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Brief Report

# A Comparison of Two Brief Screening Measures of Cognitive Impairment in Huntington's Disease

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*Abstract:* **The goal of this study was to explore whether the Montreal Cognitive Assessment (MoCA), a new screening instrument, would be more sensitive to mild to moderate cognitive impairment in Huntington's disease (HD) than an established screening measure, the Mini Mental State Exam (MMSE). Our reasoning for this query is that the MoCA includes a broader range of test items and an additional assessment of executive functioning and attention compared with the MMSE. Using the receiver operating characteristic (ROC) analysis to examine performance of HD and control groups on both tests on overall scores and scores from various subdomains (i.e., visuospatial abilities) revealed that the MoCA achieved higher sensitivity without sacrificing specificity in many domains relative to the MMSE.** © 2010 Movement Disorder Society

**Key words:** Huntington's disease; Mini Mental State Exam; Montreal Cognitive Assessment; executive function; visuospatial; language

Neuropsychological test batteries can be useful tools for discriminating between levels of cognitive impairment in individuals with neurologic diseases. However, a complete neuropsychological assessment is unsuitable for most medical visits, when clinicians require rapid assessment of global cognitive functioning. Consequently, brief screening instruments are a means to summarize, and concisely communicate, information about a patient's overall level of cognitive functioning. A number of brief screening measures have been developed, such as the Folstein Mini Mental State Exam (MMSE),[1] 7-Minute Screen,[2] Blessed Information Memory Concentration test,[3] and Alzheimer's Disease Assessment Scale.[4] These vary greatly in sensitivity and specificity depending on test length and target population (for review see Cullen et al.).[5]

The MMSE, the most commonly used brief screening instrument for cognitive impairment,[5] effectively distinguishes individuals without significant cognitive impairment from those with dementia. Although it is an accurate indicator of probable AD,[6–8] it is subject to ceiling effects in individuals with intact abilities or in patient groups with more subtle cognitive deficits. In addition, the MMSE relies heavily on intact verbal rather than visuospatial skills and it lacks items to assess executive functions and complex attention. These limitations may be more apparent in assessment of individuals with Huntington's disease (HD) since the cognitive profile is often characterized by deficits in executive functioning, visuospatial abilities, and attention,[9,10] rather than memory or language. Recently, an alternative screening measure, the Montreal Cognitive Assessment (MoCA),[11] was developed to capture performance deficits in a wider array of cognitive domains using items with a greater range of difficulty relative to the MMSE. Because of its inclusion of executive function/attention and visuospatial items, we hypothesized that the MoCA would be more sensitive than the MMSE to impairments seen in mild to moderate HD.

## SUBJECTS AND METHODS

### Subjects

Thirty-nine subjects with mild to moderate HD were recruited from the University of California, San Diego (UCSD) HD Society of America Center of Excellence

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**TABLE 1.** *Means and standard deviations for group demographics and test information*

| | HD, n = 39 | CC, n = 73 | Test statistic | *P* value |
|---|---|---|---|---|
| Age (yr) | 50.7 ± 10.8 | 51.1 ± 11.3 | $t = -0.17$ | 0.869 |
| Gender (male/female) | 14/25 | 37/36 | $\chi^2 = 0.89$ | 0.345 |
| Education (yr) | 14.1 ± 2.3 | 14.8 ± 2.2 | $t = -1.58$ | 0.117 |
| MoCA[a] total points (range) | 20.1 ± 4.5 (11–29) | 27.4 ± 1.9 (21–30) | $U = 175.50$ | <0.001 |
| MMSE total points (range) | 24.9 ± 2.8 (19–30) | 29.0 ± 1.0 (26–30) | $U = 276.00$ | <0.001 |

[a]Scores before education adjustment.

Abbreviations: HD, Huntington's disease; CC, community controls; *t*, Student's *t*-test; $\chi^2$, chi-square statistic; MoCA, Montreal Cognitive Assessment; MMSE, Mini Mental State Examination; *U*, Mann-Whitney U statistic.

