Mini-Mental State Exam Performance of Older African Americans: Effect of Age, Gender, Education, Hypertension, Diabetes, and the Inclusion of Serial 7s Subtraction Versus “World” Backward on Score

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Abstract

The Mini-Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975) is widely used to determine the cognitive status of patients and to screen for dementia. Its ubiquity is attested to by the sheer volume of literature citations; inserting MMSE or Mini-Mental State Exam as a keyword in a Medline search produces 685 publications in 2008 alone. Despite this widespread use, gaps in our knowledge of this instrument remain.

Though cognition inevitably reflects socio-cultural influences (Manly et al., 1999; Rosselli & Ardila, 2003), only a few studies have explored the role of education on performance within African American samples or have presented comprehensive normative data for this community group. The application of universal threshold (cutting) scores, or insufficiently stratified norms, results in unacceptably low classification accuracy rates for cognitive abnormality in minority populations (Fillenbaum, Heyman, Williams, Prosnitz, & Burchett, 1990).

Existing MMSE data generated with African American cohorts have been based on relatively small samples (Strickland, Longobardi, Alperson, & Andre, 2005; Unverzagt et al., 1996), low-education single-gender participants (Wood, Giuliano, Bignell, & Pritham, 2006), or elderly participants tested in their homes (Albert & Teresi, 1999). Though Alberti and Teresi report data for a relatively large sample (N = 164), their findings possess limited normative utility. Their sample likely
included a reasonable proportion of impaired subjects, since no screening methods or adaptive functioning data are reported. Rather, the authors state that some participants were unable to complete the MMSE because they were mute or could not be aroused; implicitly, anyone who could be aroused was included in their study. Participants lived in one urban region, Central Harlem. In scoring the MMSE, the authors used “the better score of the two exercises, successively subtracting 7 from 100 and spelling the world backward” in forming the total MMSE score. While this underscores one rationale for our study (that administration of the MMSE varies with unknown consequences), it limits the normative utility of the data reported. Finally, all subjects reporting 13 years of education or more were pooled together in just one educational group because they were so few in number.

To our knowledge, no published report has provided normative data stratified on several levels of age and education based on a large African American cohort or explored the influence of highly prevalent chronic illnesses on MMSE performance. Additional sources of variance in MMSE scores pertain to the presence of numerous variations in the actual test form (including, e.g., different memory items and orientation questions), along with varied administration and scoring instructions (Molloy & Standish, 1997; Woodford & George, 2007). To maximize the utility of the normative data obtained in our study, we opted to use the instructions supplied with the licensed form published by Psychological Assessment Resources.

Though the use of the licensed form allows for considerable control over variance due to form or administration and scoring differences, examiner variability likely remains with regard to whether the score obtained from the serial 7s subtraction subtest, versus the score obtained from spelling of world backward, is incorporated into an individual’s total score. Examiner choice regarding the inclusion of serial 7s subtraction versus “world” spelled backward does matter, since these items account for 5 of 30 points, correlate only modestly, and differ in difficulty level (Anthony, LeResche, Niaz, von Korff, & Folstein, 1982; Ganguli et al., 1990; Holzer, Tischler, Leaf, & Myers, 1984). Identical total scores denote different levels of cognitive competence depending on the administration approach adopted.

In the original MMSE form, spelling “world” backward is presented as a back-up alternative task to serial 7s. The administration instructions state that “if the patient cannot or will not perform this task, ask him to spell the word ‘world’ backward” (Folstein et al., 1975). “Cannot” leaves much to examiner discretion (do you discontinue and switch to “world” after they fail one, two, or however many subtractions?), and it is clear that the approach taken to this section of the MMSE has differed across studies and examiners (Ganguli et al., 1990; Woodford & George, 2007). In the licensed MMSE version, the examiner is instructed to administer “world” only if the participant refuses to attempt serial 7s (Folstein, Folstein, & Fanjiang, 2001). Leaving aside the issues of what constitutes a refusal, and whether “refusal” rates vary across examiners, the substitution of “world” backward for serial 7s subtraction implies task difficulty equivalence. This presumption of equivalence is not trivial. Research reports are seldom explicit regarding the proportion of participants whose MMSE scores reflect the inclusion of “7s” over “world”, yet typically report these MMSE scores as meaningful, replicable, and directly comparable measures of cognitive status.Clinicians monitoring cognitive course are at risk of referencing scores of questionable comparability and drawing invalid conclusions.

