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Romanian Standardization Of Raven's Standard Progressive Matrices *Plus*

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Anca Dobrean (nee Domua)

Babes-Bolyai University, Cluj Napoca, Romania

John Raven

Edinburgh, Scotland

Mircea Comsa, Camelia Rusu, & Robert Balazsi

Babes-Bolyai University

Abstract

This paper reports norms for Raven's Standard Progressive Matrices *Plus* (SPM *Plus*) for Romanian people aged 6 to 80 years. A nationally representative sample of 2,801 people covering all demographic regions of the country was tested. The norms for the Romanian sample are slightly below recent norms from other countries. The test-retest reliability, assessed over a one-month period, was high and similar to that found in other countries.

Please address correspondence concerning this article to: Anca Dobrean, Department of Psychology, Faculty of Psychology and Educational Sciences, Babe-Bolyai University, Republicii St. no. 37, 400015 Cluj Napoca, ROMANIA E-mail: ancadomuta@psychology.ro Phone: +40-74-438897 Fax: +40-264-590967

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The national standardization of a psychological assessment instrument represents a laborious task but is crucial to the effective use of assessment instruments. When the study was conducted there was no internationally accepted psychometric test with normative data for Romania. One reason for that is the fact that the subject of psychology, and with it psychological testing, was forbidden in Romania under the communist era. The discipline of psychology only obtained legal status in Romania in the winter of 1989.

Raven's *Standard Progressive Matrices* (Raven, J. C., 1938/1962/2004) is one of the most widely used tests of general cognitive ability (MacKintosh, 1998). There are many reasons for this. The Raven Matrices are easy to administer, both as an individual and group test. The *Standard Progressive Matrices* (whether *Classic*, *Parallel*, or ***Plus*** version) consists of 5 sets of 12 matrices, gradually increasing in difficulty. The same test can be used for a wide age range. Also, the test has remained little changed from its original design (Penrose & Raven, 1936). The test format is non-verbal and can therefore be employed in diverse language cultures and in different settings (e.g., homes, schools, organizations). Viewed from the point of view of Spearman's (1927) *g* theory, Raven's Progressive Matrices are considered to be among the best measures of eductive ability (Bingham, Burke, & Murray, 1966). According to Raven, Raven, & Court (1998, revised 2003), the Raven Progressive Matrices (RPM) are among the best-established measures of human characteristics whose scientific status is most secure. Details of the construction and use of the *Standard Progressive Matrices* (SPM) and *Standard Progressive Matrices Plus* (SPM ***Plus***) will be found in (Raven, Raven, & Court, 2000 revised, up-dated, and extended 2004). The RPM are among the best predictors of academic and occupational performance and, especially, social mobility (Court & Raven, 1995).

One of the most widely discussed findings obtained with the RPM has been the so-called "Flynn Effect". James R. Flynn observed in the 1980's that the scores of different groups of people on standard intelligence tests had consistently increased over time. This effect was observed in many countries and especially on those measures - whether verbal or non-verbal - having the highest loadings on eductive ability (Flynn, 1987, 2000). Tests assessing mastery of traditional "academic" knowledge show much smaller increases. This secular trend in SPM

scores emerges quite clearly by comparing two standardizations of the SPM in the UK one from 1942 and the other from 1992 (Raven, et al., 1998 revised 2003; Raven, 2000). In both standardizations the test was administered to people from age 18 to 65. It would seem from the graphs published in these sources that the 50th percentile for 20 year olds rose from about 42 to 54 over this period. But it is obvious from these graphs that the latter figure underestimates the real increase owing to the test ceiling (maximum score 60). Over the whole century for which data are available, the 50th percentile rose from some 15 to 54. While it would appear that the lower percentiles rose more than the higher ones, it is immediately obvious from the graphs that this conclusion is invalid because the test ceiling has resulted in there being little discrimination above the 75th percentile from about 1950 onwards. In view of these results, research was put in hand to develop a test - which was eventually named the SPM *Plus* - which would restore the discriminative power at the upper end that the SPM had had when it was first developed. (See Raven et al. [2000 revised, updated, and extended 2004] for an account of the way in which this test was developed.)

The present study set out to build norms for SPM *Plus* for the Romanian population, to place those norms in the context of norms from other countries, and to report on the reliability of the test in Romania.

