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# The Mini-Mental State Examination: A Comprehensive Review

*Tom N. Tombaugh, PhD, CPsych and Nancy J. McIntyre, MA*

**Objective:** The purpose of this paper is to provide a comprehensive review of information accumulated over the past 26 years regarding the psychometric properties and utility of the Mini-Mental State Examination (MMSE).

**Participants:** The reviewed studies assessed a wide variety of subjects, ranging from cognitively intact community residents to those with severe cognitive impairment associated with various types of dementing illnesses.

**Main Outcome Measures:** The validity of the MMSE was compared against a variety of gold standards, including DSM-III-R and NINCDS-ADRDA criteria, clinical diagnoses, Activities of Daily Living measures, and other tests that putatively identify and measure cognitive impairment.

**Results:** Reliability and construct validity were judged to be satisfactory. Measures of criterion validity showed high levels of sensitivity for moderate-to-severe cognitive impairment and lower levels for mild degrees of impairment. Content analyses revealed the MMSE was highly verbal, and not all items were equally sensitive to cognitive impairment. Items measuring language were judged to be relatively easy and lacked utility for identifying mild language deficits. Overall, MMSE scores were affected by age, education, and cultural background, but not gender.

**Conclusions:** In general, the MMSE fulfilled its original goal of providing a brief screening test that quantitatively assesses the severity of cognitive impairment and documents cognitive changes occurring over time. The MMSE should not, by itself, be used as a diagnostic tool to identify dementia. Suggestions for the clinical use of the MMSE are made. **J Am Geriatr Soc 40:922–935, 1992**

The use of screening tests to provide brief, objective measures of cognitive functioning has increased dramatically over the last 10 years. Although a substantial number of screening tests exist, the Mini-Mental State Examination (MMSE)[1] is the most widely used. It is a popular clinical measure that is available in many languages.[2–9] The MMSE is also widely used in epidemiological studies and community surveys. It forms part of the Diagnostic Interview Schedule (DIS),[10] a structured interview recently used in a large five-site Epidemiologic Catchment Area (ECA) study sponsored by the National Institute of Mental Health,[11] and has been incorporated into several standardized interviews designed to assess cognitive impairment and to help diagnose dementia.[12, 13, 14] Moreover, the MMSE serves as one of the tests recommended by the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA)[15] to document the clinical diagnosis of probable Alzheimer's disease. The aim of this paper is to review information accumulated over the past 26 years regarding the psychometric properties and utility of the English version of the MMSE.

## DESCRIPTION OF THE MMSE

Folstein, Folstein, and McHugh[1] originally created the MMSE to differentiate organic from functional psychiatric patients. They stated explicitly that MMSE scores were "useful in quantitatively estimating the severity of cognitive impairment" and "in serially documenting cognitive change." The MMSE was not, on its own, intended to provide a diagnosis for any particular nosological entity.

The MMSE consists of a variety of questions (see Appendix), has a maximum score of 30 points, and ordinarily can be administered in 5–10 minutes. The questions typically have been grouped into seven categories, each rationally representing a different cognitive domain or function: Orientation to time (5 points); Orientation to place (5 points); Registration of three words (3 points); Attention and Calculation (5 points); Recall of three words (3 points); Language (8 points) and Visual Construction (1 point). Originally, however, all of the orientation questions were combined into a single orientation category, and the visual construction task was classified as one of the language items.

### Variations

Variations in the wording and content of some questions, as well as in the administration and scoring of the MMSE, commonly occur. Some of these variations are described below.

**Orientation to Place** Since the MMSE was developed to test hospital patients, the orientation questions require the respondent to specify the name and floor of their hospital. However, alternative items frequently are used when the MMSE is administered outside the hospital, particularly in community surveys and epidemiological studies.[16–18]

**Registration and Recall of Three Words** The choice of words used to test a person's ability to learn and retain three words was left originally to the discretion of the examiner. When the MMSE was incorporated into the DIS, the words apple, penny, and table

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were employed, a convention adopted by most subsequent studies. Exceptions to this practice, however, have included words such as shirt, brown, honesty, flag, ball, tree, rose, ring, elephant, and dog.[19-23]

**Attention and Calculation** Folstein et al[1] routinely administered the serial 7s task on every test. However, patients were permitted to spell the word WORLD backward if they could not or would not perform the serial 7s task. While using WORLD as an alternative task has been followed in many studies, several other procedures have been adopted. Some applications, including CERAD,[13] use only WORLD[23-26] while others, including CAMDEX,[12] use only the serial 7s task.[12, 20, 27, 28] Others routinely include both tasks, which are scored in one of the following ways: (1) the higher of the two scores is used [2, 16, 19, 21, 29-33]; (2) the two scores are combined[21, 30, 34, 35] or (3) each task is analyzed separately.[16, 22, 36, 37] Variations also exist in how WORLD is scored.[1, 13, 23, 36, 38]

### General Scoring Procedures and Cut-off Scores

Ordinarily, the MMSE score is the total number of correct answers. Although, this may not be appropriate when individuals refuse to answer many questions, Fillenbaum et al.[39] concluded that, at least in epidemiological surveys, a refusal most likely represents an inability to correctly answer the question.

A score of 23 or less generally has been accepted as indicating the presence of cognitive impairment. This cut-off score evolved from research findings rather than being recommended in the original article. Its high degree of acceptance is illustrated by the fact that several community surveys have employed the cut-off score, even though modified forms of the MMSE were used.[18, 31, 32, 34] More recently, largely due to the ECA study,[40] the trend has been to classify the severity of cognitive impairment into three, rather than two, levels: 24–30 = no cognitive impairment; 18–23 = mild cognitive impairment; and 0–17 = severe cognitive impairment. MMSE scores are also frequently used to classify dementia patients as mild, moderate, or severe, a practice supported by evidence from longitudinal studies (reviewed in the current paper) and dementia rating scales.[41-43]

## RELIABILITY

**Internal Consistency** Four studies that provide data on internal consistency (ie, item homogeneity) are shown in Table 1. The highest alpha level (.96) was obtained with a mixed group of medical patients, while more modest levels (.68 and .77) were reported with community samples. Jorm et al[30] reported an association between alpha levels and years of education: the alpha level for a community sample with only a primary education (.65) was higher than for a sample with 8 or more years of education (.54). Holzer et al[16] discuss two factors that may influence alpha levels. First, in community surveys, individuals correctly answered most of the questions, thereby reducing the range of scores and decreasing the likelihood of obtaining high alpha coefficients. Higher alphas should be obtained in clinical populations in which greater variability exists, a prediction substantiated by the .96 alpha obtained with a mixed sample of hospital patients.[44] Second, since the MMSE attempted to measure a variety of cognitive processes, item heterogeneity was intentionally created. Thus, in this case, lower alpha levels may be viewed as desirable.

**Test-Retest Reliability** In order to reduce the influence that illness-induced changes might exert on reliability estimates, reliability coefficients only are reported from studies where the test-retest interval was 2 months or less. The results from these studies (Table 1) show that reliability coefficients for both cognitively intact and impaired subjects generally fell between .80 and .95. These reliability estimates are consistent with those reported by Lesher and Whelihan[53] for other brief cognitive screening tests. The unusually low coefficient of .56 for delirium patients[45] probably reflects the fluctuating course of this illness. The .38 reliability coefficient for the control subjects in the Morris et al.[50] study probably reflects the truncated distribution of scores (ie, mean MMSE = 28.9) that statistically restricts correlation coefficients.[54] Several studies reported increased scores on retest, presumably due to practice effects.[1, 29, 32, 46, 48] Moreover, evidence exists suggesting that some patients "study" for mental status tests by rehearsing answers given on a previous administration of the MMSE.[55] The site of testing can also influence retest scores.[37] For example, two studies reported that patients tested at home achieved significantly higher scores than when they were tested in a clinic.[56, 57]

The results with short test-retest intervals are compared to those obtained in six studies that used extended test-retest intervals (eg, 1 to 2 years) with subjects judged to be cognitively intact.[33, 50, 58-61] These results show that the amount of change was relatively small (usually within two points) and not statistically significant. However, in the only two studies reporting reliability estimates,[33, 60] correlation coefficients were less than .50, a value substantially less than those reported previously for studies using short test-retest intervals. Olin and Zelinski[33] attribute the decreased reliability to several psychometric problems, including regression to the mean, method for assessing attention/concentration, and lack of explicit scoring criteria for the pentagon. The finding reported by O'Connor et al[32] that the second lowest kappa value for interrater reliability occurred for the pentagon item further suggests that the lack of scoring criteria may affect the stability scores. Regardless of their cause, the relatively low reliability coefficients that occurred for "normal" subjects have important implications for using the MMSE with longitudinal assessment, suggesting that small changes in scores should be interpreted with caution.

