

THE MINI-MENTAL STATE EXAMINATION (Marshal Folstein, 1975)

Purpose

The Mini-Mental State Examination (MMSE) was designed to give a practical clinical assessment of change in cognitive status in geriatric inpatients (1). It covers the person's orientation to time and place, recall ability, short-term memory, and arithmetic ability. It may be used as a screening test for cognitive loss or as a brief bedside cognitive assessment. It cannot be used to diagnose dementia (2).

Conceptual Basis

Evaluating the mental state of elderly psychiatric patients with formal psychological tests has become a routine part of the clinical examination. The tests are often too lengthy for elderly subjects and are based on theories rather than on the types of cognitive impairment that lead to practical difficulties in daily living (2; 3). Folstein designed the MMSE as a clinical aid in the cognitive assessment of elderly patients. It had to be practical: brief enough for routine use and easy to remember; "Of the many possible items I selected those which I could remember and apply without any additional equipment at the bedside. This feature it turns out, made it useful for field studies as well." (1, p290). Folstein included orientation ("a traditional but poorly defined domain"), registration and recall as being "the essential screener items." Language comprehension and expression were included as being relevant in diagnosis and patient management, including explaining the patient's situation to families (1).

Description

Except for the language and motor skills items, the content of the MMSE was derived from existing instruments (3). The MMSE was termed "mini" because it concentrates only on the cognitive aspects of mental function, and excludes mood and abnormal mental functions that are covered, for example, in Blessed's Dementia Scale. It is administered by clinical or lay personnel after brief training and requires 5-10 minutes for completion.

The MMSE includes 11 items, divided into two sections; the first requires verbal responses to orientation, memory, and attention questions. The second section requires reading and writing and covers ability to name, follow verbal and written commands, write a sentence, and copy a polygon (2) (see Exhibit 8.8). All questions are asked in the order listed and can be scored immediately by summing the points assigned to each successfully completed task; the maximum score is 30. Details of scoring have occasioned considerable discussion. For example, it was originally proposed that counting backwards by sevens could be replaced by spelling "world" backwards. Folstein has clarified that he uses the serial sevens if at all possible; it is more difficult than the spelling alternative (1, p291). The practical issues in scoring "world" backwards are considerable, as described in our review of the Modified Mini-Mental State Exam (3MS). The challenge of scoring the overlapping pentagon diagram has even been addressed by computer digitizing and analysis (4). Treating questions not answered as errors is recommended (5). The issue of how to handle non-responses due to illiteracy or blindness has been handled either by treating these as errors or by prorating the overall score, deleting such items from the numerator and denominator. Folstein has commented that he administers the items without

regard to the reason for failure (deafness, etc.), and then, after scoring, comments on possible reasons for failure. “A basic rule of clinical medicine is to collect the facts or observations before making interpretations” (1).

The cutting point most commonly used to indicate cognitive impairment deserving further investigation is 23/24. Some authors recommend 24/25 to enhance sensitivity for mild dementia (6). The cutting point is commonly modulated according to educational level because a single cutting point may miss cases among more educated people and generate false positives among those with less education. Murden et al., for example, suggested that 23/24 was optimal for people with ninth grade or higher education while 17/18 was optimal for those with less education (7, Table 4). Uhlmann and Larson refined this by proposing 20/21 for those with 8 or 9 years of schooling, 22/23 for those with 10 to 12 years of schooling and 23/24 for those with further education (8). A Finnish study also proposed a sloping cutting point across age-groups (9). However, see the commentary for a further discussion on this issue.

