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A longitudinal study of sex differences in intelligence at ages 7, 11 and 16 years

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ABSTRACT

This paper presents the results of a longitudinal study of sex differences in intelligence as a test of Lynn's (1994) hypothesis that from the age of 16 years males develop higher average intelligence than females. The results show that at the ages of 7 and 11 years girls have an IQ advantage of approximately 1 IQ point, but at the age of 16 years this changes in the same boys and girls to an IQ advantage of 1.8 IQ points for boys.

1. Introduction

From the early years of the twentieth century it has been consistently asserted that there is no sex difference in average general intelligence defined as the sum of cognitive abilities measured by the IQ obtained in tests like the Wechslers and the Binets. In an early study, the absence of a sex difference in average intelligence was asserted by Terman (1916) who wrote that in the American standardization sample of the Stanford–Binet test on 4–16 year olds "the superiority of girls over boys is so slight ... that for practical purposes it would seem negligible". The same view was taken by Burt and Moore (1912) and Spearman (1923). In the second half of the century it was reaffirmed by Cattell (1971, p. 131): "it is now demonstrated by countless and large samples that on the two main general cognitive abilities – fluid and crystallized intelligence – men and women, boys and girls, show no significant differences"; Hutt (1972, p. 88): "there is little evidence that men and women differ in average intelligence"; Maccoby and Jacklin (1974, p. 65): "the sexes do not differ consistently in tests of total (or composite) abilities"; Jensen (1980, p. 360): "males and females do not differ in IQ"; Brody (1992, p. 323): "gender differences in general intelligence are small and virtually non-existent"; and Herrnstein and Murray (1994, p. 275): "the consistent story has been that men and women have nearly identical IQs".

This consensus was broken by Lynn (1994, 1999) who contended that while it is correct that there is virtually no sex difference in average intelligence between the ages of 5 and 15 years, from the age of 16 years males begin to have greater average intelligence than females and that this increases to an advantage of between 4 and 5 IQ points in adults. More specifically, Lynn (1994) proposed that there is virtually no sex difference in intelligence between the ages of 5–10 years, that between the ages of 11–14 years girls have a small IQ advantage of approximately 1 IQ point because they mature earlier, and that from the age of 15–16 years boys develop a small IQ advantage of approximately 1 IQ point, which increases in later adolescence to reach approximately 4 IQ points among adults.

Lynn's (1994) hypothesis was first disputed by Mackintosh (1996) on the grounds that a review by Court (1983) had shown that there is no sex difference on the Progressive Matrices, from which Mackintosh (1996, p. 567) concluded that "there is no sex difference in general intelligence worth speaking of". In response to this, Lynn and Irwing (2004) published a meta-analysis of 57 studies of sex differences on the Progressive Matrices in which they showed that there is no difference among children aged 6–14 years, but that males obtain higher means from the age of 15 through to old age, and that among adults, the male advantage is 5 IQ points. A year later Irwing and Lynn (2005) published a meta-analysis of 22 studies of sex differences on the Progressive Matrices in university students and concluded that in these samples males have an advantage of 4.6 IQ points. In a more recent study, Mackintosh and Bennett (2005) reported data for a sample of 17 year olds on the Progressive Matrices in which males obtained a higher mean of 6.4 IQ points. In this paper they conceded that "studies of older participants (over the age of 16) were more likely to yield a male than a female advantage" (p. 670).

Lynn's hypothesis has been confirmed in the Spanish standardization sample of the WAIS–III, in which men obtained a higher IQ than women of 3.6 IQ points (Colom, Garcia, Juan-Espinoza, &

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Abad, 2002). A further confirmation for a Spanish sample has been reported by Colom and Lynn (2004), who found a male advantage among 18 year olds of 4.3 IQ points on the Differential Aptitude Test. Further supportive evidence for Lynn's hypothesis has been published by Meisenberg (2009), who reports a male advantage of 2.8 IQ points among 22–3 year old whites in the United States on the ASVAB (Armed Services Vocational Aptitude Battery). This difference, however, was not present among blacks. In this study intelligence was also measured as *g*, and for this there was no significant sex difference among 15 year olds among either blacks or whites, but among whites a significant male advantage of 4 IQ points was present among 16 year olds and this increased to an advantage of 6.5 among 22–3 year olds, while for blacks a male advantage of 1 IQ point was present among 16 year olds and this increased to an advantage of 2.15 points among 22–3 year olds. Three studies in Germany have reached the same conclusion for the IST test. Amelang and Steinmayr (2006) report a male advantage of 6.0 IQ points in a sample of 34 year olds. Steinmayr and Spinath (2010) report a male advantage of 9.7 IQ points in a sample of 16 year olds; and Steinmayr, Beauducel, and Spinath (2010) report a male advantage of 11.5 IQ points in a further sample of 16 year olds.

Lynn's hypothesis has been further confirmed in a review by Ellis et al. (2008, p. 288) of sex differences in general intelligence defined as the IQ obtained in tests like the Wechsler. He lists 50 studies of adults. Males obtained statistically significantly higher IQs than females in 29 studies and there was no statistically significant difference in 20 studies. In evaluating the non-statistically significant studies, it should be borne in mind that a sample size of around 500 is required to obtain a statistically significantly difference of 5 IQ points and many of the studies fall short of this number. There was one study in which females obtained higher IQs than males, but this was of a mentally subnormal sample and should be discounted because males are more impaired in mentally subnormal samples (Ellis et al., 2008, p. 290). Thus, the preponderance of the evidence reviewed by Ellis et al. (2008) indicates that Lynn's hypothesis that men have a higher average IQ than women is correct.

