estonia, and some Scandinavian nations like Finland, Norway and Denmark (Cotton et al., 2005; Dutton & Lynn, 2013, 2015; Flynn, 2012; Lynn, 2009; Ronnlund, Carlstedt, Bloomstedt, Nilsson, & Weinehall, 2013; Shayer, Ginsburg & Coe, 2007; Shayer & Ginsburg, 2009; Shayer, Ginsburg, & Coe, 2007; Sundet, Barlaug, & Torjussen, 2004; Teasdale & Owen, 2000, 2005, 2008; Woodley & Meisenberg, 2013). The average intelligence in a number of economically developed countries is declining (Lynn, 2011; Meisenberg & Woodley, 2013).

One suggested cause of the negative Flynn effect is the so-called process of dysgenic fertility (Dutton & Lynn, 2015; Lynn, 2011). For example, Woodley of Menie (2015) investigated the decline of *g* across nine US and UK studies, and estimated a loss of 0.39 points per decade due to selection, a loss of 0.84 points per decade due to mutation accumulation and a total dysgenic loss of 1.23 points per decade. Dutton, van der Linden, and Lynn (2016) proposed that "a phenotypic increase in IQ may have largely overshadowed a possible genotypic decline in IQ and that the latter is only more recently starting to show up in several representative datasets" (p. 167).

The majority of research on the secular trend of intelligence has come from the United States, Great Britain, and other countries in Europe. There have also been some studies for East Asia. Wang, Fuerst, and Ren (2016) reported evidence for dysgenic fertility in the People's Republic of China. They estimated a fluid intelligence loss from 1971 to 2000 due to dysgenic fertility at 0.75 points after correction for the reliability and validity of the measures. For Taiwan, an IQ gain in children was estimated as 2.45 IQ points per decade over the years 1997–2007 (Chen, Liao, Chen, Chen, & Lynn, 2013). Chen, Chen, Liao, and Chen (2013) estimated the decline of genotypic intelligence as 0.82 to 1.33 IQ points per generation but this estimate was based on a small adult sample of 73. The objective of the present paper is to report a

* Corresponding author at: Department of Special Education, National Taiwan Normal University, 162, He-Ping East Road, Section 1, Taipei, Taiwan, ROC.
*E-mail address:* hsinyi@ntnu.edu.tw (H.-Y. Chen).

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further study of the secular trend of intelligence in Taiwan.

## 2. Method

### 2.1. Adults: the Taiwan WAIS-IV norming sample

We first analyzed data for 680 adults aged 35–90 years from the Taiwan WAIS-IV standardization sample that was stratified to match the 2013 census for gender, level of education and geographical region (Wechsler, 2015). The mean full-scale IQ (FSIQ) was 99.8 ($SD = 15.1$), and the mean age was 66.4 years ($SD = 15.5$). The Taiwan version of the WAIS-IV has ten core subtests: Vocabulary, Similarities, Information, Block Design, Matrix Reasoning, Visual Puzzle, Digit Span, Letter-Number Sequencing, Symbol Search, and Coding. Internal consistency reliability is 0.98 for FSIQ (Wechsler, 2015). Correlation and part correlation methodologies were used to investigate the associations among FSIQ, educational attainment[1], and a self-reported number of children.

### 2.2. Young children: the Taiwan WPPSI-IV norming sample

The Taiwan WPPSI-IV standardization sample (Wechsler, 2013) consisted of 924 children aged 2.5–7 years. It was stratified to match the 2012 census for gender, parents' education level, and geographical region. The overall mean FSIQ was 100.0 ($SD = 15.0$). The mean age was 4.95 years ($SD = 1.59$). The Taiwan version of the WPPSI-IV has five core subtests in FSIQ for ages 2.5–4 (Receptive Vocabulary, Information, Block Design, Matrix Reasoning, and Picture Memory) and six core subtests in FSIQ for ages 4–7 (Information, Similarities, Block Design, Matrix Reasoning, Picture Memory, and Bug Search). Internal consistency reliability for FSIQ is 0.95 and 0.96 for the younger and older age bands, respectively, with an overall average of 0.96 (Wechsler, 2013). Correlation methodologies were used to investigate the associations among FSIQ, parents' education[1], and a self-reported number of siblings.

## 3. Results

### 3.1. Results based on the adult sample

Table 1 presents the descriptive statistics and correlations between the studied variables and age in the adult sample.

Intelligence and educational attainment were significantly and positively correlated ($r = .65$, $p = .000$). The correlation between intelligence and the number of children was $-.18$ ($p = .000$), and the correlation between education and the number of children was $-.34$ ($p = .000$). Once intelligence was controlled for, the partial correlation between education and the number of children remained statistically significant ($r = -.30$, $p = .000$).

The correlation between age and the number of children was .55 ($p = .000$). Approximately 13.5% of the sample were childless. Compared with adults who had children, adults without children were younger ($t = 7.05$, $p = .000$), and had higher educational attainment ($t = 3.34$, $p = .000$).

