

# The diagnostic accuracy of the Thai dementia assessment tools for secondary care

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## Abstract

**Objective:** To validate the Thai dementia assessment tools for secondary care and to apply them in the community setting. **Methods:** First, staff attended a one-day workshop on study protocol where they were taught how to administer the neuropsychological battery tests. Then clinical evaluation and neuropsychological battery tests were conducted at 3 hospitals from September 2016 to April 2018. The standard neuropsychological tests were Stroop Color Word Test (SCWT) and Digit Symbol-Incidental Learning (DS). The tests developed by researchers were word list (WL), Naming Test (NT) and picture recognition. Descriptive statistical analysis was used. The receiver operating analysis curve (ROC) was applied to compare the area under curves. Then these selected tests were administered in the community setting. **Results:** Subjects were 145 cases from the clinical setting and 157 persons from the community setting. Delayed recall, food category words recall (CAT) of WL, had acceptable accuracy in the dementia group (AUC>0.80). Combined tests namely WL, NT\_6, CAT, SCWT and DS had high accuracy in the dementia group from the clinical setting. These tests can be used to confirm mild cognitive impairment and dementia at the community level.

**Conclusion:** The Thai Dementia assessment tools have acceptable accuracy to be the reference test for dementia.

**Keywords:** Dementia, validity, neuropsychological battery

## INTRODUCTION

Screening for cognitive dysfunction, which is essential for the diagnosis of dementia, is often done by general practitioners using simple tools such as the clock drawing test (CDT) or Mini Mental Status Examination (MMSE). Then, neuropsychological battery tests are used to look for more specific deficits in different domains such as memory or language or praxis. Since 1986, the Consortium to Establish a Registry of Alzheimer's Disease (CERAD) has proposed the neuropsychological battery<sup>1</sup> which have now become widely used as the standard protocol.

In Thailand, available neuropsychological battery tests in tertiary care centers such as university and psychiatric hospitals, are the Alzheimer's Disease Assessment Scale Cognitive (ADAS-cog)<sup>2</sup>, Wechsler Adult Intelligence Scale (WAIS)<sup>3</sup> and some part of CERAD such as Boston naming, word lists. ADAS-cog \_Thai version has been used in pharmaceutical clinical trials or academic theses but is not widely used as a reference test due to it being time consuming, requiring at least 3-4 hours to administer. The

WAIS full battery is more commonly used to evaluate cognition in adulthood rather than for dementia assessment in routine clinical practice. Therefore, we aimed to develop neuropsychological battery tests for dementia in the secondary hospital setting that can be used as the reference test for dementia after an initial screening test. Domains of cognitive assessment to be included were decided in a meeting of dementia experts. Data from a previous report<sup>4</sup> that is, word list learning and Boston naming have yielded a potentially acceptable accuracy compared to other tests listed in the CERAD protocol.

The assessment tools contain word list learning and visual recognition similar to other standard tests. Word list learning, picture naming and recognition have been developed and piloted in small groups as reported previously.<sup>5</sup> This study aimed to analyze the diagnostic accuracy of these tools in the clinical setting and also to look at the result of their application in the community setting.

## METHODS

The validity study of the neuropsychological battery tests was one part of the sensitivity screening test project funded by the National Research Committee of Thailand and approved by the ethical committee of 3 hospitals namely Srithanya (Q9/2559; 1 February 2016), Songkla Rachanakarindra (24/2559; 26 April 2016) and Suanprung (6/2559; 8 June 2016) respectively.

### Sample

There were 2 sample settings: the first sample being elderly patients attending 3 hospitals and the second sample coming from people living in the community.

A cross-sectional study was used in this instance. Sample size depended on the severity of dementia to ensure that cases of different levels of severity were recruited. For moderately severe dementia and above, the estimated sensitivity of screening tests developed by researchers from a previous study<sup>5</sup> was 90% with  $\leq 20\%$  error (d) was allowed ( $d=0.1$ ) and the sample size was 34 cases. For mild degrees of dementia, the estimated sensitivity of the test was 80% ( $d=0.1$ ) and the number was 64 cases. As for the control group, the estimated specificity was 90% and the number was 34.<sup>6</sup> The dementia group included patients who had attended each site at least 3 months prior to the study. Eligible cases were Thai native speaking. Exclusion criteria were delirium, psychosis or a score of five or more on the Thai Geriatric Depression (TGDS). Control cases were elderly people without dementia having demographic data comparable to those in the dementia group.

