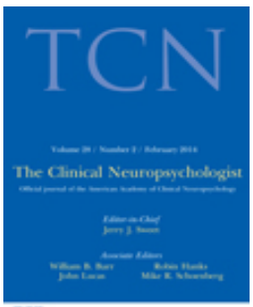

The Clinical Neuropsychologist

ISSN: 1385-4046 (Print) 1744-4144 (Online) Journal homepage: http://www.tandfonline.com/loi/ntcn20

Validation of the Turkish Version of the Montreal Cognitive Assessment Scale (MoCA-TR) in Patients With Parkinson's Disease

Betul Ozdilek & Gulay Kenangil

To cite this article: Betul Ozdilek & Gulay Kenangil (2014) Validation of the Turkish Version of the Montreal Cognitive Assessment Scale (MoCA-TR) in Patients With Parkinson's Disease, The Clinical Neuropsychologist, 28:2, 333-343, DOI: 10.1080/13854046.2014.881554

To link to this article: https://doi.org/10.1080/13854046.2014.881554

The Clinical Neuropsychologist, 2014
Vol. 28, No. 2, 333–343, http://dx.doi.org/10.1080/13854046.2014.881554

Routledge
Taylor & Francis Group

Validation of the Turkish Version of the Montreal Cognitive Assessment Scale (MoCA-TR) in Patients With Parkinson's Disease

Betul Ozdilek, and Gulay Kenangil
Department of Neurology, Erenkoy Research and Education Hospital for Neurologic and Psychiatric Disorders, Istanbul, Turkey

The study aimed to examine the reliability and validity of the Turkish version of the Montreal Cognitive Assessment Scale (MoCA-TR) as a screening tool for cognitive dysfunction in Parkinson's disease (PD). A total of 50 patients with PD and 50 healthy controls were included. The screening instruments—MoCA-TR followed by the Mini-Mental Status Examination (MMSE-TR) and MoCA-TR retest within 1 month—and detailed neuropsychological testing were administered to the PD patients. MoCA-TR and MMSE-TR were also administered to controls. The discriminant validities of the MoCA-TR and MMSE-TR as screening and diagnostic instruments were ascertained. The concurrent and criterion validity, test–retest reliability, and internal consistency of the MoCA-TR and MMSE-TR were examined. The Cronbach's alpha of the MoCA-TR as an index of internal consistency was 0.664, and the test–retest reliability of MoCA-TR was 0.742. With a cut-off score of < 21 points, the MoCA-TR showed sensitivity of 59% and specificity of 89% in the detection of cognitive dysfunction in PD. The area under the receiver-operating characteristics curve (95% confidence interval) for MoCA-TR was 0.794 (0.670–0.918), $p < .001$. The present results indicated that the MoCA-TR has acceptable psychometric properties and it should be used to assess mild cognitive impairment and early dementia in PD patients, whereas the MMSE-TR should remain the instrument of choice to assess cognitive impairment in PD dementia.

Keywords: Parkinson's disease; Cognitive dysfunction; MoCA-TR; Validation.

INTRODUCTION

Cognitive dysfunction is common in Parkinson's disease (PD) and ranges from mild impairment to frank dementia. Cognitive problems in PD can involve different domains, such as executive function, visuospatial function, attention, and memory (Emre et al., 2007). These problems in patients with PD can result in reduced quality of life and increased economic and psychological burden on the family (Marras, McDermott, Rochon, & Tanner, 2008; Ozdilek & Gunal, 2012). Therefore the early detection of cognitive deficit and precise monitoring of cognitive status using reliable scales during all stages of the disease are needed for the optimal management of PD patients.

The accepted gold standard for the assessment of cognitive function in PD is neuropsychological testing, which evaluates multiple aspects of cognitive function, including planning and organizational abilities, language, judgment, and motor skills

Address correspondence to: Betul Ozdilek, M.D., Erenkoy Research and Education Hospital for Neurologic and Psychiatric Disorders, Department of Neurology, Sinan Ercan Caddesi No: 29, 34736, Erenkoy/Kadikoy –Istanbul, Turkey. Email: betulozdilek@yahoo.com
(*Received 25 August 2013; accepted 2 January 2014*)

(Thompson & Hodges, 2002). The use of neuropsychological testing in the clinical setting is limited by its high cost and low availability, and this service is generally provided in more specialized research-oriented cognitive centers and memory clinics. Thus, relatively short, low-cost, and simple instruments have been developed for cognitive screening of PD patients in routine clinical care.

