Arq Neuropsiquiatr 2004;62(2-A):206-211

THE ROLE OF EDUCATION IN MINI-MENTAL STATE EXAMINATION

A study in Northeast Brazil

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ABSTRACT - *Background*: There is evidence that schooling can influence performance in cognitive assessement tests. In developing countries, formal education is limited for most people. The use of tests such as Mini-Mental State Examination (MMSE), could have an adverse effect on the evaluation of illiterate and low education individuals. *Objective:* To propose a new version of MMSE as a screening test to assess Illiterate and low education people. *Method:* A study was carried out enrolling 232 individuals, aged 60 or more of low and middle socio-economic classes. Three groups were studied: Illiterate;1-4 schooling years; 5-8 schooling years. The new version (MMSE-mo) consisted of modifications in copy and calculation items of the adapted MMSE (MMSE-ad) to Portuguese language. The maximum possible score was the same in the two versions: total, 30; copy, 1 and calculation, 5. *Results:* In the total test score ANOVA detected main effects for education and test, as well as an interaction between these factors: higher schooling individuals performed better than lower schooling ones in both test versions; scores in MMSE-mo were higher than in MMSE-ad in every schooling group. *Conclusion*. Higher schooling levels improve the perfomance in both test versions, the copy and calculation items contributing to this improvement. This might depend on cultural factors. The use of MMSE-mo in illiterate and low school individuals could prevent false positive and false negative cognitive evaluations.

KEY WORDS: mini-mental state examination, cognition, education, cognitive assessement.

O papel da educação no mini exame do estado mental: um estudo no Nordeste do Brasil

RESUMO - *Contexto*: Existem evidências de que a escolaridade pode influenciar o desempenho em testes de avaliação cognitiva. Já que em paises subdesenvolvidos o nível educacional da maioria da população é baixo, isso poderia prejudicar resultados de avaliação por meio de testes. Assim é oportuno adequar o mini exame do estado mental (MEEM) a populações de baixa escolaridade. *Objetivo*: Propor nova versão do MEEM como um teste geral para avaliar indivíduos analfabetos e com baixa escolaridade. *Método*: Foram estudadas 232 pessoas de ambos os gêneros com 60 ou mais anos de idade, de classes socio-econômicas média e baixa. Foram considerados 3 grupos: analfabetos; 1-4 anos e 5-8 anos de escolaridade. A nova versão (MEEM-mo) consistiu de modificações nos itens cópia e cálculo do MEEM adaptado para a língua portuguesa (MEEM-ad). O escore máximo possível foi o mesmo nas duas versões: total 30 pontos; cópia, 1; cálculo, 5 pontos. *Resultados*: No escore total, o teste de ANOVA detectou efeitos principais para teste e escolaridade, assim como interação entre estes fatores: indivíduos com escolaridade mais alta realizaram melhor ambos os testes do que aqueles com mais baixa escolaridade. Os escores do MEEM-mo foram mais elevados do que os do MEEM-ad, em cada grupo de escolaridade. *Conclusão*: Indivíduos com maior escolaridade apresentam melhor performance em ambas as versões dos testes; os itens cópia e cálculo foram responsáveis por este resultado. Isto pode depender de fatores culturais. O uso do MEEM-mo em indivíduos analfabetos e com baixa escolaridade pode prevenir resultados tanto falso-positivos como falso-negativos nas avaliações cognitivas.

PALAVRAS-CHAVE: mini exame do estado mental, cognição, educação, avaliação cognitiva.

Assessment of cognitive function is essential for accurate diagnosis and management in general neurological practice. Detailed assessment by the neurologist and psychologist requires a high degree of specialist training and is time-consuming. It is desirable to have a standardized simple and quick test of cognitive function which could be routinely used by the admiting physician[1]. Among the cognitive tests there is the Mini-Mental State Examination (MMSE) which was proposed to differentiate non specified organic brain syndrome and depression from normal patients. It is useful in quantitatively estimating the severety of cognitive impairment and in documenting serially cognitive changes[2]. It can be also used in communi-

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Received 6 June 2003, received in final form 1 October 2003. Accepted 18 November 2003.