Assessments of cognition are typically affected by both age and education (Lucas et al., 2005; J. J. Manly et al., 1998; J. J. Manly, Schupf, Tang, & Stern, 2005). Especially among the elderly, systemic illnesses such as hypertension or diabetes can also affect cognition (Arvanitakis, Wilson, & Bennett, 2006; Knopman et al., 2003). We decided to explore the issue of administration variance while simultaneously generating normative data for older African Americans living independently in the community. Specifically, we evaluated the effect of education, age, gender, and common chronic illnesses (diabetes, hypertension, and thyroid disorder) on MMSE scores that were generated in two distinct ways for each participant. In one, total score incorporates the serial 7s subtraction score. In the other, total score incorporates “world” spelled backward. We then generated norms tables stratified on the basis of the participant characteristics that emerged as most strongly associated with total score. Finally, we briefly report on item failure rates.

**Methods**

The study (human data collection) was approved by the Human Investigation Committee of Yale University School of Medicine.

**Participants**

Three hundred and fifty-five participants participated in a study of cognition in normal older African Americans living independently in the community. All participants were interviewed by a neuropsychologist with 25 years of experience, using a set series of questions pertaining to demographics, neurodevelopmental, educational, occupational, psychiatric, alcohol and substance use, and medical history with additional questioning as required for clarification. Participants with histories of alcohol or...
substance abuse, head trauma with >30 min loss of consciousness, psychiatric hospitalizations or psychotic disorder, mental retardation, dementia, and neurological conditions including epilepsy, tumor, stroke, or multiple sclerosis were excluded, as were participants living in assisted living facilities. Of the final sample of 298, 71 (24%) were recruited by newspaper advertising, 12 (4%) responded to a community flyer, 36 (12%) were recruited in church, senior center, or other community settings, and 179 (60%) were referred by other participants (“word of mouth”). MMSE score (total with serial 7s included) did not differ across recruitment origins once age differences were controlled for, $F(2) = 0.67, p = .51$.

Included participants averaged 64.2 years old ($SD = 8.0$, range 55–87), reported 12.8 years of education ($SD = 2.7$, range 3–20), took 2.1 prescribed medicines daily ($SD = 1.9$, range 0–10), and 71.5% were women. One hundred eighty-five participants (62%) reported being treated for hypertension, 66 (22%) reported type II diabetes, and 52 (17%) reported both conditions. Twenty-seven participants (9%) reported a history of thyroid treatment. Eighty-eight participants (30%) reported no chronic illness. The participants were primarily euthymic, scoring a mean of 1.8 ($SD = 2.0$, range 0–13) on the 15-item abbreviated Geriatric Depression Scale. Ninety-two percent of the participants scored 4 or lower; scores of 5+ suggest possible depression (van Marwijk et al., 1995). Of the 25 participants scoring 5 or higher, 12 scored 5, leaving just 13 participants (4%) with scores of 6+.

All participants were living independently in the community. One participant scored one point on the 12 point Activities of Daily Living scale (Katz, 1983); all other participants scored zero, indicating that they needed no assistance with activities of daily living.

**Design**

All testing and interviewing was performed by an experienced doctoral-level neuropsychologist. The MMSE was administered according to the instructions provided on the licensed version (Psychological Assessment Resources), with the exception that all participants performed both serial 7s subtraction and spelled “world” backward. All participants were encouraged to perform the serial 7s subtraction task, and none refused. Following the delayed recall portion of the three-word memory test, all participants were asked to spell “world” forwards then backward (with score based on backward spelling, per the instructions on the licensed MMSE). We delayed the spelling of “world” backward until after the three-word recall item to preserve consistency with the common administration of the MMSE, where typically just one of the concentration tests (serial 7s or “world”) is administered before the participant is asked to recall the three words. Demographic and health-history data were gathered by an interview.

**Analysis Plan**

**Evaluating the differential association of participant variables and MMSE score.** Multiple regression allows for the determination of the relative strength of association between participant attributes (“predictors”) and a test score criterion (Licht, 1995). Following the dictate that it is best to limit the number of predictors included (since the potential for sample-specific findings increases with each additional predictor [Cohen & Cohen, 1983; Licht, 1995]), the relevance of potential predictors will be first explored using more basic procedures (Leech, Barrett, & Morgan, 2008).

First, two-tailed $t$-testing will determine whether the scores obtained by the two different scoring methods (incorporation of serial 7s versus “world”) differ sufficiently to justify further analyses using both scores.