## VALIDITY

**Sensitivity and Specificity** One way to assess the validity of the MMSE is to determine how well it correctly identifies normal and impaired individuals. The sensitivity of the MMSE refers to its ability to correctly identify those individuals who have been classified as cognitively impaired according to some

TABLE 1. INTERNAL RELIABILITY AND TEST-RETEST RELIABILITY OF THE MMSE

| Measure | Sample | *n* | Age* | Test/Retest Interval | Correlations** |
|---|---|---|---|---|---|
| Internal Consistency | | | | | |
| Holzer et al[16] | Community survey | 4917 | 18–85+ | | .77 |
| Kay et al[34]*** | Community survey | 274 | 70–80+ | | .68 |
| Foreman[44] | Medical patients (normal, dementia, & delirium) | 66 | 76 | | .96 |
| Jorm et al[30] | Community survey | 269 | 70+ | | .65 (grades 0–8)<br>.54 (> grade 8) |
| Test-Retest | | | | | |
| Folstein et al[1] | Medical patients | | | | |
| | 1. Depression | 22 | 41 | 1 day (same tester) | .89 |
| | 2. Depression | 19 | 46 | 1 day (different tester) | .83 |
| | 3. Dementia, depression & schizophrenia | 23 | 74 | 28 days (unspecified) | .99 |
| Anthony et al[45] | Medical patients | | | | |
| | 1. Cognitively intact | 58 | 20–80+ | 1 day | .85 |
| | 2. Dementia | 12 | | | .90 |
| | 3. Delirium | 7 | | | .56 |
| Pfeffer et al[46] | Mixed sample of dementia/delirium & cognitively intact | 23 | 58–86 | 4 days median interval | .94 |
| Dick et al[47] | Neurological patients | 15 | 50 | 1 day (different tester) | .95 |
| | | 44 | | 1–70 days (same tester) ($M = 31$) | .92 |
| Thal et al[48] | Probable AD | 40 | 50–90 | 1 week | .84 |
| | | | | 3 weeks | .79 |
| | | | | 6 weeks | .80 |
| Bird et al[2] | Community survey | 189 | 44 | same day | .90 |
| Fillenbaum et al[39] | Probable AD | 24 | 54–75 | 1 month | .89 |
| O'Connor et al[32] | Cognitively intact | 285 | 75+ | 2 months | .64 |
| | Dementia | 196 | 75+ | | .83 |
| Kafonek et al[49] | Dementia, delirium, & depression | 29 | 65+ | 1 week (different tester) | .84 |
| Morris et al[50] | Control | 278 | 68 | 1 month | .38 |
| | Mild AD | 200 | 72 | 1 month | .74 |
| | Moderate AD | 132 | 72 | 1 month | .79 |
| Teng et al[51] | Cognitively intact | 27 | | 64 days | .79 |
| van Belle et al[52] | AD | 8 | 60+ | 1–2 weeks | .94 |
| | AD | 30 | 60+ | 3–4 weeks | .85 |
| Zaudig et al[14] | Cognitively intact | 66 | 77 | 24–72 hours ($M =$ 26 hours) | .97 |
| Jorm et al[29] | Mixed sample of dementia, depression & cognitively intact | 57 | 80 | 1–14 days ($M =$ 2.8 days) | .79 |

* *Single age score represents mean age. Pair of age scores represents range of ages.*
** *All correlations are significant, $P < 0.05$.*
*** *The Kay et al[4] and Jorm et al[3] analyses are based on data from the same study.*

generally accepted criteria or gold standard (eg, DSM-III, NINCDS-ADRDA, clinical judgment) (ie, true positives/total number of impaired cases). Specificity refers to the MMSE's ability to correctly identify those individuals who previously have been classified as cognitively intact (ie, true negatives/total number of cognitively intact cases). Sensitivity and specificity data can be used to derive a likelihood ratio [sensitivity/(1-specificity)] that may be helpful in interpreting a MMSE score for an individual from a particular population (eg, community, hospital), provided the prevalence of the cognitive impairment is known for the population. (For further information see Refs. 62 and 63).

It is also important to determine how well a positive or negative test result actually predicts the presence or absence of impairment. If someone obtains a MMSE score of 22, for instance, what is the probability that cognitive impairment actually exists? The predictive value of a positive test is the ratio of correctly identified positive cases to the total number of positive cases (ie, true positives/[true positives + false positives]), while the negative predictive value refers to the ratio of correctly identified negative cases to the total number of negative cases (true negatives/[true negatives + false negatives]).

Table 2 shows 25 experiments for which sensitivity

TABLE 2. CRITERION VALIDITY FOR MMSE USING 23/24 CUT-OFF SCORES

| Sample | Groups | *n* | Age* | Mean Score | Criteria | Results** |
|---|---|---|---|---|---|---|
| Dementia Subjects | | | | | | |
| Folstein et al[1] | 1. Cognitively intact | 63 | 74 | 28 | Psychiatric di- | Sensitivity = 100% |
| Exp 1 | 2. Dementia | 29 | 80 | 10 | agnosis | Specificity = 100% |
| | | | | | | Positive prediction = 100% |
| | | | | | | Negative prediction = 100% |
| Exp 2 | Dementia | 8 | 76 | 7 | Psychiatric di- agnosis | Sensitivity = 100% |
| Exp 3 | Dementia | 9 | 74 | 12 | Psychiatric di- agnosis | Sensitivity = 100% |
| Anthony et al[45] | 1. Cognitively intact | 74 | 20–89+ | 26 | DSM-III | Sensitivity = 87% |
| | 2. Dementia or de- lirium | 23 | 20–80+ | 15 | | Specificity = 82% |
| | | | | | | Positive prediction = 60% |
| | | | | | | Negative Prediction = 95% |
| Goldschmidt et al[64] | 1. Cognitively im- paired | 23 | 55 | 20 | Clinical assess- ment | Sensitivity = 100% |
| Folstein et al[18] | | | | | | |
| Comparison 1 | 1. Cognitively intact (no clinical diag- noses) | 106 | 65+ | | DSM-III | Sensitivity = 100% |
| | | | | | | Specificity = 62% |
| | | | | | | Positive prediction = 44% |
| | 2. Dementia | 32 | 65+ | | | Negative prediction = 100% |
| Comparison 2 | 1. Cognitively intact (clinical diag- noses | 90 | 65+ | | DSM-III | Sensitivity = 100% |
| | | | | | | Specificity = 46% |
| | | | | | | Positive prediction = 40% |
| | 2. Dementia | 32 | 65+ | | | Negative prediction = 100% |
| Kay et al[34] | | | | | | |
| Comparison 1 | 1. Cognitively intact | 235 | 70–80+ | | DSM-III | Sensitivity = 69% |
| | 2. Dementia (mild, moderate & se- vere) | 39 | 70–80+ | | | Specificity = 89% |
| Comparison 2 | 1. Cognitively intact | 235 | 70–80+ | | DSM-III | Sensitivity = 100% |
| | 2. Dementia (mod- erate & severe only) | 13 | 70–80+ | | | Specificity = 85% |
| Davous et al[65] | 1. Cognitively intact | 56 | 70*** | 27 | DSM-III | Sensitivity = 98% |
| Comparison 1 | (functional disor- ders & neurol- | | | | NINCDS- | Specificity = 100% |
| | | | | | ADRDA | Positive prediction = 100% |
| | ogy) | 44 | 74 | 15 | | Negative prediction = 95% |
| | 2. Dementia | | | | | |
| Comparison 2 | 1. Cognitively intact (psychiatric ill- | 33 | 57 | 26 | DSM-III | Sensitivity = 93% |
| | | | | | NINCDS- | Specificity = 82% |
| | ness) | | | | ADRDA | Positive prediction = 87% |
| | 2. Dementia | 44 | 74 | 15 | | Negative prediction = 90% |
| Fisk and Pannill[66] | 1. AD | 113 | 77 | 15 | DSM-III | Sensitivity = 89% |
| Foreman[44] | 1. Cognitively intact | 33 | 66–85 | | DSM-III | Sensitivity = 82% |
| | 2. Dementia or de- lirium | 33 | 66–85 | | | Specificity = 80% |
| | | | | | | Positive prediction = 80% |
| | | | | | | Negative prediction = 82% |
| Huff et al[67] | 1. Cognitively intact | 86 | 63 | 29 | NINCDS- | Sensitivity = 44% |
| | 2. AD | 79 | 67 | 22 | ADRDA | |
| Pfeffer et al[68] | 1. AD | 162 | 65+ | | DSM-III-R NINCDS- ADRDA | Sensitivity = 20% |
| Jackson and | 1. Cognitively intact | 38 | | 27 | Clinical assess- | Sensitivity = 85% |
| Ramsdell[69] | 2. Dementia | 294 | | 15 | ment | Specificity = 87% |
| | | | | | | Positive prediction = 98% |
| | | | | | | Negative prediction = 43% |
| Kafonek et al[49] | 1. Cognitively intact | 22 | 77 | | DSM-III | Sensitivity = 79% |
| | 2. Dementia or de- lirium | 47 | 77 | 14*** | | Specificity = 86% |
| | | | | | | Positive prediction = 92% |
| | | | | | | Negative prediction = 66% |
| O'Connor et al[32] | 1. Cognitively intact | 285 | 75+ | 20 | CAMDEX | Sensitivity = 86% |
| | 2. Dementia or de- lirium | 196 | 75+ | 13 | | Specificity = 92% |
| | | | | | | Positive prediction = 55 |

