Cognitive Evaluation of Non-Verbal Intelligence among Adolescents in the Middle Atlas of Morocco

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Abstract

Bacground and purpose : Non-verbal intelligence is one of the cognitive skills that plays a key role in academic performance in children and adolescents. Hence, this study intends to evaluate non-verbal intelligence in a sample of Moroccan adolescents to situate them in relation to their counterparts in other countries.

Materials and Method : To assess non verbal intelligence, we used Raven's Progressive Matrix Test, which consists of 60 items, categorized into five series of 12 items.

Results : There were 286 adolescents, 46.8 % of whom were women, with an average age of 15.2±1.7 years. Cronbach's alpha value is 0.94, the correlations between the different series of the test are highly significant, reflecting the high internal reliability of the test. The scores of the adolescents are low compared to the international standard and more than 4% of the participants are in an intellectually impaired state.

Conclusion : We consider it important to have a national standardization of the test and to establish a precise diagnosis in order to identify adolescents with an intellectual disability.

Key words : *Cognitive assessment, non-verbal intelligence, Raven's Standard Progressive, Matrices, adolescents, Morocco.*

Introduction

The diversity of models and theoretical approaches developed illustrates the difficulty encountered in defining the notion of intelligence. However, the Cattell-Horn-Carroll model remains the most validated psychometric model of cognitive skills [1]. This model includes several cognitive capacities at its base, at its summit we find the general intelligence factor or g factor[2]. Factor (g) refers to general intellectual ability, based on Spearman's theory [3]. Raven's Progressive Matrices (SPM) are generally considered to be good non-verbal indicators of general intelligence or factor (g) [4]. This makes it one of the best psychometric tests measuring the (g) factor [5].The paradigm of the (SPM) test is intended to measure the ability to extract and process information from a new situation [6]. The (SPM) test is the most widely used test for screening in many countries around the world [7]. It has been widely used in clinical, professional, educational, and research settings [8]. Court and Raven (2004) note that learners' ability to solve Raven's matrices may act as a predictor of academic success[9]. This test has become widely used and is used in many countries on five continents. Furthermore, to our knowledge in Morocco, studies that have been conducted on (SPM) are rare and have been limited to middle school learners [3,10, 8]. The objective of our study is to evaluate non-verbal intelligence in a sample of Moroccan adolescents to situate them in relation to their counterparts in other countries.

Materials and Method

Participants

There are 286 adolescent learners, 53.2% of whom are boys (n=152) and 46.8% girls (n=134). The average

age is 15.2±1.7 years, with a maximum of 18 and a minimum of 13 years. Learners are distributed over two cycles of education, with 51.20% in middle school and 48.8% in high school. People with obvious disabilities or a diagnosis established by doctors or who are undergoing treatment with psychostimulant drugs were all excluded from this study.

Measuring instrument

Raven's progressive matrices appear to be one of the best measures of the g-factor. The g-factor refers to general intellectual ability, according to Spearman's theory [3]. It is highly recommended because it minimizes cultural and linguistic barriers in the evaluation of intellectual functioning. This test measures non-verbal reasoning ability, by analogy. The version used consists of 60 items, divided into five series or sub-tests of 12 items. In order to succeed, the subject must find the rule of progression. Each item constitutes a pattern with a missing part, 6 to 8 images are proposed below which the subject must choose the missing part adequately (figure 1).

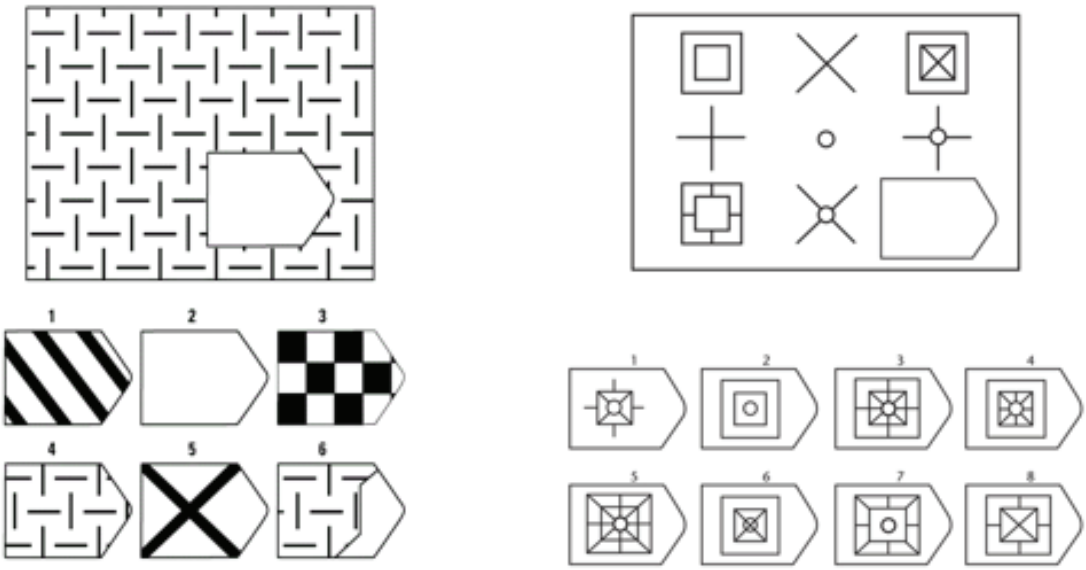

Figure 1 : Examples of items used in Raven's progressive matrices (PM 38)

Procedure

We proceeded to fill out an information sheet for each learner. The test was done in groups after having carried out two pre-tests, it was done in two phases :

- The first phase concerned series A, B, C.

