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# Age-specific norms for the Mini-Mental State Exam

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**Article abstract**—We administered the Mini-Mental State Exam (MMSE) to 194 healthy men and women, ages 40 to 89 years. Total score was significantly associated with age ($p < 0.0001$), but not vocabulary, education, Beck's Depression Inventory Score, or sex. The lowest quartile cutoff scores for the MMSE by decade were 40s - 29; 50s - 28; 60s - 28; 70s - 28; and 80s - 26. When screening for progressive decline in cognitive performance, the use of age-specific norms may provide greater sensitivity than the present recommended cutoff score of less than 24.

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The Mini-Mental State Exam (MMSE) was developed by Folstein et al[1] as a bedside test that could be used to detect cognitive impairment. When hospitalized patients were evaluated, the MMSE was 87% sensitive and 82% specific in detecting dementia and delirium. However, the limits of normal aging must be appreciated in order to screen for cases of early dementia. Can the MMSE detect age-related change in the nervous system? We attempted to answer this question.

**Methods.** The participants were 194 healthy white volunteers (87 men, 107 women) from the community, ranging in age from 40 to 89 years. Subjects were included in the study if they never had any of the following medical conditions: head trauma with loss of consciousness, stroke, seizure, uncontrolled hypertension, diabetes, congestive heart failure, abnormal thyroid function, electroconvulsive therapy, sleep disorders, coma, psychiatric disorders, or alcohol or drug abuse. No subjects were taking centrally acting medication.

We administered the MMSE to all subjects. Instead of serial calculations, all participants were asked to spell the word "world" backwards. The three words for the recall task were "apple," "table," and "penny," always presented in that order. We gave the WAIS-R Vocabulary test to measure verbal intelligence and the Beck's Depression Inventory (BDI) to determine the presence of depression, since altered mood could result in lower scores on the MMSE. The MMSE scores had a skewed distribution; we therefore used nonparametric statistics to analyze these data.

**Results.** Table 1 shows the demographics for the population. An analysis of variance (ANOVA) showed that education and vocabulary increased significantly with age [$F(4,189) = 5.62, p < 0.001$; $F(4,189) = 3.42, p < 0.01$, respectively].

Figure 1 shows the distribution of total scores for the MMSE within each decade. A Kruskal-Wallis one-way ANOVA showed the MMSE total score to be significantly associated with age [$F(4,189) = 10.69, p < 0.0001$], but not with vocabulary, BDI score, or sex. Table 2 presents the median score and range for each decade of the MMSE and the cut-off score for the lowest

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**Table 1. Demographics of study population**

| | Age groups | | | | |
|---|---|---|---|---|---|
| | 40-49 | 50-59 | 60-69 | 70-79 | 80-89 |
| Mean age* | 44 (3.3) | 55 (2.9) | 65 (3.0) | 74 (2.6) | 83 (2.8) |
| N | 31 | 41 | 51 | 47 | 24 |
| Male/Female | 15/16 | 21/20 | 22/29 | 18/29 | 11/13 |
| Mean education (yrs) | 15 (10-22) | 13 (8-20) | 13 (9-18) | 15 (7-20) | 16 (12-21) |
| Mean vocabulary | 55 (9.2) | 53 (10.2) | 54 (8.3) | 58 (9.0) | 59 (6.7) |
| Mean Beck's Depression Score | 4 (3.9) | 5 (4.4) | 6 (4.4) | 4 (4.5) | 6 (3.6) |

* All numbers in parentheses are 1 standard deviation except for education which is followed by the range.

**Table 2. Decade norms on the MMSE**

| Age | Median score (range) | Upper quartile cut-off | Lowest quartile cut-off |
|---|---|---|---|
| 40-49 | 30 (28-30) | 30 | 29 |
| 50-59 | 29 (25-30) | 30 | 28 |
| 60-69 | 29 (25-30) | 30 | 28 |
| 70-79 | 29 (26-30) | 30 | 28 |
| 80-89 | 27 (24-30) | 29 | 26 |

quartile. The Spearman rank correlation between MMSE total score and vocabulary was not significant ($r = 0.11$).