The Mini-Mental State Examination (MMSE) is the most widely used because it is short, inexpensive, easy to conduct, and effective for identifying patients with dementia (Folstein, Folstein, & McHugh, 1975). On the other hand, it is not sufficiently sensitive to detect early cognitive impairment, such as mild cognitive impairment (MCI) and conditions associated with frontal executive and subcortical dysfunction in patients with PD (Nazem et al., 2001; Wind et al., 1997; Zadikoff et al., 2008). Consequently the Montreal Cognitive Assessment (MoCA) was developed to address some of the limitations of the MMSE as a screening tool for MCI and cognitive dysfunction in PD (Nasreddine et al., 2005). The original English version of the MoCA for detection of MCI and dementia has also been validated in patients with PD (Gill, Freshman, Blender, & Ravina 2008; Hoops et al., 2009; Nazem et al., 2009). MoCA is available in different language versions. The Turkish version of the MoCA (MoCA-TR) has been validated in Alzheimer's disease (AD), and it shows high sensitivity and specificity for detecting MCI in patients who perform normally on the MMSE-TR (Selekler, Cangoz, & Uluc, 2010). However, to our knowledge, it has not been validated for patients with PD in Turkey.

This study was designed to apply the MoCA-TR to identify cognitive dysfunction in patients with PD in Turkey and to validate the MoCA-TR as a cognitive screening test for Turkish PD patients.

METHOD AND MATERIALS

Participants

A total of 50 patients meeting the clinical diagnostic criteria for idiopathic PD were recruited from movement-disorder clinics over a 6-month period. The participants ranged in age from 40 to 80 years, and they were regularly followed up. Patients were not admitted to the study if they had a history of stroke, brain damage, psychiatric comorbidity such as moderate to severe depression, recent delirium, alcohol or drug addiction, mental retardation, or brain surgery for PD or any other reason. Patients with severe visual or hearing impairment and fewer than 5 years of education and those who could not understand the native language were also not admitted.

Standardized evaluations were performed for follow-up of the PD patients using the Unified Parkinson's Disease Rating Scale (UPDRS). Disease severity as measured by the Hoehn and Yahr (HY) staging scale (scores ranging from 1 to 5, higher scores indicating greater disease severity) and Schwab England Daily Living activities scale was used for patients' daily living activities rate (Fahn & Elton, 1987; Schwab & England, 1969).

A total of 50 healthy controls matched with the patient group with respect to age, gender, and education were also included. They had no subjective cognitive complaints, MMSE scores above 24, and their instrumental activities of daily living were normal. Inclusion criteria for controls were the absence of any past or present neurological,

psychiatric, or metabolic disorders that are known to compromise cognition. All participants who scored above 17 on the Beck depression inventory were excluded from the study because of the concern that depression can affect scores on the cognitive tests.

The study protocol was approved by the Institutional Review Board, and informed written consent was obtained from all participants.

Procedure

All patients completed the demographic and clinical assessment and the screening instruments (MoCA-TR followed by MMSE-TR) on the same day, the MoCA-TR retest within 1 month, and detailed neuropsychological testing in the following month. Patients were encouraged to take their regularly scheduled PD medications during the study visit so that they would be evaluated in their "on" state. Based on the results of the neuropsychological testing and clinical diagnostic criteria, PD patients were divided into three subgroups: (1) PD group without cognitive disorders (PD-Normal); (2) patients with mild cognitive impairment (PD-MCI); and (3) PD patients with dementia (PD-Dementia). Healthy controls provided demographic data and completed the screening instruments (MoCA-TR and MMSE-TR) on the same day.

Diagnostic criteria for PD-Dementia and PD-MCI

The Movement Disorder Society task force recommended diagnostic criteria for probable PD-Dementia including cognitive deficits in at least two of the four core cognitive domains (attention, memory, visuospatial, and executive functions), as well as cognitive deficiency sufficiently severe to impair daily life (Dubois et al., 2007; Emre et al., 2007). Therefore our dementia criteria were (1) ≥ 1.5 *SD* below the normative data mean on tests in at least two cognitive domains, (2) self-reported cognitive decline, and (3) impairment of instrumental activities of daily living.

Modified Peterson criteria that allow detection of impairments in a range of cognitive domains, called the Winblad criteria, were used to diagnose PD-MCI (Petersen et al., 2001; Winblad et al., 2004). Our MCI criteria were (1) ≥ 1.5 *SD* below the normative data mean on tests in at least one cognitive domain, (2) self-reported cognitive decline, and (3) preserved activities of daily living. The diagnosis of PD-Dementia,PD-MCI, or PD-Normal cognitive function was reached at consensus meetings and was based on information derived from clinical and neuropsychological evaluations (excluding MoCA-TR and MMSE-TR) in this study.