Next, two-tailed $t$-testing will be used to explore the relationship of dichotomous variables (gender and the presence or the absence of diabetes, hypertension, hypertension plus diabetes, or thyroid disorder) to MMSE score.

Potential scale correlates of MMSE score (such as age, education, number of medications, and years of chronic illness), and of their relationship with each other, will be assessed using bivariate correlation and presented as a matrix.

Hierarchical multiple regression analyses were then undertaken to determine the unique variance associated with significant predictors.

**Norms generation.** The results of the regression analyses will determine the classification strategy employed in the development of norms tables. Prediction formula derived from the regression results will also be reported in order to provide clinicians with a second approach to establishing performance expectations for patients.

**Item difficulty level.** Item failure rates will be presented descriptively.
Results

Serial 7s versus “world”

MMSE total scores with “world” backward (M = 28.13, SD = 1.97) exceeded total scores with serial 7s (M = 26.77, SD = 2.50), two-tailed t(297) = 14.87, p < .001, Cohen’s d = 0.60. An analysis of variance with the difference between the two total scores as the dependent variable, and education group as factor, found no differences across educational levels in the size of the difference between world and serial 7s total MMSE scores, F(4, 293) = 0.59, ns.

Influence of gender, diabetes, and hypertension on MMSE

Gender had no effect on total score when total score incorporated serial 7s subtraction, men M = 26.6 (SD = 2.5), women M = 26.8 (SD = 2.4), but women performed at higher levels on total score with “world” spelled backward, M = 28.4 (SD = 1.7), men M = 27.5 (SD = 2.4), two-tailed t(121) = 3.0, p = .003, and Cohen’s d = 0.43. However, women reported slightly more years of education, M = 12.96 (SD = 2.7), men M = 12.29 (SD = 2.7), t (296) = 1.9, p = .055, and Cohen’s d = 0.25. Men and women did not differ in mean age.

Participants with diabetes scored lower than those without on both totals: serial 7s M = 26.17 (SD 2.7) versus 26.94 (SD = 2.4), two-tailed t(296) = 2.3, p = .024, and Cohen’s d = 0.30; “world” backward M = 27.7 (SD = 2.0) versus 28.25 (SD = 1.9), two-tailed t(296) = 2.0, p = .048, and Cohen’s d = 0.28. Hypertensives were not significantly inferior to participants without hypertension on either total.

Correlation matrix

As a preliminary exploration of the relationships among potential MMSE scale predictors, a correlation matrix was generated with education, age, number of medicines taken daily (a proxy for health status), years of diabetes, and years of hypertension, with total MMSE score (both variants, 7s and world). Though diabetes and hypertension were analyzed as dichotomous variables (above), we entered years of illness to determine if chronicity of illness bore any relationship with MMSE score. As can be seen in Table 1, years of education and age correlated significantly with MMSE with either serial 7s or “world” included. None of the illness variables correlated significantly with MMSE score, despite correlating with age. Older participants reported lower levels of education, r = −.20, p < .001.

Multiple regression

Since the predictors of MMSE performance are inter-related (e.g., older participants report lower levels of education and higher levels of illness, women report higher levels of education than men), hierarchical multiple regression was conducted to determine how well gender, diabetes status, and age predicted MMSE total score with serial 7s when the effect of education was controlled for. Education alone significantly predicted MMSE score, F(1, 296) = 45.4, p < .001, adjusted $R^2 = .13$. When the other variables were added, prediction was somewhat improved, $R^2$ change = .04, F(3, 293) = 4.6, p = .004. The entire group of variables predicted MMSE total (7s) F(4, 293) = 15.2, p < .001, adjusted $R^2 = .16$. The β-weights indicate that education (β = 0.32) explains most of the variance accounted for by these variables, with age contributing significantly as well (β = −0.18). Diabetes is a non-significant contributor (β = −0.08), and gender is largely irrelevant (β = 0.03).