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ty-based epidemiologic studies to evaluate the current mental functioning of participants. Assessing MMSE in research protocols is particularly important for establishing the incidence or prevalence of cognitive impairment and for examining correlates of mental status[3]. Since the general practitioners are usually the prime mover in ensuring that medical and social needs of their patients must be recognized and met, it seems worth determining how well informed they are about the health and welfare of their older patients[4]. However, there is evidence that clinicians have often difficulty in recognizing disturbances of cognition among their patients[5]. Williamson et al.[4], surveying an elderly population, found that only 13% of demented subjects were recognized as such by the physicians in charge of their care. Another study showed that 37% of cognitively impaired general medical ward patients were unidentified by physicians, while nurses failed to identify 55% and medical students, 46%6. Other authors, studying 33 patients with cognitive impairment on a neurologic in-patient service, found that 30% of them were not recognized by the attending neurologists, and 87% by general practitioners as well[7]. Therefore, is low for neurologists, the capacity to recognize and diagnose these disorders. Evidence that psychiatric disorders are common among neurological patients and that they are frequently unrecognized would support the need for further psychiatric training of neurologists. Potencially such failure to recognize cognitive impairments has considerable implications for patient care, as such changes are often the first indication of many underlying neuropathologic conditions[7]. Considering psychiatrist's standardized clinical diagnosis as a criterion, the MMSE is 87% sensitive and 82% specific in detecting dementia and delirium among hospital patients on a general medical ward[5]. The false positive ratio is 39% and the false negative ratio is 5%. All false positive people had less than 9 years of formal education. So, the MMSE has been shown to lack specificity in poorly educated persons, particularly those who did not attend high school[5]. Conversely, it has been observed a number of highly educated dement patients whose MMSE scored the conventional normal range[8]. It is possible that performance on specific MMSE items could be related to education. In fact, several studies have shown that low MMSE scores are correlated with low instructional level and poorly educated subjects score below 26 even without dementia. On the other hand equations have been developped at adjusting MMSE scores for educated people, because specific items of the MMSE are influenced by education[10]. So the use of tests which include problems beyond the comprehension capacity of an individual could mask the evaluation of this individual´s insight for the same test. Items measuring recall of three words, pentagon copy, and orientation in time seem to be most sensitive to both normal aging and dementing illnesses[11]. According to Fratiglioni et al.[12], the performance on the MMSE is variable among countries. This may be due to different degrees of education in the population, or to different curricula structures of the same schooling level in different countries. Thus, "norms" or "adjustment techniques" derived from one country can not be considered universally applicable. In order to prevent the possibility of education to mask the result of this test and, as a consequence, to represent a potential risk factor for the cognitive assessment, it is opportune to reassess the validity of the MMSE whenever it is going to be used in a new population. In developping countries, such as Brazil, most of people have a schooling level lower than eight years[13].

The main aim of the present study was to propose a MMSE modified version as a screening test to assess low schooling old people in Brazil.

METHOD

A randomized cross-sectional study was performed with 232 individuals of both genders, aged 60 or more years old (69.4 ± 6.8 years), belonging to low and middle socio-economic classes, residents in Olinda city, Pernambuco, Brazil. Previously to applying the test people were inquired about their normal daily routine. People able to conduct theirselves and recognize the primary and secondary colors, the time in a clock, cash money, and capable to use a tin opener were admitted to the study. A clinical interview was proceeded in order to investigate neurological and psychiatric diseases. People with low visual or auditory acuity, motor or rheumatic disturbance, chronic alcoholism, cardiovascular disease, recent head trauma (last 12 months) or not motivated, were excluded. Three groups were formed according to the schooling level, as follows: group illiterate (n=28) - individuals without any formal schooling instruction; group 1-4 degree (n=119) - individuals from 1 to 4 years of formal instruction; and group 5-8 degree (n=85) - individuals from 5 to 8 years of formal instruction.

