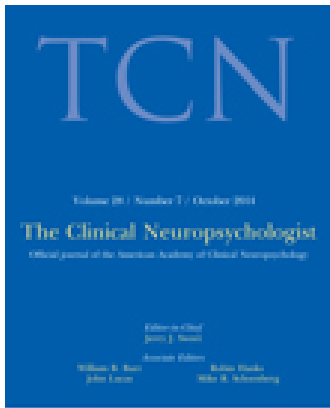


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## The Clinical Neuropsychologist

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/ntcn20>

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Erik Oudman<sup>ab</sup>, Albert Postma<sup>ac</sup>, Stefan Van der Stigchel<sup>a</sup>, Britt Appelhof<sup>a</sup>, Jan W. Wijnia<sup>b</sup> & Tanja C. W. Nijboer<sup>acd</sup>

<sup>a</sup> Department of Experimental Psychology, Helmholtz Institute, Utrecht University, The Netherlands

<sup>b</sup> Slingsdael Korsakoff Center, Rotterdam, The Netherlands

<sup>c</sup> Brain Center Rudolf Magnus, University Medical Center Utrecht Department of Neurology, The Netherlands

<sup>d</sup> Brain Center Rudolf Magnus, and Center of Excellence for Rehabilitation Medicine, University Medical Center Utrecht and De Hoogstraat Rehabilitation, The Netherlands

Published online: 24 Sep 2014.

To cite this article: Erik Oudman, Albert Postma, Stefan Van der Stigchel, Britt Appelhof, Jan W. Wijnia & Tanja C. W. Nijboer (2014) The Montreal Cognitive Assessment (MoCA) is Superior to the Mini Mental State Examination (MMSE) in Detection of Korsakoff's Syndrome, *The Clinical Neuropsychologist*, 28:7, 1123-1132, DOI: [10.1080/13854046.2014.960005](https://doi.org/10.1080/13854046.2014.960005)

To link to this article: <http://dx.doi.org/10.1080/13854046.2014.960005>

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## The Montreal Cognitive Assessment (MoCA) is Superior to the Mini Mental State Examination (MMSE) in Detection of Korsakoff's Syndrome

Erik Oudman<sup>1,2</sup>, Albert Postma<sup>1,3</sup>, Stefan Van der Stigchel<sup>1</sup>,  
Britt Appelhof<sup>1</sup>, Jan W. Wijnia<sup>2</sup>, and Tanja C. W. Nijboer<sup>1,3,4</sup>

<sup>1</sup>Department of Experimental Psychology, Helmholtz Institute, Utrecht University, The Netherlands

<sup>2</sup>Slingedael Korsakoff Center, Rotterdam, The Netherlands

<sup>3</sup>Brain Center Rudolf Magnus, University Medical Center Utrecht Department of Neurology, The Netherlands

<sup>4</sup>Brain Center Rudolf Magnus, and Center of Excellence for Rehabilitation Medicine, University Medical Center Utrecht and De Hoogstraat Rehabilitation, The Netherlands

The Montreal Cognitive Assessment (MoCA) and Mini Mental State Examination (MMSE) are brief screening instruments for cognitive disorders. Although these instruments have frequently been used in the detection of dementia, there is currently little knowledge on the validity to detect Korsakoff's syndrome (KS) with both screening instruments. KS is a chronic neuropsychiatric disorder associated with profound declarative amnesia after thiamine deficiency. A representative sample of 30 patients with KS and 30 age-, education-, gender- and premorbid-IQ-matched controls was administered the MoCA and MMSE. The area under the receiver operating characteristic curve (AUC) was calculated in addition to the sensitivity, specificity, positive predictive value, and negative predictive value for various cut-off points on the MoCA and MMSE. Compared with the MMSE, the MoCA demonstrated consistently superior psychometric properties and discriminant validity—AUC: MoCA (1.00 *SE* .003) and MMSE (0.92 *SE* .033). When applying a cut-off value as suggested in the manuals of both instruments, the MMSE (< 24) misdiagnosed 46.7% of the patients, while the MoCA (< 26) diagnosed all patients correctly. As a screening instrument with the most optimal cut-offs, the MoCA (optimal cutoff point 22/23, 98.3% correctly diagnosed) was superior to the MMSE (optimal cutoff point 26/27, 83.3% correctly diagnosed). We conclude that both tests have adequate psychometric properties as a screening instrument for the detection of KS, but the MoCA is superior to the MMSE for this specific patient population.