Cognition questionnaires

Neuropsychological testing. The neuropsychological battery included measures in the following cognitive domains: verbal and visual memory (word list recall, story recall, picture recall, and Wechsler Memory Scale-Revised (WMS-R) visual reproduction); executive function (Stroop interference, verbal fluency, letter fluency, category fluency, category switching, trails A and B); attention (Digit Span (subtest of the WMS-R) and visuospatial function (cube copying, clock drawing)); and language

(Boston Naming Test-short form) (Golden, 1994; Lezak, Howieson, & Loring, 2004; Wechsler, 1997). The test battery was administered by the same trained neuropsychologist, and it took about 60 to 90 minutes for each patient. The maximum time span between MoCA-TR or MMSE-TR and the neuropsychological battery was 2 months.

MoCA-TR. The Turkish version as it appears on the official website (www.mocatest.org) was translated. It contained certain cultural and linguistic changes from the original version presented in 2010 by Selekler, and it has been validated in AD in Turkey (Selekler et al., 2010). All items were identical to the original English version with the exception of the memory or 5-minute delayed verbal recall item. Three of the five words used in the original version were changed. These are "mosque" instead of "church", "nose" instead of "face", and "purple" instead of "red". It was used in this validation study for PD. The MoCA is a 10-minute test that briefly evaluates the following seven cognitive domains on one page: visuospatial and executive functions: alternating trail making (1 point), cube copying (1 point), clock drawing (3 points), naming: (lion, rhinoceros, camel) (3 points), attention: forward and backward digit span (2 points), tapping to the letter A (1 point), subtraction from 100 by 7s (1 point); language: sentence repetition (2 points), letter fluency (1 point); abstraction: similarities between train and bicycle, watch and ruler (2 points); memory: 5-minute delayed verbal recall of five words (5 points); and orientation to time and place (6 points). As two MoCA tasks (subtracting by 7s and orientation questions) overlapped with identical items on the MMSE, these items were tested only once. To correct for educational effects found in the original study, an additional 1 point was given to participants with 12 or fewer years of education, following the author's instructions and the procedure adopted in previous studies (Nasreddine et al., 2005). The scores on the MoCA-TR ranged from 0 to 30, with higher scores indicating better cognition and scores below 21 indicating cognitive impairment in the Turkish AD population (Selekler et al., 2010).

MMSE-TR

The MMSE-TR, which has been validated in the Turkish population, includes items for orientation to time and place (10 points), registration (immediate verbal recall of three words), serial subtraction (from 100 by 7s), memory (delayed verbal recall of three words), naming (pencil, watch), language (repeat a phrase, follow a written instruction, follow a 3-step command, write a sentence), and drawing (copy a line drawing of overlapping pentagons). The scores ranged from 0 to 30, with higher scores indicating better cognition, and scores below 24 indicating cognitive impairment (Gungen, Ertan, Eker, Yaflar, & Engin, 2002).

Statistical analyses

All statistical analyses were performed using the NCSS (Number Cruncher Statistical System) 2007 and PASS (Power Analysis and Sample Size) 2008 Statistical Software (NCSS, Kaysville, UT). The independent-samples *t*-test, the Kruskal–Wallis test, or the Mann–Whitney *U*-test was used for between-group comparisons of demographic information and clinical characteristics, including neuropsychological data scores,

between cognitively impaired and unimpaired groups. Test–retest reliability of the MoCA-TR and MMSE-TR was assessed by calculating the intraclass correlation coefficients (ICCs) for baseline and 1-month retest scores among patients. Internal consistency reliability was estimated using Cronbach's alpha coefficient. The receiver-operating characteristic (ROC) with area under the curve (AUC) (95% confidence interval [CI]) was analyzed to assess each of the instruments to discriminate validity for detecting any cognitive disorder (MCI or PD-Dementia) in PD patients and controls versus absence of cognitive disorder (as indicated by the brief cognitive battery), as this is often the primary comparison when assessing the validity of cognitive screening instruments. The AUC, sensitivity (the probability that participants with cognitive impairment will test positive), specificity (the probability that participants without cognitive impairment will test negative), positive predictive value (PPV; the probability of disease in participants who test positive), and negative predictive value (NPV; the probability of a lack of disease in participants who test negative) were calculated for the MoCA-TR and MMSE-TR. AUC can vary between 0.5 and 1, with a larger AUC signifying better diagnostic accuracy. The Kappa consistency test was used to evaluate the consistency between neuropsychological tests and the MoCA-TR. In all analyses, $p < .05$ was taken to indicate statistical significance.

