

The reliability and validity of the Thai version of the Visual Cognitive Assessment Test (VCAT: Th)

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ARTICLE INFO

Article history:

Received 24 July 2025

Accepted as revised 17 September 2025

Available online 23 September 2025

Keywords:

Cognitive screening test,
visual-based cognitive screening tool,
mild cognitive impairment,
mild Alzheimer disease, dementia.

ABSTRACT

Background: The global prevalence of dementia is projected to nearly double every 20 years, significantly impacting the quality of life for both individuals with dementia and their caregivers. Early detection is therefore critical, particularly in the context of Thailand's rapidly aging population. The Visual Cognitive Assessment Test (VCAT) is a visual-based cognitive screening tool designed to overcome educational limitations commonly associated with traditional assessments. Widely adopted across Southeast Asia, the VCAT demonstrates high sensitivity in detecting cognitive impairments from the earliest stages.

Objectives: This study aims to evaluate the validity and reliability of the Thai version of the Visual Cognitive Assessment (VCAT: Th)

Materials and methods: This study employed a cross-sectional, psychometric design and included 98 participants, consisting of 31 healthy controls (HC), 31 individuals with mild cognitive impairment (MCI), and 36 individuals with mild Alzheimer's disease (AD). The HC group was recruited from community-dwelling individuals residing in Bangkok and its surrounding metropolitan areas, while the MCI and mild AD groups were recruited from the Faculty of Medicine Ramathibodi Hospital, Mahidol University. All participants completed the Thai version of the Visual Cognitive Assessment Test (VCAT: Th), which was culturally adapted from the original version to suit the Thai context. The collected data was then used to evaluate internal consistency, test-retest reliability, concurrent validity, and known-group validity.

Results: The VCAT: Th demonstrated strong psychometric properties. Internal consistency was highly acceptable ($\alpha=0.78$), and test-retest reliability was excellent ($ICC=0.95$). Concurrent validity showed a strong and significant correlation with MoCA scores ($r=0.79, p<0.001$). Known-group validity revealed significant group differences with a large effect size ($\eta^2=0.53$).

Conclusion: The VCAT: Th is a culturally adapted cognitive assessment tool that effectively identifies impairments typically present in the early stages of cognitive decline. It demonstrates acceptable psychometric properties and is appropriate for use within the Thai population.

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doi: 10.12982/JAMS.2026.012

E-ISSN: 2539-6056

Introduction

Dementia is a major contributor to dependency among the elderly population. According to the World Health Organization, an estimated 55 million individuals were living with dementia worldwide in 2024,¹ with

more than 60% residing in low- and middle-income countries. Each year, nearly 10 million new cases are identified globally, underscoring the increasing public health burden posed by dementia. According to the Diagnostic and Statistical Manual of Mental Disorders, 5th Ed. (DSM-5), dementia is characterized by a decline in one or more cognitive domains, including executive function, complex attention, language, learning and memory, perceptual-motor function, or social cognition. This cognitive impairment interferes significantly with an individual's ability to perform daily activities and occupational tasks, thereby diminishing overall quality of life. Individuals with dementia often face limitations in independent living due to these deficits. Previous studies have shown that individuals with dementia experience difficulties with scheduling appointments, locating personal items, remembering recent events, and following television programs. Additionally, they may struggle with managing finances, shopping, completing routine tasks, taking medications, maintaining household cleanliness, as well as driving and using public transportation.²⁻⁴ Beyond the individuals affected, dementia imposes a significant burden on caregivers and family members, leading to broader social and economic consequences for both families and national healthcare systems. Managing cognitive decline and maintaining quality of life (QoL) are critical in dementia care.⁵ Occupational therapists play a key role in early detection, which helps delay dementia onset and enables timely intervention. Occupational therapists contribute to the early identification of dementia by monitoring changes in individuals' functional abilities and occupational performance during everyday activities. Through careful observation and the use of standardized assessments, they can differentiate cognitive changes from pathological decline. These evaluations provide essential insights that support timely diagnosis and enable the initiation of appropriate interventions.⁶

