Psychometric properties of the Montreal Cognitive Assessment v8.2. test: Pilot study

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Abstract. *Objectives*. The world is rapidly ageing and, with the increasing age, there is a potential increase in the number of patients with Alzheimer's disease or dementia. This calls for a reliable screening tool that easily and rapidly could identify the symptoms of pathological cognitive decline. As currently such tools are limited in Latvia, the objective of this study was to examine the psychometric properties of the newly translated Montreal Cognitive Assessment test. *Materials and Methods.* Sixty-five Latvian native speakers aged 55-90 (M = 72.11, SD = 10.26) participated in the study and were divided into three groups – with diagnosis of dementia (n = 21), mild cognitive impairment (n = 18) and control group (n = 26). All participants were assessed using the Montreal Cognitive Assessment test [1], and a test-retest was conducted after 2 weeks (n = 37). *Results*. Almost all mean values and inter-item correlation coefficients were acceptable (.2-.8), apart from indices in the Naming task and Verbal fluency task. The items showed very high reliability (α = .95) and the test-retest reliability showed consistent results (r = .98). *Conclusions*. Overall, the results from the pilot study show acceptable psychometric properties; however, the pilot study should be continued and criterion validity should be tested.

Key words: Montreal Cognitive Assessment scale, MoCA, mild cognitive impairment, dementia, test adaptation, cultural adaptation.

1 Background

The world's population is aging - almost all countries are witnessing an increase in the proportion of elderly people among total population. When studying the aging trends of the society, it can be concluded that the number of people over the age of 65 is growing faster compared to other age groups. The World Health Organization (WHO) predicts that between 2015 and 2050, the proportion of the population aged over 60 will almost double from 12% to 22%, reaching 2.1 billion [2]. The prognosis is that the number of people aged 80 and above will triple starting from 143 million in 2019 reaching 426 million by 2050 [2]. According to the data of the Central Statistical Office [3], there are 523,260 (27.4%)

residents over age of 60 live in Latvia. Comparing to 2015, the number of senior citizens in the country has increased by 3.36%.

Age is the primary risk factor for several neurodegenerative diseases, including Alzheimer's and Parkinson's diseases [4]. Clinical signs of brain aging include cognitive impairment and dementia, so the potential risk of those diseases increases as the population ages. WHO data show that currently around 50 million people suffer from dementia and it is predicted that the total number of dementia patients will increase, reaching 82 million by 2030, and by 2050 the number of these patients will reach 150 million [5]. Contrary to the wide spread opinion, dementia is not a part of natural aging, but is a brain disorder with typical multifaceted impairment of cognitive functions, which can lead to changes in behaviour, personality, and deterioration of physical functions [6].

Referring to the above mentioned, the need for timely diagnostic tools becomes obvious and such type of diagnosis can be achieved with appropriate screening tools. Therefore, WHO has declared the period from 2021 to 2030 as the Decade of Healthy Aging, encouraging public, scientific, professional, and private sector institutions to cooperate to reduce the effects of ageing. The Ministry of Health of Republic of Latvia previously developed a medium term policy- planning document "Plan for improving access to mental health care for 2019-2020", in which early diagnostics and mental illnesses prevention is one of the main directions of action in the plan for improving access to mental health care in Latvia [7]. With this, we had identified such tools available in world practice the help of which it would be possible to perform the timely cognitive diagnostics in sufficient, accurate, and efficient manner. The Montreal Cognitive Assessment (MoCA) is one of the most widely used tests for measuring general cognition and detecting possible global cognitive impairment in older adults [8]. It provides an early detection of mild cognitive impairment with 90% accuracy comparing to 18% accuracy for other cognitive screening tools (e.g. MMSE). In 2004-2005 a new standardization study was presented, which demonstrated the ability of the MoCA test to differentiate healthy patients from patients with mild cognitive impairment or mild Alzheimer's disease. In 2005, research team led by Dr. Nasreddine showed promising results for the assessment of mild cognitive impairment and demonstrated that the MoCA is the most sensitive test currently available for the early detection of Alzheimer's disease compared to the Mini Mental State Examination (MMSE) [1]. MoCA assesses executive functions and several cognitive domains that are essential factors in determining impairment but which were not measured by the MMSE. A systematic review conducted to determine whether MoCA is better than the MMSE in detecting mild cognitive impairment confirmed this fact. In turn, both instruments detect Alzheimer's disease with sufficient precision [9].