(COE) and examined by a senior neurologist. Inclusion criteria included a definitive diagnosis of HD with family history and/or expanded cytosin, adenine, and guanine (CAG) repeat over 39 and overt motor signs (e.g., chorea). The Unified Huntington's Disease Rating Scale (UHDRS)[12] was administered to quantify neurologic and functional deficits. The UHDRS Total Motor Score can range from 0 (no motor symptoms) to 124 (severe, bilateral deficits in all categories). Patients with HD with dysgraphia or dysarthria severe enough to impede administration of test items were excluded from the study. In addition, subjects were assessed on the UHDRS Functional Capacity Scale, which quantifies competence for activities of daily living on a scale of 0 to 13, with higher scores indicating better functioning.

Seventy-three community control (CC) subjects were recruited from ongoing studies at the UCSD HD COE and screened for any condition that might impair cognition (i.e., head injury, neurologic disease, and substance abuse). Control subjects matched the HD group on mean age and years of education. Human subjects' approval was obtained from the UCSD Institutional Review Board. Subjects were administered the MMSE and MoCA on the same day following standard procedures in counterbalanced order.

## Measures

The MoCA and MMSE assess a range of cognitive skills on a scale of 0 to 30 points with higher scores indicating better performance and a suggested impairment cutoff of 25 or fewer points. An item-by-item comparison is beyond the scope of this study, as the tests include items that vary by type and level of difficulty, and identical items receive differential weighting. As an alternative, we grouped individual items into four widely used cognitive domains (visuospatial, language, memory, and orientation) based on previous research[13] to compare their relative utility in distinguishing controls from patients with HD. The visual-spatial items included design copy (both tests) and figure drawing to command (MoCA only). The language items included object naming, phrase/sentence repetition (both tests), verbal commands, and reading comprehension (MMSE). The verbal memory items included recall of either five (MoCA) or three (MMSE) previously presented words. The MoCA also includes a fifth executive function/attention domain comprised of items for phonemic fluency, visuospatial sequencing/alternation based on Trail Making B Test, verbal abstraction, auditory span, and target detection using auditory vigilance for the letter "A." To permit more direct comparisons between measures, we excluded scores from the serial subtraction items from both tests because of differential weighting, consequently the MMSE does not have an executive function/attention analysis.

## Statistical Analysis

The raw data were examined for outliers and parametric distribution requirements. Between-group comparisons of demographic characteristics were conducted using Student's two-group *t*-tests (or $\chi^2$ for nominal data). Because of significantly non-normal distributions, we used nonparametric Mann-Whitney U to illustrate between-group differences, and Wilcoxon rank sum test to illustrate within-group performance on MoCA and MMSE point totals. Using the receiver operating characteristic (ROC) analyses, we examined the ability of the two instruments to differentiate between HD and CC subjects using the total number of points (excluding MoCA education correction), and using groupings of test items representing cognitive domains. The ROC analysis yields sensitivity and specificity statistics, and a graphical representation of how well each test or domain classifies patients with HD and controls beyond a chance (50%) level.[14]

# RESULTS

There were no significant differences between the groups on age, education, or gender variables (see Table 1). In the HD sample, mean CAG repeat number was 44.6 (SD = 3.6; range: 40–57). The UHDRS mean motor score was 36.9 (SD = 17.7; range: 10–

