A VISUAL BASED COGNITIVE ASSESSMENT TOOL (VCAT) FOR DIAGNOSIS OF DEMENTIA IN A MULTILINGUAL ASIAN POPULATION

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ABSTRACT

Background Mild cognitive impairment (MCI) can be regarded as a risk for developing dementia. Early diagnosis of MCI enables timely medical and non-medical intervention for patients as well as social support networks for caregivers. This is essential as the prevalence of dementia is increasing worldwide.

Objective The Visual Cognitive Assessment Tool (VCAT) may be comparable to MoCA and MMSE in detecting MCI, without the need for translation into other languages or adaptations.

Method The VCAT, MoCA and MMSE were administered to participants from the Falls clinic of University Malaya. The sensitivity and specificity, area under the curve (AUC) as well as post-hoc analysis was assessed for the detection of MCI and dementia.

Results VCAT was comparable to MoCA and MMSE in a sample of 96 participants. The sample comprised of 50 Healthy Fallers and 46 Cognitively Impaired Subjects. AUC of VCAT for detection of cognitive impairment was 88.3(95% CI 81.3 to 95.3). The sensitivity and specificity of VCAT in diagnosing cognitive impairment was 80% and 82% respectively. VCAT had better sensitivity than MMSE, and better specificity than MoCA. Post-hoc analysis showed that VCAT offers better differentiation for normal controls versus MCI in comparison to MoCA and MMSE. Mean time to completion of VCAT was 13.0 ± 5.7 min.

Conclusions The VCAT has good sensitivity and specificity for diagnosing cognitive impairment. It may also offer better differentiation for normal controls versus MCI compared to MoCA and MMSE. It also offers the advantage of being visual based, thus avoiding the need for adaptations or translations into other languages.

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ABBREVIATION

AD	Alzheimer's Dementia
ANOVA	One Way Analysis of Variance
AUC	Area Under the Curve
CDR	Clinical Dementia Rating
CIS	Cognitively Impaired Subjects
FR	Functional Reach
HF	Healthy Fallers
IPNP	International Picture Naming Project
MMSE	Mini Mental State Examination
MoCA	Montreal Cognitive Assessment Test
MCI	Mild Cognitive Impairment
NIA-AA	National Institute on Aging Alzheimer's Association
NINDS-ADRDA	National Institute of Neurological and Communicative Disorders Stroke and Alzheimer's Disease and Related Disorders
ROC	Receiver Operator Curve
SPSS	Statistical Package for Social Sciences
TUG	Time Up and Go
UMMC	University Malaya Medical Center
VCAT	Visual Cognitive Assessment Tool

CHAPTER1: INTRODUCTION

Dementia is a clinical syndrome linked to neurodegeneration and characterized by progressive deterioration in cognitive ability and capacity for independent living (Prince M, Bryce R, 2013). According to DSM-IV, the criteria for dementia is the development of multiple cognitive deficits manifested by both memory impairment and one or more of the following cognitive disturbances: aphasia, apraxia, agnosia or a disturbance in executive functioning. The cognitive defects in memory impairment and cognitive disturbances are associated with impairment in social or occupational functioning and is required to represent a measurable decline from the previous level of functioning. The disturbance also should not occur during an acute illness or the presence of medical conditions linked to delirium and disturbances in higher mental function. Mild cognitive impairment (MCI) represents an intermediate state of cognitive function between the changes seen in aging and those fulfilling the criteria for dementia and Alzheimer's disease (Petersen RC, Smith GE, 1999).

MCI is classified into two subtypes: amnestic and non-amnestic (Petersen RC, 2004). Amnestic mild cognitive impairment is clinically significant memory impairment that does not meet the criteria for dementia. Non-amnestic mild cognitive impairment is characterized by a subtle decline in functions not related to memory, affecting attention, use of language, or visuospatial skills. The non-amnestic type of mild cognitive impairment is probably less common than the amnestic type and may be the forerunner of dementias that are not related to Alzheimer's disease, such as frontotemporal lobar degeneration or dementia with Lewy bodies (Molano J, Boeve B, 2010). In clinical trials involving patients with amnestic MCI, more

than 90% of those with progression to dementia have clinical signs of Alzheimer's disease (Petersen RC, Thomas RG, 2005). The estimated prevalence of MCI in population-based studies range from 10 to 20% in persons older than 65 years of age (Busse A, Hensel A, 2006).

There is a growing need to diagnose the early stages of cognitive impairment as the prevalence of dementia is increasing worldwide (Brookmeyer R, Gray S, 1998).

An early diagnosis of dementia is essential for establishing effective medical interventions and social support networks. These patients would need regular clinical follow-ups, as well as pharmacological and lifestyle interventions to prevent the progression towards dementia (Winblad B, et al 2004).

Neuropsychometric assessments are presumed to be the best method to screen individuals in most developing countries (Chaves et al 1999). At the outset, the lack of standardization of screening tools has to be recognized as a major issue in the estimation of the true burden (Rodriguez et al 2008). Standardization might not be readily achieved because of diversity in language, culture, and levels of literacy. In certain communities, more than 80% of older people do not read or write (Hall KS et al, 1996). The mini mental state examination (MMSE) has been translated into many languages, but its use might be limited even as an initial screening tool. In a study done by Scazufca et al in 2009, education, age, sex and income influenced MMSE scores, independently of dementia cases.