Exhibit 8.8 The Mini-Mental State Examination

			Points
Orientation			
1.	What is the	Year?	1
		Season?	1
		Date?	1
		Day?	1
		Month?	1
2.	Where are we?	State?	1
		County?	1
		Town or city?	1
		Hospital?	1
		Floor?	1
Registration			
3.	Name three objects, taking one second to say each. Then ask the patient all three after you have said them. Give one point for each correct answer. Repeat the answers until the patient learns all three.		3
Attention and calculation			
4.	Serial sevens (count backwards from 100 by sevens). Give one point for each correct answer. Stop after five answers. <i>Alternatively:</i> Spell WORLD backwards.		5
Recall			
5.	Ask for names of three objects learned in Question 3. Give one point for each correct answer.		3

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Language

6. Point to a pencil and watch. Have the patient name them as you point. 2
7. Have the patient repeat "No ifs, ands, or buts." 1
8. Have the patient follow a three-stage command: "Take the paper in your right hand. Fold the paper in half. Put the paper on the floor." 3
9. Have the patient read and obey the following: "CLOSE YOUR EYES."
(Write it in large letters) 1
10. Have the patient write a sentence of his or her own choice. (The sentence should contain a subject and an object and should make sense. Ignore spelling errors when scoring.) 1
11. Enlarge the design printed below to 3-5 cm per side and have the patient copy it. (Give one point if all sides and angles are preserved and if the intersecting sides form a quadrilateral.) 1

Editor:

Note that there is a little diagram to include here:
the two overlapping pentangles (camera-ready)
The diagram is same as 2nd edition, page 316

= Total 30

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Reliability

Foreman reported an internal consistency alpha of 0.96 in a sample of 66 elderly hospitalized patients (10, p218). Kay et al. reported an alpha of 0.68 (6, p774).

Test-retest reliability has been examined in many studies; in a review of his own studies, Folstein reported that for samples of psychiatric and neurologic patients, the test-retest reliability "has not fallen below 0.89; inter-rater reliability has not fallen below 0.82" (11, p47). Results from other studies are summarized in Table 8.3, and more are cited in the review by Tombaugh and McIntyre (12, Table 1). With the exception of the study by Uhlmann, reliability declines as the time lapse increases. Thal's study compared the reliabilities of the Blessed IMC test and the MMSE, showing that at all testing intervals the results for the Blessed test (average 0.86) were slightly higher than those for the MMSE (average 0.80) (13, Table 2).

Inter-rater reliability has also been widely studied. Molloy et al. reported inter-rater reliability of 0.69 and 0.78 (14, Table 1). In a sample of 15 neurological inpatients, inter-rater reliability gave a Pearson correlation of 0.95 and a Kendall coefficient of 0.63 (15, p497). In a study by O'Connor et al., five coders rated taped interviews with 54 general practice patients. Kappas for individual items ranged from 0.88 to 1.00 with a mean kappa of 0.97 (16, p90). A comparison between self-administration and administration by a nurse (after a median delay of 49 days) gave an ICC of 0.78 (17, Table 2).

Table 8.3 Test-Retest Reliability for Mini-Mental State Examination

Study	Time lapse	Statistic *	Reliability
Anthony et al. (18)	24 hours	<i>r</i>	0.85 - 0.90
Folstein et al. (2)	24 hours	<i>r</i>	0.89
Dick et al. (15)	24 hours	<i>r</i>	0.92
Molloy et al. (14)	2 weeks	ICC	0.69
Fillenbaum et al. (19)	1 month	<i>r</i>	0.89
Thal et al. (13)	6 weeks	<i>r</i>	0.80
Mitrushina et al. (20)	1 year	<i>r</i>	0.45
Mitrushina (20)	2 years	<i>r</i>	0.38
Uhlmann et al. (21)	16 months	<i>r</i>	0.86

* *r* = Pearson correlation, ICC = intraclass correlation

Validity

In terms of content validity, the MMSE measures eight of the 11 main aspects of cognitive status; it omits abstraction, judgment and appearance (10). Although factor analyses have used different types of sample and differing versions of the MMSE, they commonly identify factors relating to orientation, memory and attention. A study by Jones and Gallo (22) came close to replicating the original structure of the MMSE, identifying five factors that have been further replicated subsequently (23). The five

factors are: orientation, attention and verbal recall (which can be subsumed under a higher-order factor of executive functioning), and comprehension and naming (subsumed under language-praxis) (23, Table 3).

Group Differences. Folstein compared the mean MMSE scores for different groups of patients, obtaining 9.7 for patients with dementia, 19.0 for patients with depression and cognitive impairment, 25.1 for those with uncomplicated affective disorder or depression, and 27.6 for normals (2, p192). There was little variation in scores by age. Folstein also presented results indicating sensitivity to treatment (2, pp193-194).

