Applied Neuropsychology
2000, Vol. 7, No. 1, 25–31

Sensitivity and Specificity of the Mini-Mental State Examination in a Spanish-Speaking Population

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The Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) was given to a total of 430 normal participants divided into 3 age ranges (16–50, 51–65, and 66–89) and 4 educational ranges (0, 1–4, 5–9, and ≥ 10 years). The educational level effect was notoriously stronger than the age effect. Normal illiterate participants obtained scores that would correspond to severe cognitive alterations (M = 17.67); low education participants (1–4 years) would be classified with moderate cognitive alterations (M = 20.61). Sensitivity and specificity of the MMSE were established. Low sensitivity and specificity were found for both the participants with 0 and 1 to 4 years of schooling, 50% and 72.73%, respectively. In participants with more than 5 years of schooling, the specificity (86.36%) and sensitivity (86.36%) indexes were higher. We concluded that the MMSE is an instrument with little diagnostic utility among participants with a low level of education.

Key words: MMSE, neuropsychology, Spanish-speaking participants, education effect

The Mini-Mental State Examination (MMSE), published by Folstein, Folstein, and McHugh (1975), is one of the most frequently used rating instruments in the evaluation of the mental state in both clinical practice and research (Crum, Anthony, Bassett, & Folstein, 1993). It was designed to quantify the degree of dementia and delirium in psychiatric and neurological patients. It consists of short and simple items that permit a rapid evaluation of various cognitive domains, including orientation, encoding, attention, recall, language, reading, writing, and drawing. The scale has 11 items that add up to 30 points. It requires 5 to 10 min for application, and when its ease and rapid administration are taken into consideration, it has been widely used to detect cognitive alterations in populations classified as neurological, psychiatric, and geriatric (Lezak, 1995); to evaluate responses to pharmacological treatment (Chatellier & Lancomblez, 1990); as part of wider batteries, such as the Consortium to Establish a Record of Alzheimer's Disease (Morris et al., 1989); and as a screening instrument in both population and epidemiological studies for the detection of dementia (George, Landerman, Blazer, & Anthony, 1991; Li et al., 1980; Rovner, Kafonek, Flipp, & Folstein, 1990).

In the original standardization with 63 normal participants over age 55, Folstein et al. (1975) reported a performance range between 24 and 30 points. Several studies (Anthony, LeResche, Niaz, von Korff, & Folstein, 1982; DePaulo, Folstein, & Gordon, 1980; Dick et al., 1984) suggest an optimum cutoff point of 23/24 to separate patients with cognitive impairment from those who are cognitively intact. Using a cutoff point of 23 and the psychiatric criterion, 87% sensitivity and 82% specificity have been reported (Folstein et al., 1975). Nevertheless, subsequent studies have only reported 63% sensitivity for the participants with 8 years of schooling or less and only 65.5% sensitivity for participants older than 60 (Anthony et al., 1982).

The MMSE has been translated into Spanish, and its usefulness has been evaluated in cross-cultural studies (Bertolucci, Brucki, Campacci, & Juliano, 1994; Bird, Canino, Rubio, & Shrout, 1987; Escobar et al., 1986).

This project was partially supported by PAPITT (Programa de apoyo a proyectos de investigación y de inovación tecnológica), Universidad Nacional Autónoma de México (IN300397).

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However, several studies have shown that the MMSE score is affected by educational level, age, and ethnic group (Fillenbaum, Heyman, Willians, Prosnitz, & Burchett, 1990; George et al., 1991; Launer, Dinkgreve, Jonker, Hooijer, & Lindeboom, 1993; Murden, McRae, Kaner, & Bucknam, 1991; Srivastav, Agarwal, & Kumar, 1989).