Similarly in Asia, a systematic review of the cognitive assessment tools used found that the MMSE is also influenced by age, education levels as well as cultural and ethnic differences (Rosli et al, 2015).

The development of tools with no linguistic and educational biases are urgently needed to address the rapid increase in persons with dementia in developing

countries. The Visual Cognitive Assessment Tool (VCAT) is a brief visual based assessment tool that may be more suitable for multicultural and multilingual societies around the world (Kandiah N et al, 2015). It is designed to screen and detect for early cognitive impairment in the older population by assessing five different cognitive domains- memory, visuospatial executive function, language and attention. It offers the advantage of avoiding the need to translate or adapt to other languages or dialects as long as the administrator and participant speak the same language (Kandiah, N, et al 2015).

Standardized cognitive batteries will facilitate information flow through the health system. The cognitive battery needs to be simple enough to be adopted into the clinical setting. Minimal or no training should be needed to use it as a screening tool. Thus, the same tool can be easily used to monitor patient progress and improvement. Clinicians would use cognitive evaluation to chart progress as patients with dementia transition between the different healthcare settings for diagnosis, treatment, and management (Kua, J, 2004).

The objective of this study is to evaluate the validity and psychometric properties of VCAT as an assessment tool for the detection of mild cognitive impairment (MCI) as well as dementia in a multi-racial urban area of Malaysia, University of Malaya in comparison with the Montreal Cognitive Assessment (MoCA) and MMSE.

Our hypotheses therefore include:

i. The VCAT would be more practical in a multilingual and multicultural society as it removes the need for translations with consequent loss of original intent of tests.

ii. The VCAT will have sensitivity and specificity comparable to the MoCA for the detection of mild cognitive impairment. Compared to the MoCA,

the VCAT can be administered without the need for translation and >90% of subjects will be able to complete the test.

CHAPTER 2: LITERATURE REVIEW

2.1 Definition of Dementia

Dementia is a syndrome (either of a chronic or progressive nature), in which there is deterioration in cognitive function beyond what might be expected from normal ageing. It affects memory, thinking, orientation, comprehension, calculation, learning capacity, language, and judgement. Consciousness is not affected.

The impairment in cognitive function is commonly accompanied, and occasionally preceded, by deterioration in emotional control, social behaviour, or motivation (World Health Organization, 2017).

Dementia impacts not only the patient's quality of life, but also for their caregivers as it is typically associated with particularly intense needs for care, exceeding the demands associated with other conditions (World Alzheimer Report 2015). There is often a lack of awareness and understanding of dementia, resulting in stigmatization and barriers to earlier diagnosis and better care (World Health Organization, 2017).

2.2 Epidemiology of Dementia

Alzheimer's disease (AD) is the most common form of dementia in older persons (van der Flier WM et al, 2005). The other major dementia syndromes include dementia with Lewy bodies, frontotemporal dementia, vascular dementia and Parkinson's disease with dementia. Currently, the world's older population comprises of nearly 900million people. There are an estimated 48 million people worldwide who are living with dementia in 2015. This number will almost double every 20 years to 74.7 million in 2030 to 131.5 million in 2050 (World Alzheimer Report 2015). For South-East Asia, the predicted growth rate for the number of people with dementia will be 68% (World Alzheimer Report 2015).

The incidence of dementia is also increasing exponentially with increasing age. There are an estimated 9.9 million new cases reported yearly worldwide, implying one new case every 3.2 seconds. Out of these new cases, 49 % will be in Asia, 25% in Europe, 18% in the Americas and 8% in Africa (World Alzheimer Report 2015).

2.3 Diagnosing Dementia

Early diagnosis of dementia remains a challenge for medical practitioners. Freud B in 2006 and Lin JS in 2013 have found that health care professionals commonly miss the diagnosis of cognitive impairment or dementia; the prevalence of missed diagnosis ranges from 25% to 90%. Primary care physicians may not recognize cognitive impairment until the moderate to severe stage. Most patients with dementia do not present with a complaint of memory loss; rather in most cases it is the spouse or other informant who will bring up the problem to the physician's attention. Informant reported memory loss is a much better predictor of the current presence and future development of dementia, whereas self -reported memory loss does not appear to correlate with the subsequent development of dementia (Carr DB, Gray S, 2000).

Screening tests are quick and useful tools to assess the cognitive condition of patients (Ashford JW, Borson S, 2006). The MMSE is the most widely used screening test for dementia, followed by MoCA (Tsoi KK, Chan JY et al, 2015).

The MMSE was developed as a screening test to quantitatively assess the severity of cognitive impairment and to document cognitive changes that occur over time. It has various questions with a maximum score of 30 points, and can usually be administered within 5-10 minutes. Tambaugh and McIntyre (1992) reviewed the strengths and weaknesses of the MMSE. They concluded that the MMSE has moderate to high levels of reliability, and the criterion validity measures show

moderate to high sensitivity levels for moderate-to- severe dementia. Of the demographic factors, age and education level exert the greatest effect. The MMSE, however, is not without its shortcomings. One of the most frequently cited was its lack of sensitivity to mild cognitive impairment and its failure to adequately discriminate patients with mild AD from normal patients. It is also highly verbal, lacking sufficient items to adequately measure visuospatial and/or constructional praxis. Items designed to measure language functions tend to be overly simplistic and insensitive to mild linguistic deficits, hence increasing the number of false negative errors (Tombaugh TN et al, 2002).