Jorm reported an effect size of 1.53 for the MMSE when used as a screening test, based on eight studies (24, p159). Christensen et al. reported a higher effect size value of 2.91 for the MMSE, but this analysis was based on studies with well-defined diagnostic groups, making discrimination between them easier (25). In longitudinal studies there is a slow and steady decline in scores, but there can be wide variation between patients in the annual change in scores. This may mean that individual change scores based on a small number of observations (e.g., annual exams for people followed for less than three years) cannot be reliably interpreted (26).

MMSE scores varied by age, education and sex in a Canadian study, and there were also interaction effects of age and education (27, Table 2).

Concurrent Validity. Tierney et al. obtained convergent correlations between 0.5 and 0.6 between MMSE sub-scores and corresponding neuropsychological tests. Discriminant correlations, however, were also high, suggesting that the components of the MMSE lack specificity (28, p715). On small samples of elderly patients, the MMSE correlated 0.78 with the WAIS Verbal IQ scale and 0.66 with the WAIS Performance scale (29, p509). In 90 psychiatric inpatients, the MMSE had Spearman correlations of 0.41 with WAIS Verbal IQ and of 0.42 with Performance IQ (30, p129). Similar values were reported by Jorm in a community sample (31, Table 1). It correlated 0.83 with the WAIS-Revised version scores on a sample of 105 Alzheimer's disease patients (29, p510). Jorm reported correlations with CT brain scan results; MMSE scores correlated 0.23 with brain diameter (perhaps reflecting pre-morbid intelligence), -0.07 with the width of the third ventricle (correlation not significant). Correlations were -0.22 with the number of infarcts in the left hemisphere and -0.13 (n.s.) with infarcts in the right hemisphere; there was no association with markers of atrophy (31, Table 4).

In a small sample of 40 subjects, the MMSE and Reisberg's Global Deterioration Scale scores correlated -0.92 (32, Table 7). Correlations with Blessed's Dementia Rating Scale include 0.67 to 0.79 (21, Table 3). A correlation of 0.87 was reported with a separate Dementia Rating Scale developed by Lawson (10, Table 3). The MMSE showed modest correlations (ranging from 0.24 to 0.39) with verbal tests (20, Table 2). Correlations with other cognitive screening tests are higher: the MMSE scores correlated -0.88 with the Blessed Information-Memory-Concentration test and 0.82 with the Dementia Rating Scale (33, Table 2). Correlations with the Orientation-Memory-Concentration test include -0.77 (34, p71) and -0.83 (19, p925). Correcting the latter figure for unreliability of both tests gives an estimated correlation of -0.93 (19, p926). Tombaugh and McIntyre conclude that correlations with the Blessed test range from -0.66 to -0.93 (12, p927). Several studies have compared MMSE scores with the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE). Coefficients range from -0.37 to -0.78, with a mean of -0.59 (35, p58). The results appear to vary according to the balance between cognitively normal and impaired people in the samples.

Predictive Validity. Mitrushina and Satz reported that all five respondents whose score decreased by more than seven points in three years were diagnosed with neurological deficits (20, p540). Faustman et al., however, found that the MMSE had limited utility in predicting the psychological functioning of 90 psychiatric inpatients (30).

The major focus in validating the MMSE has been on its sensitivity and specificity compared to

clinical diagnoses. Representative results are shown in Table 8.4. Note that for the majority of studies, the criterion was a clinical assessment using *DSM-III* diagnoses of dementia. Again, a fuller list of results is contained in the review by Tombaugh and McIntyre (12, Table 2). Very few studies have presented validity findings in the form of ROC analyses; an exception is that of Kay et al., who showed that the MMSE performed very well in identifying moderate and severe cases of dementia, but less well in identifying mild cases (6, p779). A Chilean study compared the MMSE and Pfeffer's Functional Activities Questionnaire. Sensitivity for the MMSE (at a cutting-point of 21/22) was 93.6%, but specificity was only 46%; figures for the FAQ were 89% and 71%. The combination of MMSE plus FAQ improved specificity: sensitivity was 94% and specificity rose to 83% (36, Table 3).