**TABLE 2.** *ROC analysis for MoCA and MMSE scores per group*

| | Test | AUC | S.E. | *P* | Sensitivity (%) | Specificity (%) |
|---|---|---|---|---|---|---|
| Total score | MoCA | 0.938 | 0.025 | <0.01 | 97.4 | 30.1 |
| | MMSE | 0.903 | 0.033 | <0.01 | 84.6 | 31.5 |
| Visual spatial | MoCA | 0.745 | 0.052 | <0.01 | 69.2 | 30.1 |
| | MMSE | 0.595 | 0.059 | 0.10 | 23.0 | 4.1 |
| Language | MoCA | 0.669 | 0.056 | <0.01 | 59.0 | 28.8 |
| | MMSE | 0.57 | 0.059 | 0.23 | 23.1 | 9.6 |
| Memory | MoCA | 0.825 | 0.043 | <0.01 | 82.1 | 32.9 |
| | MMSE | 0.713 | 0.052 | <0.01 | 71.8 | 32.9 |
| Orientation | MoCA | 0.603 | 0.059 | 0.08 | 20.5 | 0 |
| | MMSE | 0.713 | 0.056 | <0.01 | 46.2 | 0 |
| Exe Func Attention | MoCA | 0.833 | 0.0485 | <0.01 | 69.2 | 13.7 |

ROC, receiver operating characteristic; MoCA, Montreal Cognitive Assessment; MMSE, Mini Mental State Examination; AUC, area under the curve; SE, standard error; *P* probability value

76). Mean Functional Capacity Score (FCS) for the HD group was 6.6 (SD = 1.9; range: 2–11 points).

As expected, the HD group scored significantly lower than the CC group on the MOCA and MMSE total scores (see Table 1). In addition, within-group comparisons indicated that both the HD (Wilcoxon $z = -5.3$; $P < 0.001$) and CC groups (Wilcoxon $z = -5.9$; $P < 0.001$) had lower total scores on the MoCA relative to the MMSE.

Using ROC analysis, we examined performance of both groups on all test domains (see Table 2 for sensitivity and specificity percentages and Fig. 1). The area