The studies that have been carried out with the Spanish-speaking population have attributed poor performance to low schooling and ethnic and cultural differences. For example, authors like Escobar et al. (1986) studied nonelderly samples, and they found that schooling significantly affects performance. Gurland, Wilder, Cross, Teresi, and Barrett (1992) found that conventional scores produce an increase in false positives for minority groups, especially Hispanics. These authors suggested that the results reflect the lower schooling level of Hispanics, in addition to items with a sociocultural bias.

Some authors have suggested adjusting the MMSE score as a way to take into account demographic variables including age, schooling, and degree of dementia (Mungas et al., 1996). However, it has been found that the scale becomes more sensitive to moderate alterations only at the expense of a high index of false positives. Pfeffer et al. (1981) administered the MMSE to participants with moderate dementia and found that, if a cutoff point of 20/21 was used, a 70% false-negative rate was obtained.

So far, the studies with Hispanic samples have been carried out in populations that emigrated to the United States and resided there but had a Latin background. This situation limits the generalization of the results to other Spanish-speaking communities that have not been subject to the same process of acculturation. To make an accurate diagnosis, it is necessary to use psychological and neuropsychological tests that include the performance criteria of a normal Spanish-speaking population. Several neuropsychological studies have shown that sociocultural factors are important variables when neuropsychological tests are performed (Escobar et al., 1986; Finlayson, Jonhson, & Reitan, 1977; Ostrosky, Canseco, Quintanar, Navarro, & Ardila, 1985; Ostrosky et al., 1986; Ostrosky-Solís, Ardila, & Chayo, 1996).

Not only is it important to have standardized normative data for the Spanish-speaking population, but due to the high rates of illiteracy in Latin America, the test should also include the performance criteria for this population. Despite the lack of standardized data for the Spanish-speaking population, the MMSE has been used in the Latin population in several studies as a clinical instrument for the detection of diverse disorders and in the monitoring of the response to a medical treatment (Becerra, Ortega-Soto, & Torner, 1992). The purpose of this study was to evaluate the effects of schooling and age on the MMSE performance in both a neurologically intact population and in a group of patients with a clinical diagnosis of dementia.

Material and Method

Participants

Two samples were independently studied. The first one included neurologically intact participants, and the second one consisted of a group of patients with a clinical diagnosis of dementia.

Neurologically intact participants. The MMSE was administered to a total sample of 430 clinically normal participants between ages 16 and 85. The participants were divided into three groups according to age: 16 through 50, 51 through 65, and 66 through 89. Within each age group, four educational levels were distinguished: (a) illiterate (no education), (b) low (1–4 years of schooling), (c) middle (5–9 years), and (d) high (more than 10 years; the terms *low*, *middle*, and *high* were used for facility's sake, but they do not have any direct relation with low, middle, and high school). Table 1 presents the demographic characteristics of the sample.

Inclusion criteria were (a) absence of dementia according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed. [*DSM–IV*]; American Psychiatric Association, 1994) and (b) no history of neurological or psychiatric illness (e.g., cerebrovascular accidents, traumatism, traumatic head injury, epilepsy, Parkinson's disease) according to clinical records and a neurological examination. All the participants were active and functionally independent. The sample was taken from institutions for the elderly and people living in Mexico City and Colima.

Dementia sample. A sample of 40 participants with dementia was selected. All the participants fulfilled the *DSM–IV* diagnostic criteria for dementia. This group was matched by age, sex, and educational level with 40 participants taken from the normal group. Table 2 summarizes the demographic characteristics of both groups.

Table 1. *Total Sample: Means and Standard Deviations by Age and Years of School*

	Age (Years)											
	16–50				51–65				66–89			
	Age		Years of School		Age		Years of School		Age		Years of School	
Years of School	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Zero	40.0	9.35	0.0	0.0	59.5	2.74	0.0	0.00	72.2	4.56	0.0	0.00
1–4	28.6	9.60	2.9	1.04	58.5	3.83	2.2	.95	73.6	6.12	2.5	1.25
5–9	33.4	10.98	8.4	1.21	59.9	3.18	7.1	1.53	73.3	5.63	7.6	1.36
≥10	27.5	7.74	14.9	3.04	57.9	3.23	15.7	3.85	73.0	4.71	13.1	2.60