The Montreal Cognitive Assessment (MoCA) has since been developed to screen for patients who have mild cognitive impairment and who usually perform in the normal range of the MMSE. It is a one-page 30 point test that takes around 10 minutes to complete (Nasreddinne et al, 2005). It showed high test-retest reliability and good internal consistency. Its sensitivity and specificity in detecting mild cognitive impairment was 90% and 87% respectively. The MMSE in contrast, only had a sensitivity of 18% for the detection of MCI (Nasreddinne et al, 2005). Rosetti and Lacritz et al produced normative and descriptive data for MoCA in a population of 2, 653 ethically diverse subjects as part of a population based study for cardiovascular diseases. They found that the MoCA scores were significantly correlated with age, was more strongly associated with education and had no relation to gender. They summarized that the MoCA scores needed to be interpreted with caution in multicultural societies, and especially those with lower levels of education (Rosetti HC et al, 2011).

A few cognitive assessment tests such as the Eurotest, Phototest and Memory Alteration test have been useful in demonstrating cognitive impairment in those

without a formal education (Carnero-Pardo C et al, 2006; Carnero-Pardo C et al, 2011; Rami L et al, 2010). These tests have yet to be evaluated or validated in Malaysia.

The Visual Cognitive Assessment Tool (VCAT) is a brief and visual based assessment tool that may be more suitable for multilingual and multicultural societies such as Malaysia. It offers the advantage of bypassing the need for translations or adaptations into other languages or dialects (Nagendran et al, 2015). It was developed using a 5 -step process. Based on results from 50 healthy elderly controls (HC), unambiguous and culturally neutral pictures were identified from the International Picture Naming Project (IPNP). Shortlisted pictures were then used to construct test items in the 5 cognitive domains (Nagendran et al, 2015). A VCAT scale range of 0-30 was preplanned with lower scores indicating greater cognitive impairment.

A cut-off of 18-22 suggests cognitive impairment, whereas scores of 0-17 indicates the likelihood of a patient having dementia. In a validation study by Nagendran et al in 2015, the diagnostic performance of VCAT was generally satisfactory and similar to MoCA and MMSE in the detection of MCI and Alzheimer's.

As the VCAT is a visual based test, it is not suitable for patients with visual impairment. It may also not be suitable for use in patients suspected to have moderate to severe dementia, as well as patients with dementia presenting with isolated language impairment (Nagendran et al, 2015).

CHAPTER 3: METHODOLOGY

3.1 Research Objectives

To establish the use of VCAT for the detection of mild cognitive impairment (MCI) in a multi-racial literate urban area of the University of Malaya Medical Center (UMMC).

3.2 Research Hypotheses

Hypothesis 1: The VCAT, which is a cognitive evaluation test based on pictures, images and figures will be more practical in multilingual populations as it removes the need for translations with consequent loss of the original intent of tests.

Hypothesis 2: The VCAT will have sensitivity and specificity comparable to the MoCA for the detection of mild cognitive impairment. Compared to the MoCA, the VCAT can be administered without the need for translation and >90% of subjects will be able to complete the test.

3.3 Research design and Sample Population

This is a cross-sectional study that looks at the efficacy of VCAT in screening and detecting early dementia in the elderly. Patients were recruited from the Falls clinic of UMMC from December 2016 until September 2017. Ethical approval was obtained from the UMMC Medical Ethics Committee.

3.4 Inclusion criteria

-Age ≥50 years

-Seen at the Falls Clinic, UMMC

-Able to complete the MMSE, MoCA and VCAT tests

3.5 Exclusion Criteria

- Presence of serious systemic, neurologic or psychiatric disease
- Patients with poor vision, who in the judgement of the clinician is unable perform VCAT

3.6 Definition of Mild Cognitive Impairment and Dementia

Mild cognitive impairment and dementia were diagnosed using two established criteria. The diagnosis of the MCI was made based on the Petersen's/NIA-AA criteria, while mild to moderate dementia was determined using the NINDS-ADRDA/NIA-AA criteria. In addition, individuals with a clinical dementia rating (CDR) total score of 0.5 were considered MCI patients and those with a CDR of 1.0-2.0 were considered mild to moderate dementia.

3.7 Data Collection

Data was collected from consenting patients who fulfilled the inclusion criteria. Participants who agreed to participate with cognitive assessment and evaluation were asked to sign the consent form prior the evaluation. The MMSE, MoCA and VCAT were administered consistently in the stated order. In addition, participants' physical attributes, education level, past medical history and medication history. Participants were also asked to appraise overall and domain-level cognitive load of the VCAT. The appraisal covered comprehensibility of items, perceived difficulty level and overall test length.

3.8 Data Processing and Analysis

The Statistical Package for Social Sciences (SPSS for Mac version 23) was used for all statistical analyses. Data on patients' characteristics and demographics were presented as mean and standard deviation. Categorical data were presented as numbers with percentages.

The validity of VCAT in comparison to MMSE and MOCA was evaluated using Pearson's rank order correlation coefficient. Diagnostic performance was assessed using area under the curve (AUC), sensitivity, specificity, and positive and negative predictive values. The precision of estimates is given by 95% confidence intervals.

One way Analysis of Variance (ANOVA) was used to compare means between the cognitive tests, physical parameters as well as patients' characteristics. Post-hoc analysis using LSD was also done for the VCAT, MoCA and MMSE.

CHAPTER 4: RESULTS

4.1 Baseline Demographics

A total of 116 patients were recruited for this study. Out of this number, only data from 96 patients were included, as 4 recruits withdrew and another 16 did not complete one or more of the memory tests.