Despite these results supporting Lynn's hypothesis, many scholars continue to assert that there is no average sex difference in intelligence. For instance, Halpern (2000, p. 218): "sex differences have not been found in general intelligence"; Butterworth (1999, p. 293): "women's brains are 10% smaller than men's, but their IQ is on average the same"; Geary (1998, p. 310): "the overall pattern suggests that there are no sex differences, or only a very small and unimportant advantage of boys and men, in average IQ scores"; Bartholomew (2004, p. 91): "men on average have larger brains than women but display no significant advantage in cognitive performance"; Anderson (2004, p. 829): "it is an important finding of intelligence testing that there is no difference between the sexes in average intellectual ability; this is true whether general ability is defined as an IQ score calculated from an omnibus test of intellectual abilities such as the various Wechsler tests, or whether it is defined as a score on a single test of general intelligence, such as Raven's Matrices"; Hines (2007, p. 103) "there appears to be no sex difference in general intelligence; claims that men are more intelligent than women are not supported by experimental data; Haier (2007, p. 115): "general intelligence does not differ between men and women"; Halpern (2007, p. 123) "there is no difference in intelligence between males and females. . .overall, the sexes are equally smart"; Speke (2007, p. 65): "men and women have equal cognitive capacity".

It is apparent that Lynn's hypothesis has not been widely accepted. Our objective in this paper is to present a test of the hypothesis using longitudinal data rather than the cross-sectional data on which the hypothesis has hitherto been based. Cross-sectional data are problematic because among older adolescents, more males are in prison and other custodial institutions and these are not included in the samples on which norms are based. These excluded males have lower average IQs, so their omission from normative samples inflates the IQs of males that are tested. Longitudinal data overcome this problem by assessing IQs of the same males and females at different ages and hence provide a more stringent test of the hypothesis.

2. Method

The data to be analysed come from the National Child Development Study (NCDS). NCDS is a large-scale prospectively longitudinal study which has followed a population of British respondents since birth for more than half a century. The study began with all babies (n = 17,419) born in Great Britain (England, Wales, and Scotland) during the week of March 03–09, 1958. The respondents are subsequently re-interviewed in 1965 (Sweep 1 at age 7; n = 15,496), in 1969 (Sweep 2 at age 11; n = 18,285) (There are more respondents in Sweep 2 than in the original sample (Sweep 0) because the Sweep 2 sample includes eligible children who were in the country in 1969 but not in 1958 when Sweep 0 interviews were conducted), in 1974 (Sweep 3 at age 16; n = 14,469), in 1981 (Sweep 4 at age 23; n = 12,537), in 1991 (Sweep 5 at age 33; n = 11,469), in 1999–2000 (Sweep 6 at age 41–42; n = 11,419), and in 2004–2005 (Sweep 7 at age 46–47; n = 9534). In each Sweep, personal interviews and questionnaires were administered to the respondents, to their mothers, teachers, and doctors during childhood and to their partners and children in adulthood. 97.8% of the NCDS respondents are Caucasian.

The NCDS respondents took multiple intelligence tests at ages 7, 11, and 16. At age 7, the respondents took four cognitive tests (Copying Designs Test, Draw-a-Man, Southgate Group Reading, and Problem Arithmetic). At age 11, they took five cognitive tests (Verbal General Ability, Nonverbal General Ability, Reading Comprehension, Mathematics, and Copying Designs). At age 16, they took two cognitive tests (Reading Comprehension and Mathematics Comprehension). We first perform a factor analysis at each age to compute their general intelligence score for each age. All cognitive test scores at each age load on only one latent factor, with reasonably high factor loadings (Age 7: Copying Designs = .671, Draw-a-Man = .696, Southgate Group Reading = .780, and Problem Arithmetic = .762; Age 11: Verbal General Ability = .920, Nonverbal General Ability = .885, Reading Comprehension = .864, Mathematics = .903, and Copying Designs = .486; Age 16: Reading Comprehension = .909, and Mathematics Comprehension = .909). The latent general intelligence factors at each age are converted into the standard IQ metric, with a mean of 100 and a standard deviation of 15.

3. Results

Table 1 gives descriptive statistics for test scores of the boys and girls at ages 7, 11 and 16 years. Table 2 shows the mean IQs and sds of all the participants tested at the three ages. The two columns at the right of the table give the sex differences expressed in standard deviation units (d), and the values of Student's t as tests of the statistical significance of the differences. It will be seen that at the ages of 7 and 11 girls obtained a higher average IQ than boys, but at the age of 16 years boys obtained a higher average IQ than girls. All the sex differences are statistically significant at $p < .01$.

It will be noted that the numbers tested decline over the three age groups. By age 16 years, 16.9% of the original sample at age 0 (and 6.6% of the age 7 sample) had dropped out. This leaves open the possibility of greater attrition among lower IQ boys. To exam-