Method

Respondents

In order to maximize its representativeness, we built a three-stage stratified random sample. Stratifying a sample improves its representativeness by ensuring that various demographic groups are represented in their correct proportions. The participants in each strata are more homogenous on the stratification variables and also on the variables influenced by these. For example, if we stratify the population according to “type of location” we will obtain not only participants more similar on this variable but also on other variables related to this - such as education - which are, in turn, related to educative ability (which is the subject of the study). The present sample was stratified by 18 cultural areas* and 7 locality types (3 rural types and 4 urban types). This resulted in a total of 126 strata. Rural localities (communes) were

* They are simply cultural and historical units, not administrative ones. Counties from the same cultural area are similar in terms of urban development, rural development, land use patterns, ethnicity, and religious related culture (Sandu, 1999).

grouped into 3 categories depending upon their level of development[†] (low, medium, high).

Urban localities were grouped into 4 categories depending upon the number of inhabitants (under 30,000, 30,000 to 99,999, 100,000 to 200,000, and over 200,000 inhabitants). The three rural categories were low, medium, and high levels of economic development.

For each of the 126 strata we calculated the number of respondents to be tested in proportion to the number of people living in such areas in the total population of Romania. We kept only those strata that contained at least 10 participants (the cases from strata which had less than 10 cases were re-allocated to the most similar strata). For each layer we randomly extracted the localities from which we would select participants. In each locality we randomly selected two streets. For each of these streets we randomly selected every 5th house. In each house we selected everyone aged 6 to 80. Selection of houses and, of course, of respondents in a street ended when the required number of participants for that street had been obtained.

Because the development and decline of intellectual abilities is not constant across all ages from 6 to 80, increasing most rapidly between 6 and 17 years of age it was necessary to over-weight the population under 18 age in order to have enough respondents to generate adequate norms. In effect there were two samples, theoretically independent, for 6-17 and 18-80 year olds. Due to the combined effects of the random selection of houses (choice of people by selecting houses) and of the sample stratification procedure, we can only approximate the level of representativeness. Thus, we reached a maximal admitted theoretical error of ± 2.8 (for the sample aged between 6 and 17) and ± 2.5 (for the sample aged between 18 and 80) for $p=0.05$.

One of the chief problems confronting survey researchers is to gain the cooperation of the selected participants. The non-contact and refusal rates are presented in Table 1.

Such non-contact and refusal rates are typical for Romania. In order to check the quality of our sample we compared the demographic data for our sample with that for the population as a whole (Table 2). The national demographic data are based on the *Population and Dwelling Census, 2002*. The disproportionate number of young people was, of course, a deliberate result of having over-weighted them in the sampling procedure.

[†] The development coefficient was based on indicators relating to the structure of the population, the demographic phenomena, modern goods endowment, possession of land and animals, and reported access to the nearest urban locality (Sandu, 1996, 1999).

In summary, the sample had the following characteristics:

- a. *Size*: 2,755 people aged 6 to 80, out of which 1,240 were aged between 6 and 17 (45%) and 1,535 aged between 18 and 80 (55%).
- b. *Type*: three stage stratified random sample.
- c. *Stratification criteria*: 18 cultural areas; size of the urban location (4 types), level of development of the rural locations (3 categories).
- d. *Sampling*: random selection of locations (117 localities), places (199 streets), and houses. Within houses everyone aged between 6 and 80 was asked to take part.
- e. *Representativeness*: the sample is representative for the non-institutionalized Romanian population aged between 6 and 80 with a $\pm 2.5\%$ maximal tolerated error.

Procedure

The data were collected between October 2002 and November 2003. 178 interviewers carried out the testing. All of them were students of psychology specially instructed in how to apply the SPM *Plus*. All the students had graduated from the psychological assessment course in the second year of studying psychology and also they followed a special training about the sampling procedure to be used. Their work was supervised and verified. The instructions for testing were taken from the SPM *Manual* (Raven et al., 2000 revised and extended 2004), translated into Romanian. All testing was carried out in the participants' homes and everyone was tested individually. Respondents were first asked to complete the SPM *Plus* and then to contribute socio-demographic data. After being instructed in the procedure to be followed, each participant worked individually and the administrator intervened only if the participant asked him/her to do so. Children, older people, and people who had difficulties completing the answer sheets were assisted by the interviewer. There was no time limit for the testing, but after 20 minutes a note was made of the item the person was working on at that time. The mean time taken to complete the SPM *Plus* was 43 minutes. The second step involved contributing socio-demographic data covering: occupational status, schooling, socio-economic status, and nationality. Participants had the option not to reveal this socio-demographic and private information (although confidentiality was assured).