The original MMSE[2], adapted to the Portuguese language[14] (thereafter called MMSE-ad) was compared to a modified version of it (thereafter called MMSE-mo) (see appendix). The modification consisted of: first, the copy of intersecting apendice pentagons (MMSE-ad) was changed to the copy of an intersecting equilateral triangles (MMSE-mo); second, the subtraction 7 from 100, and then 7 from the result, repeated 5 times (MMSE-ad) was changed to the serial 1 subtracted from 25 backward, and then 1 from the result, repeated 25 times (MMSE-mo). Each subject of the sample was submitted consecutively to the two versions, first MMSE-ad, and second MMSE-mo. Concerning to the copy and calculation items the MMSE-mo version was applied immediately after the same items of the MMSE-ad version. Both test versions had the maximum possible score equivalent to 30 points, copy and calculation items having maximum score equivalent to1 and 5, respectively.

Aggreement between MMSE-ad and MMSE-mo tests concerning the scores obtained in copy item was determined by Cohen´s Kappa aggreement coeficient. Aggreement between the tests concerning the scores obtained in calculation item was determined by Kappa weighted aggreement coeficient[15]. The chi square test was used to compare frequencies. Comparisons between means of the total scores achieved in each test were made by a two-way ANOVA for repeated measures. The Spjotvoll-Stoline test was used for post-hoc multiple com-

Appendix

Patient. . . . . .
Examiner . . . . . .
Date . . . . . .

MINI-MENTAL STATE EXAMINATION IN NORTHEAST BRAZIL

Maximum Score	Score	
		ORIENTATION
5	( )	What is the (day) (date) (month) (year) (hour) ? 1 point for each correct.
5	( )	Where are we:*(place) (bulding) (district) (city or town) (state) ? 1 point for each correct.
		*Ask the name of this place and point out your finger down simultaneously.
		REGISTRATION
3	( )	Name 3 objects: 1 second to say each. Then ask the patient all after you have said them.
		Give 1 point for each correct answer. Count trials and record.
		ATTENTION AND CALCULATION
5	( )	Serial 7´s. 1 point for each correct. Stop after 5 answers, and serial 1 subtracted from 25
	( )	backward, and then 1 from the result, repeated 25 times. 1 point for each 5 itens correct.
		RECALL
3	( )	Ask for the 3 objects repeated above. Give 1 point for each correct.
		LANGUAGE
9	( )	Name a pen, and wacth (2 points)
		Repeat the following "No ifs, ands or buts," (1 point)
		Follow a 3-stage command: "Take a paper in your right hand, fold it in half, and give me it" (3 points)
		Read and obey the following: close your eyes (1 point)
		Write a sentence (1 point)
		Copy of a pair of intersecting pentagons and copy of a pair of intersecting equilateral triangles
		(1 point for each correct copy).
TOTAL SCORE		

parisons of means. Comparisons of mean values not fulfilling parametric requirements were made by Kruskal-Wallis analysis of variance followed by Dunn test. The null hypothesis was rejected when $p \leq 0.05$. The statistic software Sigma Stat 2.0 was used for calculation.

RESULTS

In the copy item (Table 1) a poor agreement between MMSE-ad and MMSE-mo was observed in 1-4 years degree (K=0.14) and in 5-8 years degree (K= 0.18) groups. The agreement for the illiterate group was fair (K= 0.35).

Like in copy item the agreements between the tests in calculation scores (Table 2) were poor in 1-4 and 5-8 schooling degree (K= 0.16 and K= 0.10, respectively) and fair for illiterates (K= 0.39).

From the results expressed in Table 1, we can observe also that global aggreement (g.a) for the copy item - defined as the addition of WW plus CC answers of the same individual - between MMSE-ad and MMSE-mo tests, presented the following proportions: illiterate 21/28 (75%), 1-4 degree 59/119 (49%), and 5-8 degree 42/85 (49%) (Chi-square= 6.41, p=0.040). For the calculus item (Table 2) g.a showed the following proportions: illiterate 11/28 (39%), 1-4 degree 23/119 (19%), and 5-8 degree 19/85 (22%) (Chi-square= 7.09, p=0.029). The g.a for copy and calculation between 1-4 and 5-8 degree did not differ significantly. However, each one of these groups differ from illiterate (p<0.01) and (p<0.01), respectively.

