A Standardisation of the Standard Progressive Matrices for Libyan adults aged 38 to 50 years

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Data are reported for a standardisation of the Standard Progressive Matrices on a sample of 520 adults in Libya. Scored against British norms, the sample obtained a mean IQ of 79. Results are reported for the urban-rural, gender and education levels in means and variance. Principal components analysis showed only one significant factor.

Key Words: Progressive Matrices; Libya; Gender; Variance.

The Coloured and Standard Progressive Matrices tests (Raven, Raven & Court, 2000) have been administered in many nations throughout the world. These include all of the nations of North Africa with the exception of Algeria (i.e. Egypt, Sudan, Libya, Tunisia and Morocco). In these studies, the results have been expressed in relation to a British IQ of 100 (SD:15), following the procedure adopted by Lynn & Vanhanen (2006) in their compilation of the mean IQs of nations worldwide.

In Egypt, Abdel-Khalek (1988) has reported data for 6-12 year olds tested with the Standard Progressive Matrices (SPM), on which they obtained a British IQ of 83. In Morocco, Sellami et al., 2010 have reported data for adults tested with the SPM, on which they obtained a British IQ of 84. In Sudan, Ahmed, 1989) has reported data for 8-12 year olds tested with the SPM, on which they obtained a British

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IQ of 75; Khatib, Mutwakkil & Hussain (2006) have reported data for 6-9 year olds tested with the Coloured Progressive Matrices (CPM), on which they obtained a British IQ of 81; has reported data for 8-12 year olds tested with the SPM, on which they obtained a British IQ of 75; Khaleefa, Khatib, Mutwakkil & Lynn (2008) have reported data for 9-25 year olds tested with the SPM, on which they obtained a British IQ of 79; and Irwing, Hamza, Khaleefa & Lynn (2008) have reported data for 7-11 year olds tested with the SPM, on which they obtained a British IQ of 79. In Tunisia, Abdel-Khalek & Raven (2006) have reported data for 20 year olds tested with the SPM, on which they obtained a British IQ of 84.

There have been two previous studies of intelligence in Libya. A study of 600 6-11 year olds using the CPM reported that the sample had a British IQ of 86 (Lynn, Abdalla & Al-Shahomee, 2008). A second study reported data for 1600 8-17 year olds using the SPM and showed that the sample had a British IQ of 78 (Al-Shahomee & Lynn, 2010). Both of these studies for Libya were based on children. In this paper we report further data for Libya on a representative sample of adults.

Method

Sample

The Standard Progressive Matrices test (Raven, Raven & Court, 2000) was standardized in Libya during November and December 2010 on a representative sample of 520 adults (260 men and 260 women) aged between 38 and 50 years. All of the sample were Libyan citizens and employed in the government service. The sampling procedure comprised a multi-stage random sampling method (cluster sampling) to obtain an urban sample of 260 from the cities of Al-Beida and Shahat. Al-Beida was the second capital of Libya during the monarchy (1951-1969). It is considered as an educational, trade and health centre for neighbouring settlements and small cities (Kezeiri, 1995). Shahat, previously known as Cyrene, was established by the Greeks in 631 B.C. It was the first city to be formed in Libya. The location of the city played a significant role in its growth and prosperity as did the availability of water from the Apollo springs and the abundance of rain. Its proximity to the port of Apollonia provided easy contact with all Mediterranean ports. The city is considered as an important political, religious, agricultural and industrial centre (Kezeiri, 1995). the main city in the eastern region of Libya. A rural sample of 260 was selected from nine villages from the surrounding region. Three villages were selected from each category of coastal, mountain or desert locations.