Table 1. Inter-correlations between potential sources of variance on the MMSE scored with either serial 7s subtraction or with “world” spelled backward

<table>
<thead>
<tr>
<th></th>
<th>MMSE with “world” included</th>
<th>Age</th>
<th>Education (years)</th>
<th>Diabetes years of illness</th>
<th>Hypertension years of illness</th>
<th>Number of medications</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMSE score with 7s included</td>
<td>.765**</td>
<td></td>
<td>-.251**</td>
<td>-.016</td>
<td>-.012</td>
<td>-.102</td>
</tr>
<tr>
<td>MMSE score with “world” included</td>
<td></td>
<td>-.215**</td>
<td>.365**</td>
<td>-.020</td>
<td>-.031</td>
<td>-.085</td>
</tr>
<tr>
<td>Age</td>
<td>-.197**</td>
<td></td>
<td>.422**</td>
<td>.144*</td>
<td>.250**</td>
<td>.229**</td>
</tr>
<tr>
<td>Education</td>
<td>.009</td>
<td></td>
<td></td>
<td>-.043</td>
<td>-.067</td>
<td></td>
</tr>
<tr>
<td>Diabetes years of illness</td>
<td></td>
<td></td>
<td></td>
<td>.255**</td>
<td>.361**</td>
<td>.511**</td>
</tr>
<tr>
<td>Hypertension years of illness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Correlation is significant at the .01 level (two-tailed).

*Correlation is significant at the .05 level (two-tailed).
The analysis was repeated with MMSE incorporating “world” spelled backward as the dependent variable. Education alone significantly predicted total score, $F(1, 296) = 64.2, p < .001$, adjusted $R^2 = .18$. When the other variables were added, prediction was somewhat improved, $R^2$ change $= .05$, $F(3, 293) = 6.6, p < .001$. The entire group of variables predicted MMSE score, $F(4, 293) = 21.9, p < .001$, adjusted $R^2 = .22$. The $\beta$-weights indicate that education ($\beta = .37$) explains most of the variance accounted for by these variables, with gender ($\beta = 0.18$) and age ($\beta = -0.14$) contributing significantly as well. Diabetes is a non-significant contributor ($\beta = -0.08$). These results indicate that for either total score demographic factors account for modest but meaningful amounts of the variance observed. Education must obviously be taken into account when interpreting MMSE total scores (and perhaps somewhat more so when “world” rather than serial 7s is included), and performance declines with age. Women performed better on “world” backward than men, but no gender effect exists for serial 7s subtraction. Once age and education are accounted for, diabetes, but not hypertension, exerts a small but non-significant effect on both total scores.

These results suggest that MMSE norms should be stratified on both education and age dimensions. To determine appropriate education strata, Cohen’s $d$ was calculated for comparisons between eight $a$ priori levels of education (<9, 9–10, 11, 12, 13–15, 16, and 17+ years of education) on total score incorporating “world” backward. Neighboring levels showing small differences ($d < 0.13$) were consolidated, resulting in five educational strata: <9, 9–10, 11–12, 13–16, and 17+ years. Effect sizes between these new neighboring levels ranged from 0.32 (between the 13–16 years group and the 17+ years group) to 1.34 (between the <9 years of education group and the 10–11 years group). The difference between the group with the smallest sample (<9 years, $n = 9$) and the neighboring group (9–10 years) is statistically significant, two-tailed $r(41) = -3.91, p < .001$. The difference between the neighboring levels exhibiting the smallest effect size, 13–16 and 17+ years, is also statistically significant, $r(75.7) = -2.219$, two-tailed $p = .029$. Levene’s test indicated unequal variances ($F = 4.368, p = .039$), so degrees of freedom were adjusted from 100 to 75.7. Education and age-based norms for MMSE total score incorporating serial 7s subtraction are presented in Table 2. Since gender differences were found for MMSE total score incorporating world, norms based on gender, age, and education are presented in Tables 3 and 4.

Our regression analyses also provide guidelines. A normative expectation for a given patient can be established by inserting relevant values into the following equations (coefficients are rounded).

For total score with serial 7s subtraction:

$$\text{Expected score} = 26.6 + (\text{years of education} \times 0.30) + (-0.06 \times \text{age})$$

For total score with “world” backward:

$$\text{Expected score} = 26.6 + (\text{years of education} \times 0.27) + (-0.04 \times \text{age}) + 0.73 \text{ (if female)}$$

**Individual MMSE item (or section) difficulty**

Item difficulty varies considerably within the MMSE. Only 25% of participants scored 5/5 on serial 7s subtraction (compared with 81% for “world” backward). Recall of the three items was the second-most difficult section, with 53% scoring 3/3. Repetition was failed by 36% of the sample, whereas only 18% failed overlapping polygon drawing. Few participants failed on the remaining items.