Analysis of the individual questions on the MMSE, using a Kruskal-Wallis one-way ANOVA, showed three specific items to be significantly associated with age. These were recall of three items [$F(4,189) = 6.51, p < 0.0001$], spelling of the word "world" backwards [$F(4,189) = 3.42, p < 0.01$], and repetition of the phrase "no ifs, ands, or buts" [$F(4,189) = 5.83, p < 0.0002$]. Figure 2A shows the percent of subjects within each decade and the distribution of their score on recall of three objects. Of the words missed, "penny" was forgotten by 11% of the participants, "table" by 3%, and "apple" by 1%. Figure 2B shows the percent of subjects within a decade who received scores ranging from 1 through 5 for spelling the word "world" backwards. The most frequent error resulting in a score of 3 was the reversal of the two letters "o" and "r." Figure 2C shows the frequency distribution of the percent of subjects within a decade with the correct response on "no ifs, ands, or buts." Of the 36 individuals who received a score of 0 on this item, 89% made what was classified as an "s" error (one or more "s" in "ifs, ands, or buts" was not stated). Seventy-five percent of the "s" errors involved dropping the "s" on the word "if" only. The other error recorded in only four individuals was incorrect word order.

**Discussion.** In a population of healthy men and women, free of known neurologic or psychiatric disease, total MMSE scores decreased significantly with age even when a measure of verbal intelligence such as vocabulary increased. Vocabulary is a useful test since it is resistant to age-related changes in cognitive performance.

Recently, Kokmen et al[2] reported a "Short Test of Mental Status," with a sensitivity of 92% and a specificity of 91% in patients with Alzheimer-type dementia and dementia of miscellaneous causes. The 93 nondemented patients showed a significant association between total score and age ($r = -0.23$) and between total score and education ($r = 0.35$); the younger patients and the better educated patients had higher scores than their counterparts. In our study, however, vocabulary was not correlated with the MMSE score.

Recall of three items has been reported[3,4] as a specific item on the MMSE that is sensitive to age. Escobar et al[4] reported that renaming of the objects after 2 to 3 minutes was good for the first object (apple), but worsened for the second (table) and third (penny), which is in agreement with our findings. In Escobar et al's study, subjects older than 60 who took the MMSE in Spanish and those with low educational level had difficulty spelling "world" backwards. There was a significant decrease on this item with age. In our study, in spite of high education levels and WAIS-R Vocabulary subtest scores, performance on this item decreased significantly with age.

In the original MMSE,[1] spelling the word "world" backwards is given as an alternative if the subject cannot perform serial calculations. For the sake of standardization, we administered only "spell the word 'world' backwards." The total scores may have been slightly lower in the older age groups due to the significant aging effect on this task, which has not been reported for the serial calculation task.

The significant age-related change with repetition of a phrase was totally unexpected. Hearing had been carefully evaluated and therefore could not account for this finding. Fricatives (continuous sounds such as "f" and "s"), when placed together, are difficult to articulate under ordinary circumstances. Decreased articulatory control previously reported in the elderly[5] may explain the frequent dropping of the "s" on the word "ifs." An expanded scoring scale on this item of the MMSE would differentiate between "s" errors and those of greater significance such as deleted, added, or misplaced words.

When Folstein et al[6] examined 3,481 community-dwelling, elderly adults, only 20% of the population 65 and over scored under 24 on the MMSE. We were specifically interested in change in MMSE score attributed to age when measures of verbal intelligence were still intact. Careful exclusion of subjects with other potential confounding variables in the present study population may account for the high MMSE median scores and lowest quartile cutoff scores (if used, a score of 29 to 28 would be required until the ninth decade, at which time 26 would be adequate). When Nelson et al[7] reviewed bedside cognitive screening instruments, including the MMSE, a major limitation was their high false-negative rates. These rates, particularly in individuals with mild diffuse disorders, would be lowered by using age-specific norms.