**Keywords:** Mini Mental State Examination; Cognitive screening; Alcoholism; Amnesia; Korsakoff's syndrome.

### INTRODUCTION

Cognitive assessments are clinical examinations to correctly diagnose individuals with cognitive disorders. However, comprehensive cognitive testing is time consuming, requires skilled clinicians, and is demanding for the patient. Therefore, brief screening tools are often applied to obtain an impression regarding cognitive performance of the patient. The Mini Mental State Examination (MMSE) (Folstein, Folstein, & McHugh,

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Address correspondence to: Erik Oudman, Helmholtz Institute, Experimental Psychology, Utrecht University, Heidelberglaan 1, 3584 CS Utrecht, The Netherlands. E-mail: [e.oudman@leliezorggroep.nl](mailto:e.oudman@leliezorggroep.nl)

(Received 10 May 2014; accepted 26 August 2014)

1975) and the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005) are two commonly used brief screening instruments for cognitive impairment. The MMSE was originally developed to screen for dementia in a psychiatric setting, and has been shown to have a good sensitivity and specificity as such (Cullen, O'Neill, Evans, Coen, & Lawlor, 2007; Folstein et al., 1975). The MoCA is another brief screening instrument for dementia and Mild Cognitive Impairment (MCI) and is thought to assess a broader array of cognitive domains than the MMSE (Nasreddine et al., 2005). Currently there is debate on the validity of the MMSE as a screening instrument to assess cognitive impairment in certain patient populations. A recent meta-analysis showed that the MMSE has limited value in making a diagnosis of MCI against healthy controls (Mitchell, 2009). Moreover, the MMSE lacks items that index executive functioning and is therefore less sensitive in the detection of patients with specific executive deficits (Mickes et al., 2009). Nevertheless, the MMSE is currently the most commonly used screening instrument for cognitive disorders (Gluhm et al., 2013). Although the MoCA has been less extensively studied than the MMSE, recent studies show that the MoCA could be successfully applied as a screening for MCI (Hoops et al., 2009; Nasreddine et al., 2005) and the instrument successfully detects executive dysfunction in Alzheimer's disease, Parkinson's disease, and Huntington's disease (Gluhm et al., 2013; Hoops et al., 2009; Nasreddine et al., 2005). Recently, the MoCA was also identified as a useful screener with good discriminatory power in Korsakoff's syndrome (KS) (Wester, Westhof, Kessels, & Egger, 2013).

KS is a chronic neuropsychiatric disorder associated with profound declarative amnesia. Often the syndrome is the result of thiamine deficiency after prolonged alcoholism (Kopelman, 2002). Commonly executive cognitive dysfunction is also present (Maharasingam, Macniven, & Mason, 2013; Van Oort & Kessels, 2009). Although the MMSE is widely used in various neurological and psychiatric patients in a variety of settings, there are currently no studies available on the usability of the MMSE in KS. Moreover, no study has yet compared the psychometric properties and validity of the MMSE and MoCA in KS. This is remarkable in light of the fact that Korsakoff's syndrome is common in alcoholics. Recent studies suggest that up to 15% of the alcoholics have KS (see Zahr, Kaufman, & Harper, 2011, for a review). Cognitive screening could dramatically improve the recognition of KS in alcoholics. There is growing evidence that cognitive impairment contributes to poor treatment outcome in treatment of alcoholism, stressing the importance of versatile cognitive screening in all alcoholics (Alterman, Kusher, & Holohan, 1990). Given these considerations, the aim of the present study was to examine the usefulness of the two screening instruments, i.e., the MoCA and the MMSE, in a group of KS patients. We compared the psychometric properties and diagnostic validity of the screening instruments for this patient group.

## METHOD

### Participants and procedure

The MoCA and MMSE were administered by the same psychologist on the same day in randomly assigned counterbalanced order in 30 patients diagnosed with KS and 30 age-, education-, gender-, and premorbid-IQ-matched controls. Between administration of the MoCA and the MMSE there was a 5-minute pause. The controls were