Note: $N = 430$

Table 2. Matched Samples: Means and Standard Deviations of Age and Years of School

		Age (Years)		Years of School	
Group	*n*	*M*	*SD*	*M*	*SD*
Control	40	73.10	6.99	7.28	4.65
Dementia	40	74.15	8.17	7.00	4.65

Material

Currently in Mexico City, there are several translations of the MMSE. After interviewing 10 clinicians, we selected the version used by 6 of them (see Appendix). It was found that some of the questions were adapted to the characteristics of the Spanish-speaking population. For example, the original item "What are the four seasons of the year?" had been removed. The seasons of the year are not relevant for orientation in tropical and subtropical Spanish-speaking countries where the dry and rainy seasons are more relevant climatic differences. The original phrase had been substituted by "*No iré si tu no llegas temprano*" ("I won't go if you don't arrive early"). The total MMSE score was obtained by adding up the correct answers.

Statistical Analysis

Analyses of variance (ANOVAs) were used to analyze age and education effects. A significance of $p < .001$ was established after the Bonferroni correction. For the normal and demented groups, means and standard deviations according to age (three levels) and schooling (four levels) were obtained. Specificity and sensitivity for a cutoff point of 23/24 was obtained using the following formulas (Hanley & McNeil, 1982):

$$Sensitivity = Tp / Tp + Fn$$
$$Specificity = Tn / Tn + Fp$$

where:

1. Tp = true positives or real cases of dementia.
2. Fn = false negatives or cases of dementia diagnosed as normal.
3. Tn = true negatives or real cases of no dementia.
4. Fp = false positives or cases diagnosed with dementia in the absence of such.

Receiver operating characteristics analyses for different cutoff values were further determined.

Results

The average performance of the 430 participants on the MMSE was 24.7 points (SD = 4.86). However, when the sample was broken down into schooling ranges, the first two levels (illiterate and 1–4 years of schooling) obtained average scores of 17 and 20, respectively. Table 3 shows the scores for each one of the subgroups in terms of age and schooling.

The ANOVAs showed that the schooling variable was statistically significant, $F(3, 425) = 166.0$, $p < .001$, and the differences appeared between the four groups, whereas the age factor did not show significant differences. The Age × Schooling interaction was statistically significant, $F(6) = 3.85$, $p < .001$. As age increased, there was a drop in the MMSE performance in the illiterates, whereas in the two groups with the highest schooling level (5–9 and ≥ 10 years), the highest performance was in the age range between 31 and 65 years, with a slight decrease after 66 years. The group with 1 to 4 years of schooling, unlike the illiterate group, did not show improved performance associated

Table 3. *Means and Standard Deviations in the MMSE in the Total Sample*

	Age (Years)					
	16–50		51–65		66–89	
Years of School	*M*	*SD*	*M*	*SD*	*M*	*SD*
Zero	19.75	3.69	16.88	4.44	16.38	4.27
1–4	19.14	3.99	21.10	4.49	21.59	4.85
5–9	26.27	1.95	27.74	1.92	25.52	2.65
≥ 10	27.93	1.96	28.27	1.83	26.34	3.90

Note: N = 430. MMSE = Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975).

with increased age. This association between age and education is illustrated in Figure 1.

When the average performance of the MMSE score of the matched samples was obtained, we noted that the normal sample had an average of 25.37, whereas the average for the participants with dementia was 18.33. When education was not considered and when we used the cutoff point of 23/24 recommended for participants older than 60 (Anthony et al., 1982), we obtained values of 80% sensitivity and 77.5% specificity. When the sample was divided by schooling, acceptable sensitivity and specificity was found only for people with more than 5 years of education. However, when we used the same cutoff point for persons with lower education, we found a considerable reduction in specificity. These results are presented in Table 4.