RESULTS

General characteristics of the participants and screening tests

The mean age of the patients with PD was 61.3 ± 9.5 years (range 40–80 years), and the mean number of years of education was 8.5 ± 3.9 (range 5–17 years). Males comprised 68% of the PD patients. A total of 70% of the patients had the tremor-dominant type of PD. All patients were equally distributed in the first, second, and third stages according to the HY scale, and the mean duration of the disease was 5.8 ± 3.7 years (range 2–18 years). In healthy controls, the mean age was 62.3 ± 9.4 years, and the mean number of years of education was 10.1 ± 4.0. The demographic and clinical characteristics of the PD patients and the healthy controls are listed in Table 1. As presented in Table 1, although the PD-Normal group had a lower mean age than the other groups, there were no significant differences in age or gender among the four groups. No significant difference in mean MoCA-TR score was found between males and females ($r = –0.186$, $p = .195$), but MoCA-TR scores were significantly associated with age ($r = –0.338$, $p = .016$). A statistically significant difference in education was observed among the four groups ($p = .003$), and the number of years of education was positively correlated with MoCA-TR scores ($r = 0.584$, $p < .001$).

The mean scores ± standard deviations (*SD*) on the MoCA-TR and MMSE-TR were 21.9 ± 4.5 (range 13–30) and 26.1 ± 2.9 (range 20–30) in PD patients, respectively. As presented in Table 1, the mean MoCA-TR and MMSE-TR scores were significantly different between healthy controls and participants in the PD-Dementia, PD-MCI, and PD-Normal groups ($p < .001$). The scores were lower in the PD-Dementia group than in all other groups, and they were lower in the PD-MCI group than in the PD-Normal and control groups. The MMSE-TR showed a ceiling effect, with six participants scoring 30/30; one participant scored 30 on the MoCA-TR.

Table 1. Characteristics of Turkish patients with Parkinson's disease by cognitive groups and healthy controls

	PD-Normal (n = 28) Mean ± *SD*	PD-MCI (n = 13) Mean ± *SD*	PD-Dementia (n = 9) Mean ± *SD*	Controls (n = 50) Mean ± *SD*	*P*-value
Age (years)	58.3 ± 9.5	63.3 ± 9.3	67.4 ± 7.8	62.3 ± 9.4	[3] ***0.059***
Education (years)	10.0 ± 4.2	7.3 ± 3.0	5.6 ± 2	10.0 ± 4.2	[4] ***0.003****
Male/Female (%)	64/36	77/23	67/33	44/56	[5] ***0.093***
Disease duration (years)	5.7 ± 3.8	5.1 ± 3.8	7.2 ± 3.3	–	[4] ***0.276***
UPDRS-I	1.5 ± 1.3	2.6 ± 1.8	3.5 ± 1.8	–	[4] ***0.009****
UPDRS-II	7.3 ± 3.9	9.7 ± 7	11 ± 9.0	–	[4] ***0.507***
UPDRS-III	8.8 ± 4.8	15.9 ± 7.9	11.5 ± 8.5	–	[4] ***0.016****
UPDRS-IV	2.6 ± 3.2	1.6 ± 2.2	3.4 ± 3.0	–	[4] ***0.425***
UPDRS-Total	20.3 ± 9.5	29.9 ± 15.9	29.5 ± 20.5	–	[4] ***0.107***
MoCA-TR (1)	**24.6 ± 3.9**	**20.6 ± 3.9**	**18.6 ± 3.7**	**23.7 ± 4.1**	[3] ***0.001****
MMSE-TR	**27.7 ± 1.9**	**24.6 ± 2.8**	**23.4 ± 2.8**	**27.5 ± 2.3**	[3] ***0.001****

[3]*One-way ANOVA.*
[4]*Kruskal–Wallis test.*
[5]*Pearson's test χ2 test.*
*$P < 0.05$.
**$p < .01$.

The average administration time for MoCA-TR depended on education level, age, and severity of cognitive symptoms, averaging 10.0 ± 2.3 minutes in PD patients and 9.6 ± 2.4 minutes in controls ($p < .001$).

Psychometric properties of the MoCA-TR

The intraclass correlation coefficient (ICC) of MoCA-TR for 1-month test–retest reliability in PD patients was 0.742 ($p < .001$). The mean change in MoCA-TR score between the first and second administration was 1.32, which was not significant ($p = .07$). Cronbach's alpha for the seven MoCA-TR subtests were 0.664 for PD patients and 0.752 for controls.