Table 1 shows demographic data for study population. The group was divided into 50 Healthy Fallers (HF) and 46 Cognitively Impaired Subjects (CIS), out of which 36 were diagnosed to have dementia, and the remaining 10 had MCI. The majority were female (53%), mean age 76.12 ± 7.72, ranging from 56-91 years of age. 65% were ethnic Chinese, 18% Indian, 9% Malay, 3% Sikh, and 1% others. The groups of NC and CIS were similar in racial composition as well as in the number of patients whose primary language was English. An analysis of variance (ANOVA) showed that increasing age and low education levels increase the risk of dementia, with $p<0.002$ for both categories respectively.

Table 1: Patients demographics characteristics

Attributes	HF N=50	MCI N=10	Dementia N=36	p value
Mean age (SD)	73.6(8.02)	76.1(7.92)	79.6(5.92)	0.002*
Gender(percentages)				
Female	27(54)	2(20)	24(66)	0.031
Male	23(46)	8(80)	12(33)	
BMI , mean (SD)	24.4(3.59)	23.5(3.46)	24.02(3.99)	0.741
Mean years of education(SD)	11(4)	13(2)	8(5)	0.002*

Ethnicity				
Chinese	32(64)	6(12)	27(75)	0.310
Indian	11(22)	3(30)	4(11)	
Malay	6(12)	1(10)	2(6)	
Sikh	0	0	3(8)	
Others	1(2)	0	0	
Participants primary language				
English	34(68)	9(90)	24(67)	0.644
Mandarin	5(10)	0	4(8)	
Cantonese	4(8)	1(10)	5(14)	
Malay	7(14)	0	3(8)	

MCI, mild cognitive impairment; BMI, Body Mass Index; SD, Standard Deviation

HF, Healthy Fallers

4.2: Outcomes of VCAT, MoCA and MMSE

Diagnostic performance of the VCAT was similar to MoCA and MMSE in differentiating between MCI and dementia (Table 2). To discriminate between HF and CIS (MCI+Dementia), the area under the curves (AUCs) (95% Confidence Intervals) are as follows:

VCAT (cut-off=22) (Nagendran et al 2015) 88.3(81.3 to 95.3), MoCA (cut-off 26) (Nasreddinne et al 2005) 91.6 (86 to 97.2), and MMSE (cut-off 27) 89.5% (83.4 to 95.6) (Kukull et al 1994) (Figure 1).

VCAT had a sensitivity of 80% and specificity of 82%. The negative predictive

value was 87.7% and the positive predictive value was 77.1%. The results were comparable to MMSE (Se=73.3%, Sp=86%), MoCA (Se=91.1%, Sp=60%).

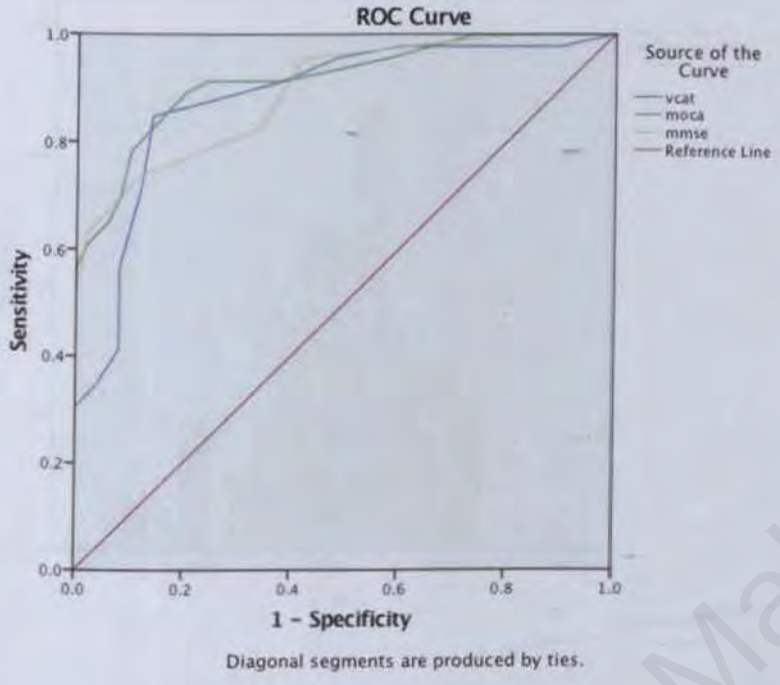
The Pearson correlations with MoCA and MMSE were 0.797 and 0.667 respectively, demonstrating concurrent validity of VCAT with MoCA and MMSE (Table 3).

Table 2: VCAT, MoCA, MMSE total scores

Test	HF, mean (SD) N=50	MCI, mean (SD) N=10	Dementia, mean(SD) N=36	P value MCI vs dementia
VCAT	24(4.0)	20(4.0)	14(16)	<0.001*
MoCA	26(3.0)	24(3)	16(5.0)	<0.001*
MMSE	28(1.0)	26(2)	21(6)	<0.001*

HF, Healthy Fallers; MCI, Mild Cognitive Impairment

Figure 1: Receiver operating characteristic curves (MMSE, Mini-Mental State Examination, MoCA, Montreal Cognitive Assessement)



VCAT AUC=88.3% (81.3,95.3), MoCA AUC=91.6% (86.0,97.2), MMSE AUC=89.5% (83.4,95.6)

Cut-off scores to determine CIS:

VCAT (cut-off=22): (Nagendran et al 2015)

MoCA (cut-off 26): (Nasreddinne et al 2005)

MMSE (cut-off 27): (Kukull et al 1994)

Table 3: Pearson correlations between VCAT, MoCA and MMSE

		MMSE	VCAT	MoCA
VCAT	Pearson Correlation	0.667	1	0.797
	Sig.(2-tailed)	<.001*		<.001*
	N	96	96	96

The distribution scores for VCAT, MoCA and MMSE are shown in figures 2a, 2b, and 2c respectively . The results show a ceiling effect for MMSE and MoCA, but not for VCAT.