volunteers who came to our attention through advertising online or by word of mouth. The patients were inpatients of the Korsakoff Center, 'Slingsdael', Rotterdam, the Netherlands. All patients fulfilled the DSM-IV criteria for alcohol-induced persisting amnesic disorder (APA, 2000) and the criteria for KS described by Kopelman (2002). All patients were in the chronic, amnesic stage of the syndrome; none of the patients had confusional Wernicke psychosis at the time of testing. All patients had an extensive history of alcoholism and nutritional depletion, notably thiamine deficiency, verified through medical charts or family reports. All patients were abstinent from alcohol for at least 6 months. General exclusion criteria were presence of neurological disorders (moderate to severe traumatic brain injury, stroke, epilepsy or brain tumor), illiteracy, and acute psychiatric conditions (psychosis, major depression, etc.), or physical conditions interfering with the testing procedure. Exclusion criteria were verified through inspection of medical charts or family reports. For both the patients and the control group, education level was assessed using seven categories, 1 being the lowest (less than primary school) and 7 being the highest (academic degree) (Verhage, 1964). Premorbid IQ was estimated for both patients and controls with the Dutch Adult Reading Test (Schmand, Lindeboom, & van Harskamp, 1992). The project was conducted according to the declaration of Helsinki and informed consent was obtained.

### MMSE

The MMSE consists of 30 items intended to index orientation, registration, attention and calculation, recall and language. The maximum possible score is 30 points, with a score < 24 considered as an indication for cognitive decline or dementia (Folstein et al., 1975).

### MoCA

The MoCA (Dutch version 1) consists of 13 tasks organized into seven cognitive domains including executive functioning, naming, memory, attention, naming, abstraction, and orientation. A total score was generated by summing scores across the seven domains. One point was added for persons with the Dutch educational level 4 or lower (Nasreddine et al., 2005; Verhage, 1964; Wester et al., 2013). The maximum possible score is 30 points, with a score < 26 considered as an indication for cognitive impairment.

### Statistical analysis

Receiver operating characteristics (ROC) were used to calculate the Area Under the Curve (AUC) for the MMSE and MoCA with SigmaPlot (Systat Software, San Jose, CA). The AUC varies between 0.5 and 1. The ideal test has an AUC of 1, meaning 100% sensitivity and specificity. The sensitivity and the specificity for various cut-off points of the MMSE and MoCA were determined (sensitivity = true positives/true positives + false negatives; specificity = true negatives/true negatives + false positives). When evaluating the usefulness of a screening measure to identify individuals with cognitive disorders, a good sensitivity (> 80%) is required, while maintaining a low false positive rate (specificity > 60%) (Blake, McKinney, Treece, Lee, & Lincoln, 2002).

Moreover, positive predictive values (PPV), negative predictive values (NPV), Likelihood Ratios and percentage correctly diagnosed in the current sample were calculated. Pearson's correlation coefficients were calculated between the MoCA and MMSE score and (1) age and (2) an index of premorbid IQ. Spearman's rank correlation coefficient was calculated between the MoCA and MMSE score and level of education (Verhage, 1964).

## RESULTS

### Clinical characteristics and demographic variables

Table 1 shows a summary of clinical characteristics and demographic variables of the patients and controls. No statistically significant differences between the patients and controls were found on clinical characteristics or demographic variables.

### MoCA versus MMSE

When applying a cut-off value of 24 for the MMSE, which is a frequently used cut-off for hospitalized patients, 14 patients (46.7%) were misclassified as cognitively intact by the MMSE. No patients were incorrectly classified when a cut-off of 26 for the MoCA was used. When differentiating patients with KS from controls, the MMSE had an ROC AUC of 0.92 (95% CI .85 – .98,  $SE = .033$ ) and the MoCA had an ROC AUC of 1 (95% CI 0 – 1,  $SE = .003$ ), indicating that the MoCA can perfectly discriminate patients with KS from controls with a confidence interval of 95%. Also, the MMSE has rather good discriminative abilities. The ROC curve is presented in Figure 1 and the sensitivity and specificity is presented in Table 2.