Some authors (Mungas et al., 1996) have proposed the use of different cutoff points depending on the level of education. Taking this proposal, we again obtained the sensitivity and specificity indexes, adjusting the cutoff point according to the performance of the first two subgroups. When we used the average obtained by each group as the cutoff point (*M*s = 17 and 20 for 0 years and 1–4 years of schooling, respectively), we obtained 18.18% sensitivity and 90% specificity for the first educational group, whereas we found 27.27% sensitivity and 90% specificity for the second group.

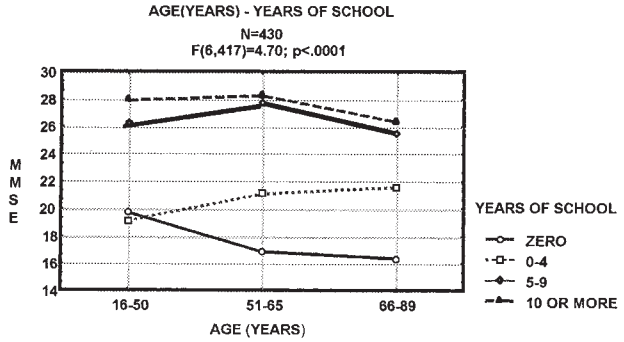

Figure 1. Mini-Mental State Examination (MMSE) scores in the different age and education groups.

Table 4. *Sensitivity and Specificity of the MMSE According to Educational Level*

	Years of School		
	0–4	5–9	≥ 10
Specificity	.50	.86	.87
Sensitivity	.73	.86	.71

Note: MMSE = Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975).

Discussion

Our results showed that the level of schooling plays a very significant role in the MMSE total score. The performance of individuals with no schooling was as low as that of participants with severe dementia, whereas the score for those with 1 to 4 years of schooling was similar to that of participants with mild dementia.

The interaction between age and schooling was mainly noted in participants with no education or limited education. The MMSE performance level in the group of illiterate persons dropped as age increased, whereas the population with 1 year of schooling or more did not show significant changes associated with age.

With a cutoff point of 23/24, the sensitivity and specificity were acceptable (80% and 77.5%, respectively), provided that the schooling factor was not included. However, when the sample was broken down into various schooling levels, a marked decline in the specificity among persons with no schooling or 1 to 4 years of schooling was noted (50%). Although the ad-

justment of the cutoff point for the population with 0 to 4 years of schooling in terms of average performance (17 for the illiterate and 20 for those with 1 to 4 years of schooling) produced a significant increase in specificity (adequate discrimination of individuals without pathology), sensitivity declined significantly (detection of individuals with cognitive deterioration). Thus, we conclude that varying the cutoff point is not sufficient to obtain adequate sensitivity and specificity indexes because one is favored to the detriment of the other.

Recently, Crum et al. (1993) reported the distribution of MMSE scores by age and education in a population of 18,056 individuals in five U.S. cities (New Haven, CT; Baltimore; St. Louis, MO; Durham, NC; and Los Angeles). The MMSE scores were related to age and schooling level. They found an inverse relation between MMSE scores and age, with a mean of 29 for those 18 to 24 years of age and 25 for individuals 80 years of age. The mean was 29 for individuals with more than 9 years of schooling, 26 for those with 5 to 8 years of schooling, and 22 for those with 0 to 4 years of schooling. In the Crum et al. study, two changes were made to the original version. Instead of asking the participants about the country they were in, they asked for the names of two major thoroughfares nearby. To obtain total scores, they used the highest score in the answers to successive subtraction items (100 – 7) or the reversed spelling of *world*. Using the score on these items can affect the total grade because each item contributes 5 points to the final score. Alterations of this kind may mean that the results are not comparable with other studies, although these results roughly support our findings.