The test has been adapted into more than 100 languages and dialects, but it has still not been done in Latvia, where only the 7th version was translated from English to Latvian. Currently, three sub-versions of the revised MoCA test version 8 have already been translated and are available for adaptation. Therefore, the aim of the present pilot study was to perform Montreal Cognitive Assessment test v8.2 adaptation in the Latvian cultural environment, proposing to investigate the psychometric properties of MoCA v8.2 and examine the criterion validity of the MoCA v8.2.

2 Materials and methods

2.1 Study participants

Sixty-five Latvian native speakers from 55 to 90 years old (M = 72.11, SD = 10.26) participated in the pilot study. Participants were divided into three groups – with diagnosis

of dementia (n = 21), with diagnosis of mild cognitive impairment (MCI) (n = 18) and control group (n = 26) (see Table 1 for Participant demographics).

Table 1. Participant demographics.

Characteristic	Age	Education	Female n (%)	MoCA (M)
Controls (n = 26)	65.08 ± 7.92	13.88 ± 6.58	17 (65%)	26.96 ± 1.56
MCI (n = 18)	73 ± 9.31	12 ± 6.4	12 (67%)	20.56 ± 3.47
Dementia (n = 21)	80.76 ± 7.27	12.71 ± 5.82	18 (86%)	9.90 ± 3.73

The inclusion and exclusion criteria for dementia and MCI diagnosed participants were as follows: at least 55 years old, a relevant diagnosis, no clinically significant CNS lesions, no ongoing other previously diagnosed psychiatric and oncologic and/or other somatic diseases, which may affect the test results.

2.2 Cognitive testing

Montreal Cognitive Assessment test (MoCA) is 10-minute brief cognitive screening tool for detecting mild cognitive impairment irrespective of the aetiology of those impairments. MoCA test was developed in 2005 by the Canadian neurologist Ziad Nasreddine. Tool was planned for use as a rapid screening tool for the diagnosis of mild cognitive disorders, helping to identify those disorders at an early stage. The MoCA was standardized for the age group 55-85 years and it assesses the following cognitive domains: attention and concentration, executive functions, memory, verbal functions, visual-constructive skills, conceptual thinking, calculation and orientation [1]. The maximum number of points to be obtained is 30, 26 points is cut-off score.
Summarizing cognitive assessment of MoCA v8.2. by tasks, the split is the following:

1. Short-term memory task, including: Trials of 5 nouns (0 points) and Delayed recall (5 points);
2. Visuo-spatial abilities: Clock drawing (3 points), Chair copying (1 point);
3. Executive functions: Trail making task (1 point), Two-item verbal abstraction (2 points);
4. Attention, concentration ability, working memory: Target detection using tapping (1 point), Serial subtraction task (3 points), Digits forward task (1 point) and Digits backward task (1 point);
5. Language: Naming low-familiarity animals (snake, elephant, crocodile) (3 points), Repetition of two syntactically complex sentences (2 points), Phonemic fluency (1 point);
6. Orientation: orientation in time and place (6 points) [10].

3 Procedure

The adaptation process of MoCA v8.2. was implemented step by step, starting from obtaining all the necessary permissions for adaptation process (see Fig. 1).