TABLE 2. CONTINUED

| Sample | Groups | *n* | Age* | Mean Score | Criteria | Results** |
|---|---|---|---|---|---|---|
| Knopman and Ryberg[70] | 1. Cognitively intact | 55 | 74 | 29 | NINCDS-ADRDA | Sensitivity = 54% |
| | 2. AD | 28 | 74 | 23 | | Specificity = 96% |
| | | | | | | Positive prediction = 88% |
| | | | | | | Negative prediction = 80% |
| Reed et al[71] | 1. AD | 21 | 70 | 20 | NINCDS-ADRDA | Sensitivity = 57% |
| Black et al[72] | | | | | | |
| Comparison 1 | 1. Cognitively intact | 80 | 70+ | | Clinical assessment plus AGECAT# | Sensitivity = 100% |
| | 2. Dementia (probable & definite) | 31 | 70+ | | | Specificity = 66% |
| Comparison 2 | 1. Cognitively intact | 80 | 70+ | | Clinical assessment | Sensitivity = 89% |
| | 2. Dementia (probable (definite & mild) | 47 | 70+ | | | Specificity = 70% |
| Galasko et al[21] | 1. Cognitively intact | 74 | 70 | 29 | NINCDS-ADRDA | Sensitivity = 68% |
| | 2. AD | 74 | 71 | 20*** | | Specificity = 100% |
| | | | | | | Positive prediction = 100 |
| | | | | | | Negative prediction = 76% |
| Jorm et al[29] | 1. Cognitively intact | 45 | 80 | | DSM III | Sensitivity = 76% |
| | 2. Dementia | 24 | 80 | | | Specificity = 73% |
| Murden et al[22] | 1. Cognitively intact | 148 | 60–99 | | Research criteria | Sensitivity = 96% |
| | 2. Dementia | 110 | | | | Specificity = 81% |
| | | | | | | Positive prediction = 79% |
| | | | | | | Negative prediction = 97% |
| Neurological and Psychiatric Subjects | | | | | | |
| DePaulo and Folstein[74] | 1. Cognitively intact | 26 | 44 | 28 | Clinical assessment | Sensitivity = 50% |
| | 2. Cerebral lesions | 42 | 56 | 23 | | Specificity = 100% |
| | | | | | | Positive prediction = 100% |
| | | | | | | Negative prediction = 55% |
| Dick et al[47] | 1. Cognitively intact | 93 | 49 | | Clinical assessment | Sensitivity = 76% |
| | 2. Neurological & cognitive impairment | 50 | 54 | | | Specificity = 96% |
| | | | | | | Positive prediction = 90% |
| | | | | | | Negative prediction = 88% |
| Lautenschlaeger et al[75] | 1. Non-organic | | 64–92 | | Clinical assessment | Sensitivity = 76% |
| | 2. Organic | | 64–92 | | | Specificity = 64% |
| Schwamm et al[76] | 1. CNS lesion (excluded dementia & delirium) | 30 | 54 | 22 | Clinical assessment | Sensitivity = 52% |
| Chandler and Gerndt[77] | 1. Mixed psychiatric without cognitive impairment or depression | 102 | | 28 | DSM-III & NINCDS-ADRDA | Sensitivity = 33% |
| | | | | | | Specificity = 91% |
| | | | | | | Positive prediction = 31% |
| | | | | | | Negative prediction = 92% |
| | 2. Mixed organic mental disorder with cognitive impairment | 12 | 53 | 24 | | |
| Faustman et al[78] | 1. Mixed psychiatric without cognitive impairment | 76 | | 29 | Luria-Nebraska Neuro-Psychological Battery | Sensitivity = 21% |
| | | | | | | Specificity = 96% |
| | | | | | | Positive prediction = 50% |
| | 2. Mixed psychiatric with cognitive impairment | 14 | | 27 | | Negative prediction = 87% |

*Note: See text for explanation of sensitivity, specificity, positive prediction, and negative prediction.*
*Note: DSM III (Diagnostic and Statistical Manual of the American Psychiatric Association-Third Edition); NINCDS-ADRDA (National Institute of Neurological and Communicative Disorders and Stroke—Alzheimer's Disease and Related Disorders Association).*
** Single age score represents mean age. Pair of age scores represents range of ages.*
*** Prediction ratios are unadjusted for estimated prevalence rates.*
**** Estimated by authors.*
*# AGECAT is a computer program for analyzing scores on the Geriatric Mental Status (GMS) exam.*

and specificity data were cited or could be derived from information in the article. Only studies that used the criterion score of 23 or less (23/24) are included.

**Sensitivity: Dementia Subjects** Anthony et al[45] were the first to employ the 23/24 cut-off score to determine the sensitivity of the MMSE. The cut-off criterion was based on data originally reported by Folstein et al[1] that suggested that a high, if not perfect, level of sensitivity would occur if the cut-off criterion was set at 23/24. Anthony et al[45] selected 99 of 101 consecutive admissions to a general medical ward who were classified as either cognitively impaired or intact based on the presence/absence of delirium or dementia as assessed by a psychiatrist using DSM-III[73] criteria. The MMSE correctly identified 20 of the 23 impaired patients (87% sensitivity). Table 2 shows that similar levels of sensitivity have been reported in approximately 75% of comparisons using dementia patients. A related and perhaps more critical clinical question is how well does a positive test score predict the presence of dementia. Inspection of the positive prediction data reveals that in approximately 70% of the studies, a MMSE score of less than 23 was associated with the diagnosis of dementia in at least 79% of the cases.

The major variable that appears to differentiate between high and low MMSE sensitivity is the level of cognitive impairment in the dementia groups. The probability of obtaining high levels of sensitivity increases as impairment increases. For example, all studies with a mean MMSE score of 15 or less for the demented subjects report relatively high levels of sensitivity. The two studies with a mean MMSE score greater than 20[67, 70] for the impaired group reported low levels of sensitivity (44% and 68%). In addition, higher sensitivity has been reported with hospital or clinic samples relative to community surveys. This trend probably reflects the over-representation of moderate and severe cognitive impairment compared to community samples.

**Sensitivity: Neurological and Psychiatric Subjects** As shown in Table 2, the sensitivity of the MMSE for general neurology and psychiatry patients usually is low, ranging from 21% to 76%. Two reasons are frequently cited for this. Probably because of its bias toward verbal items, the MMSE is relatively insensitive to damage in the right hemisphere, causing an increase in false negatives.[47, 76, 79, 80] As well, the language items are too simple to detect mild impairments.[21, 35, 47, 76, 81] In addition, according to Chandler and Gerndt[77] the heterogeneity of neurological patients makes it difficult to identify cognitive impairment. It should be noted that a high degree of variability also exists in the positive predictive values, with scores ranging from 31% to 100%.

**Specificity** Most studies report moderate-to-high levels of specificity, indicating the members of the control group are readily identified by a score greater than 23. The negative predictive value of the MMSE is also relatively high due to the low number of false negative cases. Table 2 shows that the composition of the control group is an important factor in determining specificity. Two studies[18, 65] have shown lowered specificity when psychiatric patients are included in the comparison group. Davous et al[65] reported 100% specificity when the control group consisted of patients with neurological or "functional" disorders, but only 82% when psychiatric patients were used. A similar trend was reported by Folstein et al[18] in a community survey. Specificity was 62% for elderly subjects without a clinical diagnosis and 46% for a mixed group of community-dwelling subjects diagnosed as having some type of a DSM-III condition. As discussed later, the demographic characteristics of the sample also affect specificity levels.

### Correlation with Other Tests*

The degree to which the MMSE is correlated with other tests measuring cognitive functioning provides evidence of construct validity. These correlations are reviewed below.

**Cognitive Screening Tests** Correlations ranging from −0.66 to −0.93 were obtained from the studies[27, 28, 48, 50, 65] that compared the MMSE with either the original 26-item Blessed Information-Memory-Concentration test (BIMC)[82] or the shortened 6-item Blessed Orientation-Memory-Concentration test (BOMC).[83] The negative sign occurs because the MMSE adds the number of correct answers while the Blessed sums the number of errors. Given the high degree of overlap in items, the high correlation is not unexpected. Additional research has shown that correlations generally falling within the .70 to .90 range exist between MMSE scores and those obtained from a representative sample of other cognitive screening tests administered to a variety of different types of subjects.[29, 42–44, 84–93]

**Intelligence and Memory Tests** Since the MMSE originally was designed to assess the construct of general cognitive ability, Folstein et al[1] compared MMSE scores to those obtained on the Wechsler Adult Intelligence Scale.[94] They found a correlation of .78 with the Verbal Scale and .66 with the Performance Scale. Comparable findings have been reported in several other studies using a variety of different types of subjects.[25, 47, 60, 78, 95–97] The failure of some studies to obtain significant correlations[24, 96] occurred where the average MMSE score was 27 or above and probably reflects a range restriction due to the truncated distribution of scores. Moderate-to-high correlations were also obtained with the Wechsler Memory Scale.[95, 97]

**Neuropsychological Tests** Modest-to-high correlations between scores on the MMSE and those obtained on various cognitive tests (eg, Trails B, WMS, digit span, story recall, word list recall) used in neuropsychological assessments have been reported.[37, 46, 50, 78, 87, 95, 98, 99] These results are consistent with a report by Morris et al[50] that factor analysis of several neuropsychological tests loaded on three different factors, and the MMSE loaded equally on all factors.

*A summary table containing the correlations between MMSE scores and those obtained on other tests is available on request.

**Activities of Daily Living (ADL) Measures** The relationship between cognitive deficits and ability to function independently is critical in dementia. Impaired occupational or social function has been shown to covary with severity levels, and the degree of impairment may serve as a criterion for the diagnosis of dementia (eg, DSM-III). Thus, MMSE scores should correlate with measures of functional capacity, such as those obtained with the Blessed Dementia Rating Scale (BDRS),[82] that assess an individual's everyday activities, habits, and personality. Correlations between MMSE scores and those obtained from ADL scales generally range from .40 to .75, indicating that lower MMSE scores are related to decreased independence.[19, 49, 50, 100–107] The ECA Piedmont Health Survey[107] provides the most extensive ADL data. MMSE scores from 1,637 community-dwelling individuals were correlated (.48) with instrumental activities (eg, cooking, caring for finances) but not with physical activities (eg, dressing, eating). The higher correlation obtained with instrumental, rather than physical, ADLs has been reported in several studies.[66, 103, 108, 109] Thus, scores on the MMSE are sensitive to a decline in more cognitively demanding functional behavior that is independent of physical health and mobility.