| Table 2. MMSE total score incorporating serial 7s subtraction by age and education for older African Americans living independently |
|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| **Age 55–60** | **Age 61–73** | **Age 74+** | **All Subjects by education level** |
| **M** | **SD** | **n** | **M** | **SD** | **n** | **M** | **SD** | **n** | **M** | **SD** | **n** |
| Less than 9 years education<sup>a</sup> | 22.6 | 3.6 | 5 | 21.8 | 0.5 | 4 | 22.2 | 2.6 | 9 |
| 9–10 years education | 27.5 | 1.2 | 13 | 24.9 | 3.3 | 14 | 25.4 | 2.7 | 7 | 26.0 | 2.7 | 34 |
| 11–12 years education | 27.0 | 1.9 | 61 | 26.5 | 2.5 | 64 | 25.8 | 2.7 | 28 | 26.5 | 2.4 | 153 |
| 13–16 years education | 27.7 | 2.0 | 31 | 27.3 | 2.1 | 34 | 28.1 | 0.8 | 8 | 27.6 | 1.9 | 73 |
| 17+ years education (graduate education) | 28.2 | 1.6 | 17 | 28.1 | 0.9 | 11 | 29.0 | 0.0 | 1 | 28.2 | 1.3 | 29 |
| All subjects by age group | 27.4 | 1.9 | 122 | 26.5 | 2.7 | 128 | 25.8 | 2.8 | 48 |

<sup>a</sup>No participants aged 55–60 reported <9 years of education.
Discussion

The divergent cultural, socio-political, and educational histories of African Americans and Caucasians result in performance differences on the MMSE (Fillenbaum et al., 1990; Grober, Hall, Lipton, & Teresi, 2008). Though studies have reported high misclassification rates based on the application of universal MMSE norms to specific ethnic subgroups, there is a relative dearth of normative data that adequately account for within-group differences due to age and education effects, and none that we are aware of that simultaneously control for the differing difficulty levels of the alternative attention tasks, serial 7s subtraction and “world” spelled backward, in an African American cohort.

Our cohort confirms that the MMSE with serial sevens is a significantly harder test than when “world” spelled backward is incorporated into the MMSE total score. Our 298 participants averaged 26.77 on the MMSE with serial 7s subtraction included, significantly less than the 28.13 attained with “world” spelled backward (effect size $\hat{\eta}^2 = .61$). Whereas 80.9% correctly spelled “world” backward, only 24.5% successfully completed serial 7s subtraction. The difficulty differential between these two tests was consistent across educational levels. Similar differences in difficulty, and for a relative constancy in difficulty across education levels, have been reported for samples consisting primarily of Caucasian participants (Anthony et al., 1982; Ganguli et al., 1990; Holzer et al., 1984).

Our data underscore the importance of a standardized administration of the MMSE. Researchers and clinicians alike should be cognizant of the fact that total scores derived with “world” spelled backward reflect a different metric from scores based on the inclusion of serial 7s and that this effect has been found in primarily Caucasian as well as African American cohorts. As milder states of cognitive impairment become an increasing focus of neurodegenerative research, these differences have significant implications, since differences in scores that are solely dependent on administration method may approach or even exceed the standard deviations reported for particular clinical groups in studies comparing ostensibly cognitively normal, mildly impaired (mild cognitive impairment), and dementia groups. Significant proportions of a sample could fall either side of a diagnostic threshold (e.g., a MMSE score of 28 for “normal”) simply due to this one variation in MMSE administration.

Replicable measurement is fundamental to science and clinical practice. Journal editors should ensure that MMSE reports are accompanied by a description of how the test was administered and scored, particularly with regard to the use of serial 7s subtraction versus “world” spelled backward. When serial 7s and “world” were included as alternatives, the proportion of

