COLOURED PROGRESSIVE MATRICES: ERROR TYPE IN DEMENTIA AND MEMORY DYSFUNCTION.

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ABSTRACT

The importance of the cognitive assessment in determining an early diagnosis for neurological diseases, is widely emphasized. Nevertheless, not much has been made for the development of adequate tools of investigation. These tools must be easy to administer and with a high sensitivity and specificity for different disorders.

This work describes the results obtained with Raven's Coloured Progressive Matrices (CPM), a test designed to assess the intellectual processes of children, mentally defective individuals and elderly people. The test was administered to 92 subjects (mean age= 66.2, sd= 11.3) belonging to 3 different groups: 31 demented patients, 34 dismnesic patients e 27 normal subjects. All subjects underwent a comprehensive neuropsychological examination that included, among other tests, the Mini Mental State Examination (MMSE).

CPM scores resulted to be different across groups: demented patients had (CPM=12.3) lower scores than dismnesic (CPM=22.3) and normal (CPM=27.4) subjects. The same findings were obtained with MMSE scores. Considering, for demented patients, as cut-off scores CPM<20 and MMSE<26 we obtained 90% of sensitivity. When dismnesic patients are considered, the MMSE categorizes as inferior 53% of the patients, while the CPM identifies as much only the 35%.

When CPM errors are analysed, instead of the correct responses, the best diagnostic utility of this test results evident. A factorial analysis conducted on the different types of error reveals 2 factors: a factor choice and a factor orientation. On the first type of error, dismnesic patients perform like normal subjects, while on the second type of error demented and dismnesic present an equal number of errors. This result is very important to diagnostic goals, since the first type of error might be more closely related to a diffused degeneration, while the second type might be caused by alterations of specific cerebral structures.

AIMS

The purpose of this work is to examine correct responses and errors made on the Raven Coloured Progressive Matrices in subjects with different degrees of cognitive impairment.