Several studies have commented on the effect of educational level on validity, but the crucial question concerns whether or not this indicates invalidity of the scale, as educational level is also related to risk of cognitive impairment among elderly people. Murden et al. found that education (but not race) was significantly related to MMSE scores. At a cut-point of 23/24, the MMSE had 93% sensitivity and 100% specificity in the high education group, and 98% sensitivity but only 75% specificity in the low education group. In the low-education group, using 17/18 as a cutoff resulted in a sensitivity of 81% and specificity of 100% (7, p152). Fillenbaum et al. showed that specificity was much lower in Blacks than in Whites, perhaps reflecting an education bias (37). A Spanish study likewise showed significant differences in validity across educational levels (38). However, by adjusting cutting points for different educational levels it may be possible to maintain validity. Uhlmann and Larson, for example, showed that if the MMSE cutting point was varied by educational level, the area under the ROC curve remained constant at 0.95 or 0.96 for all educational groups. At the optimal cutting points, sensitivity was comparable (82%, 79%, and 83%) in three educational groups. The corresponding specificity figures were 94%, 97%, and 100% (8, Table 1). Commenting on these findings, a study comparing identical and fraternal twins suggested that most of the association between MMSE scores and education may reflect genetically-mediated differences in cognitive capacity rather than educational biases in test-taking (39). A more sophisticated analysis of differential item functioning (DIF) by Jones and Gallo confirmed that there is some educational DIF in certain items (serial subtractions, spelling backwards, writing a sentence), but that less than 2% of the difference in cognitive function between high and low educational groups was due to this item bias (40, p554). Jones and Gallo concluded "Detected DIF is not sufficient to account for education group differences in overall level of estimated cognitive ability." (p555).

Table 8.4 Sensitivity and Specificity of the Mini-Mental State Examination in Detecting Dementia

Study	Sample	Cut-point	Sensitivity %	Specificity %
Anthony et al. (18)	97 hospital inpatients	23/24	87	82
Foreman (10)	66 hospital patients	23/24	82	80
Dick et al. (15)	143 neurological inpatients	23/24	76	96
van der Cammen et al. (41)	138 geriatric outpatients	24/25	88	82
Kafonek et al. (42)	70 chronic care patients	23/24	81	83
Kay et al. (6)	274 community residents	24/25	86	81
O'Connor et al. (16)	2,302 general practice patients	23/24	86	92
O'Connor et al. (16)	2,302 general practice patients	24/25	98	89
Weston (43)	98 general practice patients	23/24	83	100
Fillenbaum et al. (37)	164 community residents	23/24	100	78

Roth et al. (44)	92 hospital patients & community residents	23/24	94	85
Gagnon et al. (45)	2792 community residents	23/24	100	78

Alternative Forms

Teng and Chui's Modified Mini-Mental State Examination (3MS) is described in a separate entry in this chapter. Teng et al. have subsequently developed the Cognitive Abilities Screening Instrument (CASI), which is an extension to the 3MS (46). The modifications made by Roth et al. for the Cambridge Mental Disorders of the Elderly Examination (CAMDEX) are described in our review of the CAMDEX.

There are several variations in question wording, administration, and scoring for the MMSE. As the instrument was developed for hospital patients, the original orientation questions referred to the name and floor of the hospital. These are altered for community residents. The choice of words for the recall question was originally left up to the examiner, but subsequently "apple," "penny," and "table" have been used, or else "shirt," "brown," and "honesty" (12, pp922-923). Finally, the MMSE included spelling the word "World" backwards as an alternative to counting down by sevens, a move that gave rise to one of those occasionally fascinating backwaters of academic investigation: whole articles have addressed the choice. The intention had been to accept whichever alternative proved easiest for the respondent, but it turns out that subtracting sevens is the more difficult task (47; 48), although perhaps not equally so for males and females (4), and maybe not equally so across cultures. In Spanish, for example, counting and spelling backwards is not as familiar a children's game as it is in English-speaking cultures, so World backwards seems to achieve less good results in Spanish versions (49; 50, Figure 1). The issue has been formally addressed in Spanish versions using differential item functioning analyses (51). There is also debate over how the World backwards item should be scored (this is not as simple as may first appear) (52-54). As the MMSE is not sensitive to mild impairment, it may be advantageous to use the more difficult item; however, some studies select the higher-scoring response (55, p79). Other applications have used both items on the basis that the combination appears to predict the overall MMSE score better than either item alone, giving a 12-item test and a maximum score of 35 points (6).