Table 3. MMSE score incorporating “world” spelled backward for male participants

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Less than 9 years education</th>
<th>9–10 years education</th>
<th>11–12 years education</th>
<th>13–16 years education</th>
<th>17+ years education (graduate education)</th>
<th>All participants by education level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>n</td>
<td>M</td>
<td>SD</td>
<td>n</td>
</tr>
<tr>
<td>Less than 9 years education</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>19.50</td>
<td>3.54</td>
<td>2</td>
</tr>
<tr>
<td>9–10 years education</td>
<td>27.43</td>
<td>2.37</td>
<td>7</td>
<td>28.25</td>
<td>1.71</td>
<td>4</td>
</tr>
<tr>
<td>11–12 years education</td>
<td>27.79</td>
<td>1.74</td>
<td>24</td>
<td>28.00</td>
<td>1.53</td>
<td>13</td>
</tr>
<tr>
<td>13–16 years education</td>
<td>28.66</td>
<td>1.41</td>
<td>9</td>
<td>26.17</td>
<td>0.41</td>
<td>6</td>
</tr>
<tr>
<td>17+ years education (graduate education)</td>
<td>30.00</td>
<td>0</td>
<td>3</td>
<td>29.50</td>
<td>0.71</td>
<td>2</td>
</tr>
<tr>
<td>All subjects by age group</td>
<td>28.07</td>
<td>1.82</td>
<td>43</td>
<td>27.11</td>
<td>2.76</td>
<td>27</td>
</tr>
</tbody>
</table>

Table 4. MMSE score incorporating “world” spelled backward for female participants

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Less than 9 years education</th>
<th>9–10 years education</th>
<th>11–12 years education</th>
<th>13–16 years education</th>
<th>17+ years education (graduate education)</th>
<th>All participants by education level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>n</td>
<td>M</td>
<td>SD</td>
<td>n</td>
</tr>
<tr>
<td>Less than 9 years education</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>26.00</td>
<td>1.73</td>
<td>3</td>
</tr>
<tr>
<td>9–10 years education</td>
<td>28.00</td>
<td>1.90</td>
<td>6</td>
<td>26.50</td>
<td>2.64</td>
<td>10</td>
</tr>
<tr>
<td>11–12 years education</td>
<td>28.73</td>
<td>1.10</td>
<td>37</td>
<td>28.02</td>
<td>1.78</td>
<td>51</td>
</tr>
<tr>
<td>13–16 years education</td>
<td>28.95</td>
<td>1.05</td>
<td>22</td>
<td>29.18</td>
<td>1.12</td>
<td>28</td>
</tr>
<tr>
<td>17+ years education (graduate education)</td>
<td>29.34</td>
<td>1.08</td>
<td>14</td>
<td>29.00</td>
<td>0.71</td>
<td>9</td>
</tr>
<tr>
<td>All subjects by age group</td>
<td>28.85</td>
<td>1.18</td>
<td>79</td>
<td>28.22</td>
<td>1.85</td>
<td>101</td>
</tr>
</tbody>
</table>
participants administered either test should be reported, along with applicable administration decision rule, and details regarding which participants received which subtest.

As expected, age and education significantly influenced performance on the MMSE. Women outperformed men on “world” spelled backward; the norms tables generated by this cohort reflect these associations.

Item difficulty level varied substantially. When serial 7s subtraction is included in the MMSE, it accounts for a substantial amount of the variance seen in normal participants on total score.

The next most difficult item for our participants was recall of the three items, with 47% of participants recalling fewer than three. Thirty-six percent failed the verbal repetition task, reflecting cultural differences in everyday language usage that have been reported previously (Teresi et al., 1995). Only a minority failed polygon copying (18%). Errors were rare on the naming, reading, writing, comprehension, and orientation items (though naming the county was failed by 9% and date by 8%).

Hypertension did not significantly impact performance, but diabetics performed at slightly lower levels than participants without diabetes. The effect of diabetes falls to a statistical trend when age and education level are factored in. Adult-onset diabetics will average about 0.4 of a point lower on either total score.

Our methods of recruitment might possibly limit the generalization of the findings reported. All participants were volunteers, with many entering the study after hearing of it from prior participants; however, no differences in performance were detected based on the diverse recruitment methods employed. Other weaknesses include the small cell sizes for some education by age classifications, and more so for education by age and gender classifications. Another weakness is that we used years of education rather than quality of education (e.g., performance on a reading test) as our education variable. Mitigating this weakness is the fact that strong relationships between MMSE score and years of education (as participant reported) exist, and information on years of education will be available to virtually all clinicians (e.g., at the hospital bedside; in the family doctor’s office) where as indices of education quality will be available to only a minority of MMSE users. Similarly, though our data did not include measures of acculturation (assimilation into the mainstream culture), we excluded participants born outside of the US mainland (e.g., the Caribbean), and for included participants, years of education should act as a reasonable proxy. Strengths include the fact that our participants were without cognitive complaints and living independently in the community, and the sample was sufficiently large and diverse in educational background and age to allow for the formation of discrete, well-characterized groups based on cognitively salient demographics. This will allow clinicians to closely match their patients to the most applicable normative data.

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Conflict of Interest

None declared.

References