The community setting represented people living in the Bangken sub-district of Nonthaburi province. A total of 155 cases completed the neuropsychological tests and neurological examination.

### Team preparation

In the clinical setting, 12 psychologists were trained in a one-day workshop held at each site in order to learn the sequence of neuropsychological battery tests developed by researchers<sup>5</sup> Data collection took place from September 2016 to April 2017.

In the community setting, 6 psychologists affiliated with Srithanya Hospital were trained by the lead psychologist (SK) on how to administer the standard battery as well as other tests developed by researchers.

## Instruments

### For clinical setting

1.1 Thai word list (TWL): a list of 12 words was developed. It contained 5 food category words namely *hawmok* (steamed curried fish in a banana leave cup), *kaengsom* (sour curry), *meekrob* (crispy noodle), *somtum* (papaya salad) and *padkaprao* (fried basil); 4 concrete words such as school, glass, mountain and electric fan, and 3 abstract words (entertain, relax and revenge). The TWL includes 3 learning trials, a 5-minute delayed recall trial and a yes/no recognition trial. Word list memory (WLM) represents the sum of total immediate recall for each trial, whereas word list learning (WLL) represents total of 3 trials WLM.

### Word recognition (WR)

Subjects were asked to identify whether each word was previously in the TWL by giving a yes/no answer after 5 minutes of WL trial. There were 12 non-target words namely: emotion, boil rice, stream, influence, swing, bridge, country, newspaper, *kao-lao* (clear soup), bag, *kanombuang* (Thai crispy pancake) and gently.

1.2 Naming Test (NT) contained 15 line drawings namely: elephant, scissors, garland, saws, *ranard* (Thai xylophone), *tuk-tuk* (motor-tricycle), sandals, turtle, kitchen flipper, hoe, spoon, lotus, jug, seahorse and *chadaa* (Thai theatrical crown).

1.3 Visual recognition contained drawings of geometrical patterns with no intrinsic meaning. The first file consists of 10 pictures for learning and the second file contains 10 pictures for learning and 10 non-target pictures for recognition. Each picture in the first file was shown for 3 seconds silently. Following a 5 minute delay, the 20 pictures in the second file were presented to subjects in the yes/no recognition trial.

### 2. Standard psychological tests

2.1 Stroop Color Word Test (SCWT)<sup>7</sup> contained 3 trials. In the first trial subjects were asked to read the word, then says the color and finally names the color of the word. This test aimed to assess attention, mental speed, and cognitive flexibility.

2.2 The Digit Symbol-Incidental Learning (DS-IL) from *Wechsler Adult Intelligence Scale (WAIS-III)*. Pairing (P.I) Free Recall I (FRI) and Free Recall II (FRII).<sup>3</sup>

### *For community setting*

Word list, selected naming tests, and standard psychological tests were administered.

### *Data collection*

Each subject was assessed by a trained psychologist. Dementia was defined by the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (Text Revision) (DSM-IV-TR) and the severity was classified by the Functional Assessment Staging of Alzheimer's Disease (FAST).<sup>8</sup> Clinical Dementia Rating scale also applied to assess judgement, problem solving and community affair. Neurological examination and psychological tests were done either in the same visit or not more than 2 weeks apart.

### *Statistical analysis*

Descriptive data were analyzed. The receiver operating analysis curve (ROC) was applied to compare the area under curves (AUC) by MedCalc. The formula for rate of forgetting was (delayed recall-WLM3) x 100/WLM3.

## **RESULTS**

### *Clinical setting*

Of 145 cases, 54.5% were females and 43.4% had primary education. Many of them already had a diagnosis of Alzheimer's disease (65 cases). Based on FAST, there were 35, 32, and 41 cases of mild cognitive impairment, mild dementia and moderate to severe dementia cases respectively. Demographic data among control and dementia groups did not differ significantly except for age. More specifically, the age of the subject increased as the severity of dementia increased. Other details have been previously reported.<sup>9</sup> There were 134 cases who completed the neuropsychological tests.