Psychometric properties of MoCA-TR for the detection of any cognitive disorder are listed in Table 2. The ROC curve analyses were computed to evaluate the diagnostic accuracy of the MoCA-TR and the MMSE-TR to differentiate patients with cognitive

Table 2. Discriminant validity of the Turkish version of the Montreal Cognitive Assessment (MoCA-TR) for diagnosis of any cognitive disorder by neuropsychological testing

Cut-off value MoCA-TR scores	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
18	31.82	88.89	70.00	61.54
19	40.91	89.29	75.00	65.79
20	54.55	89.29	80.00	71.43
21	**59.09**	**89.29**	**81.25**	**73.53**
22	68.18	78.57	71.43	75.86
23	68.18	71.43	65.22	74.07

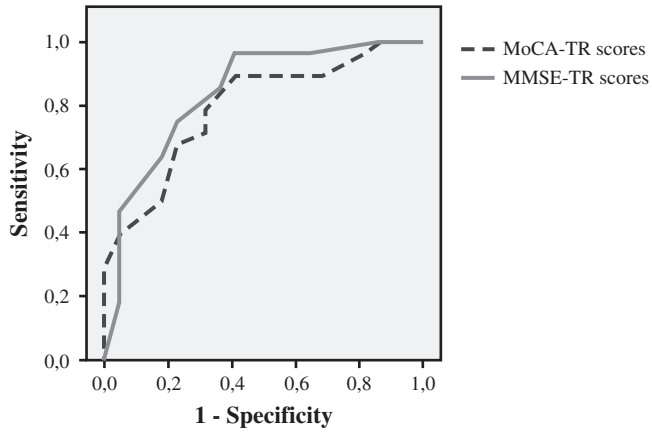

Figure 1. Receiver operating characteristic curve (ROC) analysis of the MoCA-TR total scores to detect cognitive dysfunction on neuropsychological testing (AUC = 0.794, $p < .001$).

dysfunction from the cognitively healthy adults compared with neuropsychological testing. Graphic representations of the ROC curves are presented in Figure 1. ROC analysis for the MoCA-TR revealed an optimal balance of sensitivity and specificity in differentiating patients with cognitive dysfunction from controls at a cut-off of 21 points with AUC of 0.794 (95% CI = 0.670–0.918, $p < .001$). Sensitivity, specificity, and positive and negative predictive values of MoCA-TR are presented in Table 2. A cut-off value of 26 points for the MMSE-TR provided the best balance between sensitivity (77.2%) and specificity (75.0%). The AUC for the MMSE-TR was 0.841 (95% CI = 0.727–0.955, $p < .001$).

In this sample the MoCA-TR scores were highly consistent with the composite scores on neuropsychological testing (Kappa coefficient = 0.498, $p < .001$) and with the MMSE-TR scores (Kappa coefficient = 0.269, $p = .046$). Of the 28 cases found to be normal on neuropsychological testing, only 25 (89%) were found to be normal in the MoCA-TR, and of the 36 cases found to be normal according to the MMSE-TR only 24 (66%) were normal with the MoCA-TR.

DISCUSSION

The results of this study confirmed that the MoCA-TR shows good internal consistency and convergent validity, with a high correlation to the results of neuropsychological testing and MMSE-TR in Turkish patients with PD. Recent studies also indicated that clinical use of the MoCA has become increasingly common and that it can be useful to detect cognitive impairment in patients with PD (Gill et al., 2008; Nazem et al., 2009), brain metastases (Olson, Chhanabhai, & McKenzie, 2008), cerebrovascular disease (McLennan, Mathias, Brennan, & Stewart, 2011), and Huntington's disease (Videnovic et al., 2010).

Despite conflicting results regarding the effects of sex, age, and education on the MoCA-TR in previous studies (Lee et al., 2008; Luis, Keegan, & Mullan, 2009; Nasreddine et al., 2005; Tu et al., 2013; Wong et al., 2009), we found that scores of the

MoCA-TR were affected by both education and age, but not by gender. As mentioned by Lee et al. (2008), elderly people in many Asian countries have received much less education than their counterparts in Western countries. The average number of years of education in our Turkish sample was 7–8, which was much lower than the 12 years of education reported in previous studies with Western countries. Therefore we added an extra 1 point for participants with ≤ 12 years of education. As mentioned, there are clearly important differences between countries with regard to language, culture, and education. The criteria to diagnose cognitive dysfunction may also differ between countries. It is intriguing that cut-off scores on the MoCA-TR acquired from the Turkish sample were lower than those acquired in the original sample. Moreover, time needed to complete the MoCA-TR was found to be similar to the period in the original study for patients and controls (Nasreddine et al., 2005).