In cluster sampling, intact groups, not individuals are randomly selected. All members of selected groups had similar characteristics. Cluster sampling is more convenient when the population is large or spread out over a wide geographic area. Cluster sampling can be carried out in stages, involving selection of clusters within clusters. This process is called multistage sampling (Gay, Geoffrey & Peter, 2006). When Raven (1981) standardized the Irish and British Standard Progressive Matrices test, he used this sampling method, which was defined by Denscombe (1998) as a sampling method that involves selecting samples from samples, each sample being drawn from within the previously selected sample. The procedure for conducting the multi-stage stratified sampling method involved sampling from one higher level unit called the preparatory sampling unit (Eastern Libyan Region) and then sampling of secondary sampling units from and within that higher level unit (cities and villages). This was followed by classifying the cities into two homogenous urban area clusters using the criterion of administrative boundaries as the third sampling level, i.e. main and secondary cities. The researcher selected one city from each category. In addition, villages were classified into three different categories (third clustering sampling level); coastal, dessert and mountain villages. Three villages were selected from each category with different weights or ratios as the fourth sampling level.

Measure

The Standard Progressive Matrices (SPM) test consists of 60 items given in 60 pages, and is divided into five sets lettered A, B, C, D and E. Each set consists of 12 items. Each page of the booklet contains a matrix with one missing part. Participants are asked to select the missing part from six or eight options given below each matrix, and to indicate its number on a separate answer sheet. Items are scored either right or wrong. A participant's score is the number of right answers. The maximum possible score is 60. The Raven's Standard Progressive Matrices (SPM) test was constructed to measure the educative component of *g* as defined in Spearman's theory of cognitive ability (Raven, Raven & Court, 2000). Kaplan & Saccuzzo (1997) and Jensen (1998) consider that research shows that the Raven Standard Progressive Matrices is a measure of fluid reasoning. The Progressive Matrices (Standard, Coloured, and Advanced) are the best known and most widely used tests as measures of individual differences in cognitive ability and as culture-reduced tests (DeShon & Weissbein, 1995).

The following modifications were introduced to the SPM test, to make it more suitable for the Libyan sample:

1. Instructions were given in the colloquial Libyan Arabic language.

2. English letters (A, B, C, D and E) in the five sets were changed into Arabic letters.

3. Page order (direction) of the test booklet was changed from left to right, to suit the Arabic way of writing and reading.

4. A new answer sheet was designed with Arabic letters, and right to left direction for answering and writing.

Strategy of Analysis

The analysis was carried out in the following manner:

- **First** Kolmogorov-Smirnov, Shapiro-Wilk test and normal probability plots were used to determine the normality of the data.

- **Second** Two-Way Analysis of Variance was used to compute differences between SPM test means in regard to regions and gender variables or education levels and gender variables or age groups and gender variables.

- **Third** To investigate the effect size of the SPM means by calculation of Cohen's *d,* which is equal to the difference between the means divided by the within group standard deviation (Cohen, 1988).

- **Fourth** To evaluate the gender differences in variability (variance ratios).

- **Fifth** Reliability of SPM test scores was investigated using Alpha (KR-20) and split-half methods.

- **Sixth** the construct validity of SPM test scores was investigated using Principal components analysis.

Results

Table 1 gives descriptive statistics for the samples, mean scores, standard deviations obtained, t values for the difference between urban and rural samples, level of significance and Cohen's *d* score (the difference between the urban and rural samples means divided by the within group standard deviation). The last column gives IQ point differences between urban and rural samples.

Table 1. Urban-rural differences on the Standard Progressive Matrices in Libya

Region	(N)	Mean	SD	t	sig	*d*
Urban	260	38.15	10.99	2.45	.01	0.21
Rural	260	35.87	10.20			
Total	520	36.98	10.65			

Table 2 gives the gender differences in mean scores, standard deviations and variability on the SPM for the urban, rural and total samples. The Cohen's *d,* which is calculated as the difference between the means divided by the within group standard deviation. The variance ratios (VR), i.e. the variance of the males divided by the variance of the females; a VR greater than 1.0 indicates that males had greater variance than females, while a VR less than 1.0 indicates that females had greater variance than males). The VRs show that in the total sample females had greater variance than males. The results show that region is significantly associated with SPM scores, and the gender differences tested by F show that in each region males obtained significantly higher scores than females.

The interaction effect between regions and gender was not statistically significant (F (1, 516) = 1.613, P = 0.205). There was a statistically significant main effect for regions, F (1, 516) = 5.466, P = 0.020; the magnitude of the effect size was small (partial eta squared = .044). The main effect for gender is statistically significant (F (1, 516) = 16.107 *P* = 0.000). Leven's equality test was not significant indicating that the group variance was equal.