WLM showed that subjects could remember the first two words or the last 2 words more than the others, especially in the first round and third round (Table 1). In the first round, 32.8% of normal individuals and 25.7% of possible dementia subjects could memorize 3 words or more. In the 3rd round, 75.6% of normal individuals, 60.1% of people with possible dementia and 42.9% subjects with dementia could remember 3 words or more. (Table 2) Mean score in the food category and delayed recall were significantly different among normal, MCI and dementia subjects. (Table 3)

For visual recognition, only pictures 4,6, and 18 allowed for the classification of people into

their respective FAST group. For NT, there were 6 pictures (NT\_6) namely garland, *tuk-tuk*, flipper, jug, seahorse and *chadaa* that distinguished normal subjects from people with dementia. (Table 3)

For the standard test, only the color-word task could differentiate dementia cases from normal individuals.

Regarding combination sub test, there were 2 sets i.e. sum\_second and sum\_second\_1. The sum\_second was composed of WL, NT\_6, CW from SCWT and Food category whereas the sum\_second\_1 used F.R.II instead of WL. AUC of each test and combination of tests are listed in Table 4.

### *Community setting*

There were 157 cases; most were female (65.0%) and many only had primary education (66.2%). They were classified into 16 MCI (FAST 3), 17 dementia (FAST 4 and above), 70 possible (FAST 2) and 54 normal (FAST 1). Standard neuropsychological battery tests were SCWT, DS-IL. For the tests developed by researchers, 6 pictures from the Naming Test (NT\_6) and WL were selected. The frequency of WLM and AUC were shown in Table 5 and 6 respectively.

WLM for each round had the same patterns as those in the clinical setting and also subjects could memorize food category words better than other words. In the NT\_6, apart from the 'chadaa' picture, all other pictures allowed for the classification of normal people from those with dementia AUC for each test are listed in Table 6 and they were comparable to those in the clinical setting.

## **DISCUSSION**

Word list learning showed that sequence of words and category words had influence on word learning recall. Subjects were more likely to remember the first and last two words (i.e., primacy and recency respectively)<sup>10</sup> which differed from other studies where only the first two words were remembered.<sup>11</sup> The patterns of word learning among three trials in the clinical setting were similar to those in the community setting which might be explained by level of education and culture. Category words (food) are the most popular menu of Thai people: *somtum* (papaya salad) *padkaprao* (fried basil) and *kaengsom* (sour curry). But for abstract words, these words could not classify normal elderly from dementia due to most subjects only having primary level of education. Compared to the previous Thai word list according to

**Table 1: Word list memory classified by FAST (normal n=37, MCI (F2, F3) n=35, mild (F4) n=31, mod n=31) (continue)**

	trial_1				trial_2				trial_3						
	normal	MCI	mild	mod	all	normal	MCI	mild	mod	all	normal	MCI	mild	mod	all
school X	24	26	28	28	106	24	26	28	29	107	20	19	26	25	90
	64.9	74.3	90.3	90.3	79.1	64.9	74.3	90.3	93.5	79.9	54.1	54.3	83.9	80.6	67.2
/	13	9	3	3	28	/	9	3	2	27	17	16	5	6	44
glass X	32	32	24	28	116	glass X	23	26	6.5	20.1	15	20	18	23	76
	86.5	91.4	77.4	90.3	86.6	56.8	65.7	83.9	80.6	70.9	40.5	57.1	58.1	74.2	56.7
/	5	3	7	3	18	/	12	5	6	39	22	15	13	8	58
	13.5	8.6	22.6	9.7	13.4	43.2	34.3	16.1	19.4	29.1	59.5	42.9	41.9	25.8	43.3
fan X	26	28	23	28	105	hawmok X	15	16	20	67	25	27	29	31	112
	70.3	80.0	74.2	90.3	78.4	40.5	45.7	51.6	64.5	50.0	67.6	77.1	93.5	100.0	83.6
/	11	7	8	3	29	/	19	15	11	67	12	8	2	0	22
	29.7	20.0	25.8	9.7	21.6	59.5	54.3	48.4	35.5	50.0	32.4	22.9	6.5	16.4	16.4
relax X	31	34	31	31	127	meekrob X	16	20	22	74	12	11	14	21	58
	83.8	97.1	100.0	100.0	94.8	43.2	45.7	64.5	71.0	55.2	32.4	31.4	45.2	67.7	43.3
/	6	1	0	0	7	/	19	11	9	60	25	24	17	10	76
	16.2	2.9	5.2	26	5.2	56.8	54.3	35.5	29.0	44.8	67.6	68.6	54.8	32.3	56.7
revenge X	24	24	22	26	96	padkaprao X	13	10	20	58	6	11	9	14	40
	64.9	68.6	71.0	83.9	71.6	35.1	28.6	48.4	64.5	43.3	16.2	31.4	29.0	45.2	29.9
/	13	11	9	5	38	/	25	16	11	76	31	24	22	17	94
	35.1	31.4	29.0	16.1	28.4	64.9	71.4	51.6	35.5	56.7	83.8	68.6	71.0	54.8	70.1
mountain X	20	20	14	19	73	relax X	14	21	24	78	11	13	8	15	47
	54.1	57.1	45.2	61.3	54.5	37.8	60.0	61.3	77.4	58.2	29.7	37.1	25.8	48.4	35.1
/	17	15	17	12	61	/	14	12	7	56	26	22	23	16	87
	45.9	42.9	54.8	38.7	45.5	62.2	40.0	38.7	22.6	41.8	70.3	62.9	74.2	51.6	64.9