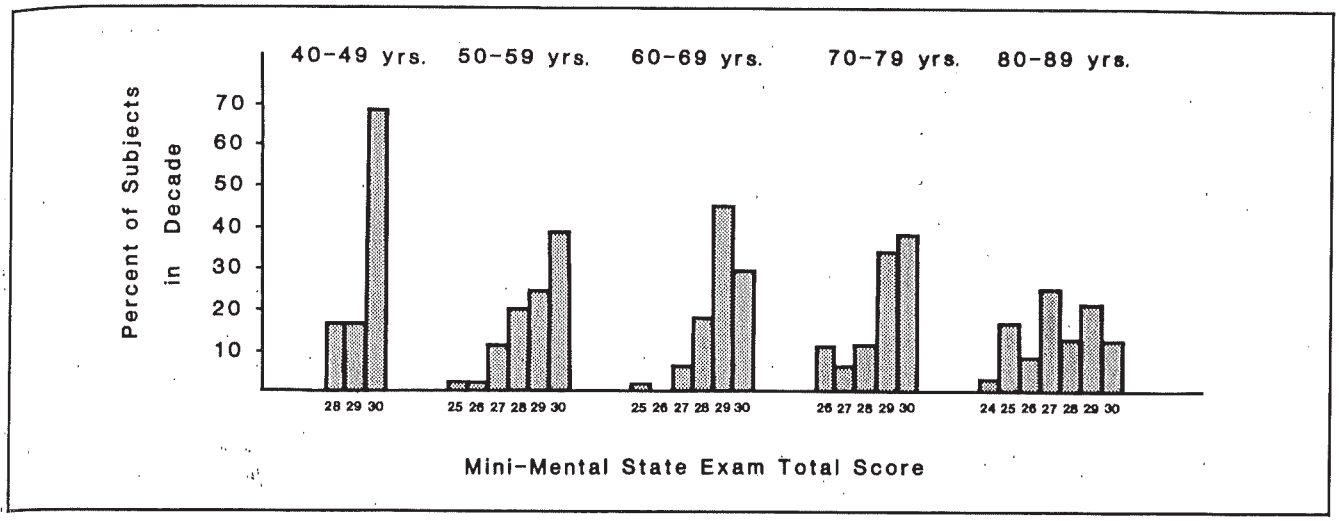


*Figure 1. Frequency distribution of total MMSE scores by decades.*

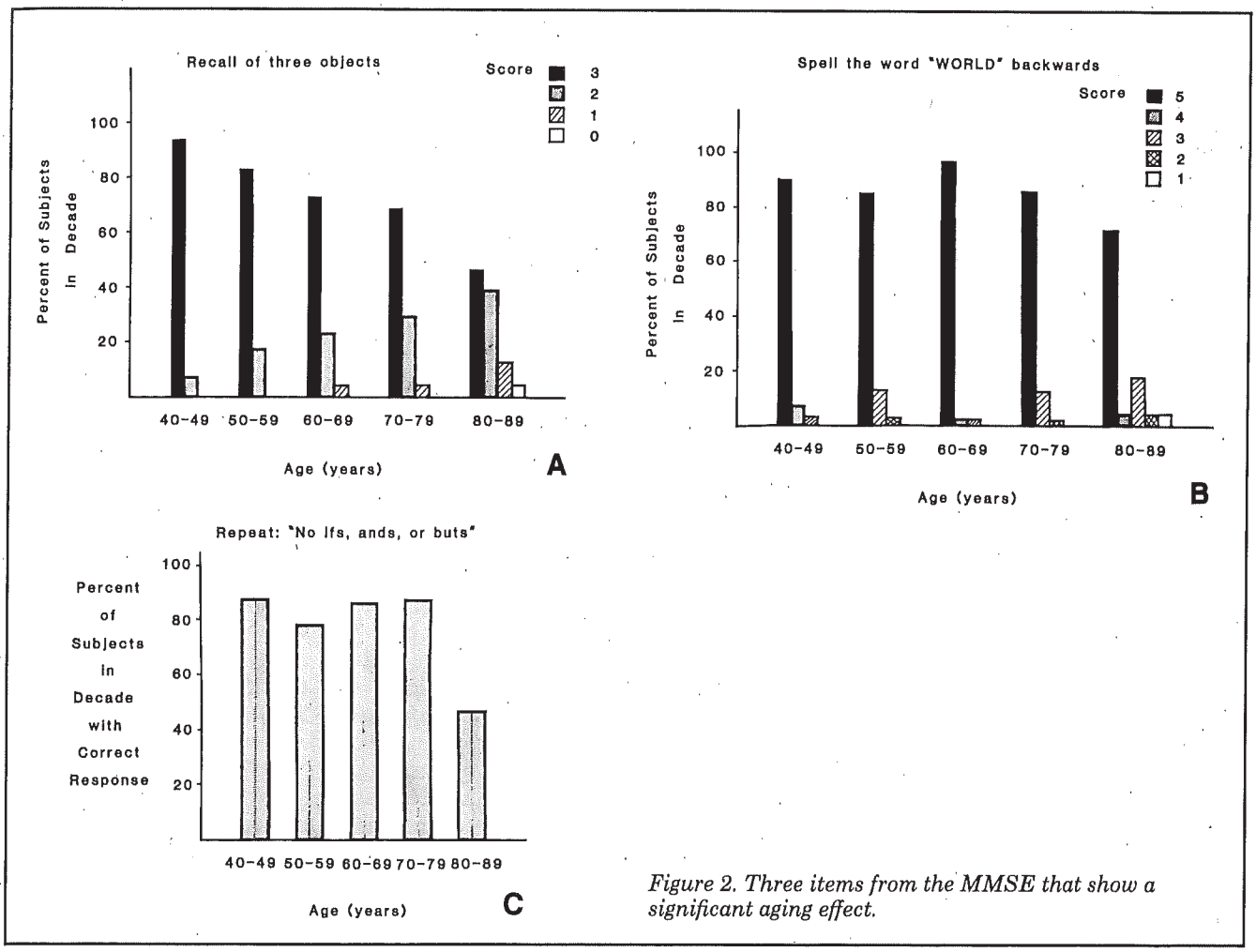


*Figure 2. Three items from the MMSE that show a significant aging effect.*

The MMSE was designed to assess cognitive function and not to differentiate focal versus diffuse hemisphere disease.[8] However, detection of change in cognitive performance beyond that established as normal requires careful determination of norms that takes into account confounding variables such as race, education, and depression.[9] Many previously studied populations have included subjects with these confounding variables, and illnesses or medications which may directly alter CNS performance. If these conditions are not present, age-related change on the MMSE should be expressed according to the cut-off scores

presented in this paper for whites with a minimum of 9 years of education. However, lack of education, particularly in the elderly, cannot be equated with low verbal intelligence. A reliable measure of verbal intelligence, vocabulary is relatively resistant to age-related change. Elderly women with 7 and 8 years of education in the present study had good performance on the vocabulary test, and therefore we felt justified to include them. In general, it is better to characterize a population by vocabulary scores, or an equivalent measure, rather than years of education, which may be influenced by other social factors. In screening large groups, this may not always be feasible.

We used the lowest quartile as a recommended cutoff score, since quartiles represent a standard and well accepted method of dividing a sample into groups without being biased by looking first at the effect of such splitting into subgroups. If an individual has an initial MMSE score in the 75th percentile for his decade norms and on repeat examination 1 to 2 years later declines to the 25th percentile, the health-care provider may wish to perform more extensive neuropsychological testing or at least more frequent examinations. Given the reliability of the MMSE,[1] longitudinal examinations at 1- to 2-year intervals, using appropriate age-specific norms, may serve as a useful screen in the elderly for the detection of change greater than that expected due to normal aging.

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