Finally, since the BDRS originally was validated against postmortem neuropathological changes,[82, 110] the high degree of relationship between the MMSE and BDRS provides indirect evidence that MMSE scores are correlated to histopathological findings. This speculation is supported by the −.70 correlation that existed between MMSE scores and plaque counts.[111]

## Longitudinal Studies

Longitudinal studies with Alzheimer's patients provide additional evidence of construct validity. Since AD is a progressive disease where cognitive functions decline over time, MMSE scores should decline with serial testing. Longitudinal studies using test-retest intervals ranging from 1 month to 3 years show that MMSE scores for dementia patients, the majority classified as AD, significantly declined over time.[50, 52, 56, 58, 71, 80, 92, 112–120] Although the rate of decline varied between and within studies, it generally fell between 2 and 5 points per year. Moreover, the rate of decline in 1 year was not correlated with that occurring during the following year.[80]

A substantial degree of variability occurred in those studies employing Alzheimer's patients. While some of the test-retest variability is related to the uneven progression of AD and the heterogeneity of subjects produced by differences in the duration of illness, age of onset, and subclass of AD, the content and psychometric properties of the MMSE are contributing factors as well. The verbal items (eg, recall of three words, 7s/WORLD) that make the MMSE sensitive to the profound decline in memory that occurs in moderately demented patients[80, 112, 118, 121] lose their discriminability as the severity of the illness increases. Thus, as the lower limits of the scale are approached, the MMSE becomes less sensitive to the progressive decline of functioning that occurs with AD. Several studies have reported that scales evaluating functional competence, such as ADL measures, assess a wider range of functions than the MMSE and are more appropriate for longitudinal studies involving severely demented patients.[19, 80, 100, 121, 122]

## Other Evidence of Construct Validity

MMSE scores also correlate with other measures that reflect severity of AD, thus providing additional evidence of construct validity. These include urinary incontinence,[104, 123] mortality,[105, 112, 124, 125] changing health status,[105] abnormal behavioral change,[104, 118, 126, 127] hearing impairment,[56, 120] length of time in hospital,[128–130] and extrapyramidal signs.[131] However, some studies have shown that neuropsychological measures, such as drawing a 3-dimensional cube, were related to behaviors such as wandering and urinary incontinence, which were not correlated with MMSE scores.[98, 132]

## Influence of Demographic and Social Variables

**Educational Level** MMSE scores repeatedly have been shown to be related to educational attainment. This association between years of education and MMSE performance has been reported in studies using hospital patients,[47] a mixed sample of dementia and cognitively intact subjects,[133] individuals randomly sampled from the community,[2, 6, 16, 17, 30, 31, 36, 40, 107, 128, 134] and subjects screened to exclude delirium and dementia.[17, 22, 45, 108, 135] The importance of education was revealed by regression analyses as well, showing that education accounted for more variance than other demographic variables including gender, race, and social class.[2, 107, 133, 134] In addition, education levels affected the distribution of errors across individual items and categories of items.[22, 31, 36, 45, 133, 134, 136] Some studies, however, have failed to find such a relation.[19, 24, 60, 90, 137] This may be due, at least in part, to sampling biases caused by an overrepresentation of individuals with either high education or severe cognitive impairment, the latter causing a restricted range of very low MMSE scores.

A central issue emerging from these results is whether the effects attributed to education represent a measurement error or a risk factor. 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. This position assumes that education reflects a stable characteristic that is not associated with any type of underlying pathology and, as such, does not constitute a risk factor. To a large degree, this view is based on evidence showing that low educational levels increase the likelihood of misclassifying normal subjects as cognitively impaired (ie, false positives). This is particularly evident when subjects have fewer than 9 years of education.[22, 45] Higher education levels also may produce classification errors. Fillenbaum et al.[107] speculated that higher education levels may mask mild impairment, and O'Connor et al[32] found that all dementia

patients with an MMSE score of 24 or greater (ie, false negative) had relatively high levels of education. Thus, evidence from cross-sectional studies shows that number of years of education affects both sensitivity and specificity.

Results from longitudinal studies provide further evidence that while education is associated with low MMSE scores, it is not associated with either the diagnosis of AD or the rate of cognitive decline that occurs as the severity of AD increases. Three studies[22, 134, 138] have reported that although educational levels and MMSE scores were correlated, number of years of education was not related to the diagnosis of dementia. This is consistent with other reports showing that education is not associated with dementia.[139, 140] Additionally, several longitudinal studies have reported that education was not associated with the rate of decline.[22, 80, 112] Similar effects have been reported from studies using measures other than the MMSE to assess rate of cognitive change in AD patients.[141–143] While these results do not conclusively demonstrate that education solely reflects a psychometric bias, they do suggest that substantial potential for misclassification exists, prompting several authors to recommend that education levels, particularly 8 years or less, be considered when interpreting MMSE scores.[31, 36, 40, 45, 51, 79, 107, 133, 144, 145]

Although little doubt exists that educational levels lead to potential misclassification, several authors caution that education may not exclusively represent a detection bias but also may reflect etiologic factors critical in a process eventually resulting in dementia.[17, 134, 146–148] Lower education levels could, for example, contribute to the incidence of dementia because education is associated with various biological risk factors typically associated with multi-infarct dementia, such as hypertension, obesity, and serum cholesterol. Moreover, the failure of education to be etiologically related to one type of cognitive impairment, say Alzheimer's disease, does not necessarily mean that education will be unrelated to other types of cognitive impairments, such as vascular dementia. Thus, modification of the cut-off score to compensate for educational biases in one sample does not justify using the same criterion for another sample, unless justified by empirical results for that sample. Berkman[146] suggests that adjusting for education level at the time of initial screening decreases, if not eliminates, the possibility of exploring the hypothesis that education constitutes a risk factor for dementia. Furthermore, it reduces the possibility of investigating the relationship between education and cognitive impairment caused by factors other than dementing illness. The importance of Berkman's warning is underscored by preliminary results from the East Boston study suggesting that rate of AD may be higher among individuals with few years of schooling.[147] Thus, it appears likely that education represents both a psychometric bias and a risk factor, differing only in degree (for further discussion see Refs. 30, 40, 144, 146–148).

**Age** Numerous studies have shown that MMSE scores decrease as age increases. This relationship has been reported in community surveys employing random sampling procedures,[2, 18, 31, 34, 36, 40, 107, 134] studies in which subjects did not suffer from dementia, delirium, or depression,[17, 24, 45, 51, 137] and studies that tested hospital or clinic patients.[17, 35, 149] Most of this age-related change begins about age 55 or 60 and then dramatically accelerates over the age of 75 or 80.[16, 40] These age effects persist when subjects are stratified by education level,[16, 18, 31, 40] demonstrating that the age effect is not simply due to cohort differences in educational attainment.

The finding that older adults tend to have lower MMSE scores than younger adults suggests that fixed, age-independent cut-off scores (eg, 23/24) may underestimate cognitive impairment with younger adults or over-estimate it with older adults. Evidence showing that dementia frequently is overestimated in older normals supports this notion.[18, 45, 145] However, since age generally is viewed as a risk factor for dementia,[134, 146, 147] all age effects cannot be merely dismissed as representing only psychometric bias. The matter is further complicated by the finding from longitudinal studies that rate of cognitive deterioration in Alzheimer's patients appears to be independent of age.[121]

Conflicting evidence exists concerning the degree to which age interacts with education. While some studies[16, 31] report that age-related impairment in scores is greater for subjects with lower educational levels, others[17] conclude that declines for age and education are independent. In addition, several studies have reported that age and education do not uniformly affect all items.[2, 16, 17, 24, 31, 36, 45, 134] These and other results suggest that the association between total MMSE performance, age, and education is complex, but nevertheless one that should be considered in interpreting MMSE performance.

**Gender** In a summary report containing data from approximately 20,000 individuals participating in the ECA study, George et al[40] concluded that no meaningful gender differences existed in the prevalence of cognitive impairment. Other studies indicate that even when differences were statistically significant, they did not account for a substantial portion of variance and generally were not substantively important.[16–18, 24, 45, 51, 107, 118, 150]

**Race/Ethnicity and Social Class** The most widely cited study on the effects of race/ethnicity on MMSE performance analyzed interview responses from over 3,000 English and Hispanic residents of Los Angeles.[36] Both English and Spanish versions of the MMSE were used. Analysis of individual items revealed that Hispanics performed significantly lower on many items. A more recent report of the results from all ECA centers[40] indicates that race/ethnicity exerts a significant effect on the distribution of MMSE scores. The finding that racial effects tend to be maintained within different educational levels suggests that education cannot explain all race/ethnicity effects. However, Murden et al[22] reported contradictory findings that MMSE performance was not affected by race. Effects

of social class and socioeconomic status on MMSE scores also have been observed.[17, 34, 150, 133]

## ANALYSIS OF INDIVIDUAL ITEMS

Various analyses, including frequency distributions of the errors, part-total correlations, item analyses, and stepwise regression analyses, have been employed to investigate the relationship between individual items and total MMSE score. Analyses of individual items from studies containing normal subjects (ie, large community surveys or ones in which participants were screened to eliminate obvious cases of dementia and delirium) revealed that most errors generally occurred in only four of the seven cognitive domains: recall of three words, serial 7s/WORLD, pentagon, and orientation to time.[2, 16, 21, 24, 31, 34, 40, 137] Although the relative contribution of each domain varied from study to study, recall of three words usually produced the greatest number of errors. Errors rarely occurred for orientation to place, registration, and individual language questions.

Analyses of individual items for Alzheimer's patients again indicated that the same four cognitive domains consistently produced the greatest number of errors.[2, 19, 21, 27, 28, 135, 151] The relative difficulty of these items varied across studies, with the exception that the greatest percentage of errors generally occurred for recall of three words. The failure to observe a consistent rank order of difficulty for the other three domains is attributable, at least in part, to differences in dementia severity that existed between studies. Although there are reports that orientation to place is highly predictive of total MMSE scores,[21] this finding is not consistent and may depend on whether subjects were tested in a familiar (eg, home) or unfamiliar (eg, hospital) environment.[37, 56, 57]

We are aware of only two studies that directly compared the performance of normals and Alzheimer's patients on each item. Brayne and Calloway[134] reported that "normal" subjects scored significantly higher than dementia patients on all MMSE items except "no ifs, and, or buts" and naming two objects (watch, pencil). Galasko et al,[21] employing a paired-comparison procedure for different age and education levels, compared scores from healthy controls with those obtained by Alzheimer's patients. As expected, the differences between the "normal" and moderate-to-severe groups increased on the same items that had previously best discriminated between mild AD and normals. In addition, a significant difference occurred for the language items. Thus, it appears that although the language items are useful in distinguishing between normals and Alzheimer's patients, they are much less discriminating than are the other four categories and are most sensitive to individual differences among patients with moderate-to-severe AD. This finding is consistent with previous findings showing that items are differentially sensitive to disease severity.[19, 119, 152–154]

Three studies were undertaken to determine if the seven rationally derived cognitive categories could be validated through factor analysis.[27, 28, 119] Although each study yielded a two factor solution, the items contained in each factor varied among the studies. Nevertheless, the results from the studies are important since they show that the set of cognitive domains measured by the MMSE is certainly less than the seven categories into which the questions usually are grouped.