Choice of test instrument

As mentioned earlier, the SPM, *Plus* was chosen because earlier studies had shown that it offered better discrimination among young adults with high cognitive abilities. Details of the construction of SPM *Plus* can be found in Raven et al. (2000, revised and up-dated 2004).

Results and Discussion

The test was scored in the usual way, assigning 1 point for a correct, and 0 for an incorrect, answer. All the analyses were conducted using raw, untransformed, scores. Respondents whose dates of birth or sex were missing were omitted from the analysis, as were those with severe neurological diseases. This reduced the sample size to 2,801.

Normative data

Two considerations influenced the way we decided to present the normative data for the Romanian population:

1. Cross-sectional studies of the development and “decline” of educative ability like our own, typically reveal a rapid increase until about 18 years of age and then what has, until recently, been interpreted as a steady decline into old age. In order to provide adequate reference data for those wishing to compare the scores of individual young people and adolescents with a normative data for their own age group it is therefore necessary for the norms for young people and adolescents to be presented at 6-monthly intervals. For adults more widely spaced - e.g., five-yearly - norms are adequate.
2. One way of assessing the significance of someone’s score is to indicate the percentage of some appropriate reference group who obtain lower (or higher) scores. The advantages of this method are summarized in Raven at al. (2000 revised and extended 2004) but mention may be made of the following: (a) the non-Gaussian within-age group distributions invalidate the application of parametric statistics and the basis on which deviation IQs are calculated; (b) conversion of percentiles to deviation IQs with means of 100 and SDs of 15 exaggerates the discriminative power of the tests and thus lead users to place undue reliance on small differences in score; and (c) from the point of view of studying the development and decline of mental abilities, it is essential to study differential growth and decline among people of different levels of ability.

Smoothed summary norms for the Standard Progressive Matrices *Plus* (untimed) for Romania are presented in Table 3.

Inspection of Table 3 suggests that the effort made to restore the discrimination that the Classic SPM had at the upper end when it was first introduced without destroying its discrimination at the lower end was successful: The range of scores goes from a 5th percentile score for 6_ year olds of 8 correct answers to the 95th percentile for 18 year olds of 47. The latter leaves room for further increases in the scores of the top 5% of the population.

Comparative data

In addition to being standardized in Romania, the SPM *Plus* has also been, to some extent, standardized in the school district of Fort Bend, Texas, USA, and in Germany, Poland, and Hungary (see 2004 update of Raven 2000/2004 for further details). Table 4 presents a selection of the results. It will be seen that the Romanian norms, on the whole, lag behind those for the other countries. However, before concluding that the observed differences reflect genuine differences in educative ability between countries it is necessary to consider the way in which the samples for the different countries were drawn. In the USA the sample (Raven et al., 2000, updated 2004) was drawn from Fort Bend school district, Texas. This has a socio-economic level well above that typical of the US as a whole. The German adult sample (Raven et al., 2000, updated 2004) consisted mainly of voluntary participants and did not reflect the structure of the entire German population. The sample from Poland (Jaworowska & Szustrowa, 1993; Jaworowska & Szustrowa, 2000) was, so far as can be judged, representative, but it was based on a quota sample and it is well known that this procedure is subject to error because of its dependence on the discretion interviewers have in their selection of respondents who satisfy the specific socio-economic criteria that they are assigned. Given those facts, we cannot say whether the differences in performance between countries arise from basic differences in levels of educative ability, from differences in the sampling procedures used, or from other reasons.

What is perhaps most revealing, however, is the comparison between the Romanian and the Hungarian results around the age of 18 presented in Table 5. In Hungary, by law, the entire age cohort who, in a particular year, becomes liable to perform military service must submit to psychological testing unless specifically granted exemption. The 1998 entry cohort all took the SPM *Plus*. As can be seen from Table 5, the norms for the Romanian and Hungarian samples for this age group are similar.