In Thailand, the screening test for cognitive impairment such as the Montreal Cognitive Assessment (MoCA) and the Mini-Mental State Examination (MMSE) are commonly used. However, these screening test have notable limitations, particularly regarding educational dependence, as they require reading, spelling, and arithmetic skills. Furthermore, they are not suitable for individuals with hearing impairments, a common issue in the aging population. The Visual Cognitive Assessment Test (VCAT) addresses these limitations by using visually based tasks, making it less dependent on education and auditory skills. The VCAT originally was developed in Singapore by Kandiah,⁷ and has been implemented in several Asian countries, including Malaysia, Indonesia, and the Philippines.⁸ Its use has since extended beyond Southeast Asia, with ongoing validation studies being conducted in a range of international settings, such as Brazil, Canada, China, Korea, and India.⁹ However, the VCAT remains a novel

assessment tool and has not yet been widely recognized in Thailand. The original version of the VCAT also provides verbal instructions in English. Additionally, some of the pictures used in the assessment are not culturally relevant to the Thai context. Therefore, this study aims to examine the psychometric properties of the Thai version of the VCAT to ensure its applicability within the Thai context.

The Visual Cognitive Assessment Test (VCAT) is a visual-based cognitive screening tool designed for early detection of cognitive impairment. It evaluates five core cognitive domains: episodic memory, attention and working memory, executive function, visuospatial ability, and language. All components of the assessment are delivered through an image-based format, with visual stimuli specifically selected and validated for clarity and recognize ability in older adult populations.⁷ The VCAT has demonstrated high accuracy in differentiating individuals with cognitive impairment from cognitively healthy controls, as well as in distinguishing between mild cognitive impairment (MCI) and mild Alzheimer's disease (AD). Compared with the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA), the VCAT demonstrates superior discriminative capacity and performs in discriminating between healthy people, MCI, particularly in identifying early-stage dementia. Its diagnostic utility is especially evident in contexts requiring precise detection during the early phases of cognitive decline.¹⁰

At present, the Visual Cognitive Assessment Test (VCAT) has not been implemented in Thailand, primarily due to certain test items being culturally inappropriate. In response to this limitation, the present study aims to evaluate the validity and reliability of the Thai version of the Visual Cognitive Assessment Test (VCAT: Th), which has been culturally adapted to align with the sociocultural characteristics of the Thai population.

Materials and methods

Design and participation

This study employed a cross-sectional, psychometric design and included a total of 98 participants, comprising 31 healthy controls (HC), 36 individuals with mild cognitive impairment (MCI), and 31 individuals with mild Alzheimer's disease (AD). The sample size was calculated using the G*Power program. The effect size (Cohen's *d*) was derived from the mean and standard deviation reported in a comparative study of Visual Cognitive Assessment Test (VCAT) scores between normal participants and those with cognitive impairment.¹¹ The resulting effect size was $d=0.8$. By setting the significance level (α error probability) at 0.05 and statistical power ($1-\beta$ error probability) at 0.80, the required sample size was determined to be 26 participants per group. To account for an anticipated dropout rate of 20%, the adjusted sample size was increased to approximately 31 participants per group. In addition, five

participants with MCI were recruited to participate in the pilot testing phase of the assessment. Inclusion criteria for all groups required participants to be aged 50 years or older, no significant visual or motor impairments, Thai nationality, and proficient in Thai language skills in listening, reading, and speaking. Participants in the HC group were recruited from community-dwelling individuals residing in Bangkok and its surrounding metropolitan areas. Eligibility for this group required a MoCA score of 25 or above. While individuals in the MCI and mild AD groups were recruited from the Faculty of Medicine Ramathibodi Hospital, Mahidol University. For the MCI group, inclusion was based on a clinical diagnosis of mild cognitive impairment made by cognitive neurologists in accordance with the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5).¹² For the mild AD group, inclusion was based on a diagnosis of mild Alzheimer’s disease following the criteria established by the National Institute on Aging and the Alzheimer’s Association (NIA-AA).^{13,14} All participants were diagnosed by psychiatrists in a clinical setting. The demographics characteristics of participants are summarized in Table 3.