Figure 2a: Histogram of VCAT score range for Study Population

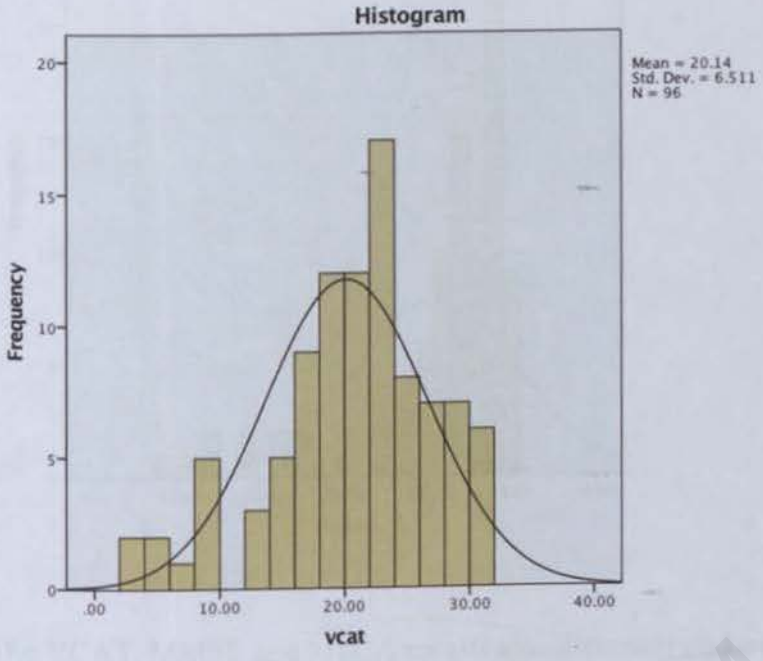


Figure 2b: Histogram of MoCA score range for Study Population

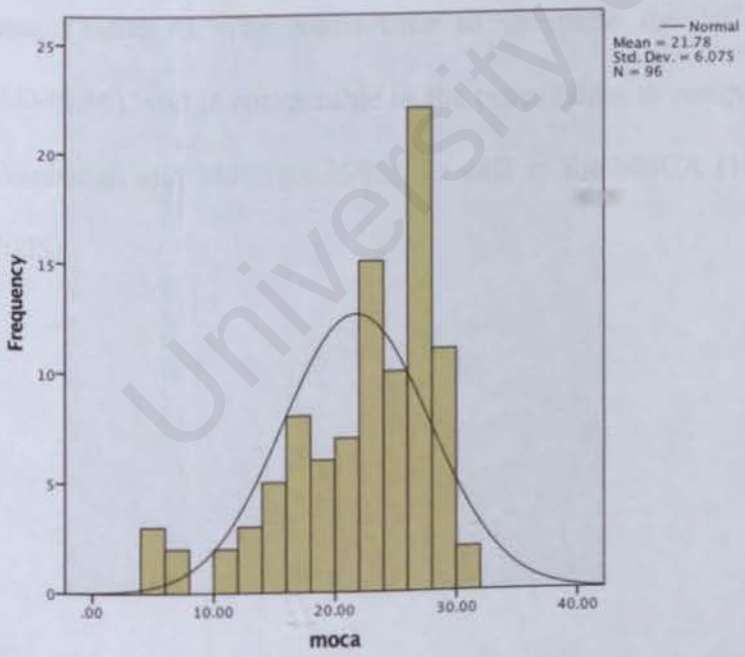
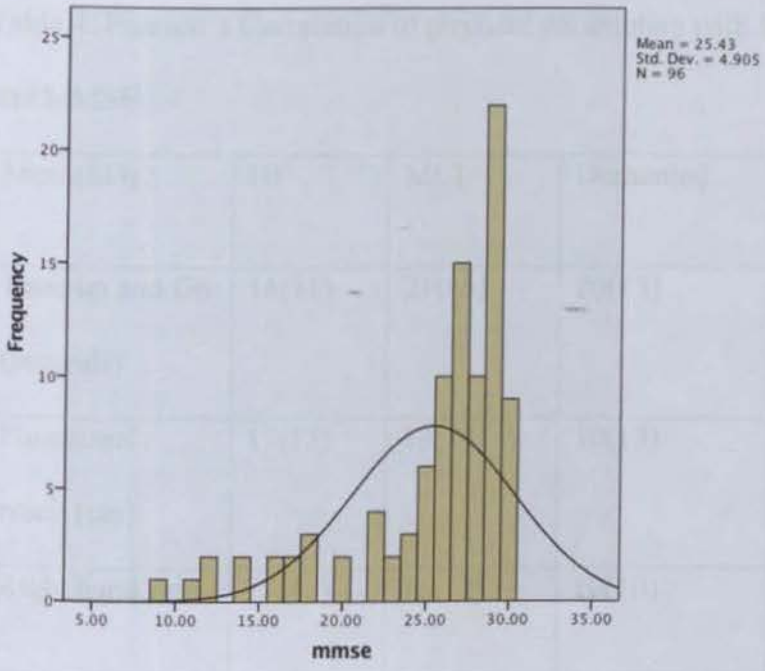