Comparing the total scored values between the tests (Table 3) ANOVA indicated a significant main effect for test ($p < 0.001$) and for schooling degree ($p < 0.001$) as well as an interaction between these two factors ($p = 0.007$). The values were significantly higher for MMSE-mo than for MMSE-ad, in every schooling degree. Moreover, in both tests illiterates scored lower than literates ones (p<0.01).

In Table 4, we can observe that in every schooling degree MMSE-mo produced higher proportions of individuals answering correctly to copy than MMSE-ad: illiterate, (p<0.034); 1-4 years, (p<0.001); and 5-8 years, (p<0.001). In both test versions, a significant difference was also observed among schoo-

Table 1. Distribution, of the individuals according to agreement of their scores for copy in MMSE-ad and MMSE-mo tests.

	MMSE-ad					
	Illiterate		1-4 degree		5-8 degree	
	W	C	W	C	W	C
W	18	7	37	56	15	43
C	0	3	4	22	0	27
	K= 0.35 (fair)*		K= 0.14 (poor)*		K= 0.18 (poor)*	

* according to Altmam[15]; W = wrong; C = correct.

Table 2. Distribution of individuals according to agreement between MMSE-ad and MMSE-mo tests

	Illiterate	1-4 degree	5-8 degree
MMSE-ad	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
MMSE-mo			
0	8 1 0 0 1 3	5 2 2 1 3 10	1 0 1 0 3 8
1	0 0 0 0 0 2	2 1 0 0 0 24	0 0 0 1 1 10
2	1 1 0 0 2 1	0 0 1 1 6 14	0 0 0 1 4 14
3	0 0 0 0 0 2	0 1 0 1 0 13	0 0 0 0 0 12
4	1 0 0 0 0 2	2 0 0 0 0 15	0 0 0 0 0 11
5	0 0 0 0 0 3	0 0 0 0 0 15	0 0 0 0 0 18
	K = 0.39 (fair)*	K = 0.16 (poor)*	K = 0.10 (poor)*

* according to Altmam[15] .

Table 3. Mean scores for MMSE-ad and MMSE-mo of 232 individuals according to the schooling degree.

Schooling degree	N	MMSE-ad			MMSE-mo			*p* value
		$\overline{X}$	±	sd	$\overline{X}$	±	sd	
Illiterate	28	18.68	±	4.59[a]	20.07	±	5.28[d]	0.003
1-4 years	119	22.98	±	3.47[b]	25.58	±	3.48[e]	0.001
5-8 years	85	23.98	±	3.39[b]	26.65	±	2.67[e]	0.001

Schooling effect: F = 15.80 ($p < 0.001$).Test effect: F = 19.70 ($p < 0.001$). Schooling X Test interaction: F = 6,30 ($p < 0.007$).*Multiple comparisons between schooling degrees (SpjotivolI-Stoline test): Values sharing different over script letter are significant ($p < 0.01$).

ling groups: MMSE-ad (Chi-square= 6.095; p=0.047) and MMSE-mo (Chi-square= 12.178; p= 0.002). In both test versions the illiterate groups presented lower proportions of correct answers than the literate ones.

Mean scores for calculation (Table 5) indicate that, in MMSE-mo, individuals performed better than in MMSE-ad, for all schooling degrees: Illiterate (p=0.011), 1-4 years (p<0.001) and, 5-8 years (p<0.001). For each test in particular, significant difference among schooling degrees was detected: (MMSE-ad, p< 0.018); (MMSE-mo, p< 0.001). By comparing schooling groups we can verify that, in MMSE-ad, the first group (illiterate) is similar to the second one, and differ of the third schooling group (p<0.05). However, the second group does not differ from the third group, the higher score having been verified in this last group. In the MMSE-mo, we observe that the illiterate scored lower than 1-4 and 5-8 degrees (p<0.05), but these two last groups did not differ between them.

Table 4. Distribution of individuals according to correct copy scores.