Procedures
Cultural adaptation and psychometric properties studies

The adaptation of the original Visual Cognitive Assessment Test (VCAT) into the Thai version involved a four-step process. The first step focused on modifying test content that was culturally inappropriate with

the Thai context. Although the original version of the Visual Cognitive Assessment Test (VCAT) has been implemented in several countries,^{7,9,15} where cultural and lifestyle contexts are generally similar, certain contextual differences exist in Thailand particularly regarding food culture. As such, specific modifications to food-related test items were necessary to ensure cultural appropriateness and relevance for Thai people. To address this, the research team obtained formal permission from the original VCAT developers to make the required content adaptations for the Thai version, ensuring alignment with the sociocultural context of Thailand. One key modification was made to the Delayed Memory: Objects item. Specifically, the image of a hamburger was replaced with grilled chicken, and the accompanying cue images of French fries and cola in the test booklet were substituted with somtam (papaya salad) and sticky rice -foods that are widely recognized among the Thai population. In this method, the research team adapted the pictures to align with the sociocultural context of Thailand prior to expert evaluation. These modifications are detailed in Table 1.

The second step involved evaluating content validity. In this phase, three experts independently assessed each item using the Index of Item-Objective Congruence (IOC) method.¹⁶ All experts had more than ten years of professional experience, comprising two occupational therapists specializing in cognition and one professional psychiatric nurse. The results demonstrated a high level of agreement among the experts, with all items receiving an IOC score of 1.00. (Table 2)

Table 1. The content modifications of the Visual Cognitive Assessment Test (VCAT) to align with the Thai cultural context.

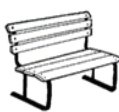
Original version		Culturally adapted version for the Thai context	
Delayed memory: objects			
Visual stimuli for assessment			
			
			
Cue images in test booklet			
			

Table 2. Index of Item–Objective Congruence (IOC) for the items and scoring levels of the VCAT: Th.

VCAT-Th items	IOC
Memory-Shapes	1
Memory-Objects	1
Memory-Scene	1*
Attention-Shape cancellation	1
Executive function-Gears	1
Executive function-Pattern	1
Executive function-Category	1
Visuospatial-Cube	1
Visuospatial-Grid	1
Language-Picture naming	1
Language-Semantic fluency	1

*Note: The IOC value was obtained after revision according to the experts' recommendations.

The third step consisted of a pilot trial of the VCAT: Th with a sample of five participants clinically diagnosed with mild cognitive impairment (MCI). Feedback from this trial was used to further refine and adjust the assessment. This process resulted in the finalized version of the VCAT: Th.

The final step was to examine the psychometric properties of the VCAT: Th, including (1) internal consistency, (2) test–retest reliability, (3) concurrent validity, and (4) known-group validity.

Psychometric evaluation

The psychometric properties of the Thai version of the Visual Cognitive Assessment Test (VCAT: Th) were examined using data from 93 participants, comprising 31 healthy controls (HC), 31 individuals with mild cognitive impairment (MCI), and 31 individuals with mild Alzheimer's disease (mild AD). Internal consistency was evaluated using the all-item scores of VCAT: Th derived from all participants.

Test-retest reliability was assessed exclusively in the MCI group. This decision was based on the primary purpose of the VCAT: Th, which was developed as a screening tool for individuals with early-stage cognitive impairment. Administering the test-retest procedure in the healthy control group would likely result in a ceiling effect, as most individuals in this group are expected to achieve maximum or near-maximum scores. Such score clustering at the upper limit would eliminate meaningful variance, thereby precluding an accurate estimation of reliability. Conversely, administering the test-retest in the mild AD group may yield artificially low reliability estimates, given the inherent clinical instability and day-to-day fluctuations in cognitive performance associated with the disease. Thus, the MCI group was deemed the most appropriate population in which to evaluate test-retest reliability. Participants

in this group completed the VCAT: Th twice, with a one-week interval between assessments. Intraclass correlation coefficients (ICCs) were calculated using total, subdomain and item scores from both time points to determine stability over time.