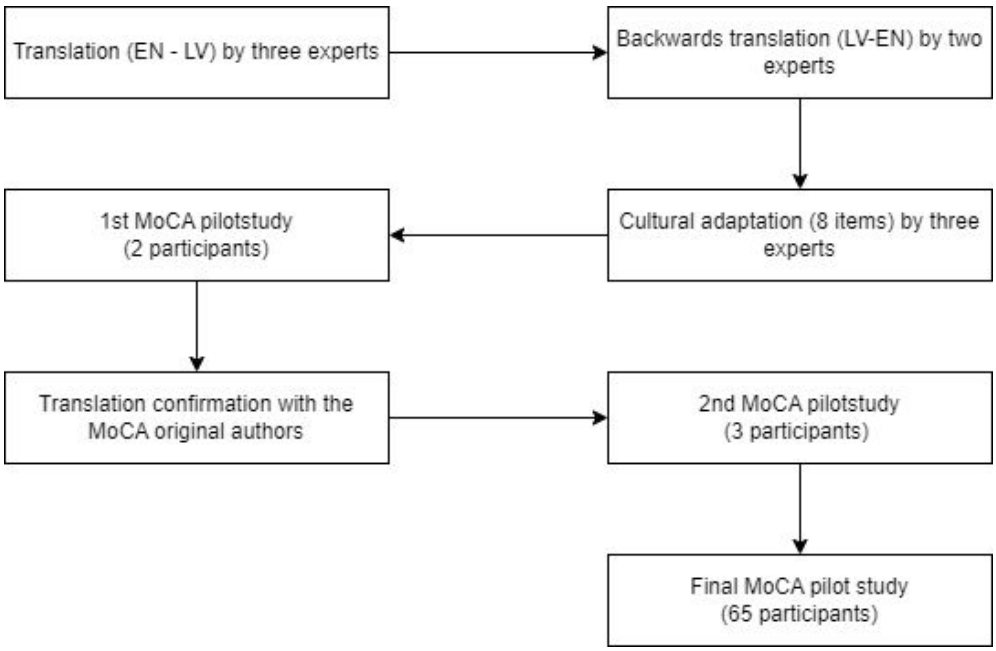

Figure 1. MoCA v8.2. adaptation process by steps.

The translation from English into Latvian language was conducted taking into consideration not only linguistic, but also cultural aspects of the translation process. The translation was performed by three bilingual specialists with expertise in the content of the features to be measured and the basic principles of test construction. Two independent experts reviewed all three versions of the translation and agreed on the final version. Then backward translation from Latvian to English language was performed by two independent professional translators with the expertise in the neuropsychological testing and principles of test construction.

After experts' agreement of the final Latvian version of the MoCA v8.2, there were three tasks adapted to Latvian cultural environment and Latvian language: Memory task, Verbal fluency and Sentence repetition task. According to the MoCA translation guidelines, the word category, frequency of appearance and word length of the translated word in the Memory task must match the original version that was followed. The word substitution for each assignment was agreed with the MoCA copyright holders. For the Verbal fluency task, according to MoCA's translation guidelines and personal communication with MoCA's representatives, the first letters of the most frequently used words were suggested, but cultural adjustments were also allowed. In order to clarify this, all first letters that form prefixes (e.g., s, a, n) were excluded and then the words with medium frequency use in the LVK2018 corpus were searched. LVK2018 is the representative ten million words corpus of contemporary Latvian language, which had been designed as general language, representative and balanced corpus and aiming to cover the variety of existing Latvian texts in determined estimated proportions. As a result, the letter "F" was chosen for MoCA v8.2. Letter substitution was coordinated with the MoCA copyright holder. According to the MoCA translation guidelines, the sentence repetition task requires direct translation, but cultural adjustments are allowed. Therefore, Latvian language grammar rules regarding the order of words in a sentence were observed, nouns were replaced according to the definitions of the Latvian language, and discussion about the frequency of appearance of nouns in Latvian cultural environment was held. Word substitutions as well as word order changes for each task were agreed with the MoCA copyrights holder.

After translation, first pilot study was conducted with two representatives of MoCA target group who met the inclusion criteria (55+ years old and native Latvian). This was followed by submission of the final translated version of MoCAv8.2. to its author for feedback. Once the approval was received, second pilot study was conducted involving three participants meeting abovementioned MoCA inclusion criteria. The participants completed the translated test, providing feedback on the wording of the tasks, the clarity of the instructions and the time required to complete the test.