The optimal screening cut-offs are 26/27 (81.7–83.3% correctly diagnosed) for the MMSE and 22/23 for the MoCA (95–98.3% correctly diagnosed) (see Table 2). The optimal proportion of correctly diagnosed individuals was significantly higher for the

**Table 1.** Summary of demographic variables for all participants

| Measurement                                 | Patients   | Controls     | Significance           |
|---|------------|--------------|------------------------|
| Number (number of males)                    | 30 (24)    | 30 (24)      |                        |
| Age   | 59.5 (8.9) | 60.3 (7.2)   | $t(58) = .34$          |
| Educational level mode (range) <sup>a</sup> | 5 (2–7)    | 4 (3–7)      | $U(58) = 1.64$         |
| IQ estimation $\mu$ ( $SD$ ) <sup>b</sup>   | 99.2 (8.3) | 103.6 (10.7) | $t(58) = 1.76$         |
| MMSE ( $SD$ )                               | 23.2 (3.3) | 28.2 (1.8)   | $t(58) = 7.23^{****}$  |
| MoCA ( $SD$ )                               | 18.1 (3.9) | 27.1 (1.9)   | $t(58) = 11.18^{****}$ |

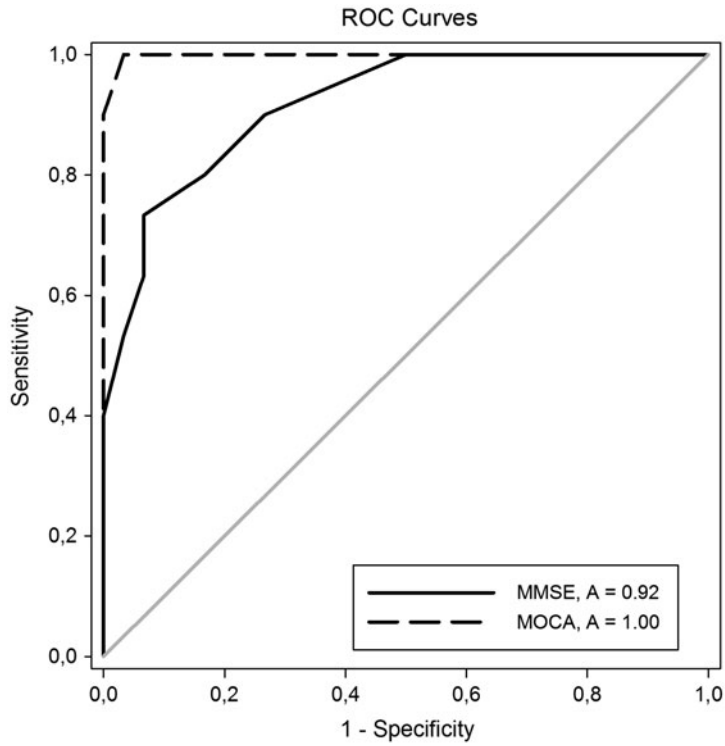
\*\*\*\* = statistically significant ( $p < .001$ ).

MMSE = Mini Mental State Examination.

MoCA = Montreal Cognitive Assessment.

<sup>a</sup>Educational level was assessed in seven categories: 1: less than primary school (1–5 years of education); 2: primary school (6 years of education); 3: prolonged primary school (7–8 years of education); 4: lower secondary school (7–9 years of education); 5: secondary school (7–11 years); 6: higher secondary school and/or university bachelor degree (7–16 years of education); 7: university master degree or Phd (17–20 years of education) (Verhage, 1964).

<sup>b</sup>IQ was estimated with the Dutch Adult Reading Test (Schmand et al., 1992).



**Figure 1.** Receiver Operating Characteristics (ROC) curve for the Mini Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA) in 30 patients diagnosed with Korsakoff's syndrome and 30 age-, education-, gender-, and premorbid-IQ-matched controls.

MoCA compared to the MMSE ( $z = 2.8, p < .01$ ). As could be inspected in Table 2, the screening cut-off of 23 for the MoCA has nearly perfect PPV, NPV, and Likelihood Ratios.

### Correlational analysis

To investigate possible relations between both screening instruments and the clinical characteristics we computed several correlations. Correlation coefficients should be interpreted with caution, since the number of participants was rather small. Results are displayed in Table 3. The MMSE and MoCA showed a very strong positive relationship in patients and a strong positive relationship in controls. This suggests that despite psychometric differences between both screening instruments, there is also a strong consistency in performance on the tasks. Moreover, in controls but not in patients, the MMSE showed a strong positive relationship with a task intended to index premorbid intellectual functioning. In KS patients the performance on the MMSE thus could be independent of intellectual functioning. While the MoCA score showed a moderate positive relationship with the level of education in controls, the relation was not significant in patients. This demonstrates that within-group performance variations in KS patients on the MoCA are not related to academic skills.