To evaluate concurrent validity, the MoCA was administered to participants in the MCI and mild AD groups. The total scores from the MoCA and VCAT: Th were then compared using correlation analysis to determine the degree of association between the two assessments.

To assess known-groups validity, VCAT: Th scores were statistically compared across the three diagnostic groups-healthy controls (HC), mild cognitive impairment (MCI), and mild Alzheimer's disease (AD)- to evaluate the instrument's ability to distinguish between differing levels of cognitive impairment.

Measurements

The Visual Cognitive Assessment Test (VCAT) is a visually mediated cognitive screening instrument developed to facilitate the early identification of cognitive decline. Made up of 11 items, the VCAT is designed to be completed in approximately 15.7 ± 7.3 minutes. It yields a total score ranging from 0 to 30, with higher scores indicating better cognitive performance. The development of the VCAT was informed by widely accepted diagnostic criteria for mild cognitive impairment (MCI) and Alzheimer's disease (AD), with the test structured to assess five core cognitive domains: episodic memory, attention and working memory, executive function, visuospatial abilities, and language.⁷ Notably, the assessment places particular emphasis on episodic memory, given its strong association with progression to AD, thereby enhancing the tool's sensitivity in early detection of the disease. In addition, greater weight is allocated to executive

functioning to improve the identification of cognitive profiles associated with vascular dementia.¹⁰

The VCAT demonstrated strong discriminative ability in distinguishing individuals with cognitive impairment from those without, yielding an area under the curve (AUC) of 85.5%. In comparison, the MoCA and MMSE produced AUCs of 85.3% and 79.5%, respectively. Furthermore, the VCAT effectively differentiated between individuals with MCI and those with mild AD, with an AUC of 84.2%, outperforming the MoCA (AUC=81.8%) and the MMSE (AUC=76.5%). Based on these findings, VCAT cut-off scores were established as follows: 23-30 for normal cognition, 18-22 for MCI, and 0-17 for dementia.¹⁰

Data analysis

Data analysis for this study was conducted using SPSS for Windows, version 23. Continuous variables were first assessed for normality using the Shapiro-Wilk test. For variables that followed a normal distribution, such as age, between-group comparisons were conducted using one-way analysis of variance (ANOVA). For non-normally distributed continuous variables, including MoCA scores, the Kruskal-Wallis test was applied. Categorical variables such as gender and education level were analyzed using chi-square (χ^2) tests of independence.

Internal consistency of the VCAT: Th was evaluated using Cronbach's alpha coefficient. Test-retest reliability was assessed using the Intraclass Correlation Coefficient (ICC), based on the ICC (3,1) model (two-way mixed-effects, single measurement).¹⁷ Given that the Shapiro-Wilk test indicated non-normal distribution for the VCAT scores ($p<0.05$), Spearman's rank correlation coefficient

was used to assess concurrent validity with the MoCA. While known-groups validity was evaluated through the Kruskal-Wallis test.

Ethical considerations

This study received ethical approval from the Human Research Ethics Committee of Mahidol University, under the reference number COA No. MU-MOU 2023/176.0612, granted in December 2023. Participant rights were rigorously safeguarded throughout the research process, and all collected data were treated with strict confidentiality. Personal identifiers were excluded from all analyses; participant responses were fully anonymized and utilized solely in aggregated form for the purpose of this study.

