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Sex differences on Raven's Standard Progressive Matrices among 6 to 18 year olds in Sudan

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ABSTRACT

The Standard Progressive Matrices (SPM) was administered to a sample of 7226 school students aged 6 to 18 years in Sudan. There were no statistically significant sex differences between the total scores of the 6 to 13 year olds, but among 14 to 18 year olds males obtained higher average scores than females and among the 16, 17 and 18 years olds the average male advantage was 0.337*d*, equivalent to 5 IQ points. An analysis of the data for the sex differences on the three factors of Gestalt Visualization, Verbal-analytic Reasoning and Visuospatial Ability identified by Lynn, Allik and Irwing (2004) showed similar age trends to those for the total scores.

1. Introduction

Throughout almost the whole of the twentieth century it was consistently asserted that there is no sex difference in general intelligence defined as the IQ obtained from tests like the Stanford–Binet, the Wechsler, the Cattell and numerous others. In the early twentieth century this conclusion was advanced by Burt and Moore (1912) and Terman (1916), who wrote: "the superiority of girls over boys is so slight (on the American standardization sample of the Stanford–Binet test on 4–16 year olds) … that for practical purposes it would seem negligible", and by 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"; Eysenck (1981, p. 40): "on practically all tests now in use, men and women have equal average scores"; Brody (1992, p.323): "gender differences in general intelligence are small and virtually non-existent"; Herrnstein and Murray (1994, p. 275): "the consistent story has been that men and women give nearly identical IQs".

This consensus that there is no sex difference in intelligence was broken by Lynn (1994) who advanced a developmental theory of sex differences in intelligence that stated that boys and girls mature at different rates both physically and mentally during childhood and adolescence. Boys and girls mature at about the same rate up to the age of around 7 years; from the age of 8, girls begin a growth spurt in which there is an acceleration of their physical growth in respect of height, weight, and brain size; the growth rate of girls slows at the age of 14 and 15, while the growth of boys continues. Lynn's (1994)

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developmental theory proposed that there are the same sex differences in intelligence. In regard to abstract (nonverbal) reasoning ability, Lynn's original formulation of the theory stated that there is no sex difference up to the age of around 8 years, between the age range of around 9 through 12 years, girls have an advantage of approximately 1 IQ point; there is no sex difference between the ages of around 13 to 15 years, and at the age of 16 years, boys have a small advantage that increases with age reaching an advantage among adults of around 4 IQ points. These estimates were not derived from data on the Progressive Matrices but from other data and, in the case of adults, from the American standardization samples of the Differential Aptitude Test. In a subsequent compilation of studies, Lynn (1999) proposed that among adults the male advantage on abstract reasoning is approximately 5 IQ points. Lynn's thesis was derived from the findings by Ankney (1992) and Rushton (1992) that men have a larger average brain size than women, even when this is controlled for body size. Brain size is positively associated with intelligence at a correlation of .40, as shown in the meta-analysis by Vernon, Wickett, Bazana, and Stelmack (2000, p.248), so it was argued that it follows that men should have greater average intelligence than women.

Lynn's thesis was criticized by Mackintosh (1996, p.567) who argued that Raven's Progressive Matrices is among the best measures of intelligence and that on this test "there is no sex difference in general intelligence worth speaking of …large scale studies of Raven's tests have yielded all possible outcomes, male superiority, female superiority and no difference… there appears to be no difference in general intelligence". He reiterated this conclusion in a subsequent paper contending that there is at most only a very small difference consisting of no more than a difference of 1–2 IQ points among adults either way (Mackintosh, 1998).

In response to this criticism, Lynn presented further data on sex differences on the Progressive Matrices that confirmed his thesis of a male advantage from the age of 16 years into adulthood (Colom & Lynn, 2004; Lynn, Allik, & Irwing, 2004; Lynn, Allik, & Must, 2000; Lynn, Allik, Pullmann, & Laidra, 2002; Pullmann, Allik, & Lynn, 2004). He also published a meta-analysis of sex differences on the Progressive Matrices among general population samples that confirmed his thesis of a male advantage from the age of 16 years reaching 5 IQ points among adults into adulthood (Lynn & Irwing, 2004), and a meta-analysis of sex differences on the Progressive Matrices among college student samples that concluded that males have an advantage of 4.6 IQ points (Irwing & Lynn, 2005).