**Table 2.** Discriminant validity for the Mini Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) for diagnosis of Korsakoff's syndrome

| MMSE Cut-off | Sensitivity (%) | Specificity (%) | Correctly diagnosed (%) | PPV (%) | Positive Likelihood Ratio | NPV (%) | Negative Likelihood Ratio | MoCA Cut-off | Sensitivity (%) | Specificity (%) | Correctly diagnosed (%) | PPV (%) | Positive Likelihood Ratio | NPV (%) | Negative Likelihood Ratio |
|--------------|-----------------|-----------------|-------------------------|---------|---------------------------|---------|---------------------------|--------------|-----------------|-----------------|-------------------------|---------|---------------------------|---------|---------------------------|
|              |                 |                 | 51.7%                   | 100%    | Infinite                  | 50.8%   | 0.9%                      |              |                 |                 | 51.7%                   | 100%    | Infinite                  | 50.8%   | 0.9%                      |
| <16          | 6.7             | 100             | 51.7%                   | 100     | Infinite                  | 50.8    | 0.9                       | <7.5         | 6.7             | 100             | 51.7%                   | 100     | Infinite                  | 50.8    | 0.9                       |
|              |                 |                 |                         |         |                           |         |                           | <11          | 10              | 100             | 53.3%                   | 100     | Infinite                  | 51.7    | 0.9                       |
|              |                 |                 |                         |         |                           |         |                           | <14          | 26.7            | 100             | 55%                     | 100     | Infinite                  | 52.6    | 0.7                       |
|              |                 |                 |                         |         |                           |         |                           | <16          | 30              | 100             | 63.3%                   | 100     | Infinite                  | 57.7    | 0.7                       |
| <18          | 10.0            | 100             | 53.3%                   | 100     | Infinite                  | 51.7    | 0.9                       | 5            |                 |                 |                         |         |                           |         |                           |
|              |                 |                 |                         |         |                           |         |                           | <17          |                 |                 | 65%                     | 100     | Infinite                  | 58.8    | 0.5                       |
|              |                 |                 |                         |         |                           |         |                           | 5            | 50              | 100             |                         |         |                           |         |                           |
|              |                 |                 |                         |         |                           |         |                           | <18          |                 |                 | 75%                     | 100     | Infinite                  | 66.7    | 0.3                       |
|              |                 |                 |                         |         |                           |         |                           | 5            | 67.7            | 100             |                         |         |                           |         |                           |
|              |                 |                 |                         |         |                           |         |                           | <19          |                 |                 | 83.3%                   | 100     | Infinite                  | 75%     | 0.2                       |
|              |                 |                 |                         |         |                           |         |                           | 5            | 76.7            | 100             |                         |         |                           |         |                           |
|              |                 |                 |                         |         |                           |         |                           | <20          |                 |                 | 88.3%                   | 100     | Infinite                  | 81.1    | 0.1                       |
|              |                 |                 |                         |         |                           |         |                           | 5            | 86.7            | 100             |                         |         |                           |         |                           |
|              |                 |                 |                         |         |                           |         |                           | <21          |                 |                 | 88.3%                   | 100     | Infinite                  | 81.1    | 0.1                       |
|              |                 |                 |                         |         |                           |         |                           | 5            | 90              | 100             |                         |         |                           |         |                           |
|              |                 |                 |                         |         |                           |         |                           | <21          |                 |                 | 66.7%                   | 100     | Infinite                  | 60.0    | 0.6                       |
| 5            | 40              | 100             |                         |         |                           |         |                           |              |                 |                 |                         |         |                           |         |                           |
| <22          |                 |                 | 70%                     | 100     | Infinite                  | 62.5    | 0.5                       |              |                 |                 |                         |         |                           |         |                           |
| 5            | 53.3            | 100             |                         |         |                           |         |                           |              |                 |                 |                         |         |                           |         |                           |
| <23          | 63.3            | 96.7            | 76.7%                   | 94.1    | 19.2                      | 67.4    | 0.4                       |              |                 |                 |                         |         |                           |         |                           |
| 5            | 100             | 100             |                         |         |                           |         |                           |              |                 |                 |                         |         |                           |         |                           |
| <23          | 100             | 96.7            | 98.3%                   | 96.8    | 30.3                      | 100     | 0                         |              |                 |                 |                         |         |                           |         |                           |

(continued)