Results

The sample included 93 participants. No significant gender differences were found between groups, though females were more prevalent in the HC group (67.70%), the MCI group (77.40%), and the mild AD group (67.70%). In terms of age, participants in the mild AD group were significantly older (mean=77.90, SD=7.12) than those in the HC (mean=58.36, SD=6.33) and MCI groups (mean=73.81, SD=6.31). Most participants in the HC and MCI groups held a bachelor's degree, whereas the majority in the mild AD group had completed a high vocational certificate. The three diagnostic groups showed significant differences in total MoCA scores, with the highest scores observed in the HC group (mean=26.29, SD=1.13), followed by the MCI group (mean=23.55, SD=3.95) and then the mild AD group (mean=15.87, SD=5.62). (Table 3)

Table 3. Demographic characteristics by group (N=93).

Characteristic or Test	HC (N=31)	MCI (N=31)	Mild AD (N=31)	p value
	N (%)	N (%)	N (%)	
Gender ¹				0.625
Male	10 (32.30)	7 (22.60)	10 (32.30)	
Female	21 (67.70)	24 (77.40)	21 (67.70)	
Education ¹				<0.001
Elementary school	5 (16.10)	9 (29.00)	3 (9.70)	
Junior high school	2 (6.50)	2 (6.50)	5 (16.10)	
Senior high school	3 (9.70)	5 (16.10)	1 (3.20)	
Vocational certificate	0 (0.00)	0 (0.00)	1 (3.20)	
High vocational certificate	2 (6.50)	0 (0.00)	10 (32.30)	
Bachelor Degree	14 (45.20)	11 (35.50)	3 (9.70)	
Master Degree	5 (16.10)	4 (12.90)	1 (3.20)	

Table 3. Demographic characteristics by group (N=93). (Continue)

Characteristic or Test	HC (N=31)	MCI (N=31)	Mild AD (N=31)	p value
	N (%)	N (%)	N (%)	
	M (SD)	M (SD)	M (SD)	
Age ² (years)	58.36 (6.33)	73.81(6.31)	77.90 (7.12)	<0.001
MoCA ³	26.29 (1.13)	23.55 (3.95)	15.87 (5.62)	<0.001

Note: ¹: χ^2 test, ²: ANOVA, ³: Kruskal–Wallis test.

The internal consistency of the VCAT: Th was found to be highly acceptable ($\alpha=0.78$)¹⁸. Test-retest reliability of the VCAT: Th was evaluated using intraclass correlation coefficients (ICCs) calculated for the total score, subdomain scores, and individual item scores. The total score demonstrated excellent reliability¹⁹, with excellent ICC values for the total VCAT-Th score (ICC= 0.95). Subdomain scores also showed good

reliability, with ICCs ranging from moderate to excellent values (ICC = 0.64-0.89): 0.89 for episodic memory, 0.76 for attention/working memory, 0.88 for executive function, 0.88 for visuospatial function, and 0.64 for language. At the item level, ICCs similarly indicated good reliability, reflecting moderate to excellent agreement across repeated administrations (ICC=0.56-0.95). (Table 4)

Table 4. Test-retest reliability of VCAT:Th as demonstrated by intraclass correlation coefficients (ICC) and 95% confidence interval (CI) (N=31).

	ICC (3,1) (95% CI)	p value
VCAT-Th total score	0.95	0.000
VCAT-Th subdomains		
Episodic Memory	0.89	0.000
Attention/Working Memory	0.76	0.000
Executive Function	0.88	0.000
Visuospatial	0.88	0.000
Language	0.64	0.004
VCAT-Th items		
Memory-Shapes	0.81	0.000
Memory-Objects	0.88	0.000
Memory-Scene	0.56	0.013
Attention-Shape cancellation	0.76	0.000
Executive function-Gears	0.81	0.000
Executive function-Pattern	0.76	0.000
Executive function-Category	0.86	0.000
Visuospatial-Cube	0.63	0.004
Visuospatial-Grid	0.85	0.000
Language-Picture naming	0.80	0.000
Language-Semantic Fluency	0.95	0.000

Note: VCAT:Th: Visual Cognition Assessment Test: Thai version.