We further investigated the phenomenon according to gender. For women, the correlation between fertility and FSIQ was $-.25$ ($p = .000$). The correlation between fertility and education was $-.44$ ($p = .000$). When the analysis was controlled for intelligence, the partial correlation between education and the number of children remained significant at $-.38$ ($p = .000$). The 14% of women who were childless, compared with those who had children, were younger ($t = 5.12$, $p = .000$), higher in educational attainment ($t = 5.86$, $p = .000$), and higher in intelligence ($t = 2.08$, $p = .03$). For men, the correlation between fertility and IQ was non-significant ($r = -.08$, $p = .138$), which was considered as zero in the population. However, the correlation between fertility and education was significant at $-.21$ ($p = .000$). The partial correlation between education and the number of children remained $-.20$ ($p = .000$) after intelligence was controlled. Approximately 13% of the men were childless. Compared with men who had children, this group was younger ($t = -4.85$, $p = .000$), but did not show significant differences in education and intelligence.

The average number of children was 3.16 for adults with an FSIQ less than 84 and 2.29 for adults with an FSIQ higher than 115. The average number of children was 3.42 for adults with the lowest education level (elementary school or lower) and 1.93 for adults with the highest education level (4-year university or college, or higher). The fertility of those with the lowest FSIQ and the fewest years of education, was approximately 1.4 to 1.8 times the rate of those with the highest FSIQ and most years of education.

To estimate the decline of genotypic intelligence[2], we weighted the IQ of the parents by their number of children and assuming that, on average, the mean IQ of the children is the same as that of their parents, the differences between the mean IQ of the sample and that of their children was estimated as 1.67. With the adoption of Jinks and Fulker's (1970) estimate of .71 for the narrow heritability of intelligence[3], the decline of genotypic intelligence is 1.19 IQ points per generation. To examine possible variations between cohorts, we further divided the whole adult sample into two age bands: an older cohort (65 to 90 years) and a younger cohort (35 to 64 years). The differences between the mean IQ of each sample and that of their children were estimated as 1.43 for the older cohort and 2.06 for the younger cohort. The estimated decline of genotypic intelligence was 1.02 IQ points for the older cohort and 1.46 IQ points for the younger cohort.

### 3.2. Results based on the sample of young children[4]

Intelligence and the educational attainment of both parents were significantly and positively correlated ($r = .33$ and .31 respectively, $p = .000$ for both). The correlation between intelligence and the number of siblings was negative ($r = -.12$, $p = .000$). The correlation between fathers' education and the number of siblings was $-.12$ ($p = .000$), and for mothers it was $-.11$ ($p = .000$). In addition, the data showed a positive correlation between children's ages and the number of elder siblings ($r = .11$, $p = .000$). Table 2 presents the descriptive statistics and correlations between the studied variables and age in this sample of young children.

## 4. Discussion

There are five points of interest in the results. First, the results based

[1] Educational attainment was coded on a 1 to 6 scale: 1 = elementary school or lower; 2 = junior high school; 3 = senior high school; 4 = 2-year college; 5 = 4-year university or college; 6 = graduate school or higher.

[2] We used the following formula to estimate the decline of genotypic intelligence ($D$). $D = (h^2) \times \left[MIQ_P - \left(\frac{\sum(IQ_P \times N_C)}{\sum N_C}\right)\right]$, where $h^2$ is the heritability of intelligence, $MIQ_P$ is the mean IQ for the group of parents, $IQp$ is the IQ for each parent, $Nc$ is the number of children for each parent, and $\Sigma N_c$ is the total number of children. The decline of genotypic intelligence for the overall sample was calculated by a) estimating the mean IQ difference between parents and their children, [99.7544 − (176849/1803)] = 1.67, and b) estimating the decline of genotypic intelligence, .71∗1.67 = 1.19.

[3] The heritability of IQ ($h^2$) increases with age (Bouchard, 2013; Haworth et al., 2010). In childhood, $h^2$ for IQ is approximately .45, and by late adolescence, $h^2$ is approximately .75 (Neisser et al., 1996). For adults, this value is between approximately .70 and .80 (Bouchard et al., 1990; Plomin, Pedersen, Lichtenstein, & McClearn, 1994). One of our coauthors personally consulted Prof. Robert Plomin, who agrees that Jinks and Fulker's estimate of .71 is correct.

[4] We present the sibling data for young children only for reference. The data themselves are insufficient for estimating the rate of intelligence decline per generation, and the sibling data have problems attributable to the undersampling of parents with few children and the omission of adults who are childless.