Table 2. Gender differences in mean scores, standard deviations and variability (VR) on the SPM in urban and rural regions

Region	Gender	N	Mean	SD	d	Vr
Urban	Male	130	40.45	10.86	0.45	1.05
	Female	130	35.61	10.61		
	Total	260	38.15	10.99		
Rural	Male	130	37.14	9.78	0.25	0.87
	Female	130	34.63	10.49		
	Total	260	35.87	10.21		
Total	Male	260	38.80	10.45	0.36	0.98
	Female	260	35.09	10.53		
	Total	520	36.98	10.65		

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2577.574a	3	859.191	7.884	.000	.044
Intercept	708752.895	1	708752.895	6503.561	.000	.926
Regions	595.709	1	595.709	5.466	.020	.010
Gender	1755.358	1	1755.358	16.107	.000	.030
Regions Gender	175.832	1	175.832	1.613	.205	.003
Error	56233.271	516	108.979			
Total	770025.000	520				
Corrected Total	58810.844	519				

R Squared = .044 (Adjusted R Squared = .038)

Table 3 gives the differences in mean scores, standard deviations and variability on the SPM as a function of three education levels. Preparatory level consists of those at school until the age of 14, secondary level consists of those at school until the age of 17, and the university level consists of those who had completed university. The results show that education is significantly associated with SPM scores, and the gender differences tested by F show that at each educational level males obtained significantly higher scores than females. The interaction effect between gender and education levels was not statistically significant (F (2, 514) = .396, *P* = .673). There was a statistically significant main effect for gender (F (1, 514) = 7.699, *P* =.000); the magnitude of the effect size was small (partial eta squared = .055). Post-hoc comparisons using the Tukey HSD test showed that there were statistically significant differences between the different education levels. The main effect for education levels is statistically significant (F (2, 514) = 6.053 *P* = .003). Leven's equality test was not significant indicating that the group variance was equal.

Table 3. Gender differences in mean scores and variability on SPM as a function of education levels.

Education Levels	Gender	(N)	Mean	SD	d	Vr
preparatory	Male	51	36.45	10.27	0.33	1.04
	Female	20	33.05	10.02		
	Total	71	35.49	10.27		
secondary	Male	134	38.50	10.46	0.39	1.01
	Female	184	34.34	10.43		
	Total	318	36.09	10.63		
University	Male	75	40.81	10.30	0.21	0.96
	Female	56	38.61	10.52		
	Total	131	39.95	10.40		

Table 3. (Continued)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3228.314a	5	645.663	5.971	.000	.055
Intercept	429067.105	1	429067.105	3967.802	.000	.885
Education Level	1309.118	2	654.559	6.053	.003	.023
Gender	832.602	1	832.602	7.699	.006	.015
Education Level – Gender	85.730	2	42.865	.396	.673	.002
Error	55582.531	514	108.137			
Total	770025.000	520				
Corrected Total	58810.844	519				

R Squared = .055(Adjusted R Squared = .046).

Table 4 gives the differences in mean scores, standard deviations and variability on the SPM as a function of three age groups. The results show that the gender differences tested by F show that at each age group males obtained significantly higher scores than females. Based on age groups and gender there was a statistically significant main effect for gender (F (1, 514) = 15.773 p = 0.000); the magnitude of the effect size was small (partial eta squared = .041). Post-hoc comparisons using Tukey HSD test showed that there were statistically significant differences between the age groups. The main effect for age groups was statistical significant (F (2, 514) = 2.667 P = 0.070). The interaction effect between age groups and gender was not statistically significant (F (2, 514) = .063, p = .939). Leven’s equality test was not significant indicating that the group variance was equal.

Table 4. Gender differences in mean scores and variability on SPM as a function of age groups.