/ = correct answer, X = wrong answer

**Table 2: Picture naming classified by FAST** (normal n=37, MCI (F2, F3) n=35, mild (F4) n=31, mod n=31)

Picture		N (%)				
		normal(n=37)	MCI(n=35)	mild(n=31)	moderate(n=31)	All (n=134)
elephant	X	0	0	0	4(12.9)	4(3.0)
	/	37(100.0)	35(100.0)	31(100.0)	27(87.1)	130(97.0)
scissors	X	0	0	1(3.2)	4(12.9)	5(3.7)
	/	37(100.0)	35(100.0)	30(96.8)	27(87.1)	129(96.3)
<b>garland</b>	<b>X</b>	<b>1(2.7)</b>	<b>4(11.4)</b>	<b>11(35.5)</b>	<b>14(45.2)</b>	<b>30(22.4)</b>
	/	<b>36(97.3)</b>	<b>31(88.6)</b>	<b>20(64.5)</b>	<b>17(54.8)</b>	<b>104(77.6)</b>
saws	X	0	0	2(6.7)	7(22.6)	9(6.8)
	/	37(100.0)	35(100.0)	28(93.3)	24(77.4)	124(93.2)
ranard	X	6(16.2)	5(14.3)	17(56.7)	11(35.5)	39(29.3)
	/	31(83.8)	30(85.7)	13(43.3)	20(64.5)	94(70.7)
<b>tuk-tuk</b>	<b>X</b>	<b>2(5.4)</b>	<b>9 (25.7)</b>	<b>19(63.3)</b>	<b>21(67.7)</b>	<b>51(38.3)</b>
	/	<b>35(94.6)</b>	<b>26 (74.3)</b>	<b>11(36.7)</b>	<b>10(32.3)</b>	<b>82(61.7)</b>
sandals	X	3(8.1)	2(5.7)	8(26.7)	6(19.4)	19(14.3)
	/	34(91.9)	33(94.3)	22(73.3)	25(80.6)	114(85.7)
turtle	X	0	1(2.9)	0	4(12.9)	5(3.8)
	/	37(100.0)	34(97.1)	30(100.0)	27(87.1)	128(96.2)
<b>flipper</b>	<b>X</b>	<b>4(10.8)</b>	<b>3(8.6)</b>	<b>10(33.3)</b>	<b>16(51.6)</b>	<b>33(24.8)</b>
	/	<b>33 (89.2)</b>	<b>32 (91.4)</b>	<b>20 (66.7)</b>	<b>15 (48.4)</b>	<b>100 (75.2)</b>
hoe	X	13(35.1)	17(48.6)	23(76.7)	26(83.9)	79(59.4)
	/	24 (64.9)	18(51.4)	7(23.3)	5(16.1)	54(40.6)
spoon	X	0	1(2.9)	1(3.3)	7(22.6)	9(6.8)
	/	37(100.0)	34(97.1)	29(96.7)	24(77.4)	124 (93.2)
lotus	X	1(2.7)	5(14.3)	10(33.3)	12(38.7)	28(21.1)
	/	36(97.3)	30(85.7)	20(66.7)	19(61.3)	105(78.9)
<b>jug</b>	<b>X</b>	<b>8(21.6)</b>	<b>19(54.3)</b>	<b>22(73.3)</b>	<b>22(71.0)</b>	<b>7(53.4)</b>
	/	<b>29(78.4)</b>	<b>16(45.7)</b>	<b>8(26.7)</b>	<b>9(29.0)</b>	<b>62(46.6)</b>
<b>seahorse</b>	<b>X</b>	<b>8(21.6)</b>	<b>17(48.6)</b>	<b>24(80.0)</b>	<b>24(77.4)</b>	<b>73(54.9)</b>
	/	<b>29(78.4)</b>	<b>18(51.4)</b>	<b>6(20.0)</b>	<b>7(22.6)</b>	<b>60(45.1)</b>
<b>chadaa</b>	<b>X</b>	<b>0</b>	<b>6(17.1)</b>	<b>11(36.7)</b>	<b>13(41.9)</b>	<b>30(22.6)</b>
	/	<b>37(100.0)</b>	<b>29(82.9)</b>	<b>19(63.3)</b>	<b>18(58.1)</b>	<b>103(77.4)</b>