**Table 1**
Descriptive statistics and correlations between studied variables and age: adult sample aged 35 to 90 years.

| Variables | Overall sample (N = 680) | | | | | Male sample (N = 330) | | | | | Female sample (N = 350) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | SD | Correlations | | | M | SD | Correlations | | | M | SD | Correlations | | |
| | | | 2 | 3 | 4 | | | 2 | 3 | 4 | | | 2 | 3 | 4 |
| 1. Age in years | 66.4 | 15.5 | −.07 | −.32** | .55** | 66.1 | 15.7 | .04 | −.22** | .56** | 66.7 | 15.3 | −.16** | −.42** | .55** |
| 2. FSIQ | 99.8 | 15.1 | | .65** | −.18** | 102.4 | 15.0 | | .61** | −.08 | 97.3 | 14.9 | | .67** | −.25** |
| 3. Education level | 2.7 | 1.5 | | | −.34** | 3.0 | 1.5 | | | −.21** | 2.5 | 1.5 | | | −.44** |
| 4. Number of children | 2.7 | 1.7 | | | | 2.6 | 1.6 | | | | 2.8 | 1.8 | | | |

** $p < 0.01$.

**Table 2**
Descriptive statistics and correlations between studied variables and age: sample of children aged 2.5 to 7 years.

| Variables | Overall sample (N = 924) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | M | SD | Correlations | | | | | |
| | | | 2 | 3 | 4 | 5 | 6 | |
| 1. Age in years | 5.0 | 1.6 | .04 | −.04 | −.08* | .14** | .11** | |
| 2. FSIQ | 100.0 | 15.0 | | .33** | .31** | −.12** | −.03 | |
| 3. Fathers' education level | 3.8 | 1.1 | | | .80** | −.12** | −.04 | |
| 4. Mothers' education level | 3.7 | 1.1 | | | | −.11** | .01 | |
| 5. Number of siblings | 1.0 | 0.7 | | | | | .54** | |
| 6. Number of elder siblings | 0.5 | 0.6 | | | | | | |

* $p < 0.05$.
** $p < 0.01$.

on the adult sample provide evidence of dysgenic fertility in intelligence in Taiwan. The negative correlations observed in the sample of young children also imply the presence of dysgenic fertility. The magnitude of the decline of genotypic intelligence is estimated as 1.19 IQ points per generation, which is similar to the estimated 1.0 to 1.2 IQ point decline of genotypic intelligence calculated in the United States (Lynn, 2011; Meisenberg & Kaul, 2010). The results also show a much stronger genotypic IQ decline for the younger cohort with an estimated decline of 1.46 IQ points per generation compared with 1.02 IQ points for the older cohort. The finding that this decline is accelerating deserves close attention.

Second, dysgenic fertility for IQ was only present for women consistent with results for several countries summarized in Lynn (2011) and confirmed by Meisenberg (2010) and Wang, Fuerst, & Ren (2016) in China. Third, the results show the presence of dysgenic fertility for education in Taiwan[5], and it was greater in women than men. Such results are also consistent with results summarized in Lynn (2011). Opportunity costs are one possible reason for the observed differences between genders. Compared with highly educated men, highly educated women incur much greater losses in income and satisfaction by work-related factors such as reputation and intrinsic value when they have a child.

Fourth, with intelligence controlled, the partial correlations between education and the number of children remained statistically significant at −.20 for men and −.38 for women. This shows that there has been dysgenic fertility for non-cognitive factors. One possibility is the personality trait of conscientiousnes that has been identified in the literature as a significant predictor of educational attainment and work achievement (Hagmann-von, Gygi, Weidmann, & Grob, 2016), and the correlation between conscientiousness and academic performance was found independent of intelligence (Poropat, 2009). The present results support Lynn's thesis (2011) that there is dysgenic fertility for conscientiousness as well as for intelligence in contemporary economically developed societies.

Fifth, the average number of children was 3.42 for adults with 6 years of education or less and 1.93 children for adults with 16 or more years of education. The average number of children was 3.16 for adults with an FSIQ less than 84 and 2.29 for adults with an FSIQ higher than 115. These figures for fertility are well above those required for replacement. However, they are for a cohort with a mean age of 66.4 years. Fertility has declined substantially in younger cohorts. In Taiwan, there has been a sharp decline from a fertility rate of almost 6 children per woman in the early 1960s to a low of .91 in 2010 (Population Reference Bureau, 2012), while the total fertility rate for 2014–2015 was approximately 1.18 (Ministry of the Interior in Taiwan, 2016; Population Reference Bureau, 2016). Based on a recent survey, the intention for Taiwanese women to have children remains low (Basten & Verropoulou, 2015). One fifth of women with no children do not intend to ever have children, and 53.4% of women with one child do not intend to have another. Similar low fertility rates have been found in other East Asian countries including Hong Kong, Japan, South Korea and Singapore, and also in Europe and North America (Population Reference Bureau, 2016) adding population decline to dysgenic fertility to the demographic problems of contemporary economically developed societies.

This analysis has limitations. First, large sample sizes facilitate providing reliable estimations. Though not perfect, the datasets used here are the largest, most recent, and most representative available in Taiwan. Second, our effect estimates for generation were influenced by the manner in which data were collected and estimated. Generation length varies among generations and countries. Consequently, the reported dysgenic effects could vary among studies because of differences in generation length.

The current findings reveal dysgenic fertility in intelligence and education in Taiwan, and the decline is much stronger for younger people. Once the cognitively stimulating effect of the current environment reaches its limit, a negative Flynn effect may be observed in Taiwanese society. Our study confirms the suspicion that genotypic decline in IQ deserves close attention in the coming years.

[5] To clarify whether age differences biased the current results, we performed additional analyses to partial out age. Fertility remained significantly negatively correlated with IQ and education after we controlled for age.

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