Reacting to the uncertainty, Molloy et al. proposed a Standardized Mini-Mental State Examination, with expanded guidelines for administration and scoring, and time limits. They report that the Standardized MMSE was easier to administer, and intraclass inter-rater reliability improved from 0.69 for the MMSE to 0.92 for the standardized version (14, Table 1).

Various authors have taken scissors to the MMSE. A four-item abbreviation included orientation to time, orientation to place, recall, and spelling WORLD backwards; this version had a sensitivity of 98% and a specificity of 87% compared to the overall MMSE (56). In a replication study, the four items had a sensitivity of 95.5% and a specificity of 90.5% (57). A five-item abbreviation included the items on orientation to day, month and year, WORLD backwards and recall; adding the patient's age in a discriminant function equation yielded a sensitivity of 95.8% at a specificity of 83.2% (58). A seven-item version used a scoring system based on regression weights and showed a sensitivity of 100% and specificity ranging from 93% to 100% in different age and educational groups compared to the complete MMSE (59). A 12-item abbreviation had a sensitivity of 98% and specificity of 91% compared to the full scale (60). The impression is that the four-item abbreviation has the virtue of brevity and simplicity of scoring, and shows good results. Tierney et al. found that an abbreviated version that was supplemented by ratings made by an informant provided higher sensitivity and specificity than the overall MMSE (61).

Uhlmann et al. tested a written version among people with mild to moderate hearing loss. They found

that verbal administration did not bias scores for people with mild or moderate hearing impairments; it also provided preliminary evidence that the written and standard MMSE are comparable (62).

A telephone-administered version is called the Telephone Interview for Cognitive Status (TICS) (63). A comparison of telephone administration versus face-to-face gave a correlation of 0.85 (64, Figure 1) or 0.81 (65).

There are innumerable translations of the MMSE, some including abbreviated versions. Translations include French (45), Dutch (41), Spanish (49; 66-68), Italian (69), Swedish (70), Chinese (71-73), Finnish (9; 72), Korean (74), and Icelandic (4). The Chinese version showed a sensitivity of 77% and specificity of 70%, but varying the cutting points for different educational groups improved validity (71, Table 5). A Brazilian version showed a sensitivity of 84% at a specificity of 60% using the 23/24 cut-point (75). A Spanish adaptation called the Mini Examen Cognitivo (MEC) had a sensitivity of 93.5% and a specificity of 82% (68, p167).

Several issues have been noted in developing cross-culturally equivalent versions of the MMSE. Certain items appear to show particular variability across ethnic groups and should be modified (66). A trivial example is the orientation item "What county are we in?" which differs from country to country: a county in Britain is a very much more significant political entity than in the United States. The MMSE was modified for use in a West African setting; questions such as "How long does it take maize to ripen?" certainly seem to reverse the normal trend of questions being simpler for educated white people to answer! (76; 77)

Reference Standards

Folstein et al. presented scores from a population sample in Baltimore; 4.2% of those aged 18-64 scored 23 or less compared to 20.8% of those over 65 (3, Table 1). Crum et al. present norms based on a total of 18,056 participants in U.S. community surveys; mean and median scores, and percentile distributions are given by age and educational levels (78). Bleecker et al. presented median and quartile scores by age for a small sample of healthy people (79). Heeran et al. presented norms from 532 healthy respondents over the age of 85; they suggested that in this age group, scores below 25 warrant further testing (80, p1096). Holzer et al. provided norms for each item on the MMSE by age group (81, Table 3), and for the total scores by age, sex, and education (81, Tables 7 and 8). Brayne and Calloway provided some norms for British samples by age and socioeconomic status (82). Reference standards by age-group and educational level have been derived from a non-demented Canadian population (27, Table 3; 83, Table 3).