Table 2. (Continued)

|      |      |      |       |      |      |      |     |      |      |       |      |     |     |   |
|------|------|------|-------|------|------|------|-----|------|------|-------|------|-----|-----|---|
| 5    |      |      | %     | %    |      |      | 5   |      |      | %     |      |     |     |   |
| <24. |      |      | 78.3% | 90.4 | 10.9 | 71.8 | 0.3 | <24. |      | 93.3% | 88.2 | 7.5 | 100 | 0 |
| 5    | 73.3 | 93.3 | %     | %    |      |      | 5   | 100  | 86.7 |       |      |     |     |   |
| <25. |      |      | 83.3% | 91.7 | 11.5 | 77.8 | 0.2 | <25. |      | 90%   | 83.3 | 5.0 | 100 | 0 |
| 5    | 80   | 93.3 | %     | %    |      |      | 5   | 100  | 80   |       |      |     |     |   |
| <26. |      |      | 81.7% | 82.8 | 5.4  | 80.6 | 0.1 | <26. |      | 81.7% | 73.2 | 2.7 | 100 | 0 |
| 5    | 90   | 83.3 | %     | %    |      |      | 5   | 100  | 63.3 |       |      |     |     |   |
| <27. |      |      | 85%   | 77.1 | 3.8  | 88%  | 0   | <27. |      | 70%   | 62.5 | 1.7 | 100 | 0 |
| 5    | 100  | 73.3 | %     |      |      |      | 5   | 100  | 40   |       |      |     |     |   |
| <28. |      |      | 75%   | 66.7 | 2.0  | 100  | 0   | <28. |      | 65%   | 58.8 | 1.4 | 100 | 0 |
| 5    | 100  | 50   | %     | %    |      |      | 5   | 100  | 30   |       |      |     |     |   |
| <29. |      |      | 63.3% | 57.7 | 1.4  | 100  | 0   | <29. |      | 55%   | 52.6 | 1.1 | 100 | 0 |
| 5    | 100  | 26.7 | %     | %    |      |      | 5   | 100  | 10   |       |      |     |     |   |

Grey areas indicate acceptable sensitivity (> 80%) and specificity (> 60%) (Blake et al., 2002). Borders indicate the best possible cut-off. PPV = Positive Predictive Value; NPV = Negative Predictive Value; MMSE = Mini Mental State Examination; MoCA = Montreal Cognitive Assessment.

Table 3. Pearson’s correlations (MoCA, MMSE, Age, Premorbid IQ) and Spearman’s correlation (Level of Education) between the demographic variables and test performance in 30 patients diagnosed with Korsakoff’s syndrome (in grey) and 30 age-, education-, gender- and premorbid-IQ matched controls (in white)

|                    | MoCA   | MMSE    | AGE  | Premorbid IQ | Level of Education |
|--------------------|--------|---------|------|--------------|--------------------|
| MoCA               |        | .73**** |      | .19          | -.10               |
| MMSE               | .60*** |         | -.06 | .13          | .10                |
| AGE                | -.36   | -.20    |      | .05          | -.10               |
| Premorbid IQ       | .28    | .53***  | -.08 |              | .26                |
| Level of Education |        |         |      |              |                    |
| Education          | .40**  | .34     | -.08 | .43**        |                    |

\*\* = statistically significant (p < .05).  
 \*\*\* = statistically significant (p < .01).  
 \*\*\*\* = statistically significant (p < .001).  
 MoCA = Montreal Cognitive Assessment; MMSE = Mini Mental State Examination; Premorbid IQ = Estimated premorbid intelligence with the Dutch Adult Reading Test (Schmand et al., 1992).

DISCUSSION

In the current study we analyzed performance on two screening instruments, the MoCA and the MMSE, in a representative sample of KS patients and age-, education-, gender-, and premorbid-IQ-matched controls to evaluate their psychometric properties

and discriminant validity for assessing cognitive impairment. The results suggest that the MoCA is superior to the MMSE in detecting cognitive disorders in KS. The MoCA displayed excellent diagnostic accuracy in discriminating patients with KS from cognitively intact controls. Both the discriminant validity (optimal sensitivity and specificity, PPV, NPV and Likelihood Ratios) and the percentage correctly diagnosed patients were higher for the MoCA than the MMSE. The optimal cutoff point for detecting KS that allowed a maximization of the sensitivity and specificity was below 22/23 points, with a near to maximum PPV and NPV for a cut-off of 23 points. All indices for discriminant validity were consistent and higher than the respective MMSE values, suggesting that the MoCA has accurate psychometric properties and diagnostic validity to detect KS with a cut-off of 23 points. This cutoff is equivalent to the optimal cutoff point established in a previous validation study for the MoCA for KS (Wester et al., 2013).