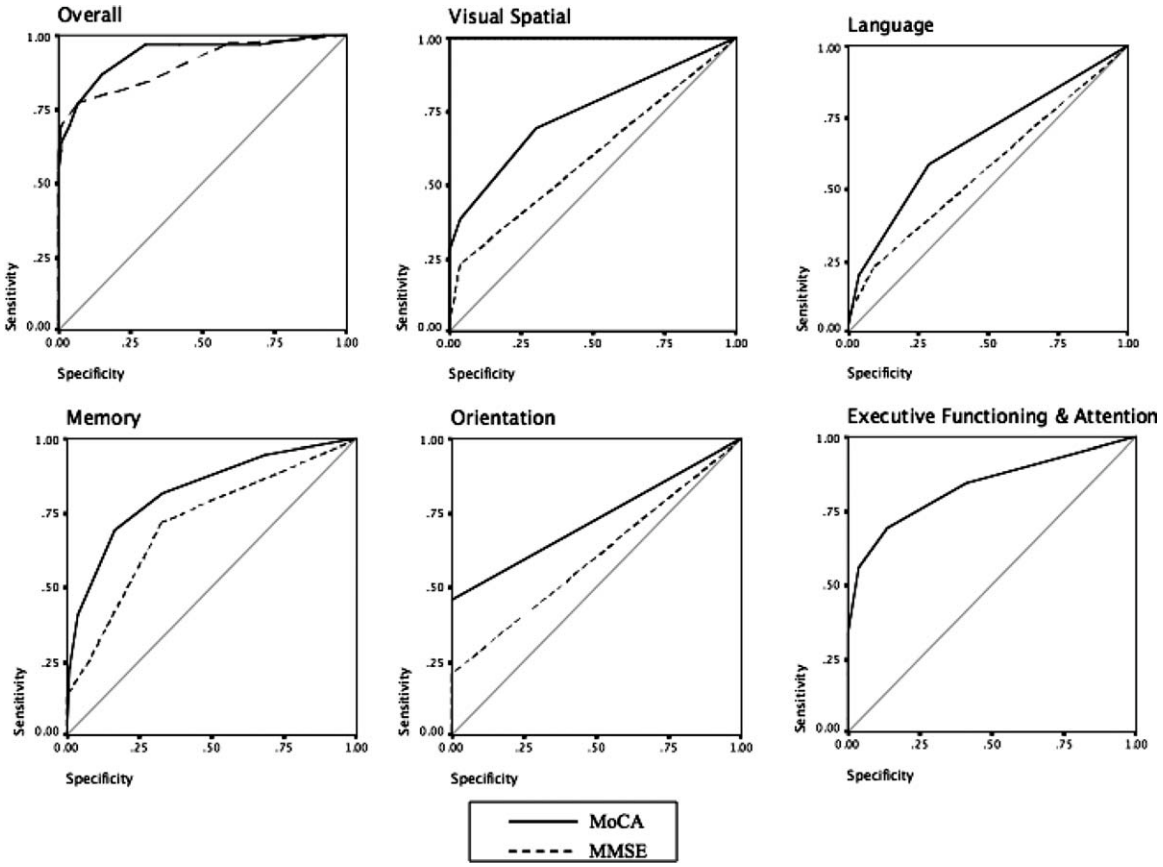


**FIG. 1.** Receiver operating characteristic curves for showing MoCA and MMSE discriminatory capability in HD and CC for total scores (upper left), visual spatial ability (upper middle), language (upper right), memory (lower left), orientation (lower middle), and executive functions (MoCA only).

under the curve (AUC) values demonstrate that both tests significantly discriminated HD from CC subjects on total scores; however, the MoCA score yielded higher sensitivity while maintaining a comparable level of specificity relative to the MMSE. A similar pattern was found in the memory domain, with both tests accomplishing successful group discrimination; the MoCA, however, yielded higher sensitivity and comparable specificity. In contrast, only the MoCA, and not the MMSE, yielded significant AUC values for visuospatial and language scores, with higher sensitivity and specificity relative to the comparable MMSE domains. The MMSE showed superior discrimination on orientation. Finally, the MoCA executive function/attention score yielded a significant AUC for group discrimination.

## DISCUSSION

To determine whether the MoCA would be more sensitive to HD-related cognitive impairment than the more widely used MMSE, we evaluated the performance of patients with HD and matched CCs on these two measures. Our expectation that the MoCA's expanded assessment of executive function/attention and visuospatial skills would improve discrimination between groups was confirmed. The HD group had significantly lower total scores on both the MoCA and the MMSE relative to controls. More importantly, the MoCA yielded a broader range of scores than the MMSE in both groups, suggesting better identification of within-group differences in deficits in the patients with mildly to moderately impaired HD. Although our primary focus was a within-subjects comparison for the HD group, we noted that the MoCA's range of scores for the control group was more than twice that of the MMSE, again suggesting improved sensitivity to cognitive differences.

The ROC analyses also showed that the MoCA achieved higher sensitivity without sacrificing specificity in many domains relative to the MMSE. For example, the MoCA improved discrimination of spatial abilities by including a visuospatial item (clock drawing) that requires planning abilities. Another somewhat surprising advantage of the MoCA was in the language domain. Despite fewer items relative to the MMSE, the MoCA showed superior discriminability in this HD group with putatively intact language skills. On the other hand, the MMSE was more discriminatory on the orientation domain, likely a result of differential weighting of these items.

To our knowledge, this is one of the first investigations of the MoCA's ability to assess cognitive deficits in patients with HD. Because our selection of subjects with HD focused on those with mild to moderate symptoms, the range of scores represents a potential limitation for the generalizability of these findings to more severely impaired subjects. Furthermore, without additional neuropsychological testing, it is difficult to estimate appropriate cutoffs for patient groups, and further research will be needed to translate these findings into implications for everyday functioning. Nevertheless, our findings are consistent with other studies that examined the ability of these instruments to detect evidence of cognitive impairment in other patient groups (e.g., Parkinson's disease[15] and cerebrovascular disease).[16,17] These findings also support a recent observation by Zadikoff and colleagues[15] that the MMSE fails to adequately sample the executive function/attention domain, with a corresponding loss of sensitivity to disorders like Parkinson's Disease (PD), especially in its early stages. In conclusion, the MoCA may be the preferable screening measure for assessing mild to moderate cognitive impairment in individuals with HD due to its ability to detect subtle deficits in specific cognitive domains associated with the disease.

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