Figure 2c: Histogram of MMSE score range for Study Population



The VCAT, MMSE and MoCA results also demonstrated a positive correlation with right and left grip strength. There is, however, no correlation between Time Up and Go (TUG), as well as Functional Reach (FR) with all three memory tests (Table 4). The mean time to complete the VCAT was around 13 minutes (SD=5.68), and is comparable to the times taken to complete the MMSE (5-10minutes- Tambaugh and McIntyre,1992), as well as the MoCA (10 minutes- Nasreddinne et al, 2005).

Table 4: Pearson's Correlation of physical parameters with VCAT, MoCA and MMSE

Mean(SD)	HF	MCI	Demented	p value
Time up and Go (seconds)	16(11)	21(13)	20(13)	0.284
Functional reach (cm)	17(13)	13(13)	10(13)	0.050
Right hand grip	17(11)	15(12)	10(10)	0.011*
Left hand grip	16(11)	11(9)	9(9)	0.005*

Post-hoc analysis using LSD on all 3 cognitive tests shows that MMSE and MoCA significantly differentiated MCI from dementia (MMSE, $p<0.001$ and MoCA, $p<0.001$); as well as differentiating healthy fallers (HF) from dementia (MMSE, $p<0.001$ and MoCA, $p<0.001$).

However, there was no significant difference between HF and MCI in terms of MMSE ($p=0.138$) or MoCA ($p=0.318$).

The VCAT, however, correctly differentiated between HF and MCI ($p=0.036$), MCI and dementia ($p=0.002$), and HF and dementia ($p<0.001$). All 3 cognitive tests showed similar association between grip strengths, FR and TUG; this also adds to the validity of VCAT as a cognitive assessment tool.

As documented in Table 4, only grip strength showed a positive correlation with dementia.

CHAPTER 4: DISCUSSION

4.1. Interpretation and findings

The VCAT was initially developed as a novel visual based screening test designed to detect dementia at an early stage. As it is visual based, it does not need to be translated or adapted to other languages (Nagendran et al, 2015). It can also be administered in any language as long as the test administrator and the participant converse in the same language (Nagendran et al 2015).

In this study, the VCAT demonstrated comparable diagnostic performance as the MoCA and MMSE in terms of specificity and sensitivity. The VCAT shows better sensitivity than MMSE (80%), and better specificity compared to MoCA (82%).

In addition, VCAT offers better differentiation in post-hoc analysis for HF versus MCI as compared to MoCA and MMSE. In distinguishing between MCI, dementia, and healthy fallers, there was no ceiling effect seen in distribution of scores for VCAT when compared to MoCA and MMSE. This may make VCAT a more useful tool for the detection of MCI in the elderly.

In comparing between the frailty measures (time up and go, functional reach, grip strength) among the participants, only grip strength was shown to have a positive correlation with dementia. This finding was also reported by Rogers et al in 2008, which suggested that dementia is associated with strength loss, a key contributor to functional disability. Idiopathic decline in motor function is a familiar consequence of aging, with older persons displaying a wide spectrum of loss of muscle strength, muscle bulk, and walking speed (Camicioli R. et al 2007). These deficits are subsumed under several constructs, including physical frailty, sarcopenia, and parkinsonism, and there is now considerable evidence showing that idiopathic decline in motor function is common in old age and precedes and predicts a wide range of important health and cognitive outcomes, including death, disability, MCI, and dementia

(Mitchell et al 2006, Wang L et al 2006, Waite LM et al 2005). The TUG in this study did not show a positive correlation as there may be a large variability due to factors as mentioned above (physical frailty, sarcopenia, parkinsonism).

There was a positive correlation between advancing age and education levels with dementia. Jorm A.F et al in 2007 found that the relationship between prevalence and age was remarkably consistent, with estimated prevalence rates doubling every 5.1 years, up to the age of 95 years. The 95% confidence interval for this doubling period is 4.8-5.4 years. Persons with higher educational attainment may have a greater cognitive reserve that can postpone the clinical manifestation of dementia. Unhealthy lifestyles may independently contribute to the depletion of this reserve or directly influence the underlying pathologic processes (Ngandu T et al 2007).

4.2. Strengths and limitations

The initial validation study had a sample of 206 participants. This study had a relatively smaller number of samples, which was 96 participants. However, the results of this study are identical in terms of comparative findings with MoCA and MMSE. The number of participants detected to have MCI was only 10, compared to dementia which was 36. This could be due to the fact that the NNIA criteria may have led to some patients being classified as dementia instead of MCI.

There may be some element of fatigue among the participants when they were tested with all 3 congnitive tests in succession. One of the ways to avoid this is for the patients to be tested with the cognitive tests on separate days in a given week. The drawback is that some patients may have logistic difficulties in coming frequently within a short span of time. If the cognitive tests were done separately over a longer duration of time, it may not be accurate also as their cognition may change within that period of time.

The functional impairment in the dementia group may be due to other factors rather than dementia. This may be addressed by a study using continuous cognitive scores adjusted for the presence of other conditions. A larger sample is required for such a study, which is outside the scope of this current study.