Although the MMSE is widely used in a variety of settings, this is the first study to investigate the usability of the MMSE in KS. In the current sample the optimal cutoff of the MMSE to detect KS was 26/27 points. Specificity and sensitivity were both acceptable for this cut-off (see Table 2), whereas the traditional cut-off of 23 points resulted in 46.7% of the patients being incorrectly labeled as cognitively intact. This suggests that, in the detection of KS, a higher cut-off should be used than the originally suggested one for the detection of dementia in a psychiatric setting (Folstein et al., 1975). This finding is consistent with earlier research in Parkinson's and Huntington's disease that indicated that the cut-off of 23 is too low to show an adequate sensitivity for cognitive decline (Gluhm et al., 2013; Hoops et al., 2009). However, a negative consequence of applying a higher cut-off value could be an increased likelihood for false positive results. Earlier research indicated, for example, that a higher cut-off value for the MMSE would result in an unacceptably low specificity in the detection of cognitive dysfunction following stroke, thereby compromising the usefulness of this screening instrument (Nys et al., 2006). It is important to notice that the base rate of KS was 50% in the current sample. If the base rate of Korsakoff's syndrome had been much lower, the PPV would decrease and NPV would increase, resulting in an increased likelihood for false positives (Ioannidis, 2005). The implication of this finding is that the PPV and NPV should be interpreted with caution in clinical settings with base rates lower than 50%.

In the current study the correlation coefficient between the total scores of the MoCA and MMSE was high, suggesting convergent validity. The correlational analyses also showed that in patients the MMSE was not related to premorbid intellectual functioning, although it was in controls. In fact, 28.1% of the variance on the MMSE in controls was explained by the premorbid IQ estimate. This finding could reflect that, for all levels of premorbid intellectual functioning, KS is associated with comparable cognitive deficits irrespective of functioning before onset of the disease. An earlier study in dementia reflected a comparable loss of association between intellectual functioning and MMSE in the progression from healthy aging to dementia, suggesting that severe neurocognitive disorders could mask the relationship between premorbid intellectual functioning and cognition (Alves, Simões, Martins, Freitas, & Santana, 2013). In the current study the scores on the MoCA were positively related to the level of education in controls but not in patients. Earlier studies already reflected that, despite the standardized correction of the MoCA score for persons with 12 years of education or less, educational level does still relate to the MoCA scores, with lower education levels often leading to lower MoCA scores (Kaya et al., 2014; Lee et al., 2008). Since this relationship between

education and cognition is not reflected in KS patients, it could be suggested that the cognitive symptoms in KS are irrespective of educational level. It has to be noted that the correlation coefficients should be interpreted with caution, since the number of participants was rather small. Therefore, the specific relationship between the level of education, and intellectual and cognitive functioning in KS warrants future investigation.

The strengths of the current study include the relatively large sample size of KS patients and the stringent matching criteria between KS patients and healthy controls. This study rigorously selected patients without any co-morbid neurological or other psychiatric disorder. The demographic variables and clinical characteristics are comparable to the general build-up of the KS population (Kopelman, 2002; Wester et al., 2013). Moreover, all included KS patients had been abstinent for at least 6 months, minimizing the influence of alcohol-related cognitive decline. A limitation of the current study concerns the homogeneity of the KS patients; all patients were inpatients of long-term care clinic for KS patients, weakening possible generalizations to the acute state of KS. The MoCA and MMSE have adequate psychometric properties but it should be stressed that brief cognitive screening instruments are a poor substitute for comprehensive neuropsychological assessments, since extensive assessment covers a wide range of additional neuropsychological domains that are not included in screening instruments (Goldstein & Naglieri, 2014; Wester et al., 2013).

In conclusion, given the high prevalence of KS in chronic alcoholics, early and routine screening for cognitive impairment with a brief, sensitive instrument is warranted. This is the first study that investigated the psychometric properties and discriminant validity of the MMSE and compared the performance on the MMSE and MoCA in KS. The results for the MoCA were systematically superior to the results for the MMSE. The MoCA was confirmed as a valid, sensitive, and accurate instrument for the brief cognitive assessment in patients with KS.

### Funding

Tanja C.W. Nijboer was supported by NWO [grant #451-10-013]. Stefan Van der Stigchel was supported by NWO [grant #452-13-008].

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