In this study there were no significant differences in MOCA-TR total scores between patients in the MCI and dementia groups as diagnosed by neuropsychological testing. Therefore it is difficult to determine an appropriate cut-off score for differential diagnosis of MCI or dementia using the MOCA-TR unlike previous studies (Dalrymple-Alford et al., 2010). The optimal MoCA-TR cut-off score for detecting any cognitive dysfunction in our study was 21, which was equivalent to the optimal cut-off point established in prior validation studies of MoCA for Turkish patients with AD (Selekler et al., 2010). This cut-off score was lower that the value of 26 in the original validation study of the MoCA (Nasreddine et al., 2005). It has been suggested that using a higher cut-off point of 26 could lead to misclassification of some normal individuals as cognitively impaired. Similar to other validation studies, lower scores such as 22–23 were found to be better with regard to sensitivity and specificity (Lee et al., 2008; Luis et al., 2009; Wong et al., 2009). The discrepancies between different studies highlight the importance of the development of local norms and cut-off scores for specific disease groups. The above findings can be explained by the differences in cultural factors (i.e., elderly people are not involved in cognitive exercises and activities, and young people assume daily activities) and/or educational factors (i.e., lifelong education is not settled, reading habits and/or hobbies are abandoned). Accordingly, there are similarities between the Korean and Turkish samples with regard to MoCA cut-off score used in general cognitive evaluation (Lee et al., 2008). On the other hand, the cut-off scores in East Asian countries other than Korea (China, Japan, and Thailand) and in Western countries (Canada, UK, France, Germany, and Denmark) were similar (Nie et al., 2012). Approximately 42% of the patients (18% of PD-MCI and 24% of PD-Dementia) in the present study met the diagnostic criteria for a cognitive disorder according to neuropsychological testing. Using this cut-off score of 21 on the MoCA-TR, approximately 36% of the patients had cognitive dysfunction, whereas 28% had dysfunction in MMSE-TR.

An intraclass correlation coefficient (ICC) greater than 0.75 is generally considered to indicate excellent test–retest reliability (Fleiss, 1986). The ICC of MoCA-TR for PD patients in our study was 0.742. The Cronbach's alphas for patients and healthy controls were 0.664 and 0.752, respectively. A Cronbach's alpha between 0.60 and 0.70 is considered to indicate acceptable internal consistency. This high test–retest reliability and internal consistency of the MoCA-TR and its good convergent validity with neuropsychological testing are in concordance with previous reports (Gill et al., 2008; Hoops et al., 2009; Nasreddine et al., 2005; Lee et al., 2008; Wong et al., 2009). Item analysis

in the original study found that the domains of visuospatial skills, attention, abstraction, and orientation had high discriminant ability. We also found that all the domains of MoCA-TR had significantly high discriminant ability.

We used ROC analyses to assess the capacities of the two tests to discriminate between participants with and without cognitive disorders. The results are expressed as AUC, representing the efficacy of the test. The overall discriminant validity was acceptable for the MoCA-TR, with an AUC of 0.794 (95% CI 0.670–0.918), whereas the corresponding AUC of the MMSE-TR was 0.841 (95% CI 0.727–0.955). These AUC values were significantly different from each other ($p < .001$), indicating that the instruments differed in the accuracy of their classifications.

The sensitivity and specificity rates of the MoCA-TR and MMSE-TR were determined using neuropsychological testing as the gold standard. With the cut-off point of MoCA-TR and MMSE-TR in our study, the sensitivity rate of MoCA-TR for identifying cognitive dysfunction was low (59%) compared with that of the MMSE-TR (77%), the most commonly used clinical screening instrument for cognitive impairment in elderly patients in most countries. The specificity of MoCA-TR for cognitive dysfunction was lower than that of MMSE-TR (75% vs. 89%, respectively). The positive and negative predictive values (PPV and NPV) for MoCA-TR were 81% and 73%, respectively, compared with 70% and 80% for MMSE-TR. Thus the results for MMSE-TR were significantly superior to those for MoCA-TR for both discriminant validity and diagnostic accuracy. Therefore MMSE-TR was found to be a better cognitive screening instrument for PD than MoCA-TR. This was likely because of the relatively lower education levels in our sample, as the MoCA-TR was significantly related to education. The MoCA-TR is superior in well-educated patients with early stage dementia and mild cognitive impairment, whereas the MMSE-TR characterizes PD-dementia well. Comparison of the results of the present study with those of a previous study using the English version of MoCA indicated an obvious difference in reported sensitivities and specificities. Nasreddine et al. reported a sensitivity of 90% and a specificity of 87% for the English version of the MoCA (Nasreddine et al., 2005).