It would seem from the above data taken together that, as one becomes more confident about the representativeness of the samples, the norms obtained become more and more similar to those obtained in Romania. And this conclusion is generally supported by the extensive collection of international data for the *Classic Standard Progressive Matrices* which have been brought together in Raven et al. (2000, revised and extended 2004).

Reliability analysis

Test-retest reliability

The test-retest reliability over an interval of one month, based on a sample of 142, 1st to 12th grade pupils was 0.88. The mean score at retest was 28.23. This compares with an original mean of 26.71, indicating a fairly typical increase in scores at re-test (Domuta, Comsa, Raven, Raven, Fischer, & Prieler, 2004; Domuta, Balazsi, Comsa, & Rusu, 2004). As a result, we can argue that the SPM *Plus* test will reflect with some accuracy the real performances of the test-taker both in the case of a single assessment (as in personnel recruitment) as well as in the case of repeated assessments of the educative ability (as in the case of monitoring development).

Conclusions

The main objective of this paper was to describe the procedure adopted to standardize the SPM *Plus* in Romania and to discuss the results. We chose this form of the SPM because it seemed to have excellent discriminative power across the whole range of ability from early childhood, through adolescence, to old age. This hope and expectation was amply justified by the results. More specifically, it emerges that the construction of the SPM *Plus* has restored the discriminative power that the *Classic* SPM had at the upper end among adolescents and young adults when it was first developed but which had been eroded by the secular increase in scores that has come to be known as the “Flynn Effect”. This increased discriminative power has also been achieved in a way which leaves room for a continuing increase in scores. This improved discriminative power at the top end has been achieved without destroying either the test’s discriminative power at the bottom end or its ability to register even the very lowest levels of performance.

So far as can be judged, the sample from whom the data were obtained is representative of the Romanian population and the norms based upon it are comparable with, and support, those established in other countries. The most likely explanation of the fact that the Romanian norms

are slightly lower than those reported in most of the other studies is that the samples in these other studies left something to be desired.

But the similarity in the norms obtained in different countries is not the only thing that is impressive. The Item-Response-Theory-based internal consistency studies reported elsewhere (Domuta et al., 2004; Raven, Prielor, & Benesch, 2005) show that the tests' properties are remarkably stable across cultural groups. This, together with the test-retest correlation reported above, strongly suggest that the test offers a valid and reliable measure of educative ability.

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Table 1

Non-Contact and Refusal Rates

<i>Reasons for non-contact and refusal</i>	<i>Percent of target sample</i>
Refusals	17.03
Absence after 3 visits	8.19
Moved	0.73
Died	0.68
Institution at that address	2.68
Other	11.36

Table 2

Demographic Composition of Obtained Sample Compared with that of the Population (INSSE Data, 2002)

<i>Variable</i>	<i>Sample (%) Without weight</i>	<i>Population (%)</i>
<i>Gender</i>		
Male	44.9	48.0
Female	55.1	52.0
<i>Age intervals</i>		
5 - 9	8.8	5.7
10 - 14	23.5	8.1
15 - 29	27.9	25.5
30 - 49	22.3	29.7
50 - 59	9.3	11.2
Over 60	8.2	19.8
<i>Last school finished¹</i>		
Primary	4.9	19.4
General (8 classes)	15.6	26.2
Professional (10 classes)	20.3	17.6
High school	32.3	24.7
More than high school	24.3	12.1
<i>Residence</i>		
Urban	45.1	53.5
Rural	54.9	46.5
<i>Ethnic group</i>		
Romanian	90.3	89.5
Hungarian	7.1	6.6
Gipsy	1.3	2.5
Other	-	1.4
<i>Car possession</i>	-	38.0
<i>TV possession</i>	-	92.0

¹ Respondents over 18 years of age only.