Finally, psychometric properties of MoCA v8.2 were obtained to examine the consistency and validity of the adapted tool.

Data collection was conducted from September, 2022 till December, 2022. The recruitment of all 3 groups participants took place in cooperation with non-governmental organizations, long-term social care and social rehabilitation institutions (nursing homes), medical institutions, as well as state administrative institutions in cities of Riga, Cēsis, Valmiera, Mālpils, Jelgava, Skrunda and Sigulda. In compliance with the ethical and legal principles of research, prior to the start of data collection, the permission of the Riga Stradins University Ethics Committee (No. 2-PĒK-4/107.2022) and the permission of the Heads of the institutions involved in the collection of research data was obtained. Involvement of the participants in the clinical group (dementia and mild cognitive impairment) was carried out in collaboration with long-term social care and social rehabilitation institutions, identifying patients who met the inclusion criteria and contacting each patient personally to offer voluntary participation in the study. Medical records were not analysed, information about participants' diagnoses was obtained from the attending physician or social worker.

All data were collected in person, from each participant individually. All participants signed an informed consent before being included in the study. First, the participants were asked to fill in a demographic survey, which includes data on the participant's age, gender, marital status, education, occupation, place of residence (region), self-assessment of health, diagnosed diseases, smoking, and alcohol consumption. All participants completed the MoCA v8.2. test. After 21+/-30 days, 37 participants were invited for a test-retest procedure (repeated completion of the MoCA v8.2. test) to examine the consistency of the adapted tool results over time.

4 Results

Data analysis of the current study was performed using Microsoft Excel and IBM SPSS Statistics 27.0 programs. Mean item values, inter-item discrimination indices, internal consistency scores, test-retest scores, as well as, criterion validity was examined.

4.1 Psychometric properties of the MoCA

Mean item values were mostly within the acceptable range (.2-.8), apart from values in the Naming task where all three items ("Snake", "Elephant", "Crocodile") were above the desired range (.91-.97) and Verbal fluency task ("Letter F"), which was below the desired range (.12) (see Table 1 in Appendix). Similarly, the inter-item correlation coefficients were mostly within the recommended range (.2-.8) except for index in the Naming task ("Elephant"), which was below the recommended range (.09). For the internal consistency of MoCA v8.2., Cronbach's alpha coefficient was used and the items showed very high reliability ($\alpha = .95$) in comparison with the original index ($\alpha = .83$). Test-retest reliability data were collected from a sub-sample of 37 participants and the measures were obtained 21-30 days apart. Pearson's correlation between both measures was within the optimal

range (r = .98) and was higher than the test-retest correlation coefficient of the original version of the MoCA test (r = .98; p < 0.001; n = 37) [1].

4.2 Criterion validity scores

To assess the differences between the groups, Kruskal-Wallis H test and Mann - Witney U criterion were used. There were statistically significant differences between groups in all domains of MoCA (see Table 2). Results of Mann-Witney U criterion indicated differences between the dementia group and control group and MCI group in all tasks apart from "Naming" task, while there were differences in almost all MoCA subtests between MCI and control group participants, apart from the Naming task and abstraction task.

Table 2. Group differences between the seven domains of MoCA test.

Domain	Control group			MCI group			Dementia group			K-W H test
	Me	25	75	Me	25	75	Me	25	75	
Visuo-spatial	5	4.75	5	3	2	4	1	1	2.5	42.11**
Naming	3	3	3	3	3	3	2	3	3	10.53*
Attention	8	7	7	6	4	7	0	1	2.5	47.29**
Verbal fluency	2	2	3	2	1	2	0	1	2	22.60**
Abstraction	2	2	2	2	1.75	2	0	0	1	33.51**
Recall	3	3	4	0	0	1.25	0	0	0	48.38**
Orientation	6	6	6	3	5	6	0	1	3	32.50**

Note. Me – median, 25-25th percentile, 75-75th percentile, * - p < .05, ** - p < .01, K-W H test – Kruskal-Wallis H test.