Concurrent validity

Spearman correlation coefficients between the total VCAT: Th scores and the total MoCA scores reported significantly strong correlations ($r=0.79$, $p < 0.001$)²⁰. These results provide for the hypothesis regarding the concurrent validity of VCAT: Th.

Known-group validity

The results of the Kruskal-Wallis test assessing known-group validity and effect sizes are presented

in Table 5. The total VCAT:Th score demonstrated a significant difference among groups, with a large effect size ($\eta^2=0.53$).²¹ Subdomain scores also showed significant differences, with effect sizes ranging from small to large ($\eta^2 = 0.16-0.54$). At the item level, most VCAT:Th items showed significant differences with small to large effect sizes ($\eta^2=0.10-0.56$), except for the Executive Function-Gears item, which did not reach statistical significance.

Table 5. Kruskal-Wallis test and effect size for known-group validity (N=93).

		Range	M (SD)			Chi square (χ^2)	Effect size (η^2)
			HC (N=31)	MCI (N=31)	Mild AD (N=31)		
VCAT:Th	total score	0-30	26.06 (2.66)	22.39 (4.49)	13.36 (6.22)	48.82***	0.53
VCAT:Th	subdomains						
	Episodic Memory	0-13	11.61 (1.61)	10.13 (2.32)	4.90 (3.10)	49.80***	0.54
	Attention/WM	0-3	2.58 (0.99)	1.90 (1.35)	0.77 (1.26)	26.22***	0.29
	Executive Function	0-6	4.52 (1.26)	3.81 (1.74)	2.45 (1.59)	21.64***	0.24
	Visuospatial	0-3	2.48 (0.63)	2.13 (0.89)	1.55 (1.06)	14.53***	0.16
	Language	0-5	4.84 (0.37)	4.42 (0.89)	3.36 (1.02)	35.79***	0.39
VCAT:Th items							
	Memory-Shapes	0-2	1.13 (0.99)	0.77 (0.81)	0.29 (0.59)	13.15***	0.14
	Memory-Objects	0-8	7.48 (1.06)	6.39 (1.98)	2.55 (2.14)	51.66***	0.56
	Memory-Scene	0-3	3.00 (0.00)	2.97 (0.18)	2.07 (0.96)	40.26***	0.44
	Attention-Shape cancellation	0-3	1.13 (0.99)	0.77 (0.81)	0.29 (0.59)	26.22***	0.29
	Executive function-Gears	0-3	1.87 (1.23)	1.68 (1.19)	1.65 (1.08)	0.557	0.01
	Executive function-Pattern	0-2	1.65 (0.49)	1.42 (0.67)	0.48 (0.72)	33.76***	0.37
	Executive function-Category	0-1	1.00 (0.00)	0.71 (0.46)	0.65 (0.49)	12.98**	0.14
	Visuospatial-Cube	0-1	0.61 (0.50)	0.39 (0.50)	0.19 (0.40)	11.28**	0.12
	Visuospatial-Grid	0-2	1.87 (0.50)	1.74 (0.68)	1.36 (0.92)	9.09**	0.10
	Language-Picture naming	0-3	2.97 (0.18)	2.94 (0.25)	2.68 (0.54)	10.91**	0.12
	Language-Semantic Fluency	0-2	1.87 (0.34)	1.48 (0.77)	0.68 (0.87)	30.03***	0.33

Note: ** $p < 0.01$, *** $p < 0.001$

Discussion

This study aimed to examine the validity and reliability of the Thai version of the Visual Cognitive Assessment Test (VCAT: Th), which was culturally modified to suit the Thai population. The findings demonstrated excellent content validity, with an IOC of 1.00, indicating that the assessment effectively measures cognitive abilities as intended and is appropriate for use in the Thai context. This strong alignment may be attributed to the fact that individuals with dementia or MCI commonly exhibit pronounced deficits in domains such as visuospatial skills, attention, delayed recall, language, and executive function—all of which are core cognitive components of the VCAT.

