Gender Differences in Intelligence in a Sample of 5-12 Year Olds in Sudan

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The Coloured Progressive Matrices (CPM), a non-verbal reasoning test for children, was administered to a sample of 4785 primary school students aged 5-12 years in Sudan. Girls obtained higher average scores equivalent to an IQ difference of 3.56 points and showed greater variability than boys. Comparison with scores obtained in a similar study performed in the same area in 2004 shows that the female advantage that is presently seen is a recent phenomenon, and that boys scored higher than girls in the earlier study.
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   Studies of gender differences on the Coloured Progressive Matrices (CPM) in primary school students have been given in a meta-analysis of 15 studies of

samples from economically developed Western countries by Lynn and Irwing (2004), in which boys had an advantage of 0.21d equivalent to 3.2 IQ points. Little is known about gender differences on the CPM in economically developing countries and in countries with more "traditional" gender roles. To contribute to this issue we report a high-powered study of gender differences on the CPM in Sudan. This study also permits the calculation of secular gains (Flynn effects) separately for males and females.

Method

As part of an academic research project sponsored by King Saud University, the Coloured Progressive Matrices (CPM) was administered in 2016 to a sample of 4785 primary school students aged 5 to 12 years in Sudan. The CPM is a non-verbal test of visual comprehension and figural reasoning that has been standardized on children aged 4 to 11 years in Britain in 2007 (Raven, 2008). The sample was selected from Khartoum State by the stratified sampling method and was representative of public and private schools and socio-economic levels. The children were tested in their schools by a research team of trained psychologists. The test was group-administered, but groups were small at the younger ages.

Results

The sex differences are shown in Table 1, with numbers, mean raw scores and standard deviations on the Coloured Progressive Matrices, the variance ratios (VR) calculated as the standard deviation of the boys divided by the standard deviation of the girls, the ds (differences between the scores of the boys and girls divided by the averaged standard deviations), and the sex-combined IQs for each age group according to the British 2007 standardization of the CPM (Raven, 2008).

Another question that is addressed in Table 1 is whether the sex differences favoring females that we observe in the present study have been stable across time, or whether they are of recent origin. To this end, the scores in the present study were compared with those described in an earlier one that had been performed in the same part of Sudan with virtually the same methods in 2004 (Bakhiet & Lynn, 2014; Dutton et al., 2018). This earlier study included only ages from 6 to 9 years. Table 1 shows that Flynn effect gains were positive during this 12-year period, and that the gains were stronger in females than males at every age. For example, at age 6 the scores rose by 0.39 standard deviations (5.9 IQ points) for boys and 0.52 standard deviations (7.8 IQ points) for girls. Averaged over the four age groups, the gains were 0.43 standard deviations (6.45 IQ points)

for boys and 0.72 standard deviations (10.7 IQ points) for girls.

Table 1. *Gender differences on the Coloured Progressive Matrices in Sudan. Shown are raw score mean and standard deviation (SD), standardized Flynn effect gains between 2004 and 2016, the variance ratio VR (male SD divided by female SD), standardized sex difference d, and sex-averaged IQ according to the British 2007 standardization. **p<.01; ***p<.001.*

Age	Sex	N	Mean ± SD	Flynn	VR	*d*	IQ
5	M	169	14.6 ± 7.0		1.21	.05	90
	F	179	14.3 ± 5.8				
6	M	305	15.6 ± 5.5	0.39	0.96	.09	82
	F	269	15.1 ± 5.7	0.52			
7	M	284	17.2 ± 6.2	0.56	1.00	-.05	77
	F	294	17.5 ± 6.2	0.63			
8	M	368	18.6 ± 6.9	0.39	0.99	-.20**	72
	F	431	20.0 ± 7.0	0.76			
9	M	505	20.5 ± 7.4	0.39	0.97	-.19**	77
	F	559	21.9 ± 7.6	0.95			
10	M	242	20.0 ± 7.1		0.90	-.44***	72
	F	280	23.3 ± 7.9				
11	M	315	20.6 ± 7.8		0.99	-.51***	66
	F	237	24.6 ± 7.9				
12	M	180	20.5 ± 7.2		1.14	-.65***	-
	F	168	24.9 ± 6.3				

Discussion

There are four points of interest in the results. First, in the three youngest age groups, 5 through 7 years, there was no statistically significant difference between the average scores of the boys and girls, but in the five older age groups 8 through 12 the girls obtained higher average scores than the boys. The average female advantage in the entire sample is 0.2375*d* and is equivalent to 3.56 IQ points. This female advantage is inconsistent with the male advantage in the 15 studies in the meta-analysis of 15 studies in which boys had an advantage of 0.21*d* equivalent to 3.2 IQ points given by Lynn and Irwing (2004). It is also different from the results of a standardization of the CPM in the Khartoum area in 2004, which found small male advantages in the 6 to 9 years age range but did not include subjects older than 9 years (Bakhiet & Lynn, 2014).

There are two explanations for the finding in the present study that females have an advantage in the 10-12 years age range, which are not mutually exclusive. One is that as a result of earlier physical and intellectual maturation at

the start of puberty, girls in Sudan gain a temporary advantage over boys at this age. However, physical and intellectual maturation are expected to proceed on similar schedules for boys and girls world-wide. Therefore this hypothesis predicts that in other countries as well, girls gain on boys in the 8-12 years age range. Further research in countries with different cultures and economic conditions is needed to determine whether this is the case. Another explanation is that due to cultural factors, or perhaps due to specific features of the Sudanese educational system, girls profit more than boys from schooling in Sudan.

Second, there was no consistent difference in variability between girls and boys. This is contrary to many studies, done mainly in Western countries, reporting that males have a slightly wider distribution than females (Jensen, 1998).

Third, when the mean raw scores are scaled to the IQ metric based on British 2007 norms, the average across the seven age groups for which British norms are available is 76.6. Importantly, the British-scaled IQs decline with rising age. This observation has been made in several other studies in Arab countries before, summarized in Bakhiet et al. (2018). When cognitive test scores, scaled according to British norms, decline with age in school-aged children, this usually is taken as evidence that the school system in the country is worse than the British school system as far as the development of intellectual abilities is concerned. Other explanations are possible, though. In the case of CPM scores, one other possible explanation is that the CPM test assesses two different abilities: visual perceptual organization with the easier items, and abstract reasoning ability with the more difficult items. Individual differences among younger subjects and those with lower raw scores are mainly on the easier visual items, whereas differences among older children and those with higher scores are mainly on the more difficult reasoning items. Therefore it is possible that British-Sudanese differences are greater on reasoning ability than on visual ability at all ages, and the apparent age trend is explained by lack of measurement invariance in different age groups.

Fourth, for ages 6 to 9 the results of the present study can be compared with those of a study performed with the same test and similar methods in the same area in 2004 (Dutton et al., 2018). The comparison shows that there have been substantial gains for males and females at all ages during the 12 years from 2004 to 2016: 6.45 IQ points for males, and 10.7 points for females. Assuming that the results do not reflect methodological artefacts, this means that the small female advantage that we see in this age range in the later study is of recent origin, due to a stronger female than male Flynn effect. The results point to the likelihood that improvements in the Sudanese school system between 2004 and 2016 have accelerated children's cognitive development, and that females have responded

more than males to these improvements.

Acknowledgement

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