The present study had several limitations. First, the paper-and-pencil test items might pose difficulties for poorly educated participants. We found that some older and poorly educated participants had difficulty in comprehending the instructions for the MoCA-TR despite having normal language abilities. Additionally, some participants indicated that the spaces for drawing the cube and clock might be too small for elderly people with sub-optimal visual or motor abilities. Furthermore, some patients had difficulty drawing a clock with digits settled in the appropriate size. Second, several sub-items are unsuitable for the culture and linguistic background of Turkey, and one especially (matching the picture of rhinoceros) was very difficult to evaluate in a large number of poorly educated Turkish patients. As the original validation study did not report poor performance for this item, we feel that it would be useful to replace this item with a much more familiar animal, such a goat, rabbit, or elephant, in the Turkish version. Finally, this was solely an outpatient-based study, i.e., it did not include any patients from inpatient follow-ups. Therefore the sample included only nine patients with PD-Dementia, a much lower incidence than that commonly reported.

In conclusion, brief screening instruments, such as the MoCA-TR, can provide an objective and cost-effective means of identifying cognitive decline. Such instruments may help to determine the need for more detailed assessments. Our validation evidence

suggested that the MoCA-TR is a psychometrically valid, reliable, and clinically useful cognitive assessment test for Turkish patients with PD in routine clinical practice.

REFERENCES

Dalrymple-Alford, J. C., MacAskill, M. R., Nakas, C. T., Livingston, L., Graham, C., Crucian, G. P., … Anderson, T. J. (2010). The MoCA: Well-suited screen for cognitive impairment in Parkinson disease. *Neurology, 75*(19), 1717–1725.

Dubois, B., Burn, D., Goetz, C., Aarsland, D., Brown, R. G., Broe, G. A. … Emre, M. (2007). Diagnostic procedures for Parkinson's disease dementia: Recommendations for the Movement Disorder Society Task Force. *Movement Disorders, 16*, 2314–2324.

Emre, M., Aarsland, D., Brown, R., Burn, D. J., Duyckaerts, C., Mizuno, Y. … Dubois B. (2007). Clinical diagnostic criteria for dementia associated with Parkinson's disease. *Movement Disorders, 22*, 1689–1707.

Fahn, S., Elton, R. L., & the UPDRS Development Committee. (1987). Unified Parkinson's Disease Rating Scale. In S. Fahn, C. D. Marsden, D. Calne & M. Goldstein (Eds.), *Recent developments in Parkinson's disease* (pp. 153–163). Florham Park, NJ: Macmillan Health Care Information.

Fleiss, J. L. (1986). *The design and analysis of clinical experiments*. New York, NY: Wiley.

Folstein, M. F., Folstein, S. E., & McHugh, P.R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*(3), 189–198.

Gill, D. J., Freshman, A., Blender, J. A., & Ravina, B. (2008). The Montreal Cognitive Assessment as a screening tool for cognitive impairment in Parkinson's disease. *Movement Disorders, 23*, 1043–1046.

Golden, C. (1994). *The Stroop Color and Word Test*. Wood Dale, IL: Stoelting Company.

Gungen, C., Ertan, T., Eker, E., Yaflar, R., & Engin, F. (2002). Reliability and validity of the standardized Mini Mental State Examination in the diagnosis of mild dementia in Turkish population. *Turk Psikiyatri Derg, 13*(4), 273–281.

Hoops, S., Nazem, S., Siderowf, A. D., Duda, J. E., Xie, S. X., Stern, M. B., … Weintraub, D. (2009). Validity of the MoCA and MMSE in the detection of MCI and dementia in Parkinson disease. *Neurology, 73*, 1738–1745.

Lee, J. Y., Dong, W. L., Cho, S. J., Na, D. L., Hong, J. J., Kim, S. K. … Maeng, J. Cho. (2008). Brief screening for mild cognitive impairment in elderly outpatient clinic: Validation of the Korean version of the Montreal Cognitive Assessment. *Journal of Geriatric Psychiatry and Neurology, 21*, 104–110.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment* (4th ed.). New York, NY: Oxford University Press.

Luis, C. A., Keegan, A. P., & Mullan, M. (2009). Cross validation of the Montreal Cognitive Assessment in community dwelling older adults residing in the southeastern US. *International Journal of Geriatric Psychiatry, 24*, 197–201.

Marras, C., McDermott, M. P., Rochon, P. A., & Tanner, C. M. (2008). Predictors of deterioration in health-related quality of life in Parkinson's disease: Results from the DATATOP trial. *Movement Disorders, 23*, 653–659.