5 Discussion

The aim of the present study was to conduct a pilot study for the Montreal Cognitive Assessment test v8.2 adaptation in Latvian. To examine the psychometric properties of the individual items of MoCA v8.2 Latvian translation, the calculation of the mean values and inter-item correlation indices was carried out. It was found that the mean values of 28 test items out of 32 are within the recommended range. The exception was the item from Verbal fluency task "Letter F", where mean value was below the recommended range, which might point out that this task was difficult to complete for all participant groups. While verbal fluency scores indicated higher difficulty, the items of the Naming task "Snake", "Elephant", "Crocodile" showed mean values above the recommended range that might point out that these tasks were easy to perform for all three participant groups. These findings were unexpected, especially for the dementia group. A meta-analysis conducted by Henry et al. [11] concluded that semantic tasks, such as naming, are often harder for people with dementia of the Alcheimer's type, while phonemic fluency tasks are easier, as semantic memory is often the one that is more damaged in case of AD.

Nevertheless, if the number of tasks in the test is large enough, it might be a good practice to include both extremely easy tasks with the mean values within range .81-.99 and difficult tasks with the mean values within range .01-.19 [12]. Taking into account that tasks with an increased mean values are distributed proportionally throughout the scale, MoCA v8.2 tool was compiled according to psychometric norms. It should also be noted that previous adaptations of the MoCA test have shown similar results. For example, a normative study in Italy showed that the least difficult items were from the domains of Naming, Visual-spatial tasks, the letter detection (Attention domain) and Orientation task,

while the most difficult items turned to be three-dimension tasks (Visual-spatial abilities domain), CDT hands, repetition task and phonemic fluency, as well as verbal abstraction tasks [13].

The inter-item correlation coefficients were mostly within the recommended range except for one index in the Naming task "Elephant", which was below the range. This would indicate that this specific item does not sufficiently discriminates participants according to the characteristic being measured, that is, study participants with diagnosed dementia and mild cognitive impairment were able to perform this task as successfully as did the healthy participants from the control group. Comparing the mean value and inter-item correlation coefficient, one can conclude that the item is both quite easy to implement and does not discriminate participants according to the characteristic to be measured, so it would be advisable to revise this item. Still the characteristics of the sample size should be taken into consideration when interpreting the data.

To detect internal consistency Cronbach's alpha coefficient was tested. The results showed high reliability of the test, which was higher than the Cronbach's alpha of the original version of the MoCA test. It should be noted that good internal consistency scores were also identified in previous MoCA test adaptations, showing that the screening task is reliable [13-15].

To find out MoCA v8.2 reliability Pearson's correlation coefficient was compared between the results of the two measurements. 37 participants from all 3 groups took a part in repeated testing with an interval of 21-30 days. The obtained data showed high test-retest scores, which indicate a positive, statistically significant correlation between the two measurements. When comparing correlation coefficients of the MoCA v8.2 with the correlation coefficient of the original version of the MoCA test, it has been observed that the correlation coefficient the original scale is lower despite the fact that the number of retested participants was smaller. The obtained result allows concluding that the results of the adapted MoCA v8.2 are stable over time. This is again consistent with other adaptation studies [13-15].

Criteria validity was tested by comparing the MoCA v8.2 scores between the three subgroups – control, MCI and dementia, showing significant differences between the subgroups in all domains, with dementia group having the lowest scores in all domains. The least difference was identified in the Naming domain – a result that complies with the findings based on difficulty and discrimination indices.

6 Limitations

While overall these results further support that MoCA v8.2 test could be used as a valid screening tool, several limitations are present in this study. Sample size was a significant limitation, as the groups were not age, education, and gender matched. Nevertheless, this mismatch also represents the general situation, as age, level of education obtained during the life and gender could be predictors for dementia. Another challenge present in the study were the circumstances of data acquisition. While the authors strived for equal conditions in all cases, it was not always possible, thus noise during testing, different time of day, poor lighting and various examiners could factor in the reliability of the data.