In the process of cultural adaptation and psychometric evaluation, modifications were applied to the *Delayed Memory: Objects* item. Specifically, the image of a hamburger was replaced with grilled chicken, while the accompanying cue images of French fries and cola in the test booklet were substituted with somtam (papaya salad) and sticky rice, which are more culturally familiar to the Thai population. Testing instruments developed predominantly within Western paradigms frequently overlook cultural nuances, variations in educational background, and differences in language use, all of which may substantially influence test outcomes and compromise the accuracy of diagnostic conclusions. This challenge carries serious consequences, as reliance on instruments that neglect cultural factors may result in the erroneous diagnosis of intact patients with cognitive disorders, while simultaneously failing to identify individuals with actual cognitive impairment.²²

The internal consistency of the VCAT: Th, indicated by a Cronbach's alpha coefficient of 0.78, reflects a good level of reliability. This finding suggests that the test items are sufficiently correlated and consistently measure the underlying cognitive constructs. These results align with those of Low *et al.*,¹⁰ who reported a comparable internal consistency ($\alpha=0.74$) for the original version of the VCAT in a study involving healthy controls, individuals with MCI, and patients with mild AD.

The cognitive domains assessed by the VCAT—visuospatial ability, attention, delayed recall, language, and executive function—are known to be among the first areas affected in individuals with MCI. Prior research has consistently shown that individuals with MCI demonstrate significantly lower performance in visual attention and visuospatial tasks compared to cognitively healthy individuals.^{3,23} Moreover, previous studies examining the risk of Alzheimer's disease have demonstrated that individuals with MCI perform significantly worse on visual memory tasks compared to cognitively normal individuals. These findings suggest not only an increased risk of progression to Alzheimer's disease in the MCI group but also provides clear evidence of visual memory deficits associated

with early cognitive decline.^{24,25} Language difficulties have also been documented in previous studies involving individuals with dementia or MCI. These studies indicated that such individuals often exhibit early impairments in delayed recall and language-related functions, including word retrieval, accurate word usage, syntactic construction, and the ability to convey clear and coherent information.²⁶ In addition, executive function deficits have been identified as a prominent feature in individuals with MCI. Research has shown that impairments in executive functioning are frequently observed in this population.^{27,28} These deficits can substantially affect an individual's ability to manage daily activities and maintain independence.²⁹ Accordingly, each item within the VCAT: Th has been carefully designed to target specific cognitive domains commonly affected in individuals with MCI, ensuring the tool's sensitivity in detecting early-stage cognitive impairments.

The findings from the test-retest reliability analysis demonstrated good reliability, indicating that the VCAT: Th produces stable and consistent results over time. The moderate to excellent levels of agreement across repeated administrations suggest that the instrument can capture cognitive performance reliably, even when reassessed after a short interval. These results confirm that the VCAT: Th is a standardized tool for assessing cognitive abilities.

The results of the concurrent validity analysis demonstrated a strong and statistically significant correlation between the total scores of the VCAT: Th and the MoCA, indicating that both instruments assess similar cognitive constructs. This finding supports the convergent validity of the VCAT: Th and affirms its capability to evaluate global cognitive function in a manner consistent with internationally standardized assessment tools. These results are in line with the study by Low *et al.*,¹⁰ which also reported a strong correlation between the original VCAT and MoCA scores ($r=0.81$), further affirming the validity of the VCAT across diverse cultural settings.

The findings from the known-groups validity analysis revealed that both the total score and subdomain scores of the VCAT: Th were significantly different between diagnostic groups. At the individual item level, most items showed statistically significant differences, except for the Executive Function-Gears item, which did not reach significance. This lack of difference may be attributable to the dichotomous response format of the item, consisting of only two options (i.e., an arrow rotating to the left or to the right), which could have increased the likelihood of chance-level responding among participants with MCI and mild AD. Consequently, no statistically significant differences in scores were observed across the three groups. These results align with previous research by Low and colleagues,¹⁰ who examined the construct validity of the original VCAT in healthy individuals,

MCI, and mild AD. The results indicated that the VCAT demonstrated superior discriminative ability compared to the MMSE and performed comparably to the MoCA in differentiating between individuals with mild AD and MCI, as well as distinguishing cognitively healthy individuals from those with cognitive impairment.