Finally, studies have determined if serial 7s and reverse spelling of WORLD represent equivalent tasks. The overwhelming weight of the data shows they are not comparable. Spelling WORLD backward consistently produces higher scores than does counting backward by sevens.[16, 19, 21, 33, 36, 37, 45, 137, 155–158] Moreover, Holzer et al[16] reported a correlation between serial 7s and WORLD of only .37, with WORLD having a higher correlation with the total score than serial 7s (.47 vs .39). Finally, studies on the effects of age, education, and gender on performance on these two items have been inconsistent.[22, 32, 36, 45, 155, 156]

## SUGGESTED MODIFICATIONS TO THE MMSE

Several attempts have been made to improve the sensitivity and specificity of the MMSE. Some studies have explored altering the cut-off score, but without much success. In general, changing the cut-off points alters both the sensitivity and specificity of the test, increasing one while decreasing the other.[21, 32, 34, 45, 72, 77]

A second approach has been to compensate in some manner for various ages and/or educational levels.[2, 22, 24, 45, 51, 133, 145, 159] One strategy is to assume that the MMSE is valid only if the person has 9 or more years of schooling.[22, 105, 133, 145] Another tack is to generate normative data, stratified for age and/or education.[24, 51] Although using different cut-off scores for various ages and educational levels has its merits, it also suffers the same problem noted above—attempts to increase sensitivity usually decrease specificity.

A third avenue is using multivariate procedures to differentially weight existing MMSE items.[2, 16, 21, 31, 36, 38, 137, 144, 160] For example, Cullum et al,[137] using a stepwise regression analysis with highly educated normal subjects aged 50 to 80, reported that recall of three words and orientation to time correlated .87 with total score. Galasko et al,[21] employing a logistic-regression model with AD patients, found that the sum of the scores for recall of three words and orientation to place resulted in sensitivity and specificity levels that were similar to those produced by total MMSE scores. Magaziner et al[31] generated a series of prediction equations for different age groups and educational levels. However, results from several studies make the generality of these equations questionable.[161–163]

A fourth alternative is to modify the content of the MMSE.[2, 21, 22, 36, 45, 81, 144] One way to modify the MMSE would be to exclude questions particularly sensitive to age, education, and culture or to add questions less sensitive to these demographic variables. Another approach would involve eliminating items with little diagnostic utility and/or adding items known to be sensitive to cognitive impairment. The need for more adequate language items, for example, has been mentioned by several authors.[35, 47] In some instances, sup-

plementary items have been employed. For example, Galasko et al[21] found that adding a word fluency task decreased error rates and increased the sensitivity of the MMSE from 79.2% to 87.5% for mild AD. Mayeux et al[81] created a modified version of the MMSE (mMMS) by adding digit span, recall of four US presidents, confrontational naming, sentence for repetition, and copy of two additional designs. The mMMS correlated .89 with the MMSE, has a test-retest reliability of .95,[164] and has been employed in several dementia studies.[81, 103, 131, 165]

The most extensive revision of the MMSE was undertaken by Teng et al.[135] The Modified Mini-Mental State Examination (3MS) maintains the MMSE's basic format while extensively modifying its content. It contains four new test items, an expanded range of scores (0–100 rather than 0–30), and modified scoring procedures allowing assignment of partial credit on some items. Subsequent research[51] demonstrated that the 3MS possesses higher reliability and validity than the MMSE. Additional information on the psychometric properties of the 3MS should be forthcoming since it currently is being used to assess cognitive impairment in the Canadian Study on Health and Aging,[166] an epidemiological survey sponsored by the Health and Welfare Canada.

A fifth alternative has been to include the MMSE as part of a battery of tests. For example, Pfeffer et al[167] developed the Mental Function Index (MFI) by using a discriminant function analysis to obtain weighted scores for the MMSE, the Symbol Digit Modalities Tests,[168] and the Raven Subtest B.[169] The combined sum of the weighted scores yielded 93% sensitivity for demented patients and 80% specificity for normals. Similar values were obtained in a follow-up study.[46] However, substantially lower levels of sensitivity have been reported.[26, 70] In addition, Mowry and Burvill[26] noted that high refusal rates and administrative time also contraindicate the MFI's use as a screening device.

## SUMMARY AND RECOMMENDATIONS

The MMSE was developed as a screening test to quantitatively assess the severity of cognitive impairments and to document cognitive changes that occur over time. The research reviewed over the past 26 years indicates, to a large degree, that the MMSE has been able to fulfill these goals. Examination of its psychometric properties shows moderate-to-high levels of reliability, with test-retest reliability higher than measures of internal consistency. Items measuring recall of three words, copy pentagon, 7s/WORLD, and orientation to time appear to be the most sensitive to both normal aging and dementing illnesses. The MMSE, like many measures of cognitive ability, is affected by demographic factors. Of these, age and education exert the greatest effect. Criterion validity measures show high levels of sensitivity for moderate-to-severe levels of dementia. Construct validation studies demonstrate that MMSE scores correlate highly with those obtained from other types of cognitive screening tests as well as from psychological and neuropsychological tests measuring intelligence, memory, specific types of cognitive abilities, and activities of daily living. Other evidence shows the MMSE to be correlated with AD pathology. Longitudinal research with dementia patients illustrates its ability to serially document cognitive change.

However, the MMSE is not without problems. Perhaps the most frequently cited shortcoming relates to its lack of sensitivity to mild cognitive impairment and its failure to adequately discriminate patients with mild AD from normal patients. Attempts to improve the sensitivity, including altering the cut-off scores, differentially weighting existing items, modifying the content of the items, or using supplementary items, have met with mixed success. The MMSE also has received its share of criticism because of its insensitivity to progressive changes occurring with severe Alzheimer's disease. Moreover, inconsistencies in the way it is administered, scored, and interpreted make cross-study comparison difficult. The content of the MMSE is highly verbal, lacking sufficient items to adequately measure visuospatial and/or constructional praxis. Hence, its utility in detecting impairment caused by focal lesions, particularly those residing in the right hemisphere, is uncertain. Items designed to measure language functions also tend to be overly simplistic and tend to be insensitive to mild linguistic deficits, hence increasing the number of false negative errors.

Some of the shortcomings may have occurred because the MMSE, in its current form, is expected to provide too many different types of screening functions. It may be unrealistic to expect a single version of the test to meet all of these demands. Different types of screening applications (eg, AD) may require different versions of the MMSE. Thus, it also may be more efficient to employ one set of cut-off scores for a hospital-based geriatric clinic and a different set for epidemiological surveys. Since altering cut-off scores typically increases either the sensitivity or specificity while the other decreases, the selection of the specific criterion score may depend on a cost-benefit analysis to assess the relative importance of increased numbers of false positives or false negatives.

In view of the above, we feel the following recommendations are warranted when the MMSE is employed in a clinical setting.

(1) The MMSE should be used as a screening device for cognitive impairment or a diagnostic adjunct in which a low score indicates the need for further evaluation. It should *not* serve as the sole criterion for diagnosing dementia or to differentiate between various forms of dementia. However, MMSE scores may be used to classify the severity of cognitive impairment or to document serial change in dementia patients.

(2) The following three cut-off levels should be employed to classify the severity of cognitive impairment: no cognitive impairment = 24–30; mild cognitive impairment = 18–23; severe cognitive impairment = 0–17.

(3) The MMSE should not be used clinically unless the person has at least a grade eight education and is fluent in English. While this recommendation does not discount the possibility that future research may show

that number of years of education constitutes a risk factor for dementia, it does acknowledge the weight of evidence showing that low educational levels substantially increase the likelihood of misclassifying normal subjects as cognitively impaired.

(4) Serial 7s and WORLD should not be considered equivalent items. Both items should be administered and the higher of the two should be used. In scoring serial 7s, each number must be independently compared to the prior number to insure that a single mistake is not unduly penalized. WORLD should be spelled forward (and corrected) prior to spelling it backward. The scoring procedures employed by either Morris et al[13] or Teng et al[23] are recommended.

(5) The words apple, penny, and table should be used for registration and recall. If necessary, the words may be administered up to three times in order to obtain perfect registration, but the score is based on the first trial.

(6) The "county" and "where are you" orientation to place questions should be modified. The name of the county where a person lives should be asked rather than the name of the county where the testing site resides, and the name of the street where the individual lives should be asked rather than the name of the floor where the testing is taking place.