Age Group	Gender	N	Mean	SD	d	Vr
23:27	Male	100	39.88	9.18	0.34	0.71
	Female	100	36.45	10.92		
	Total	200	38.24	10.18		
28:32	Male	100	38.42	10.61	0.34	1.04
	Female	100	34.85	10.39		
	Total	200	36.65	10.62		
33:37	Male	60	37.58	12.12	0.38	1.47
	Female	60	33.32	10.00		
	Total	120	35.45	11.27		

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2389.661a	5	477.932	4.354	.001	.041
Intercept	662676.811	1	662676.811	6037.021	.000	.922
Age Group	585.588	2	292.794	2.667	.070	.010
Gender	1731.412	1	1731.412	15.773	.000	.030
Age Group – Gender	13.914	2	6.957	.063	.939	.000
Error	56421.184	514	109.769			
Total	770025.000	520				
Corrected Total	58810.844	519				

R Squared = .041 (Adjusted R Squared = .031)

The alpha reliability tested by α Cronbach (KR-20) for the SPM for the total sample was 0.92 and split-half reliability for the total sample was 0.88. A principal components analysis was carried out to ascertain whether the items contained a general factor and possibly some 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 2.93. This factor accounted for 58.56 per cent of the variance. A scree-plot of the eigenvalues showed three additional smaller factors with eigenvalues between 0.6 and 0.4. These are 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 interpreted as Spearman's *g*.

Table 5 gives the correlation coefficients between the scores on the five sets of the SPM. These range between 0.33 and 0.59 and are all statistically significant. To indicate a moderate or higher relationship, correlation coefficients should be 0.3 or higher ($r > 0.3$) in the principal component analysis. One highly loaded factor (from 0.45 to 0.68) was extracted which accounted for 58.56% of the common variance, that can be identified as Spearman's *g*. These results indicate satisfactory internal consistency and factorial validity as a result of the test items' homogeneity. In addition, results show the Kaiser-Meyer-Oklin value was 0.821, exceeding the recommended value of 0.6 (minimum value for good factor analysis) (Kaiser 1970, 1974 and Tabachnick & Fidell 2007) and the Bartletts' test of sphericity (Bartlett, 1954) reached statistical significance (0.000), supporting the factorability of the correlation matrix.

Discussion

There are six principal points of interest in the results. One, Table 1 shows that the urban sample obtained a significantly higher score on the SPM than the rural sample, although the difference was quite small at only 0.21*d*, equivalent to 3.15 IQ points.

Table 5. Correlations matrix between the five sets of the SPM

Set	Correlations					Factor 1
	A	B	C	D	E	
A						0.45
B	0.51**					0.64
C	0.42**	0.58**				0.68
D	0.38**	0.55**	0.59**			0.65
E	0.33**	0.39**	0.50**	0.53**		0.50
Eigen value						2.928
% of variance						58.56
KMO and Bartlett's Test						
Kaiser-Meyer-Olkin Measure of Sampling Adequacy				.821		
Bartlett's Test of Sphericity	Approx. Chi-Square			882.88		
	df			10		
	Sig.			.0000		

Two, Table 2 shows that in the total sample and in the rural sample but not in the urban sample males scored significantly higher than females. In the total sample the difference was 0.36*d*, equivalent to 5.52 IQ points. In addition in the 38-42 age group, again males obtained a significantly higher mean than females by 0.34*d* (5.1 IQ point), among the 43-47 age group males obtained a significantly higher means than females by 0.32*d* (4.8 IQ points), and in the 48-50 age group, males scored significantly higher than females by 0.38*d* (5.7 IQ points). These results are closely similar to the 5 IQ point male advantage among adults on the SPM in economically developed nations reported by Lynn & Irwing (2004) in their meta-analysis of gender differences.