Our findings coincide with other studies (Bertolucci et al.,1994; Bird et al., 1987; Escobar et al., 1986) that have also reported that the MMSE score is sensitive to the participant's schooling level and cultural background. As in our study, the items that were most sensitive to educational level were those that involve reading, writing, and calculation, whereas cultural factors affect the answers referring to seasons of the year and the concept of the state. The concepts of *state* may be confusing for someone who is not used to this term.

The specificity of the test was particularly low among participants with a low schooling level (0–4 years) when compared to those with 5 to 9 years of schooling (50% vs. 86%). This finding has significant implications for both research and clinical practice. Epidemiological studies that only include the MMSE as a rating instrument will classify normal participants with low schooling as pathological individuals. Like other screening scales, the MMSE may be useful in monitoring changes associated with pharmacological treatment or other types of intervention but not for diagnosis purposes. In clinical practice, it is necessary to use instruments that permit early detection of cognitive alternations in the diagnosis of dementia symptoms. This detection becomes especially relevant in the cases of treatable or partially treatable dementia, which require an early diagnosis (Ostrosky-Solís et al., 1996).

Another criticism of screening instruments like the MMSE is the high percentage of false negatives, for example, the lack of sensitivity to slight cognitive disorders (Nelson, Fooel, & Faust, 1986). This problem is particularly apparent in patients with high levels of premorbid intelligence. In our sample, the ability to detect participants with a dementia diagnosis with 10 or more years of schooling was 71.43%.

In conclusion, the MMSE may be helpful for confirming the presence of severe cognitive alterations in participants with more than 5 years of schooling, but it should not be considered for the detection of slight cognitive deterioration.

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Original submission May 28, 1999
Accepted September 8, 1999

Appendix:
Examen Mental Breve (MMSE)

ORIENTACION

1. Punto para cada una de las respuestas correctas.
¿Qué hora es?. . . . . ( )
¿Qué fecha es hoy? . . . . . ( )
¿Qué día de la semana es hoy? . . . . . ( )
¿Qué mes? . . . . . ( )
¿Qué año? . . . . . ( )
Total 5 puntos ( )
¿Cómo se llama este lugar? . . . . . ( )
¿En qué rumbo de la ciudad, colonia está? . . . . ( )
¿Ciudad? . . . . . ( )
¿País?. . . . . ( )
¿Norte, sur, poniente, etc? . . . . . ( )
Total 5 puntos ( )

REGISTRO

Repita el nombre de los 3 objetos que voy a decir, puntúe 2 ó 1 si éste es el número correcto que ha repetido el paciente. Insista hasta que el paciente logre repetir los 3 nombres ya que se valorará la EVOCACIÓN. Lápiz. Llave. Libro.

Total 3 puntos ( )

ATENCIÓN Y CÁLCULO

Pida al paciente que sustraiga 7 de 100 cinco veces, puntuando una correcta por cada ocasión bien realizada.

Total 5 puntos ( )

EVOCACIÓN

Pida al paciente que repita las 3 palabras que se le dijo. 1 punto por cada palabra correcta.

Total 3 puntos ( )

LENGUAJE

1 puntos por cada objeto bien nombrado: (reloj, lápiz).

Total 2 puntos ( )

1 punto si la siguiente oración es repetida correctamente.

"NO IRÉ, SI TU NO LLEGAS TEMPRANO"

Total 1 punto ( )

1 punto por las 3 órdenes bien ejecutadas

"Con el dedo derecho, toque la punta de su nariz y luego su oído izquierdo o tome este pedazo de papel con su mano derecha, dóblelo y tírelo al suelo"

Total 3 puntos ( )

LECTURA

1 punto por obedecer la orden escrita: "CIERRE SUS OJOS"

Total 1 punto ( )

ESCRITURA

1 punto por escribir una oración que incluya verbo y sujeto y tenga sentido.

Total 1 punto ( )

DIBUJO

1 punto por la copia de 2 pentágonos (2 cm cada lado) interceptados.

Total 1 punto ( )

PUNTUACIÓN OBTENIDA _____