McLennan, S. N., Mathias, J. L., Brennan, L. C., & Stewart, S. (2011). Validity of the Montreal Cognitive Assessment (MoCA) as a screening test for mild cognitive impairment (MCI) in a cardiovascular population. *Journal of Geriatric Psychiatry and Neurology, 24*(1), 33–38.

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I. … Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of The American Geriatrics Society, 53*, 695–699.

Nazem, S., Siderowf, A. D., Duda, J. E., Have, T. T., Colcher, A., Horn, S. S. … Weintraub, D. (2009). Montreal cognitive assessment performance in patients with Parkinson's disease with "normal" global cognition according to mini-mental state examination score. *Journal of The American Geriatrics Society, 57*, 304–308.

Nie, K., Zhang, Y., Wang, L., Zhao, J., Huang, Z., Gan, R. … Wang, L. (2012). A pilot study of psychometric properties of the Beijing version of Montreal Cognitive Assessment in patients with idiopathic Parkinson's disease in China. *Journal of Clinical Neuroscience, 19*, 1497–1500.

Olson, R. A., Chhanabhai, T., & McKenzie, M. (2008). Feasibility study of the Montreal Cognitive Assessment (MoCA) in patients with brain metastases. *Support Care Cancer, 16*(11), 1273–1278.

Ozdilek, B., & Gunal, D. I. (2012). Motor and nonmotor symptoms in Turkish patients with Parkinson's disease affecting family caregiver burden and quality of life. *Journal of Neuropsychiatry and Clinical Neurosciences, 24*(4), 478–483.

Petersen, R. C., Doody, R., Kurz, A., Mohs, R. C., Morris, J. C., Rabins, P. V. … Winblad, B. (1985). Current concepts in mild cognitive impairment. *Archives of Neurology, 58*, 1985–1992.

Schwab, R. S., & England, A. C. (1969). Projection technique for evaluating surgery in Parkinson's disease. In F. J. Gillingham & M. C. Donaldson (Eds.), *Third symposium on Parkinson's disease* (pp. 152–157). Edinburgh, UK: Livingston.

Selekler, K., Cangoz, B., & Uluc, S. (2010). Power of discrimination of Montreal cognitive assessment (MoCA) scale in Turkish patients with mild cognitive impairment and Alzheimer's disease. *Turkish Journal of Geriatrics, 13*, 166–171.

Thompson, S. A., & Hodges, J. R. (2002). Mild cognitive impairment: a clinically useful but currently ill-defined concept? *Neurocase, 8*(6), 405–410.

Tu, Q. Y., Jin, H., Ding, B. R., Yang, X., Lei, Z. H., Bai, S. … Tang, X. Q. (2013). Reliability, validity, and optimal cutoff score of the Montreal Cognitive Assessment (Changsha version) in China. *Dementia and Geriatric Cognitive Disorders Extra, 3*, 25–36.

Videnovic, A., Bernard, B., Fan, W., Jaglin, J., Leurgans, S., & Shannon, K. M. (2010). The Montreal Cognitive Assessment as a screening tool for cognitive dysfunction in Huntington's disease. *Movement Disorders, 25*, 401–404.

Wechsler, D. (1997). *Wechsler Adult Intelligence Scale—third revision (WAIS-III)*. San Antonio, TX: Psychological Corporation.

Winblad, B., Palmer, K., Kivipelto, M., Jelic, V., Fratiglioni, L., Wahlund, L. O. … Petersen R. C. (2004). Mild cognitive impairment: beyond controversies, towards a consensus: Report of the International Working Group on Mild Cognitive Impairment. *Journal of Internal Medicine, 256*, 240–246.

Wind, A. W., Schellevis, F. G., Van Staveren, G., Scholten, R. P., Jonker, C., & Van Eijk, J. T. (1997). Limitations of the mini–mental state examination in diagnosing dementia in general practice. *International Journal of Geriatric Psychiatry, 12*(1), 101–108.

Wong, A., Xiong, Y. Y., Kwan, P. W., Chan, A. Y., Lam, W. W., Wang, K. … Mok, V. C. (2009). The validity, reliability and clinical utility of the Hong Kong Montreal Cognitive Assessment (HK-MoCA) in patients with cerebral small vessel disease. *Dementia and Geriatric Cognitive Disorders, 28*, 81–87.

Zadikoff, C., Fox, S. H., Tang-Wai, D. F., Thomsen, T., de Bie, R. M., Wadia, P. … Marras, C. (2008). A comparison of the mini mental state exam to the Montreal cognitive assessment in identifying cognitive deficits in Parkinson's disease. *Movement Disorders, 23*, 297–299.