Table 3

Standard Progressive Matrices Plus

2003 Smoothed Norms for Romania Age in Years (Months)

Percentile	Age In Years (Months)													
	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	
	6(3) to 6(8)	6(9) to 7(2)	7(3) to 7(8)	7(9) to 8(2)	8(3) to 8(8)	8(9) to 9(2)	9(3) to 9(8)	9(9) to 10(2)	10(3) to 10(8)	10(9) to 11(2)	11(3) to 11(8)	11(9) to 12(2)	12(3) to 12(8)	
95	22	24	28	31	32	33	34	35	36	37	38	38	39	
90	20	22	26	30	30	31	32	33	33	34	35	36	37	
75	19	20	22	25	27	28	28	29	29	30	31	32	33	
50	15	16	18	20	22	23	24	24	25	25	26	27	28	
25	10	11	12	14	15	16	17	18	19	20	21	21	22	
10	9	9	11	11	12	13	13	14	14	14	15	16	16	
5	8	9	9	10	10	10	11	11	12	12	13	13	14	
<i>n</i>	20	30	28	31	37	22	31	44	51	62	55	66	73	

Percentile	Age In Years (Months)												
	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	
	12(9) to 13(2)	13(3) to 13(8)	13(9) to 14(2)	14(3) to 14(8)	14(9) to 15(2)	15(3) to 15(8)	15(9) to 16(2)	16(3) to 16(8)	16(9) to 17(2)	17(3) to 17(8)	17(9) to 18(2)	18(3) to 18(8)	
95	39	40	40	41	42	44	45	45	46	47	47	48	
90	38	39	39	40	40	41	42	43	44	45	45	46	
75	34	34	35	36	36	37	38	39	40	40	40	41	
50	29	30	31	31	32	32	33	33	34	34	35	36	
25	23	23	24	24	25	25	26	26	27	28	28	29	
10	17	18	18	19	19	20	21	22	22	22	22	22	
5	15	15	16	16	17	17	18	18	18	18	18	18	
<i>n</i>	72	80	77	80	62	58	51	56	64	63	40	45	

Percentile	Age in Years												
	20	25	30	35	40	45	50	55	60	65	70	73+	
	18 to 22	23 to 27	28 to 32	33 to 37	38 to 42	43 to 47	48 to 52	53 to 57	58 to 62	63 to 67	68 to 72		
95	49	48	47	46	45	44	42	41	40	38	36	34	
90	46	45	44	43	42	41	40	39	37	34	32	30	
75	42	41	39	38	37	36	34	32	30	29	27	25	
50	37	36	34	32	31	30	28	27	25	24	22	19	
25	29	27	25	24	22	21	20	19	17	16	15	13	
10	21	20	18	17	16	15	14	14	13	12	12	11	
5	16	15	14	13	12	12	12	11	11	10	10	10	
<i>n</i>	158	157	142	157	148	188	150	123	85	74	58	63	

Table 4

Standard Progressive Matrices Plus

Smoothed 2004 Norms for Romania, in the Context of 1999 Norms for United States (Fort Bend), and 2000 Norms for Poland

Age in Years (Months)										
6.5 8 12 15										
6(3) 7(9) 11(9) 14(9) 14(6)										
to To to to to										
6(8) 8(2) 12(2) 15(2) 15(5)										
Percentile	RO	FB	RO	FB	RO	FB	RO	FB	PL	
95	22	30	31	36	38	41	42	46	49	
50	15	18	20	25	27	33	32	37	39	
5	8	7	10	12	13	23	17	29	30	
<i>n</i>	20	90	31	52	66	54	62	24	98	
17 18 25 55										
16(9) 16(6) 17(9) 17(6) 23 21 53 51										
to to to to to to to to										
17(2) 17(5) 18(2) 18(5) 27 30 57 60										
Percentile	RO	FB	PL	RO	PL	RO	PL	RO	PL	
95	46	48	51	47	52	48	50	41	42	
50	34	39	41	35	42	36	39	17	29	
5	18	30	32	18	33	15	21	11	14	
<i>n</i>	64	24	364	40	343	157	90	123	82	

RO - Romania; FB - Fort Bend; PL - Poland

Table 5

Standard Progressive Matrices Plus

Smoothed 2003 Norms for Romania in the Context of Norms for Army Conscripts in Hungary and Army Recruits in Poland

	Age in Years (Months)				
	18	18.5	18	18	20
	17(9)	18(3)			18
	to	to			to
	18(2)	18(8)			22
Percentile	RO	RO	HU	PL	RO
95	47	48	49	44	49
90	45	46	47	42	46
75	40	41	42	38	42
50	35	36	37	34	37
25	28	29	32	30	29
10	22	22	27	25	21
5	18	18	24	21	16
<i>n</i>	40	45	7,588	395	158

RO - Romania; HU - Hungary; PL - Poland