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Norms and Sex Differences for the Standard Progressive Matrices in Libya

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Results are reported for a standardization of the Standard Progressive Matrices in Libya. The sample consisted of 1800 children, comprising 180 (90 boys and 90 girls) for each year of age for 8-17 year olds. The test had high reliability and adequate validity. Factor analysis revealed the presence of a strong general factor interpreted as Spearman's *g*. Girls obtained a significantly higher mean than boys at age 10, while boys obtained higher means at ages 15 through 17. The variability was generally greater among girls than among boys. In relation to British norms, the sample obtained a mean IQ of 82.7, which is reduced to 78 if an adjustment is made for a Flynn effect increase in Britain of 2 IQ points per decade. The younger Libyan children performed better than older children, relative to British norms.

Key Words: Intelligence; Progressive Matrices; Libya; Sex differences; Variability.

Raven's Progressive Matrices test (RPM, Raven, 1939; Raven et al., 2000) is the most widely used test of intelligence in numerous countries throughout the world. Several hundred studies that have used the test are summarized in Lynn (2006). One reason for the popularity of the test is that it is non-verbal and can therefore be applied cross-culturally, while verbal tests are more culture specific and preclude cross-cultural comparisons. Another reason for the popularity of the test is that it is considered to be an excellent test of *g*, the general factor present in all cognitive tasks that was first identified by Spearman (1904) and is largely a measure of reasoning ability (e.g. Carroll, 1993; Jensen, 1998; McGrew & Flanagan, 1998).

Although the Progressive Matrices have been administered in many countries, few studies have been done in the countries of North Africa. The only countries in this

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region for which normative data exist are Egypt, Tunisia, and Libya. Abdel-Khalek (1988) reported normative data for the Standard Progressive Matrices for Egypt, on which Egyptian children obtained an average British IQ of 83. Normative intelligence data for Tunisia have been reported by Abdel-Khalek & Raven (2006). The results come from a standardization of the Standard Progressive Matrices on adults carried out in 2001.The sample size was 509 and a score of 47 is given as the 50th percentile of 20 year olds, together with a score of 54 for British 20 year olds obtained in the 1992 standardization. The raw score difference of 7 is equivalent to approximately 14 IQ points, giving the Tunisian sample an IQ of 86. If a Flynn effect adjustment is made for an increase in the British IQ of 2 IQ points per decade, the British IQ will have increased by 2 IQ points from 1992 to 2001. Hence the difference between Britain and Tunisia will become 16 IQ points, reducing the Tunisian mean to 84, in relation to a British IQ of 100.

A further calculation of the IQ in Tunisia has been made by Rindermann (2007). He adopted scores obtained in the 2003 PISA study of mathematics in 15 year old school students as a measure of intelligence. In this study the mean score of school students in 29 economically developed OECD countries was 489 (sd=104), and the mean score of Tunisian school students was 359 (sd=82). The difference between the economically developed countries and the Tunisians is 1.40 sd units, equivalent to an IQ difference of 21 IQ points, and therefore giving an IQ of 79 for Tunisia in relation to 100 for the 29 OECD countries. This calculation confirms earlier studies reviewed in Lynn & Vanhanen (2002, 2006) showing that the use of tests of mathematics as proxies for intelligence tends to magnify the between-country differences obtained from IQ tests. A more recent study of 86 countries found that the standard deviation *between* countries, relative to standard deviations *within* countries, was nearly 49% larger for scholastic achievement tests than for "IQ tests" (Lynn & Meisenberg, in press). Nevertheless, the results from the Standard Progressive Matrices and from the mathematics test are broadly consistent for Tunisia, giving IQs of 84 and 79, respectively.

Table 1 Descriptive statistics for the SPM in Libya. For explanations, see text.

Age	Sex	Mean	SD	F	P	VR	Brit Pc
8	Boys	15.51	6.23	.439	.508	0.93	16
	Girls	16.14	6.44				
	Total	15.82	6.33				
9	Boys	17.04	6.60	3.122	.079	0.98	13
	Girls	18.79	6.66				
	Total	17.92	6.67				
10	Boys	18.81	6.97	13.018	.000**	0.68	8
	Girls	22.97	8.43				
	Total	20.89	7.99				
11	Boys	26.90	9.49	6.258	.013*	1.23	4
	Girls	23.53	8.55				
	Total	25.21	9.16				
12	Boys	28.44	7.92	.096	.757	0.65	7
	Girls	28.86	9.81				
	Total	28.65	8.89				
13	Boys	32.40	8.31	.227	.634	0.90	9
	Girls	31.80	8.73				
	Total	32.10	8.50				
14	Boys	33.52	8.00	.029	.866	0.90	11
	Girls	33.31	8.46				
	Total	33.42	8.21				
15	Boys	35.92	7.55	4.630	.033*	0.79	10
	Girls	33.34	8.51				
	Total	34.63	8.13				
16	Boys	37.44	9.10	4.472	.036*	1.12	10
	Girls	34.65	8.59				
	Total	36.04	8.93				
17	Boys	39.95	8.17	4.434	.037*	0.87	12
	Girls	37.29	8.74				
	Total	38.62	8.54				