Schooling degree	N	MMSE-ad n	MMSE-ad %	MMSE-mo N	MMSE-mo %	χ^2 Yates*	*p* value
Illiterate	28	4	14.2	11	39.2	3.278	0.034
1-4 years	119	30	25.2	76	63.8	35.99	< 0.001
5-8 years	85	31	36.4	64	75.3	25.98	< 0.001
		**χ^2_{2df}=6.095 (p=0.047)		**χ^2_{2df}=12.178 (p=0.002)			

*Comparison between tests. **Comparison among schooling.

Table 5. Mean scores of calculation item according to schooling.

Schooling degrees		MMSE-ad	MMSE-mo	p value* (Wilcoxon)
Illiterate	X ± dp	1.5 ± 1.8[a]	2.6 ± 2.4[c]	0.011
	Md (mini-max)	0.5 (0-5)	4.0 (0-5)	
1-4 years	X ± dp	2.1 ± 1.7[ab]	4.3 ± 1.5[d]	0.001
	Md (mini-max)	2.0 (0-5)	5.0 (0-5)	
5-8 years	X ± dp	2.6 ± 1.7[b]	4.8 ± 0.7[d]	0.001
	Md (mini-max)	2.0 (0-5)	5.0 (0-5)	
Comparisons among schooling:		H= 8.05 (p=0.018)	H= 72.74 (p<0.001)	

Kruskal-Wallis test. Multiple comparisons between schooling degrees (Dunn test): Values sharing different over script letter are significant (p < 0,05).

DISCUSSION

The very low (poor) or low (fair) agreements according to Kappa coefficients[15] verified between the scores of MMSE-ad and MMSE-mo in the copy and calculation items, here reported, indicates that the test modification induced changes in the ability of the individuals to solve the proposed tasks. However, the higher agreement for illiterate group compared to schooling instructed (both in Kappa coefficient and in observed percent agreement) suggest that the influence of the test modification is lesser in illiterate individuals. In addition, the comparisons between mean values of the total score obtained in the two test versions reveal that these changes correspond to an improved performance when the individuals are submitted to MMSE-mo. Of course, the total MMSE-mo score refleted the alterations introduced in the copy and calculation items, because the other items were not modified. Indeed, the higher proportion of subjects correctly designing the triangles, as well their better performance in calculus in MMSE-mo supports this point. Since this improvement was observed in every schooling degree, including in illiterate individuals, it is likely the highest MMSE-mo copy achievement to be associated with basic knowledge of culture features in which they have lived.

In Northeastern Brazil some of these features, such as recognizing a triangle, is easier than recognizing a pentagon. In their daily activity the people routinely deal with triangle shapes (popular musical instruments, objects for playing behavior), but not with pentagon shapes[16]. This recognition might be even more difficult when the overlapping design of the figures in the test is required. So the cultural background acquired out the school can improve their capacity to solve the problem, because a familiar figure is included in MMSE-mo but no in MMSE-ad. These findings indicate that informal knwoledge about geometric shape is an important way to face the test challenge. On the other hand, the association of calculation and praxia with education suggest that the improved performance of the highest schooling groups in both test versions is accounted for by education-dependent skills.

There is mounting evidence that education has an effect on testing cognitive state in different culture groups[5,8-12]. So in our population- based sample, education and culture background could also influence responses to the calculation question when changing subtracting serial sevens to subtracting serial one. Further our data show that differences observed between MMSE-ad and MMSE-mo are related not only to the test structure or to the schooling degree working as independent factors (indicated by their main effects), but also to an active association of them (indicated by the interaction effect). Therefore we can admit these factors influencing each other

by inducing a better performance in MMSE-mo. In conclusion, the present data suggest that social and psychological factors contribute substantially to cognitive test scores and emphasize the importance of detailed assessment procedures for aplication of MMSE-ad and MMSE-mo tests as clinical instruments. In this way an individual belonging to a non afluent population could be adequately assessed in its insight capacity without damaging its ability at solving the problems presented in the test.

Therefore the MMSE new version here developed supports the view that the criterious use of both test versions (applying them according to social and educational groups) could prevent false-positive and false-negative evaluations.

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