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## REFERENCES

1. Folstein MF, Folstein SE, McHugh PR. 'Mini-mental State'. A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–198.
2. Bird HR, Canino G, Stipec MR et al. Use of the Mini-Mental State Examination in a probability sample of Hispanic population. J Nerv Ment Dis 1987;175:731–737.
3. Engedal K, Haugen P, Gilje K, Laake P. Efficacy of short mental tests in the detection of mental impairment in old age. Compr Gerontol 1988;2:87–93.
4. Heeren TJ, Lagaay AM, Beek WAC et al. Reference values for the Mini-Mental State Examination in octo- and nonagenarians. J Am Geriatr Soc 1990;38:1093–1096.
5. Karno M, Audrey MA, Escobar JI, et al. Development of the Spanish-language version of the National Institute of Mental Health Diagnostic Interview Schedule. Arch Gen Psychiatry 1983;40:1183–1188.
6. Katzman R, Zhang M, Ya-Qu O et al. A Chinese version of the Mini-Mental State Examination: Impact of illiteracy in a Shanghai dementia survey. J Clin Epidemiol 1988;41:971–978.
7. Park JH, Ha JC. Cognivitive impairment among the elderly in a Korean rural community. Acta Psychiatr Scand 1988;77:52–57.
8. Rocca WA, Bonaiuto S, Lippi A, et al. Prevalence of clinically diagnosed Alzheimer's disease and other dementing disorders: A door-to-door survey in Appignano, Macerata Province, Italy. Neurology 1990;40:626–631.
9. Salmon D, Riekkinen PJ, Katzman R, et al. Cross-cultural studies of dementia. Arch Neurol 1989;46:769–772.
10. National Institute of Mental Health. The Diagnostic Interview Schedule. Washington, DC: NIMH Center for Epidemiological studies, 1979.
11. Robins LN, Regier DA, eds. Psychiatric Disorders in America: The Epidemiologic Catchment Area Study. New York: The Free Press, 1991.
12. Roth M, Tyme E, Mountjoy Q et al. CAMDEX: A standardized instrument for the diagnosis of mental disorder in the elderly with special reference to the early detection of dementia. Br J Psychiatry 1986;149:698–709.
13. Morris JC, Mohs RC, Rogers H et al. Consortium to establish a registry for Alzheimer's disease (CERAD) clinical and neurological assessment of Alzheimer's disease. Psychopharmacol Bull 1988;24:641–652.
14. Zaudig M, Mittelhammer J, Hiller W et al. SIDAM—A structure interview for the diagnosis of dementia of the Alzheimer type, multiinfarct dementia and dementias of other aetiology according to ICD-10 and DSM-III-R. Psychol Med 1991;21:225–236.
15. McKhann G, Drachman D, Folstein M, et al. Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's disease. Neurology 1984;34:939–944.
16. Holzer CE III, Tischler GL, Leaf PJ et al. An epidemiologic assessment of cognitive impairment in a community population. In: Greenley JR, ed. Research in Community Mental Health, Vol 4. London England: JAI Press, 1984, pp 3–32.
17. O'Connor DW, Pollitt PA, Treasure FP et al. The influence of education, social class and sex on Mini-Mental State scores. Psychol Med 1989;19:771–776.
18. Folstein MF, Anthony JC, Parhad J, et al. The meaning of cognitive impairment in the elderly. J Am Geriatr Soc 1985;33:228–235.
19. Ashford JW, Kolm P, Colliver JA et al. Alzheimer patient evaluation and the Mini-Mental State: Item characteristic curve analysis. J Gerontol 1989;44:P139–146.
20. Beatty W, Goodkin DE. Screening for cognitive impairment in multiple sclerosis: An examination of the Mini-Mental State Examination. Arch Neurol 1990;47:297–301.
21. Galasko D, Klauber MR, Hofstetter CR et al. The Mini Mental State Examination in the early diagnosis of Alzheimer's dementia. Arch Neurol 1990;47:49–52.
22. Murden RA, McRae TD, Kaner S et al. Mini-Mental State Exam scores vary with education in blacks and whites. J Am Geriatr Soc 1991;39:149–155.
23. Teng EL, Chiu HC. The Modified Mini-Mental State (3MS) examination. J Clin Psychiatry 1987;48:314–318.
24. Bleecker ML, Bolla-Wilson K, Kawas C et al. Age-specific norms for the Mini-Mental State Exam. Neurology 1988;33:1565–1568.
25. Farber JF, Schmitt FA, Logue PE. Predicting intellectual level from the Mini-Mental State Examination. J Am Geriatr Soc 1988;36:509–510.
26. Mowry BJ, BurvilL BW. A study of mild dementia in the community using a wide range of diagnostic criteria. Br J Psychiatry 1988;153:328–334.
27. Fillenbaum GG, Heyman A, Wilkinson WE et al. Comparison of two screening tests in Alzheimer's disease. Arch Neurol 1987;44:924–927.
28. Zillmer EA, Fowler PC, Gutnick HN et al. Comparison of two cognitive bedside screening instruments in nursing home residents: A factor analytic study. J Gerontol 1990;45:69–74.
29. Jorm A, Scott R, Cullen JS et al. Performance of the Informant Questionnaire on Cognitive Decline in the Eldrly (IQCODE) as a screening test for dementia. Psychol Med 1991;21:785–790.
30. Jorm AF, Scott R, Henderson AS et al. Educational level differences on the Mini-Mental State: The role of test bias. Psychol Med 1988;18:727–731.
31. Magaziner J, Bassett SS, Hebel JR. Predicting performance on the mini-mental state examination: Use of age- and educational-specific equations. J Am Geriatr Soc 1987;35:996–1000.
32. O'Connor DW, Pollitt PA, Hyde JB et al. The reliability and validity of the Mini-Mental State in a British community survey. J Psychiatr Res 1989;23:87–96.
33. Olin JT, Zelinskin M. The 12-month reliabiltiy of the Mini-Mental State Examination. Psychol Assessment 1991;3:427–432.
34. Kay DWK, Henderson AS, Scott R et al. Dementia and depression among the elderly living in the Hobart community: The effect of the diagnostic criteria on the prevalence rates. Psychol Med 1985;15:771–788.
35. Tsai L, Tsuang MT. The Mini-Mental State Test and computerized tomography. Am J Psychiatry 1979;136:436–439.
36. Escobar J, Burnam A, Karno M et al. Use of the Mini-Mental Status Examination (MMSE) in a community population of mixed ethnicity: Cultural and linguistic artifacts. J Nerv Ment Dis 1986;174:607–614.
37. Livingston G, Sax K, Willison J et al. The Gospel Oak study stage II: the diagnosis of dementia in the community. Psychol Med 1990;20:881–891.
38. Klein LE, Roca RP, McAuthur J et al. Diagnosing dementia: Univariate and multivariate analyses of the Mental Status Examination. J Am Geriatr Soc 1985;33:483–488.
39. Fillenbaum GG, George LK, Blazer DG. Scoring nonresponse on the Mini-Mental State Examination. Psychol Med 1988;18:1021–1025.
40. George LK, Landerman R, Blazer DG et al. Cognitive impairment. In: Robbins LN, Regier DA, eds. Psychiatric Disorders in America. New York: Free Press, 1991, pp 291–327.
41. Franssen EH, Reisberg B, Kluger A et al. Cognition-independent neurologic symptoms in normal aging and probable Alzheimer's disease. Arch Neurol 1991;48:148–154.
42. Reisberg B, Ferris SH, de Leon MJ et al. Age-associated cognitive decline and Alzheimer's disease: Implications for assessment and treatment. In: Bergener M, Ermini M, Stahelin HB, eds. Thresholds in Aging. New York: Academic Press, 1985.
43. Reisberg B, Ferris SH, Anand R et al. Functional staging of dementia of the Alzheimer type. Ann NY Acad Sci 1984;35:481–483.
44. Foreman MD. Reliability and validity of mental status questionnaires in elderly hospitalized patients. Nurs Res 1987;36:216–220.
45. Anthony JC, LaResche L, Niaz U et al. Limits of the 'Mini-Mental State' as a screening test for dementia and delirium among hospital patients. Psychol Med 1982;12:397–408.
46. Pfeffer RI, Kurosaki TT, Chance JM et al. Use of the Mental Function