- The second phase concerned series D, E.

Statistical methodology

The collected data are first entered on an Excel sheet, after filtering the matrix is transferred to an SPSS statistical processing software. The statistical analyses used are descriptive and analytical, a significance level of 5% was used for this study. To determine the internal reliability of the measuring instrument we have calculated the Cronbach index, this value is considered "acceptable" from 0.7[11].

Results

A. Psychometric properties

- The determination of the internal reliability of the test (SPM) and the five test series is performed by calculating the Cronbach alpha value (Table 1)

Table 1 : Cronbach's Alpha Coefficient for Subtests and for the Total Score

Sub-test	Number of items	Cronbach's Alpha
Serie A	12	0.75
Serie B	12	0.80
Serie C	12	0.82
Serie D	12	0.85
Serie E	12	0.83
Total Score	60	0.943

The determination of the value of the Cronbach's alpha coefficient shows that the different subtests or series have values respectively of 0.75 for series A, 0.80 for series B, 0.82 for series C, 0.85 for series D, 0.83 for series E and a value of 0.94 for the total test score.

- The Pearson test is used to examine the correlation between the scores of the five series A, B, C, D and E of (SPM) (Table 2).

Table 2 : Pearson correlation between the scores of the five series A, B, C, D and E of (SPM) (N= 286)

		Serie A Score	Serie B Score	Serie C Score	Serie D Score	Serie E Score	Total Score
Serie A Score	Correlation r	1					
	P-value						
Serie B Score	Correlation r	.58**	1				
	P-value	.000					
Serie C Score	Correlation r	.58**	.72**	1			
	P-value	.000	.000				
Serie D Score	Correlation r	.59**	.70**	.80**	1		
	P-value	.000	.000	.000			
Serie E Score	Correlation r	.45**	.52**	.68**	.67**	1	
	P-value	.000	.000	.000	.000		
Total Score	Correlation r	.71**	.82**	.90**	.90**	.80**	1
	P-value	.000	.000	.000	.000	.000	

****. The correlation is highly significant at the 0.01 level.**

According to Perason's correlation, a highly significant positive correlation between the scores of the different subtests and with the total score is noted, with respectively: [(r=.58; p<0,000 between the scores of series A and B), (r=.58. ; p<0,000 between the scores of series A and C), (r=.59. ; p<0,000 between the scores of series A and D), (r=.71 ; p<0,000 between the scores of series A and E) , (r=.71 ; p<0,000 between the scores of series A and the total score)]. [(r=.72; p<0,000 between Series B and Series C scores), (r=.70; p<0,000 between Series B and Series D scores), (r=.52; p<0,000 between Series B and Series E scores), (r=.82; p<0,000 between Series B scores and total SPM score)]. [(r=.80; p<0,000 between Series C and Series D scores), (r=.68; p<0,000 between Series C and Series E scores), (r=.90; p<0,000 between Series C scores and total score)]. [(r=.67; p<0,000 between Series D and Series E scores), (r=.90; p<0,000 between Series D scores and total score)]. [(r=.80; p<0,000 between Series E scores and total score)].

B. Learner Performance in the SPM Test

Learners' performance in SPM is assessed by determining the average scores totalled by the learners and the average of the errors made in the test series (table 3).

Table 3 : Average scores totalled by learners and average errors in the test series with correlations between scores and errors (n=286)

		Minimum	Maximum	Mean	Standard Deviation	Pearson Correlation	P-value
Serie A	Score	2.0	12.0	10.45	1.85	-0.99**	,000
	Erreurs	.0	10.0	1.55	1.85		
Serie B	Score	.0	12.0	9.55	2.83	-0.98**	,000
	Errors	.0	12.0	2.41	2.79		
Serie C	Score	.0	12.0	7.96	2.88	-1**	,000
	Errors	.0	12.0	4.03	2.87		
Serie D	Score	.0	12.0	7.77	2.98	-1**	,000
	Errors	.0	12.0	4.22	2.98		
Serie E	Score	.0	12.0	4.20	3.15	-0.96**	,000
	Errors	.0	12.0	7.74	3.17		
Total	Score	7.0	59.0	39.82	11.59	-0.98**	,000
	Errors	1	53	19.97	11.52		

****. The correlation is highly significant at the 0.01 level.**

The analysis of the results of the mean scores and the means of the errors committed in the test series shows that for series A, the learners totalled a mean of 10.45 items and a mean of the errors of 1.55. For Series B, adolescents in our population recorded an average score of 9.55 and an average of 2.41 for errors made. In series C, the average score is 7.96 and an average error of 4.03. For Series D, learners had a mean score of 7.77 and a mean error score of 4.22. In Series E, the mean score for correct items was 4.20 and the mean error score was 7.74. For the average total score, learners recorded an average score of 39.82 and an average error of 19.97. According to the bi-variate analyses, we found a highly significant negative correlation between scores and

errors committed by adolescents in SPM.