We have recently published normative data for the Colored Progressive Matrices for Libya, collected on 600 6-11 year olds in 2006 (Lynn et al., 2008). The means were converted to the means for the Standard Progressive Matrices using the conversion table given by Raven et al. (1995). The British 1979 percentile equivalent of the mean scores of the 6 age groups was 28, and this is equivalent to an IQ of 91.2. Deduction of 5.2 IQ points for the Flynn effect gives an IQ of 86.

In this paper we present data for a standardization sample of the Standard Progressive Matrices in Libya.

Method

The Standard Progressive Matrices test (SPM, Raven et al., 1995) was standardized in Libya in 2007/8. A representative sample of 180 children (90 boys and 90 girls) from each of the ten age groups 8 through 17 years old were tested. The sampling procedure comprised a multi-stage random sampling method (cluster sampling). The school students were randomly selected from third year at elementary schools up to the last year at secondary schools from three cities according to their population sizes: large, medium and small; and from nine villages according to their geographic locations: coastal, desert and mountain villages (three villages in each region). Children in Libya begin school at the age of 6.0 years and boys and girls are educated together. This ensures that the boys and girls are matched for educational experience and family background.

Results

Descriptive statistics for the results are summarized in Table 1. Shown are the mean scores obtained by boys and girls of each age (age 8 = 8.0, etc); the standard deviations; the statistical significance of the sex differences tested by analysis of variance giving F and P (probability) values; the variance ratios (VR: the variance of the boys divided by the variance of the girls); and the percentile equivalents of the means of boys and girls combined on the British norms for the Standard Progressive Matrices collected in 1979 and given in Raven (1981). Statistical significance is flagged with one asterisk for male-female differences significant at

$p<0.05$, and with two asterisks for differences significant at $p<0.01$.

A principal components analysis was carried out to ascertain whether the items contained a general factor and possibly other factors. In this procedure the number of significant factors is normally taken to be those with eigenvalues greater than unity. On this criterion, the analysis found only one significant factor, and this had a large eigenvalue of 3.35. This factor accounted for 67 per cent of the variance. The second factor had an eigenvalue of 0.7. A scree-plot of the eigenvalues showed three additional smaller factors with eigenvalues well below unity. Simulation has shown that the scree-plot is a consistently good indicator of the number of significant factors (Zwick & Velicer, 1986). These results are interpreted as showing that there is only one significant factor in the test, and this is Spearman's *g*.

Discussion

The results show five interesting features. First, the factor analysis showed a strong general factor and no significant additional factors, showing that the SPM is a good measure of Spearman's *g* (Spearman, 1904; Spearman & Wynn-Jones, 1951) in Libya, as it is in Britain and the United States.

Second, the sex differences in Libya are similar to those found in many economically developed countries, i.e. there are no significant differences at the ages of 8 and 9 years. Girls obtained a significantly higher mean than boys at the age 10 years, supporting the developmental theory that girls mature more rapidly than boys at this age, advanced in Lynn (1994, 1999). At the ages of 15 through 17, boys obtained consistently and significantly higher means than girls. This again supports the developmental theory that boys obtain higher average means at these ages. These age trends are consistent with numerous studies from western countries given in a meta-analysis by Lynn & Irwing (2004). These are interesting results because they show that the sex differences in Libya are similar to those in economically developed nations, contrary to the received wisdom that girls in traditional societies are handicapped and this

impairs their intellectual development, and that as females have become more emancipated and gained greater equality in economically developed western nations, their cognitive abilities improve. This theory receives no support from the present results.

Third, the sex differences in variance were examined because it has frequently been contended that males have greater variability than females. This assertion was made in the early years of the twentieth century by Havelock Ellis (1904), Thorndike (1910) and Terman (1916). This difference in variability was proposed by these early writers to explain why men are so greatly over-represented among geniuses. When they found that there is no sex difference in general intelligence, a greater variability among males entailing more males among those with very high intelligence (as well as more males with very low intelligence) seemed to provide a solution to this problem.