4.3. Summary and recommendations

The VCAT is comparable to MoCA and MMSE as a cognitive assessment tool. Being a visual based test, it does not need to be translated into other languages, thus making it more feasible for use in a multicultural society.

The VCAT may need some minimal training initially for those who have not conducted the test before. It is simple enough to be administered by either a clinician or an occupational therapist. The VCAT can be used on its own, or with other cognitive tests as a screening tool for MCI or dementia in either the outpatient or hospital setting.

Patients whose caregivers, or they themselves report memory impairment should be deemed suitable to undergo cognitive assessment tests such as the VCAT, and that their progress should be documented during subsequent clinic sessions.

It is recommended to have larger samples for future studies to better understand the psychometric properties of other criteria for the diagnosis of dementia. In terms of clinical practice, VCAT may be better than MMSE and MoCA in detecting MCI and dementia, especially when it is being used in a multilingual and multicultural population.

CHAPTER 5: REFERENCES

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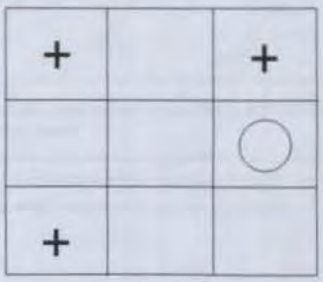
VCAT Form :

Visual Cognitive Assessment Test (VCAT)

Picture Page

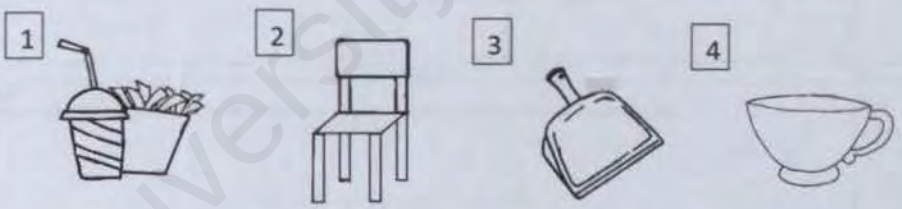
Memory: Scenario

Memory: Shapes



Memory: Objects

Memory: Objects (Cues)



Scoring Table

Visuospatial: Grid In 30s, 0 – 3 correct boxes = 0 point 4 – 5 correct boxes = 1 point 6 (All) correct boxes = 2 points	*Memory: Shapes* 0 – 1 shape and position correct = 0 point 2 – 3 shape and position correct = 1 point 4 (All) shape and position correct = 2 points
	Executive function: Gears Both gears wrong = 0 point Either 1 of the gears correct = 1 point 2 gears correct = 3 points
Language: Fluency 8 – 10 vegetables = 1 point 11 or more vegetables = 2 points	*Attention/ Working Memory* 3 or more errors = 0 point 2 errors = 1 point 0 -1 error = 3 points

Visual Cognitive Assessment Test (VCAT)

Memory (part 1) — Total Score

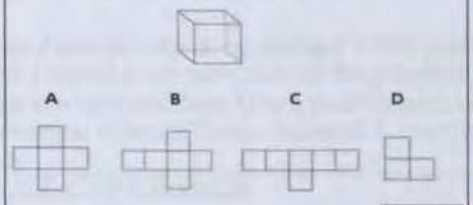
Scenario
Please look at the picture and (a) name the location and (b) name the items that you can see.
(Refer to picture page)

Dog	Coconut Tree	Kite	Crab	Lady	Bone

No marks

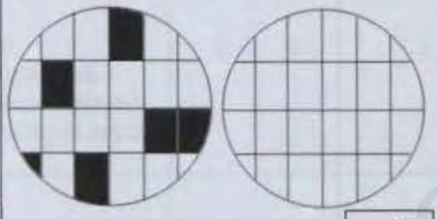
Visuospatial

(a) Cube
Which of the following option (A, B, C or D) when folded up will result in the figure below? Please circle one option.



. /1

(b) Grid
Please copy the figure from on the left to the empty one on the right as fast as you can.



. /2*

*Refer to scoring table

. /3

Memory (part 2)

(a) Scenario
3 objects below were **NOT** present in the picture earlier. Please circle these three items.

1 point for EACH correct answer

. /3

(b) Shapes
Please look at the shapes and try to remember as many elements as you can. You will be asked about this later.
(Refer to picture page)

No marks

Language

(a) Fluency
Please name as many vegetables as you can in 1 minute.

Total:

. /2*

(b) Naming
Please name the items below.

1 point for EACH correct answer

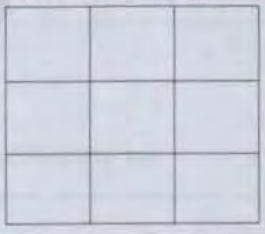
. /3

*Refer to scoring table

. /5

Memory (part 3)

(a) Shapes
You were showed you some shapes earlier. Please try to recall and fill in the boxes below with the shapes you saw.