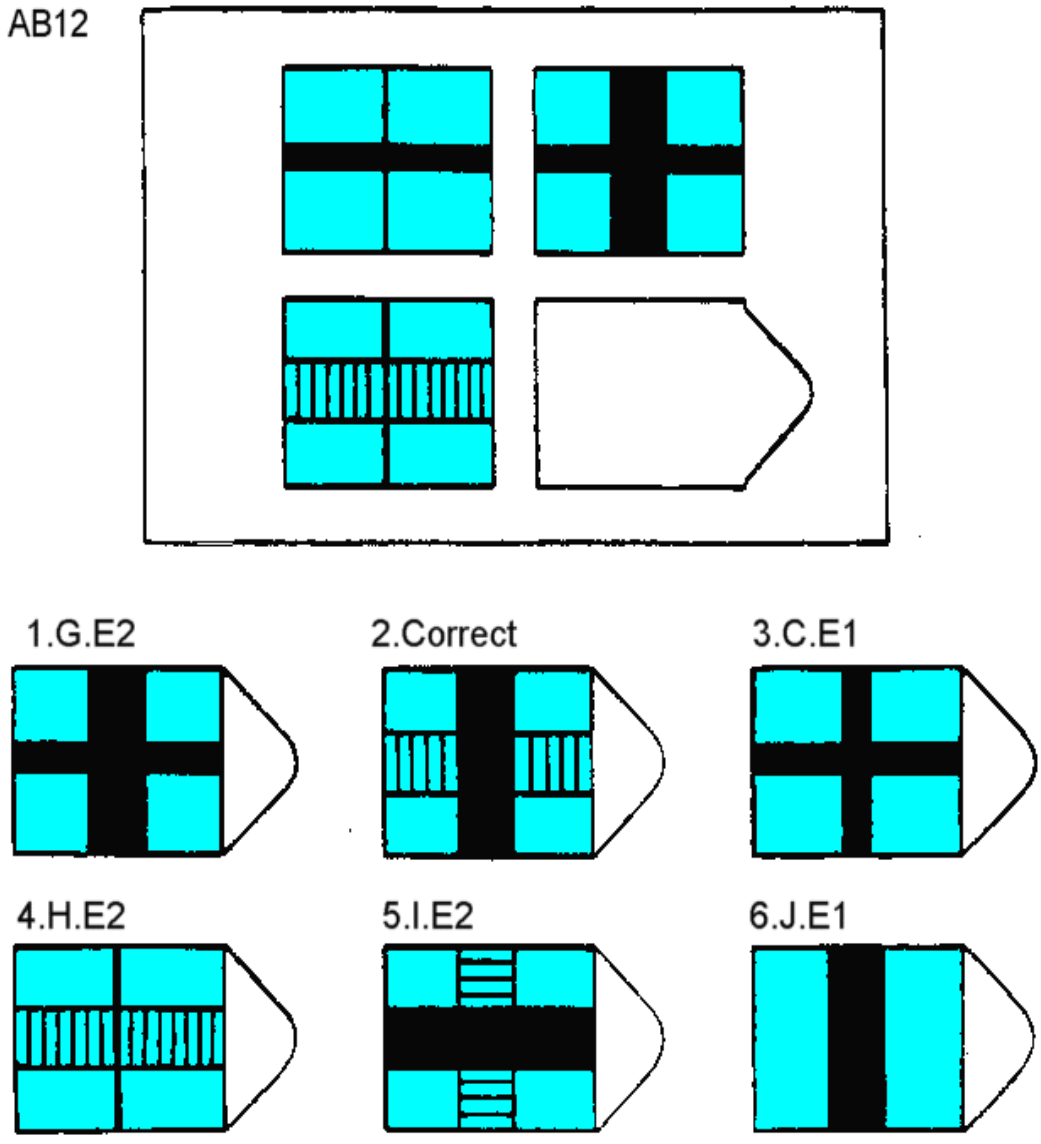
INTRODUCTION

The importance of the cognitive assessment in determining an early diagnosis for neurological diseases is widely emphasized. Nevertheless, not much has been made for the development of adequate instruments of investigation. These tools must be easy to administer and should have high sensitivity and specificity for different disorders.

This work focuses on the usefulness of Raven's Coloured Progressive Matrices (CPM; Raven, 1947)), a test designed to assess the intellectual processes of children, mentally defective individuals and elderly people.

The CPM test is a popular measure of intellectual ability as responses require neither verbalization nor skilled manipulation ability. In addition, verbal instruction is kept to a minimum. For all these reasons CPM is widely used in clinical practice.

FIGURE 1



TEST DESCRIPTION

The test consists of 36 coloured tables, grouped into three sets (A, Ab, B) of 12 items each. Each table (see one example in figure 1) contains a drawing with one part removed and six different inserts, one of which contains the correct pattern. The subject's responses have no time limit.

Each set involves different principles of matrix transformations, and within each set the items become increasingly more difficult. Set A consists of problems in the form of a continuous pattern. Tables in the Ab and B series are made up of 4 parts, 3 of which are given and one is to be selected from the response alternatives. Through the Ab and B sets, there is a gradual shift from four parts which form a coherent whole (gestalt) to problems in which each part is a symbol in an analogy test and there is no discrete perceptual gestalt per se.

Raven (1947) differentiated 4 classes of incorrect responses (see Table I).

TABLE I: CATEGORIZATION OF INCORRECT RESPONSES (FROM RAVEN, 1947).

DIFFERENCE
A - Responses without any figure.
B - Responses in which the figure shown is irrelevant.
INADEQUATE INDIVIDUATION
C - Responses contaminated by irrelevancies.
D - Responses contaminated by distortions.
E - Responses which are the whole or half the pattern to be completed.
REPETITION OF ONE PART
F - Left and above the space to be filled.
G - Above the space to be filled.
H - To the left of the space to be filled.
INCOMPLETE
I - Wrongly oriented
J - Incomplete

SUBJECTS

The study was carried out on 92 subjects (49 males, 43 females; mean age=66.2; mean schooling=7.6) belonging to three different groups: 31 demented patients, 34 dismnesic patients and 27 normal subjects. All subjects underwent a comprehensive neuropsychological examination that included, among other tests, the Mini Mental State Examination (MMSE). Table II summarizes some demographic data.