/ = correct answer, X = wrong answer

CERAD protocol, neither category nor abstract words existed. There were ordinary words such as king, letter, rice etc.<sup>12</sup> Therefore the words in the list learning trial developed by researchers could be used to evaluate incidental memory to classify those with suspected dementia amongst Thai people.

For picture naming, only some pictures could classify normal people from those with dementia. Selected picture (NT\_6) that is; garland, *tuk-tuk*, flipper, jug, seahorse and *chadaa*, had higher accuracy in the clinical setting than that in the community. But the accuracy was limited in the MCI group in the community. Thus, the line drawings designed by researchers were matched to Thai culture and way of life of the elderly. The NT\_6 which is a shorter version, could function as reference test in the clinical setting. For long term care, the full version NT (15 figures) is

recommended in order to monitor the clinical course.

For visual recognition (VR), picture with no meaning could not classify normal elderly from abnormal groups (Table 3 & Table 4). This may be explained by visual recognition skill which depends on deficit area and personal interest<sup>13</sup> and the expertise and familiarity did not have impact on visual learning either.<sup>14</sup> It was noticed that if all answers were yes/no, examiner should cautiously recheck the reliability of the data. Therefore, this task was not used in the community.

For the DS-IL, the average score of F.R.II in the control group was comparable to other studies<sup>15</sup> but in the community the average score was only 2 which can be explained by 2 factors namely level of education and home environment. The accuracy of F.R.II in the community was lower than that in the clinical setting. This phenomenon

**Table 3: Average means score of tests and 95% confident interval (95% CI)**

neuropsychological test	mean(SD), 95% CI							
	normal	dementia						
		MCI	mild	moderate				
n	n	n	n	n				
learn	37	2.7(1.9) 2.0,3.3	35	2.5(2.0) 1.8,3.2	31	2.0(1.3) 1.5,2.5	29	1.3(1.3) 0.8,1.8
WLL	37	17.3(4.2) 15.9,18.7	34	14.7(5.0) 13.0,16.4	32	10.3(3.6) 9.0,11.6	29	6.8(4.3) 11.6,13.6
delayed recall	37	5.0(2.7) 4.0,5.9	34	2.7(2.7) 1.8,3.7	31	0.9(1.7) 0.3,1.6	28	0.5(1.1) 0.0,0.9
category_recall	37	2.7(1.2) 2.3,3.1	34	1.8(1.5) 1.3,2.4	31	0.5(1.0) 0.2,0.8	29	0.3(0.6) 0,0.5
abstract recall	37	0.7(0.8) 0.5,1.0	34	0.3(0.1) 0.1,0.5	31	0(0.2) 0,0.1	28	0 0
Word recognition	37	22.2(2.1) 21.5,22.9	34	19.6(2.5) 18.7,20.4	31	18.1(2.9) 17.0,19.1	28	15.4(3.9) 13.9,16.9
Forget		-18.4(46.0) -33.8,-3.0	34	-48.8(37.9) -62.0,-35.6	31	-79.4(35.4) -92.1,-66.1	28	-81.4(33.9) -95.8,67.2
NT	37	13.8(1.2) 13.4,14.2	34	12.6(1.8) 12.0,13.2	32	9.4(2.9) 8.4,10.5	29	8.6(4.4) 7.0,10.3
NT_6		5.3(0.8) 5.1,5.6		4.4(1.3) 3.9,4.8		2.4(1.9) 1.8,3.1		2.5(1.9) 1.8,3.2
picture recog	37	11.6(2.7) 10.7,12.5	34	9.5(4.1) 8.1,11.0	31	8.4(6.0) 6.2,10.6	27	8.7(6.6) 6.1,11.4
Digit	29	5.5(3.3) 4.4,6.6	11	1.8(3.2) 0.7,2.9	7	0.3(1.2) -0.1,0.8	3	0.2(0.9) -0.2,0.4
CW	37	23.6(10.8) 20.0,27.2	34	14.1(9.0) 11.0,17.2	28	6.7(6.3) 4.4,9.0	25	2.7(4.0) 1.4,4.0
sum_second		34.4(1.2) 30.4,38.5		22.6(11.7) 18.6,26.6		11.9(7.5) 9.2,14.6		5.5(6.2) 3.6,7.5
sum_second.1		37.2(13.5) 32.7, 41.7		22(12.7) 17.6, 26.4		10.2(7.6) 7.5,13.0		4.7(6.3) 2.7, 6.7