. /2*

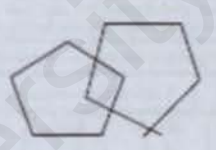
*Refer to scoring table

(b) Objects
Please name the objects. Repeat all of them twice and remember these FOUR objects. You will be asked about them later.
(Refer to picture page)

No marks

MMSE Form:

MINI MENTAL STATE EXAMINATION (MMSE)

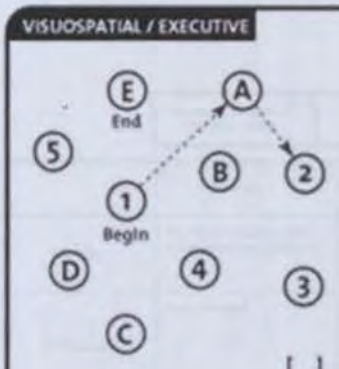
Orientation.	**Score**	**Max. Score**
What is the (date) (day) (month) (year) (season)?	( )	5
Where are we: (country) (province) (town) (hospital) (floor)	( )	5
Registration.		
Name 3 common object eg. (mango) (table) (coin) Take 1 second to say each, then ask the patient to repeat all 3 After you have said them. Give 1 point for each correct answer. Then repeat them until he/she learns all 3. count trails and record trails	( )	3
Attention and Calculation		
Spell "world" backward. The score is the number of latters in correct order (D L R O W)	( )	5
Recall		
Ask for the 3 object repeated above. Give 1 point for each correct answer [note : recall cannot be tested if all 3 object were not remembered during regestration]	( )	3
Language.		
Name a "pencil" and "watch"	( )	2
Repeat the following. "No ifs, ands, or buts"	( )	1
Follow a 3-stage command : "Take a paper in your hand, fold it in half, and put in on the floor"	( )	3
Do the following : Close your eyes,	( )	1
Write a sentence,	( )	1
Copy the following design. 	( )	1
Total score : **Score of 27 – 30 : Normal** **Score of < 27 : Impaired cognitive function**	( )	

MoCA Form:

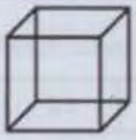
MONTREAL COGNITIVE ASSESSMENT (MOCA)

NAME :
Education : Date of birth :
Sex : DATE :

VISUOSPATIAL / EXECUTIVE



Copy cube



[ ] [ ]

Draw CLOCK (Ten past eleven) (3 points)

[ ] Contour [ ] Numbers [ ] Hands

POINTS /5

NAMING

[ ]

[ ]

[ ] /3

MEMORY Read list of words, subject must repeat them. Do 2 trials. Do a recall after 5 minutes.

	FACE	VELVET	CHURCH	DAISY	RED
1st trial					
2nd trial					

No points

ATTENTION Read list of digits (1 digit/ sec.). Subject has to repeat them in the forward order [ ] 2 1 8 5 4

Subject has to repeat them in the backward order [ ] 7 4 2 /2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors

[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B /1

Serial 7 subtraction starting at 100 [ ] 93 [ ] 86 [ ] 79 [ ] 72 [ ] 65

4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt** /3

LANGUAGE Repeat : I only know that John is the one to help today. [ ]

The cat always hid under the couch when dogs were in the room. [ ] /2

Fluency / Name maximum number of words in one minute that begin with the letter F [ ] ____ (N ≥ 11 words) /1

ABSTRACTION Similarity between e.g. banana - orange = fruit [ ] train – bicycle [ ] watch - ruler /2

DELAYED RECALL

	Has to recall words WITH NO CUE	FACE [ ]	VELVET [ ]	CHURCH [ ]	DAISY [ ]	RED [ ]	Points for UNCUED recall only
Optional	Category cue						
	Multiple choice cue						

/5

ORIENTATION [ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City /6

Normal ≥ 26 / 30

TOTAL /30

Add 1 point if ≤ 12 yr edu

www.mocatest.org

Clinical Dementia Rating (CDR) Form:

Subject Initials: _____

CLINICAL DEMENTIA RATING (CDR)

CLINICAL DEMENTIA RATING (CDR):	0	0.5	1	2	3

	Impairment				
	None 0	Questionable 0.5	Mild 1	Moderate 2	Severe 3
Memory	No memory loss or slight inconsistent forgetfulness	Consistent slight forgetfulness; partial recollection of events; "benign" forgetfulness	Moderate memory loss; more marked for recent events; defect interferes with everyday activities	Severe memory loss; only highly learned material retained; new material rapidly lost	Severe memory loss; only fragments remain
Orientation	Fully oriented	Fully oriented except for slight difficulty with time relationships	Moderate difficulty with time relationships; oriented for place at examination; may have geographic disorientation elsewhere	Severe difficulty with time relationships; usually disoriented to time, often to place	Oriented to person only
Judgment & Problem Solving	Solves everyday problems & handles business & financial affairs well; judgment good in relation to past performance	Slight impairment in solving problems, similarities, and differences	Moderate difficulty in handling problems, similarities, and differences; social judgment usually maintained	Severely impaired in handling problems, similarities, and differences; social judgment usually impaired	Unable to make judgments or solve problems
Community Affairs	Independent function at usual level in job, shopping, volunteer and social groups	Slight impairment in these activities	Unable to function independently at these activities although may still be engaged in some; appears normal to casual inspection	No pretense of independent function outside home Appears well enough to be taken to functions outside a family home	Appears too ill to be taken to functions outside a family home
Home and Hobbies	Life at home, hobbies, and intellectual interests well maintained	Life at home, hobbies, and intellectual interests slightly impaired	Mild but definite impairment of function at home; more difficult chores abandoned; more complicated hobbies and interests abandoned	Only simple chores preserved; very restricted interests, poorly maintained	No significant function in home
Personal Care	Fully capable of self-care		Needs prompting	Requires assistance in dressing, hygiene, keeping of personal effects	Requires much help with personal care; frequent incontinence

Score only as decline from previous usual level due to cognitive loss, not impairment due to other factors.

10