TABLE II: DEMOGRAPHIC DATA

	N	AGE	SCHOOL	MMSE
NORMALS	27			
Mean		60.9	10.4	28.0
sd		11.5	4.7	1.9
DISMNESICS	34			
Mean		66.4	7.7	24.8
sd		12.4	4.3	4.0
DEMENTED	31			
Mean		70.3	5.4	16.8
sd		7.7	3.1	6.4

RESULTS AND DISCUSSION

Internal consistency (0.87) and validity (the correlation CPMxMMSE, 0.78) were both acceptable: 9 out of the 36 items, obtained percentage of correct responses greater than 80%.

To study the influence of visual spatial defects on correct responses, an analysis has been conducted on location preferences. This analysis indicated a prevalence of responses located in the upper row and positions 1 and 2. These effects were equivalent in normals and dismnesics, while demented manifested only the upper/lower effect.

For better understanding the diagnostic power of the CPM, the results have been analyzed according to different views. The means for the CPM, for subtests (A, Ab, B) and for the three sets (1,2,3) identified by Villardita (1985), are listed in Table III. All means were statistically different except those marked with an "=" sign.

TABLE III: MEANS OF CPM AND SUBTEST SCORES FOR EACH GROUP

	NORMALS		DISMNESICS		DEMENTED
CPM	27.4		22.3		12.3
sd	4.7		6.4		5.7
Set A	10.4		9.2		6.1
Set Ab	9.6		7.2		3.3
Set B	7.4	=	6.0		3.0
Set 1	10.9	=	10.3		7.2
Set 2	15.0		10.7		4.5
Set 3	1.6	=	1.3	=	1.0

As for CPM scores, intergroup scores resulted to be significantly different ($F(2,89)=54$, $p<.000$): demented scored lower than dismnesic and normals scored higher than dismnesics. Only 55% of the variance in CPM is accounted for by diagnostic category and hence the total score alone would not be a good predictor of deterioration of intelligence. The MMSE scores (see Table II) revealed the same difference among groups.

The analysis of each subset of the CPM confirmed the assumption that set A is easier than set Ab and B. Demented scored always lower than dismnesics and normals. As illustrated in Table III for set B dismnesics did not differ from normals. This result seems to be more easily explained by a decrease of performance in normals more than by a differential effect of set B on dismnesic patients. As known, the age of subjects is supposed to be more relevant as task complexity increases.

Subset distinction as indicated by Villardita provided no better explanations on the nature of group differences. Actually, Set 3 was unusable and Set 1 did not differentiate between normals and dismnesics. Only Set 2, in which the principle of symmetry is, presumably, required, revealed intergroup differences.

In conclusion, it seems to us that the total score is enough to differentiate our patients.
Considering as cut-off scores CPM<20 we obtained 90% of sensitivity, for demented, and 65% and 93% of specificity for dismnesics and normals. Taking into consideration that dismnesics were not deteriorated, these estimates provide an acceptable categorization of the population.

As typical of other cognitive diagnostic contexts, the analysis of the correct responses could provide only moderate information, especially whenever an early detection of cognitive impairment is necessary. On the other hand, error analysis provides better diagnostic information.

Incorrect responses given by each subject in each table were classified according to the scheme reported in Table 1. A-type errors resulted to be only 0.7% of the total errors; for this reason they were excluded from the analysis. A principal component analysis revealed 2 factors accounting for 51% of the total variance. The first factor (E-1, CHOICE) incorporates B, C, E and J error, while the second (E-2, ORIENTATION) contains F, H, I, G errors.

When single errors are pooled according to the previous 2 factors we obtained the following results (Table IV). Statistical analysis indicates that dismnesics perform like normal subjects as to the first group of errors, while they are equivalent to demented as to the second group.

TABLE IV: ERROR MEANS FOR CHOICE (E1) AND ORIENTATION (E2)

	NORMALS		DISMNESICS		DEMENTED
E1	1.7	=	2.8		8.5
sd	2.1		2.4		5.0
E2	6.6		10.5	=	11.1
sd	3.7		4.5		5.2

CONCLUSIONS

The analysis of the correct responses to the CPM provides the obvious confirmation that the 3 groups differ.

By contrast, the analysis of the errors made by the subject in each table highlights 2 separate components of the process of their analysis; such components turn out to be distinctly altered in subjects with different degrees of cognitive impairment.

This last result seems to be very relevant to the construction of increasingly more sensitive diagnostic tests. In fact, the first type of error might be more closely related to a diffused degeneration, while the second type might be caused by alterations of specific cerebral structures.