Commentary

In a testimonial to the MMSE, Carol Brayne wrote "At the time it was published the authors cannot have conceived how widespread its use would become, indicated by the speed with which large numbers of papers incorporating it were published . . . I think it can be seen that the MMSE has been unexpectedly and wildly successful, whatever the reservations." (84, pp286, 288). The MMSE is brief enough for routine clinical use, and can be administered in survey settings by non-professionals (85). Validity results appear as good as, or slightly better than, those of other scales. Essentially, it is an aid to the clinician and too much should not be expected of it; diagnosis requires a full mental status examination, history, and physical examination. In his 1998 retrospective, Folstein wrote ". . . the MMS is now 22 years old and can speak for itself. It travels around the world, never sends home any money, never wins prizes and depends on me to answer the mail and the phone and to speak to its friends." (1, p290).

Because of its centrality in the literature, the MMSE has been closely examined. It is a brief and practical scale, so cannot be expected to perform perfectly in every situation. Various limitations have been identified. It may miss impairments resulting from right hemisphere lesions and may miss mild

impairments (86). It has both floor and ceiling effects. Instructions for administration and scoring lacked detail. Many authors have reported that people with low education tend to give false positive responses (12, p928). The major issue concerns whether this should be viewed as a bias in the test or as a risk factor. Kittner et al. provided a general discussion of adjusting cutting scores to remove the effect of education (87), while Berkman raised the challenge that, if low education is of etiological significance in dementia, then one should *not* adjust scores for educational attainment for fear of over-adjusting (88). Both factors may be at work. As Tombaugh and McIntyre noted, "the prevalent view is that education introduces a psychometric bias leading to a misclassification of individuals from different educational backgrounds, and this bias should be corrected by employing norms stratified for education" (12, p928). Empirical studies that have compared age- and education-adjusted scores to unadjusted scores have not shown an advantage in terms of validity to the adjustment (89; 90). Most norms are presented by educational level. Anthony et al. investigated an alternative approach, attempting to remove (rather than compensate for) the bias by deleting items that caused the false positive responses. Unfortunately, each approach that improved specificity did so at the expense of sensitivity, and so no simple modification significantly improved the performance of the MMSE with less educated persons (18, pp405-406). This was consonant with Katzman's results in the Chinese study.

The MMSE may not discriminate between moderate and severe cases of Alzheimer's disease but, more important in a screening instrument, several studies (6; 43; 85) suggest that the MMSE may miss many mild cases of dementia. This may be especially true among psychiatric patients (30). Schwamm also found that mild and moderate impairments are missed by the MMSE, as they are by most other cognitive screening instruments (91; 92). He and others propose that this is because the MMSE involves relatively simple tasks, has a limited number of test items within each cognitive domain, and combines results of performance in different domains into one overall score (85; 91; 92). Fillenbaum reminded us that extreme caution should be used when applying most instruments, including the MMSE, to minority groups, or groups with low education (37).

Perhaps reflecting its wide use and its apparent potential, various improvements have been proposed for the MMSE; these include altered cutting points by age and education, differential weighting of items, altering the content of the MMSE, and supplementing it with other tests. The first approach does not work well, for it usually trades gains in sensitivity for losses in specificity. The differential weighting has shown greater promise; for example, the scores assigned to each item appear somewhat arbitrary and not based on evidence of their relative contributions in detecting dementia. Kay et al. showed that, when item scores were standardized, alpha internal consistency rose from 0.68 to 0.80 (6, p774). Magaziner et al. showed that regression analyses could be used to re-weight the individual items and thereby reduce the number of items required to achieve equally good discrimination (59). Extending the MMSE was tested by the 3MS approach which appears to improve validity compared to the original; supplementing the MMSE with other tests to enhance its sensitivity to mild dementia remains a common recommendation, although there is little consensus over what the supplement should be.

The MMSE forms the leading screening instrument in North America but is somewhat less popular in Europe. While it has known weaknesses, it has the great virtue of being well understood. The diversity of efforts to improve it illustrate the difficulty of developing the ideal dementia screening instrument.

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