C. The profile of non-verbal intelligence of adolescents in the population

- Distribution of learners' scores in SPM by age in percentiles (Table 4).

Table 4 : Percentile distribution of test scores (PMS) by age.

	Age (years)					
Percentiles	13	14	15	16	17	18
5	12,200	11,300	10,650	15,600	19,500	32,750
10	19,600	13,000	13,300	26,200	34,200	36,500
25	34,000	27,000	27,250	32,500	42,000	45,000
50	40,000	36,000	36,500	46,000	49,000	48,000
75	44,000	43,000	42,500	50,000	52,000	51,750
90	49,000	49,800	50,400	53,000	54,800	55,000
95	51,000	55,100	51,700	54,000	55,900	57,750
Mean	37.701	34.778	34.615	41.514	45.976	47,250
Standard Deviation	10.0830	12.3966	12.1964	11.0821	8.9763	7,8685

Calibration of Raven's progressive matrices by age showed that the 50th percentile had a score of 40 points at age 13 ; 36 points at age 14 ; 36.5 points at age 15 ; 46 points at age 16 ; 49 points at age 17 and 48 points at age 18.

- The authors propose a categorization of subjects into five classes, from group I "higher intellectual abilities" to group V "intellectual disability". The status of the results obtained allowed us to classify the subjects into 5 intellectual classes (Figure 2).

According to the categorization of adolescents in our population according to intellectual abilities, we find that : 4% of adolescents in our population correspond to an intellectually defective state.

Discussion

The present study, which aimed to assess non-verbal intelligence among adolescents in the Moroccan Middle Atlas, was able to highlight the following points:

The calculation of Cronbach's alpha coefficient for the total test score is 0.94. The correlations between the scores of the different series of the test l are positive and highly significant. Therefore (SPM) has a very high degree of reliability, which supports the results obtained at the national and international level [8].

Analysis of the results shows that the participants recorded an average score of 39.82±11.59 and an average error of 19±11.52, and a negative correlation is noted between the scores of the totaled items and the errors made. The same result is observed among Argentine an adolescents[12].

The average score of our population is higher than the score totalled by learners from Moroccan populations in other studies [3- 8-10].

Calibration of Raven's progressive matrices in our age-dependent study showed that adolescent performance increases with age from 14 to 17 years of age with the exception of 13 and 18 years of age. These results are consistent with several studies conducted in

Morocco [3-10- 8] and international studies from Icelandic, Slovenian [8] and Kuwaiti [13]. The increase in non-verbal intelligence with age is explained by the fact that intellectual maturation continues in parallel with physical maturation [8]. In other studies, a steady increase in the overall volume of white matter until the age of 21 has been observed [14]. The functional consequences of this increase are rapid and effective communication within the fronto-cortical circuit and other cortical and sub-cortical regions [15]. Other studies have shown continued growth of the corpus callosum during childhood and adolescence [14-15-16].

In order to situate the results of adolescents in our population at the international level, we're going to rank them against international standards. Compared to several international studies, the scores obtained by respondents are considerably lower than those of the British [13], American [10], Chilean [10], Indian - Pune and Mumbai population[8], Icelandic [8], Slovenian [10] and Kuwaiti [13] international standardization standards. As we can add that 4% of the adolescents of our population corresponds to an intellectually defective state. These revealed differences in mean test scores may be related to several factors, including the Flynn effect[17]. The low performance recorded in the test could also be explained by the high level of illiteracy among parents [18] and also by malnutrition [19]. Other work links cognitive functions to non-verbal intelligence to explain intra-individual variability, such as updating skills [20], processing speed [21] and working memory [1]. Recent studies have demonstrated links between cognitive strategies and performance on fluid intelligence tasks [22].

Conclusion

The study realized has reconfirmed the very high degree of test reliability (SPM). The scores totaled by the adolescents in (SPM) show that they present a superior non-verbal intelligence compared by studies carried in Morocco, however in comparison with the international standardization norms these scores are considerably lower, all the more so as 4% of the adolescents of our population corresponds to an intellectually defective state. These low performances in non-verbal intelligence could be explained by several factors including the Flynn effect, the socio-economic environment of learners, the development of cognitive functions and the reasoning strategies used by adolescents. In addition, we must underline the importance of having national standardization of (SPM) and the importance of to realize an accurate diagnosis to identify adolescents who may show signs of intellectual deficits.

Significance Statement:

This study assessed nonverbal intelligence in a population of adolescent adolescents, as well as, this study will help researchers discover areas of neuroscience that many researchers have not been able to explore.

Conflict of Interest: The Authors declare that there are no conflicts of interest.

Ethical approval: The procedures were carried out in accordance with the recommendations of the internal ethics committee of the Ibn Tofail University of Kenitra. This procedure has been reviewed and approved by the Committee.

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