Index in older adults. Am J Epidemiol 1984;120:922–935.
47. Dick JPR, Guiloff RJ, Stewart A et al. Mini-mental state examination in neurological patients. J Neurol Neurosurg Psychiatry 1984;47:496–499.
48. Thal LJ, Grundman M, Golden R. Alzheimer's disease: A correlational analysis of the Blessed Information-Memory-Concentration Test and the Mini-Mental State Exam. Neurology 1986;36:262–264.
49. Kafonek S, Ettinger WH, Roca R et al. Instruments for screening for depression and dementia in a long-term care facility. J Am Geriatr Soc 1989;37:29–34.
50. Morris JC, Heyman A, Mohs RC, et al. The Consortium to Establish a Registry for Alzheimer's Disase (CERAD). Part I. Clinical and neuropsychological assessment of Alzheimer's disease. Neurology 1989;39:1159–1165.
51. Teng EL, Chui HC, Gong A. Comparisons between the Mini-Mental State Exam (MMSE) and its modified version—the 3MS test. Psychogeriatrics: Biomedical and Social Advances. Tokyo: Excerpta Medica, 1990, pp 189–192.
52. van Belle G, Uhlmann RF, Hughes JP et al. Reliabiltiy of estimates of changes in mental status test performance in senile dementia of the Alzheimer type. J Clin Epidemiol 1990;43:589–595.
53. Lesher EL, Whelihan WM. Reliability of mental status intruments administered to nursing home residents. J Consult Clin Psychol 1986;54:726–727.
54. Marascuilo LA, Serlin RC. Statistical Methods for the Social Sciences. New York: WH Freeman and Company, 1988, pp 87–91.
55. Keating JJ III. "Studying" for the Mini-Mental Status Exam. J Am Geriatr Soc 1987;35:594–597.
56. Peters CA, Potter JF, Scholer SG. Hearing impairment as a predictor of cognitive decline in dementia. J Am Geriatr Soc 1988;36:981–986.
57. Ward HW, Ramsdell JW, Jackson JE, et al. Cognitive function testing in comprehensive geriatric assessment. J Am Geriatr Soc 1990;38:1088–1092.
58. Becker JT, Huff J, Nebes RD et al. Neuropsychological function in Alzheimer's Disease: Pattern of impairment and rates of progression. Arch Neurol 1988;45:263–268.
59. Lopez OL, Swihart AA, Becker JT et al. Reliabiltiy of NINCDS-ADRDA clinical criteria, for the diagnosis of Alzheimer's disease. Neurology 1990;40:1517–1522.
60. Mitrushina M, Satz P. Reliability and validity of the Mini-Mental State Exam in neurologically intact elderly. J Clin Psychol 1991;47:537–543.
61. O'Connor DW, Pollitt PA, Hyde JB et al. A follow-up study of dementia diagnosed in the community using the Cambridge Mental Disorders of the Elderly Examination. Acta Psychiatr Scand 1990;81:78–82.
62. Sackatt DL, Haynes RB, Tugwell P. Clinical Epidemiology: A Basic Science for Clinical Medicine. Toronto: Little, Brown and Company, 1985.
63. Siu, AL. Screening for dementia and investigating its causes. Ann Intern Med 1991;115:122–132.
64. Goldschmidt TJ, Malli R, Still CN. Recognition of cognitive impairment in primary care outpatients. Southern Med J 1983;76:1264–1270.
65. Davous P, Lamour Y, Debrand E et al. A comparative evaluation of the short orientation memory concentration test of cognitive impairment. J Neurol Neurosurg Psychiatry 1987;50:312–317.
66. Fisk AA, Pannill FC III. Assessment and care of the community-dwelling Alzheimer's disease patient. J Am Geriatr Soc 1987;35:307–311.
67. Huff FJ, Becker JT, Belle SH et al. Cognitive deficits and clinical diagnosis of Alzheimer's disease. Neurology 1987;37:1119–1124.
68. Pfeffer R, Afifi AA, Chance JM. Prevalence of Alzheimer's disease in a retirement community. Am J Epidemiol 1987;125:420–436.
69. JAckson MD, Ramsdell JW. Use of the Mini-Mental State Examination (MMSE) to screen for dementia in elderly outpatients. J Am Geriatr Soc 1988;36:662.
70. Knopman DS, Ryberg S. A verbal memory test with high predictive accuracy for dementia of the Alzheimer's type. Arch Neurol 1989;46:141–145.
71. Reed BR, Jagust, WJ, Seab JP et al. Memory and regional cerebral blood flow in mildly symptomatic Alzheimer's disease. Neurology 1989;39:1537–1539.
72. Black SE, Blessed G, Edwardson JA et al. Prevalence rates of dementia in an ageing population: Are low rates due to the use of insensitive instruments? Age Ageing 1990;19:84–90.
73. American Psychiatric Association Committee on Nomenclature and Statistics. Diagnostic and Statistical Manual of Mental Disorders. 3rd Ed. Washington DC: APA, 1980.
74. DePaulo JR, Folstein F. Psychiatric disturbances in neurological patients: Detection, recognition, and hospital course. Ann Neurol 1978;4:225–228.
75. Lautenschlaeger E, Meier HMR, Donnelly M. Folstein vs. Goldfarb mental status exams. Clin Gerontol 1986;4:41–42.
76. Schwamm LH, Van Dyke C, Kiernan RJ et al. The Neurobehavioral Cognitive Status Examination: Comparison with the Cognitive Capacity Screening Examination and the Mini-Mental State Examination in a neurosurgical population. Ann Intern Med 1987;107:486–491.
77. Chandler JD, Gerndt J. Cognitive screening tests for organic mental disorders in psychiatric inpatients. J Nerv Ment Dis 1988;176:675–681.
78. Faustmen WO, Moses JA Jr, Csernansky JG. Limitation of the Mini-Mental State Examination in predicting neuropsychological functioning in a psychiatric sample. Acta Psychiatr Scand 1990;81:126–131.
79. Nelson A, Fogel BS, Faust D. Bedside cognitive screening instruments: A critical assessment. J Nerv Ment Dis 1986;174:73–82.
80. Salmon DP, Thal LJ, Butters N et al. Longitudinal evaluation of dementia of the Alzheimer's type: A comparison of 3 standardized mental status examinations. Neurology 1990;40:1225–1230.
81. Mayeux R, Stern Y, Rosen J et al. Depression, intellectual impairment and Parkinson's disease. Neurology 1981;31:645–650.
82. Blessed G, Tomlinson BE, Roth M. The association between quantiative measures of dementia and of senile change in the cerebral grey matter of elderly subjects. Br J Psychiatry 1968;114:797–811.
83. Katzman R, Brown T, Fuld P et al. Validation of a short orientation-memory-concentration test of cognitive impairment. Am J Psychiatry 1983;140:734–739.
84. Blessed G, Black SE, Butler T et al. The diagnosis of dementia in the elderly. Br J Psychiatry 1991;159:193–198.
85. Block RI, Devoe M, Russell M et al. Clinical ratings: Relationship to objective psychometric assessment in individuals with dementia. Psychol Rep 1985;57:183–189.
86. Burch EA, Andrews SR. Cognitive dysfunction in psychiatric consultation subgroups: Use of two screening tests. South Med J 1987;80:1079–1082.
87. Horn L, Cohen CI, Teresi J. The EASI: A self-administered screening test for cognitive impairment in the elderly. J Am Geriatr Soc 1989;37:848–855.
88. Jorm AF, Scott R, Jacomb PA. Assessment of cognitive decline in dementia by informant questionnaire. Int J Geriatr Psychiatry 1989;4:35–39.
89. Kokmen E, Smith GE, Peterson RC et al. The Short Test of Mental Status. Arch Neurol 1991;48:725–728.
90. Pearson JL, Cherrier M, Terri L. The Mini-Mental State Exam and the Mental Status Questionnaire: Depression in Alzheimer's patients. Clin Gerontol 1989;8:31–37.
91. Strain JJ, Fulop D, Lebovits A et al. Screening devices for diminished cognitive capacity. Gen Hosp Psychiatry 1988;10:16–23.
92. Teitelbaum L, Ginsburg L, Hopkins RW. Cognitive and behavioral impairment among elderly people in institutions providing different levels of care. Can Med Assoc J 1991;144:169–173.
93. Yesavage JA, Poulsen SL, Sheikh J et al. Rates of change of common measures of impairment in senile dementia of the Alzheimer's type. Psychopharmacol Bull 1988;24:531–534.
94. Wechsler D. Manual for the Wechsler Adult Intelligence Scale. New York: Psychological Corporation, 1955.
95. Giordani B, Boivin MJ, Hal AL et al. The utility and generality of Mini-Mental State Examination scores in Alzheimer's disease. Neurology 1990;40:1894–1896.
96. Myers BA. The Mini-Mental State in those with developmental disabilities. J Nerv Ment Dis 1987;175:85–89.
97. DePaulo JR, Folstein MF, Gordon B. Psychiatric screening on a neurological ward. Psychol Med 1980;10:125–132.
98. Henderson VW, MacK W, Williams BW. Spatial disorganization in Alzheimer's disease. Arch Neurol 1989;46:391–394.
99. Selnes QA, Carson K, Rovne B et al. Language dysfunction in early- and late-onset possible Alzheimer's disease. Neurology 1988;38:1053–1056.
100. Ashford J, Hsu LN, Becker M et al. Mini-mental status and activities of daily living: Cross validation by scalogram and item analysis techniques. Gerontologist 1986;26:143.
101. Bondareff W, Raval J, Woo B et al. Magnetic resonance imaging and the severity of dementia in older adults. Arch Gen Psychiatry 1990;47:47–51.
102. Breen AR, Larson EB, Reifler BV et al. Cognitive performance and functional competence in coexisting dementia and depression. J Am Geriatr Soc 1984;32:132–137.
103. Stern Y, Hesdorffer D, Sano M et al. Meausrement and prediction of functional capacity in Alzheimer's disease. Neurology 1990;40:8–14.
104. Teri L, Larson EB, Reifler BV. Behavioral disturbance in dementia of the Alzheimer's type. J Am Geriatr Soc 1988;36:1–6.
105. Uhlmann RF, Larson EB, Buchner DM. Correlations of Mini-Mental State and Modified Dementia Rating Scale to measures of transitional health status in dementia. J Gerontol 1987;42:33–36.
106. Warren EJ, Grek A, Conn D et al. A correlation between cognitive performance and daily functioning in elderly people. J Geriatr Psychiatr Neurol 1989;2:96–100.
107. Fillenbaum GG, Hughes DC, Heyman A et al. Relationship of health and demographic characteristics to Mini-Mental State Examination score among community residents. Psychol Med 1988;18:719–726.
108. Bassett SS, Folstein MF. Cognitive impairment and functional disability in the absence of psychiatric diagnosis. Psychol Med 1991;21:77–84.
109. Mahurin RK, DeBettignies BH, Pirozzolo FJ. Structured Assessment of Independent Living Skills: Preliminary report of a performance measure of functional abilities in dementia. J Gerontol 1991;46:58–66.
110. Tomlinson BE. Morphological changes and dementia in old age. In: Smith, WL, Kinsbourne, M, eds. Aging and Dementia. Holliswood NY: Spectrum, 1977, pp 25–56.
111. Martin EM, Wilson RS, Penn RD et al. Cortical biopsy results in Alzheimer's disease: Correlation with cognitive deficits. Neurology 1987;37:1201–1204.
112. Burns A, Jacoby R, Levy R. Progression of cognitive impairment in