Three, Table 3 shows that the variance ratio for the total sample was 0.98, showing that females had greater variance than males. This result is contrary to numerous assertions that the variance of intelligence is greater in males than in females. This contention was advanced a century ago by Havelock Ellis (1904, p.425) who wrote that "It is undoubtedly true that the greater variational tendency in the male is a psychic as well as a physical fact". In the second half of the twentieth century this opinion received many endorsements. For instance, Penrose (1963, p. 186) wrote that "the larger range of variability in males than in females for general intelligence is an outstanding phenomenon". In similar vein: "males are more variable than females" (Lehrke, 1997, p.140); "males' scores are more variable on most tests than are those of females" (Jensen, 1998, p.537); "the general pattern suggests that there is greater variability in general intelligence within groups of boys and men than within groups of girls and women" (Geary, 1998, p.315); and "there is some evidence for slightly greater male variability" (Lubinski, 2000, p.416). This position has been confirmed by the largest data set on sex differences in the variability of intelligence given in the 1932 Scottish survey of 86,520 11 year olds, in which there was no significant difference between boys and girls in the means but boys had a significantly larger standard deviation of 14.9 compared with 14.1 for girls, reported by Deary, Thorpe, Wilson, Starr & Whalley (2003). The excess of boys was present at both extremes of the distribution. In the 50-59 IQ band 58.6 % of the population were boys and in the 130-139 IQ band 57.7% of the population were boys. Despite these results, the greater variance of males is not a universal phenomenon, as noted by Meisenberg (2009) and Sellami, Infanzón, Lanzón, Díaz & Lynn (2010).

Four, Table 4 gives the differences in mean scores on the SPM as a function of three education levels and shows that SPM scores were significantly associated with education levels. However, the differences were quite small. The difference between those with the least education and those with university education was 0.43d, equivalent to 6.5 IQ points.

Five, the principal components showed only one factor with an eigenvalue greater than unity, and therefore only one significant factor. This is consistent with many other studies of the Progressive Matrices, indicating it is a pure measure of Spearman's *g* (Jensen. 1998). Some factor analytic studies, however, have found that while the Progressive Matrices is largely a measure of *g* it also contains a small visualization or spatial factor. These include Adcock (1948), Keir (1949), Banks (1949), Gabriel (1954) and Gustaffson (1984, 1988), who concluded that the SPM measures a reasoning factor and a further factor that he called "c*ognition of figural relations*". Lynn, Allik & Irwing (2004) identified a general factor and three further factors that they reported as the gestalt continuation found by van der Ven & Ellis (2000), verbal-analytic reasoning and visuospatial ability. Further analysis of the three factors showed a higher order factor identifiable as "*g*". Despite these reports, the present study is consistent with Jensen's (1980) conclusion that the SPM measures "*g*" and little else, and that the loadings occasionally found on other "perceptual" and "performance" type factors, independently of "g" are usually trivial and inconsistent from one analysis to another.

Six, the mean score of the total sample was 36.98. This is the 8th percentile on the British 1992 standardisation given in Raven, Raven & Court (2000) and is equivalent to a British IQ of 79. In addition, the British percentile average equivalent was 7.1th PC for 38-42 age group (IQ=78), 8th PC for the 43-47 age group (IQ=79) and 8th PC for the 38-50 age group (IQ= 79). No Flynn effect correction is required because British means on the SPM for those aged over 13 years have remained stable between 1979 and 2008 (Lynn, 2009). This result is closely similar to the two previous studies of IQs in Libya for children that gave British IQs of 78 and 86. The lower scores of the Libyan sample on the SPM test, compared with those in developed countries were expected. All studies conducted in developing countries have shown that individuals from developed countries score higher than individuals from developing countries on the SPM test. This has been shown in a meta-analysis conducted by Al-Shahomee, (2011).

There are a number of possible explanations for the lower scores obtained by the peoples in Libya and other developing countries. These include (1) an emphasis in schools on memorisation at the expense of problem solving skills; the human development report in 2002 on Libya stated that the teaching skills of many teachers were deficient in this regard; (2) poorer schools, such as the average class size is 30 or more students per teacher and school building and facilities are out-dated in many schools and inappropriate for carrying effective teaching. Up-to-date computer programs are not available in 89% of the schools; (3) poorer nutrition, which as been shown to have an adverse effect on intelligence (Lynn, 1990); (4) large family size, which also appears to have an adverse effect on intelligence (Belmont & Marolla, 1973): in 2005 the average number of children (total fertility rate) in Libya was 3.28, compared with less than 2.0 in economically developed countries (U.S. Census Bureau, 2006); (5) for almost all of the Libyan samples this was their first time to take an IQ test so they lacked the test-taking experience of most people in economically developed countries and this may have contributed to their low scores; (6) it is possible that there are race differences in intelligence as argued by Lynn & Vanhanen (2006, p.249), although this has been disputed by, for example, Nisbett (2009).

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