These results have not persuaded Mackintosh whose most recent position is that "data from the middle of the last century are quite unreliable indicators of the position today" and "males are not superior to females in reasoning ability" (Mackintosh, 2011, p.366).

Many other scholars have continued to assert that there is no sex difference in intelligence. Thus: Seligman (1998, p. 72): "on average, men and women are equal in mental ability"; Lubinski (2000, p.416): "most investigators concur on the conclusion that the sexes manifest comparable means on general intelligence"; 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"; Dolan et al. (2006, p.194): "sex differences are absent on Raven Progressive Matrices"; Hines (2004, p.103): "there appears to be no sex difference in general intelligence"; Halpern (2012, p.233) "females and males score identically on IQ tests".

The objective of the study to be reported was to examine the data for a sample in Sudan to examine sex differences on the Standard Progressive Matrices among 6 to 18 year olds, and on the three factors of Gestalt Visualization, Verbal-analytic Reasoning and Visuospatial Ability identified in an Estonian sample by Lynn et al. (2004).

2. Method

The Standard Progressive Matrices (Raven, 1981) was administered in the academic years 2005/2006 to a sample of 7226 (3810 males; 3916 females) school students aged 6 to 18 years in Sudan. The sample consisted of all the school students in the central sector of the provinces of Al Jazeera Aba, Raback, & Kosti in the White Nile state, approximately 300 km south of the capital, Khartoum. Schooling is compulsory in Sudan from the age of 6 and to 18 years.

The data were analysed for the sex differences on the total scores on the Standard Progressive Matrices and for the scores on the three factors of Gestalt Visualization, Verbal-analytic Reasoning and Visuospatial Ability identified by Lynn et al. (2004). To calculate scores on the three factors, a principal components analysis was carried out that showed three factors with eigenvalues greater than unity. The data were then analysed by exploratory factor analysis using a three factor solution. Items with loadings higher than .30 were then selected from each extracted factor that were identical to the items of the same factor in the study Lynn et al. (2004), except items E10, E11 and E12, which had lower loadings than .20 were excluded from the Verbal-analytic Reasoning factor. The Cronbach's Alpha was .87 for Gestalt Visualization, .68 for Verbal-analytic Reasoning, and .93 for Visuospatial Ability.

3. Results

The results are given in Table 1. This shows the numbers of males and females for each age group from 6 to 18 year olds, their mean scores on the SPM and standard deviations, and the differences between the males and females expressed as *d*s (standard deviation units), followed by the differences between the males and females expressed as *d*s on the three factors of Gestalt visualization, Verbal-analytic reasoning and Visuospatial ability. The statistical significance of the sex differences was tested by t-tests.

Table 1
Sex differences on the total scores and the three sub-factors of the Standard Progressive Matrices in Sudan (negative signs denote higher scores by females).