7 Future implications

Since the sample of existing study has not been representative, when thinking about the process of adaptation of the tool, we would propose to continue to carry out MoCA v8.2 adaptation and conduct its standardization. Regarding the differentiation of patients by

diagnosis, it would be necessary to make a comparison by item between all 3 groups of study participants. This might help to determine which item differentiates the diagnosis of mild cognitive impairment from dementia and the differentiation of these both diagnoses from the control group the best.

As translations of all three versions of the MoCA test are currently available, it is proposed to conduct a cross-validation of parallel forms between MoCA v8.2., v8.1. and v8.3., which would be useful for determining the dynamics of cognitive functions of study participants.

Additional methods might be used in further data collection, selecting participants to complete the MoCA test, as well as to obtain more information about participants' independence in daily activities, e.g., ADL (Activity of Daily Living) survey.

8 Conclusion

The set aim of this pilot study to perform MoCA v8.2 adaptation in the cultural environment of Latvia has been achieved and it was concluded that:

1. MoCA v8.2 mean values and inter-item correlation indices generally correspond to the norms accepted in psychometric science, at the same time some of the items have increased and decreased reaction index and decreased discrimination index.
2. MoCA v8.2 internal consistency index is high, which point out that the scale is reliable.
3. MoCA v8.2 test-retest result shows that the test results are consistent over time.
4. MoCA v8.2 criterion validity is adequate, as it shows that at least 5 subscales of the tool differentiate the diagnoses of dementia and mild cognitive impairment among themselves and between the control group.

Overall, the results from the pilot study show acceptable psychometric properties; however, the pilot study should be continued and criterion validity should be tested.

The results of the study can help specialists to identify the symptoms of mild cognitive impairment at an early stage for individuals starting from the age of 55. It may also help to differentiate the characteristic signs of mild cognitive impairment from the signs of dementia disorder. Besides, the results can help to identify patients' disorders in one specific or several cognitive domains, as well as, in addition to other diagnostic methods, can help to determine the form of dementia based on disorders in the defined cognitive domain.

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Appendix

Table 1. Montreal Cognitive Assessment v8.2. test items psychometric properties.

Item	Mean value	Inter-item correlation coefficient
Trail making	0.60	0.72
Chair	0.52	0.68
Clock (contour)	0.82	0.32
Clock (numbers)	0.58	0.58
Clock (clock hands)	0.55	0.80
Naming (snake)	0.97	0.27
Naming (elephant)	0.97	0.09
Naming (crocodile)	0.91	0.47
Attention (forward digits)	0.55	0.33
Attention (backward digits)	0.66	0.50
Attention (alertness)	0.77	0.54
Attention (7 series - 63)	0.82	0.61
Attention (7 series - 56)	0.54	0.68
Attention (7 series - 49)	0.54	0.82
Attention (7 series - 42)	0.54	0.85
Attention (7 series - 35)	0.51	0.81
Sentence repetition 1	0.88	0.38
Sentence repetition 2	0.69	0.56
Verbal fluency (letter F)	0.12	0.32
Generalization (bed - chair)	0.65	0.54
Generalization (letter - telephone)	0.77	0.68
Recall (hand)	0.35	0.67
Recall (nylon)	0.26	0.58
Recall (park)	0.22	0.41
Recall (carrot)	0.35	0.63
Recall (yellow)	0.38	0.67
Orientation (date)	0.60	0.62
Orientation (month)	0.77	0.64
Orientation (year)	0.68	0.84
Orientation (day)	0.74	0.64
Orientation (place)	0.75	0.76
Orientation (city)	0.85	0.51

Note. $N = 65$.
Mean values recommended range: .2 – .8.
Inter-item correlation coefficient recommended range: .2 – .8.