Thorndike (1910) put the theory as follows: "The trivial difference between the central tendency of men and that of women which is a common finding of psychological tests and school experience may seem at variance with the patent fact that in the great achievements of the world in science, art, invention, and management, women have been by far excelled by men. One who accepts the equality of typical representatives of the two sexes must assume the burden of explaining this great difference in the high ranges of achievement. The probably true explanation is to be sought in the greater variability within the male." Thorndike examined test data on variability and concluded that men are about 5 percent more variable than women.

Terman (1916) also discussed the question and wrote that "it is often said that women are grouped closely around the average, while men show a wider range of distribution." However, in his data for 1000 children aged 6 to 14 years he found no difference between boys and girls in variability. The greater male variability was reaffirmed by Eysenck (1981, p. 42) and recently by Deary et al. (2007) and Meisenberg (2009). However, not all studies have found greater male variability, including a meta-analysis of the performance of college students on the Progressive Matrices by Irwing & Lynn (2005).

In the present data the variability is greater for girls in nine of the age groups and greater for boys in only two of the age groups (the 11 and 16 year olds). This confirms a number of other studies that have found that the supposed greater variance of males is by no means a universal phenomenon.

Fourth, compared to the British norms, the Libyan children scored at the 16th percentile at age 8 (IQ = 85), the 13th at age 9 (IQ = 83), the 8th at age 10 (IQ = 79), and the 6.7th percentile for ages 11 to 14 combined (IQ = 77.5). Thus, over the age range 8 through 14 years, the IQs of Libyan children decline steadily from 85 to 77.5, relative to the IQs of British children. In the age range from 15 to 17 the means of the Libyan children increase to the 11th percentile (IQ= 81.6). The likely reason for this increase is that compulsory education ends at age 15, and many 15 year olds leave school. These are likely to have lower IQs than those who remain in school, so that beyond age 15 the samples are no longer fully representative of the population.

Fifth, to obtain an estimate of the Libyan IQ relative to the British, it is considered best to discard the 15 through 18 year olds because they are unrepresentative, and take the average of the IQs for the seven age groups 8 through 14. These give an average British percentile equivalent of 12.5 (IQ= 82.7). If a Flynn effect adjustment is made for an increase in the British IQ of 2 IQ points per decade, the British IQ will have increased by 5 IQ points from 1979 to 2005, and this will reduce the Libyan mean to 78. This is lower than the Libyan IQ of 86.5 calculated for the standardization of the Coloured Progressive Matrices on 6-11 year olds reported by Lynn et al. (2008). The reason for this is that younger Libyan children perform better, relative to British children, than do older Libyan children. The Libyan 6 and 7 year olds performed better on the CPM than the 8-11 year olds, who obtained an average British percentile of 12 (IQ=82.4), almost identical to the British percentile of 12.5 (IQ= 82.7) of the 8 through 14 year olds in the present SPM sample. Thus, the results of the present SPM sample and the previous CPM sample are consistent. These results are closely similar to those of 84 in Tunisia

and 83 in Egypt, noted in the introduction.

Sixth, the result that younger Libyan children perform better, relative to British children, than do older Libyan children, replicates the results reported for Syria and the United Arab Emirates by Khaleefa & Lynn (2008a and 2008b). Why should this be? One reason is that it has been shown by Lynn et al. (2004) that the initial items in the SPM are measures of visualization ability, while the later items are measures of abstract reasoning ability. The 8 and 9 year olds are scored mainly on the easy visualization items because the abstract reasoning items are too difficult for them. The older children aged 10 and over are scored mainly on the abstract reasoning items because the visualization items are so easy that they mostly get them all right, so the visualization items are largely a constant that is added to their scores on the abstract reasoning items. A second factor is that abstract reasoning ability (also known as fluid intelligence) has increased considerably in economically developed nations during the last 70 years or so (Flynn, 1984, 2007). The reasons for this are not understood. They probably lie in improvements in nutrition and education that have accompanied increasing living standards (Lynn, 1990), and it can be anticipated that as living standards increase in North Africa and the Middle East, abstract reasoning ability will also increase. Further factors explaining the better performance of younger children may be that Libyan schools do not promote problem solving abilities as well as do British schools, teachers are not so well trained, and children in Libya do not have much experience of testing. The last factor has been suggested as being responsible for the lower scores obtained on intelligence tests by children in the Middle East by Stanczak et al. (2001). Whatever the explanation, it is evident that the Libyan children fail to develop reasoning skills while they are in school, as compared with British children. Perhaps the solution to this problem would be for teachers in Libya to devote more attention to teaching reasoning skills.

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