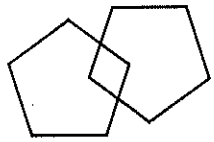
Alzheimer's disease. J Am Geriatr Soc 1991;39:39–45.
113. Burns A, Lewis G, Jacoby R, et al. Factors affecting survival in Alzheimer's disease. Psychol Med 1991;21:363–370.
114. Forette FF, Henry JF, Orgogozo JM et al. Reliability of clinical criteria for the diagnosis of dementia. Arch Neurol 1989;46:646–648.
115. Lopez OL, Boller F, Becker JT et al. Alzheimer's disease and depression: Neurological impairment and progression of the illness. Am J Psychiatry 1990;147:855–860.
116. O'Connor DW, Pollitt PA, Hyde JB et al. The progression of mild idiopathic dementia in a community population. J Am Geriatr Soc 1991;39:246–251.
117. Small GW, Kuhl DE, Riege WH et al. Cerebral glucose metabolic patterns in Alzheimer's disease. Arch Gen Psychiatry 1989;46:527–532.
118. Teri L, Hughes JP, Larson EB. Cognitive deterioration in Alzheimer's disease: Behavioral and health factors. J Gerontol 1990;45:P58–63.
119. Tinklenberg J, Brooks JO, Tanke ED et al. Factor analysis and preliminary validation of the Mini-Mental State Examination from a longitudinal perspective. Int Psychogeriatr 1990;2:123–134.
120. Uhlmann RF, Larson EB, Koepsell TD. Hearing impairment and cognitive decline in senile dementia of the Alzheimer's type. J Am Geriatr Soc 1986;34:207–210.
121. Galasko D, Corey-Bloom J, Thal LJ. Monitoring progression in Alzheimer's disesase. J Am Geriatr Soc 1991;39:932–942.
122. Berg L, Miller JP, Storandt M et al. Mild senile dementia of the Alzheimer type: 2. Longitudinal assessment. Ann Neurol 1988;23:477–484.
123. Ouslander JG, Zarit SH, Orr NK et al. Incontinence among elderly community-dwelling dementia patients: Characteristics, management and impact on caregiver. J Am Geriatr Soc 1990;38:440–445.
124. Berg S, Jeppson L. Cognitive functioning and survival in psychogeriatric patients. Acta Psychiatr Scand 1991;84:160–162.
125. Heyman A, Wilkinson WE, Hurwitz BJ et al. Early-onset Alzheimer's disease: Clinical predictors of institutionalization and death. Neurology 1987;37:980–984.
126. Cooper JK, Mungas D, Weiler PG. Relation of cognitive status and abnormal behaviors in Alzheimer's disease. J Am Geriatr Soci 1990;38:867–870.
127. Petry S, Cummings JL, Hill MA et al. Personality alterations in dementia of the Alzheimer type. Arch Neurol 1988;45:1187–1190.
128. Binder EF, Robbins LN. Cognitive impairment and length of hospital stay in older persons. J Am Geriatr Soc 1990;38:759–766.
129. Fields SD, MacKenzie DR, Charlson ME et al. Cognitive impairment. Can it predict the course of hospitalized patients? J Am Geriatr Soc 1986;34:579–585.
130. Johnston M, Wakeling A, Graham N et al. Cognitive impairment, emotional disorder and length of stay of elderly patients in a district general hospital. Br J Med Psychol 1987;60:133.
131. Mayeux R, Stern Y, Spanton S. Heterogeneity in dementia of the Alzheimer type: Evidence of subgroups. Neurology 1985;35:453–461.
132. Davidson HA, Borrie MJ, Crilly RG. Copy task performance and urinary incontinence in Alzheimer's disease. J Am Geriatr Soc 1991;39:467–471.
133. Uhlmann RF, Larson EB. Effect of education on the Mini-Mental State Examination as a screening test for dementia. J Am Geriatr Soc 1991;39:876–880.
134. Brayne C, Calloway P. The association of education and socioeconomic status with the Mini Mental State Examination and clinical diagnosis of dementia in elderly people. Age Ageing 1990;19:91–96.
135. Teng EL, Chiu HC, Schneider LS et al. Alzheimer's dementia: Performance on the Mini-Mental State Examination. J Consult Clin Psychol 1987;55:96–100.
136. O'Connor DW, Pollitt PA, Hyde JB et al. The prevalenec of dementia as measured by the Cambridge Mental Disorders of the Elderly Examination. Acta Psychiatr Scand 1989;79:190–198.
137. Cullum CM, SMernoff EN, Lord SE. Utility and psychometric properties of the Mini Mental-State Examination in healthy older adult. Paper presented at the 19th Annual meeting of the International Neuropsychological Society, San Antonio, TX 1991.
138. O'Connor DW, Pollitt PA, Treasure FP. The influence of education and social class on the diagnosis of dementia in a community population. Psychol Med 1991;21:210–224.
139. Kay DWK, Beamish P, Roth M. Old age mental disorder in Newcastle Upon Tyne. II. A study of possible social and medical causes. Br J Psychiatry 1964;110:668–682.
140. Parsons PL. Mental health of Swansea's old folk. Br J Prev Soc Med 1965;19:43–47.
141. Berg L, Danziger WL, Storandt M et al. Predictive features in mild senile dementia of the Alzheimer types. Neurology 1984;34:563–569.
142. Filley M, Brownell HH, Albert AL. Education provides no protection against Alzheimer's disease. Neurology 1985;35:1781–1784.
143. Katzman R, Brown T, Thal LJ et al. Comparison of rate of annual change of mental status score in four independnet studies of patients with Alzheimer's disease. Ann Neurol 1988;24:384–389.
144. Kittner SJ, White LR, Farmer ME. Methodological issues in screening for dementia: The problem of education adjustment. J Chron Dis 1986;39:163–170.
145. Naugle RI, Kawczak K. Limitations of the Mini-Mental State Examination. Clevel Clin J Med 1989;56:277–281.
146. Berkman LF. The association between educational attainment and mental status examinations: Of etiologic significance for senile dementias or not? J Chron Dis 1986;39:171–174.
147. Evans DA, Scherr PA, Cook NR et al. Estimated prevalence of Alzheimer's disease in the United States. Milbank Q 1990;68:267–289.
148. Gurland BJ. The borderline of dementia: The influence of sociocultural characteristics on rates of dementia occurring in the senium. In: Miller NE, Cohen GD, eds. Clinical Aspects of Alzheimer's Disease and Senile Dementia, Aging, Vol 15. New York: Raven Press, 1981, pp 61–84.
149. Folstein MF, McHugh PR. Dementia syndrome of depression. In: Katzman R, Terry RD, Bick KL, eds. Alzheimer's Disease: Senile Dementia and Related Disorders, Aging, No. 7. New York: Raven Press, 1978.
150. Cavanaugh S, Wettstein RM. The relationship between severity of depression, cognitive dysfunction, and age in medical inpatients. Am J Psychiatry 1983;140:495–496.
151. Brandt J, Folstein SF, Folstein MF. Differential cognitive impairment in Alzheimer's disease and Huntington's disease. Ann Neurol 1988;23:555–561.
152. Folstein MF, Whitehouse PJ. Cognitive impairment of Alzheimer's disease. Neurobehav Toxicol Teratol 1983;5:631–634.
153. Heyman A. Aprasia/apraxia and familial aggression in Alzheimer's disease. Ann Neurol 1984;15:615.
154. Kaszniak AW, Fox J, Gandell DL et al. Predictors of mortality in presenile and senile dementia. Ann Neurol 1978;3:246–252.
155. Bernard BA, Wilson RS, Gilley DW et al. Backward spelling as an alternative to serial subtraction on the Mini-Mental State. Paper presented at the 20th Annual meeting of the International Neuropsychological Society, San Diego, CA, 1992.
156. Ganguli M, Ratcliff G, Huff FJ et al. Serial sevens versus word backwards: A comparison of the two measures of attention from the MMSE. J Geriatr Psychiatry Neurol 1990;3:203–207.
157. Tombaugh TN. The Mini-Mental State (MMSE): Normative data over a 60-year-age range. Unpublished research, Carleton University, 1991.
158. Watkins P, Gouvier WM, Callon E et al. Equivalence of items on the mini-mental state. Arch Clin Neuropsychol 1989;4:381–384.
159. Yesavage JA. Degree of dementia and improvement with memory training. Clin Gerontol 1982;1:77–80.
160. Garcia CA, Tweedy JR, Blass JP. Underdiagnosis of cognitive impairment in a rehabilitation setting. J Am Geriatr Soc 1984;32:339–342.
161. Bucknam M, Kanar SM. Predicting performance on the MMSE. J Am Geriatr Soc 1988;36:1072.
162. Kessler J, Beil C. Predicting performance on the MMSE? J Am Geriatr Soc 1988;36:1072–1073.
163. Solomon DH. Anti-sense of prediction equations. J Am Geriatr Soc 1988;36:1072.
164. Stern Y, Sano M, Paulson J et al. Modified Mini-Mental State Examination. Neurology 1987;37(Suppl 1):179 (Abstract).
165. Stern Y, Mayeux R, Sano M et al. Predictors of disease course in patients with probable Alzheimer's disease. Neurology 1987;37:1649.
166. Gauthier S, McDowell I, Hill G. Canadian study of health and aging (CaSHA). Psychiatr J Univ Ott 1990;15:227–229.
167. Pfeffer RI, Kuroski TT, Harrah CH et al. A survey diagnostic tool for senile dementia. Am J Epidemiol 1981;114:515–527.
168. Smith A. Symbol Digit Modalities Test. Los Angeles: Western Psychological Services, 1973.
169. Raven JC. Coloured Progressive Matrices. London: HK Lewis and Co, 1969.

## APPENDIX

### Mini-Mental State Examination (MMSE)

| Questions | | Points |
|---|---|---|
| 1. | What is the: Year? Season? Date? Day? Month? | 5 |
| 2. | Where are we: State? County? Town or City? Hospital? Floor? | 5 |
| 3. | Name three objects (Apple, Penny, Table), taking one second to say each. Then ask the patient to tell you the three. Repeat the answers until the patient learns all three. | 3 |
| 4. | Serial 7s. Subtract 7 from 100. Then subtract 7 from that number, etc. Stop after five answers. *Alternative:* Spell WORLD backwards. | 5 |
| 5. | Ask for the names of the three objects learned in # 3. | 3 |

| | | |
|---|---|---|
| 6. | Point to a pencil and watch. Have the patient name them as you point. | 1 |
| 7. | Have the patient repeat "No ifs, and, or buts". | 3 |
| 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. | 1 |
| 11. | Have the patient copy the following design (overlapping pentagons). | 1 |



Total points = 30