Age	Gender	N	Total IQ scores Mean (SD)	*d*	GV Mean (SD)	*d*	VR Mean (SD)	*d*	VA Mean (SD)	*d*
6	Males	124	10.54 (5.23)	.01	.39 (.21)	−.05	.08 (.11)	0.2	.13 (.11)	0
	Females	150	10.49 (5.56)		.40 (.18)		.06 (.09)		.13 (.10)	
7	Males	303	13.25 (9.94)	−.12	.44 (.29)	−.11	.08 (.11)	.09	.22 (.23)	−.17*
	Females	278	14.44 (10.01)		.47 (.28)		.07 (.11)		.26 (.24)	
8	Males	295	13.83 (7.45)	−.07	.47 (.25)	−.12	.09 (.10)	.10	.21 (.18)	−.04
	Females	270	14.33 (7.52)		.50 (.24)		.08 (.11)		.22 (.18)	
9	Males	342	14.61 (7.65)	−.01	.52 (.26)	−.04	.09 (.11)	.09	.21 (.19)	−.05
	Females	355	14.65 (7.68)		.53 (.24)		.08 (.11)		.22 (.19)	
10	Males	472	16.79 (9.41)	0	.57 (.25)	−.04	.11 (.14)	.07	.26 (.23)	−.08
	Females	380	16.81 (10.08)		.58 (.26)		.10 (.13)		.28 (.26)	
11	Males	401	20.48 (11.02)	−.09	.67 (.26)	.04	.13 (.16)	0	.34 (.28)	−.17*
	Females	383	21.57 (12.07)		.66 (.25)		.13 (.15)		.39 (.31)	
12	Males	381	23.09 (11.88)	.13	.71 (.23)	.13*	.15 (.17)	.06	.41 (.31)	.07
	Females	441	21.56 (11.13)		.68 (.23)		.14 (.17)		.39 (.29)	
13	Males	257	23.87 (12.22)	.16	.73 (.24)	.18*	.17 (.19)	.17*	.40 (.30)	.07
	Females	307	21.96 (11.82)		.69 (.21)		.14 (.17)		.38 (.30)	
14	Males	396	26.10 (12.90)	.17*	.75 (.22)	.18*	.18 (.19)	0	.47 (.32)	.16*
	Females	248	23.90 (12.57)		.71 (.23)		.18 (.19)		.42 (.31)	
15	Males	232	29.09 (14.61)	.10	.78 (.23)	.05	.25 (.24)	.18*	.51 (.34)	.03
	Females	327	27.77 (12.98)		.77 (.21)		.21 (.21)		.50 (.32)	
16	Males	199	29.03 (12.11)	.15	.81 (.21)	.19*	.21 (.21)	.15	.51 (.31)	.03
	Females	371	27.19 (12.22)		.77 (.21)		.18 (.19)		.50 (.30)	
17	Males	261	35.16 (12.62)	.66***	.88 (.17)	.54***	.29 (.24)	.57***	.66 (.29)	.61***
	Females	206	27.11 (11.87)		.78 (.20)		.17 (.18)		.48 (.30)	
18	Males	147	30.61 (12.47)	.20	.82 (.22)	.14	.24 (.21)	.24*	.56 (.30)	.21
	Females	200	28.19 (11.71)		.79 (.20)		.19 (.20)		.50 (.28)	

GV = Gestalt visualization, VR = Verbal-analytic reasoning, VA = Visuospatial ability.
* $p < .05$.
*** $p < .001$.

4. Discussion

The results contain four points of interest. First, there were no statistically significant sex differences between the IQs of the 6 to 13 year olds, consistent with many results in economically developed countries reviewed by Lynn and Irwing (2004). This suggests that girls are not disadvantaged in Sudan.

Second, the results disconfirm the contention that there is no sex difference on the Progressive Matrices. The results are broadly consistent with Lynn's (1994) thesis that there is no sex difference up to the age of around 8 years, between the ages of around 9 through 12 years, girls have an advantage of approximately 1 IQ point; there is no sex difference between to the ages of around 13 to 15 years, and at the age of 16 years, boys have a small advantage that increases with age reaching an advantage among adults of 4 IQ points. Thus, in the present data, there was a virtually zero (0.1*d*) sex difference of among 6 year olds; over the age range 7 through 11 years girls obtained higher total IQs than boys averaging 0.9 IQ points, virtually identical to the 1 IQ point advantage of girls estimated by Lynn; from the ages of 12 through 18, males obtained higher average scores than females, and this difference was statistically significant at the ages of 14 and 17; the average male advantage among the 16, 17 and 18 years olds was 0. 337*d*, equivalent to 5 IQ points and thus the 5 IQ point advantage of among adults on abstract reasoning estimated by Lynn (1999) and reported in the meta-analysis of sex difference on the Progressive Matrices by Lynn and Irwing (2004).

Third, there are some minor discrepancies with Lynn's thesis in so far as in the present sample the male advantage appears at the age of 12 years although it is not statistically significant until the age of 14 years and that the male advantage of approximately 5 IQ points is present among 16–18 year olds. These results suggest that the male advantage appears at a younger age in Sudan than in the western samples summarized in the meta-analysis of sex difference in the Progressive Matrices by Lynn and Irwing (2004).

Fourth, the sex differences on the three sub-factors show similar although not identical age trends as those for the total scores. The only major difference is that on Visuospatial ability girls performed significantly better than boys at age 11 (.17*d*).

Apart from this anomaly, the present results are generally similar to those reported by Lynn et al. (2004) on their Estonian sample.

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