The VCAT was designed to assess multiple domains of cognitive functioning, with particular emphasis on memory and executive function. This targeted focus provides a key advantage over other cognitive screening tools, particularly in the detection of Alzheimer's disease (AD) and vascular dementia (VaD), the two most prevalent types of dementia.⁷ Prior research has indicated that older adults, irrespective of amyloid-beta accumulation, consistently demonstrate significantly lower performance on assessments of visuospatial memory and executive functioning compared to younger adults. These findings suggest that aging is associated with a general decline in brain function, especially in regions such as the prefrontal cortex and medial temporal lobe, which play critical roles in memory and learning.³⁰

Limitations

This study has several limitations that should be acknowledged. First, there was a gender imbalance in the sample, with a greater proportion of female participants compared to males. Second, participants with MCI and mild AD were recruited exclusively from a single institution located at the Faculty of Medicine Ramathibodi Hospital, Mahidol University, which may limit the generalizability of the findings to broader clinical populations. Third, there were differences in the distribution of educational levels across the diagnostic groups, which may have influenced cognitive performance and affected the interpretation of group comparisons.

Conclusion

The findings of this study support that the VCAT: Th is a cognitive assessment tool capable of detecting cognitive impairments commonly observed from the early stages of cognitive impairment. It is culturally appropriate for use in the Thai context and demonstrates acceptable psychometric properties. Furthermore, the VCAT: Th functions as a standardized screening instrument, exhibiting diagnostic accuracy comparable to that of internationally recognized cognitive assessment tools.

Ethical approval

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and complied with all applicable institutional and national regulations governing research involving human participants. Ethical approval was granted by the Human Research Ethics Committee of Mahidol University (COA No. MU-MOU 2023/176.0612) prior to data collection.

All participants received detailed information regarding the study's objectives and procedures, and written informed consent was obtained before enrollment. Participation was entirely voluntary, and participants retained the right to withdraw from the study at any point without consequence.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors

Conflict of interest

The authors declare no conflicts of interest related to the research, authorship, or publication of this article.

CRediT authorship contribution statement

Sutinun Juntorn: conceptualization, methodology, data curation, formal analysis, writing: original draft, supervision, project administration, correspondence; **Thitiya Wangkawan:** methodology, data curation, investigation, writing: review and editing; **Parlinzhaadaa Phatcharapisitgul:** data curation, validation; **Peeradech Thichanpiang:** supervision, writing: review and editing; **Tharadon Rodkao:** data curation; **Paweena Sangsawee:** data curation.

Future direction and clinical implementation

Future research on the VCAT: Th should extend its application to populations with hearing impairments. Given that traditional cognitive screening tools often rely heavily on verbal instructions, individuals who are deaf or hard of hearing may be systematically disadvantaged, resulting in inaccurate diagnostic outcomes. The VCAT, as a visually based assessment, offers unique potential for reducing such barriers and ensuring more equitable cognitive evaluation. Furthermore, the VCAT: Th provides occupational therapists and clinicians with a culturally adapted, visually based tool for the screening and assessment of cognitive function. Finally, use of the VCAT: Th in clinical settings may facilitate interdisciplinary collaboration, where results can be incorporated into comprehensive evaluations of cognitive function that inform medical, psychological, and occupational therapy interventions.

Acknowledgements

The authors would like to express their sincere gratitude to all participants for their valuable cooperation in this study. Appreciation is also extended to the Faculty of Medicine Ramathibodi Hospital, Mahidol University, for the support and facilitation provided during the data collection process.

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