WLL = sum WLM3 rounds, learn= WLM 3- WLM1, NT= naming test, NT\_6= 6-picture naming, CW= Stroop color word, Digit = Digit\_FR.II, second.1 = sum (naming + CAT + Digit + CW), second = sum (name + learn + Digit + CW)

**Table 4: Area under ROC (AUC) among groups classified by FAST (normal n=37, MCI (F2, F3) n=35, mild (F4) n=31, mod n=31)**

neuropsychological test	AUC 95% CI			
	MCI	Dementia		
		mild (1)	mod (2)	dementia (1+2)
WLL	<b>0.67(0.54,0.78)</b>	<b>0.89(0.80,0.96)</b>	<b>0.96(0.88,0.99)</b>	<b>0.92(0.85,0.97)</b>
learn	0.55(0.43,0.67)	0.63(0.50,0.75)	0.75(0.63,0.85)	0.69(0.58,0.78)
forget	0.70(0.58,0.80)	0.87(0.77,0.94)	0.86(0.74,0.94)	0.86(0.78,0.93)
abstract rec	0.66(0.53,0.76)	0.76(0.64,0.85)	0.77(0.64,0.87)	0.88(0.63,0.82)
delay	<b>0.71(0.59,0.81)</b>	<b>0.86(0.76,0.94)</b>	<b>0.90(0.80,0.96)</b>	<b>0.88(0.80,0.74)</b>
WREC	<b>0.81(0.70,0.89)</b>	<b>0.88(0.78,0.95)</b>	<b>0.92(0.82,0.97)</b>	<b>0.90(0.82,0.95)</b>
CAT	<b>0.68(0.56,0.78)</b>	<b>0.90(0.80,0.96)</b>	<b>0.94(0.86,0.98)</b>	<b>0.92(0.85,0.97)</b>
CW	<b>0.75(0.63,0.84)</b>	<b>0.93(0.84,0.98)</b>	<b>0.98(0.90,1.0)</b>	<b>0.95(0.89,0.98)</b>
Digit	<b>0.75(0.64,0.85)</b>	<b>0.86(0.76,0.94)</b>	<b>0.87(0.76,0.94)</b>	<b>0.87(0.78,0.93)</b>
NT	0.69(0.57,0.80)	0.93(0.84,0.98)	0.91(0.82,0.97)	0.92(0.85,0.96)
NT_6	<b>0.71(0.99,0.81)</b>	<b>0.91(0.82,0.99)</b>	<b>0.91(0.82,0.97)</b>	<b>0.91(0.84,0.96)</b>
picture_true	0.72(0.60,0.86)	0.73(0.61,0.83)	0.75(0.62,0.85)	0.73(0.63,0.82)
picture_all	0.64(0.52,0.75)	0.67(0.55,0.78)	0.70(0.56,0.81)	0.68(0.57,0.78)
sum_second	0.75(0.64,0.85)	0.95(0.87,0.99)	0.98(0.91,1.0)	0.96(0.91,0.99)
sum_second.1	<b>0.80(0.68,0.88)</b>	<b>0.96(0.88,0.99)</b>	<b>0.97(0.91,1.0)</b>	<b>0.97(0.91,0.99)</b>

WLL = sum WLM3 rounds, learn= WLM 3- WLM1, CAT= food category recall, WREC= word recognition, NT= naming test, NT\_6= 6-picture naming, CW= Stroop color word, Digit= Digit\_FR.II, second.1 = sum (NT + CAT + Digit + CW), second = sum (NT + learn + Digit + CW)

**Table 5: Word list memory classified by EAST (normal n=55, possible (F2) n=70, MCI (F3) n=16, dementia (F4)=17**

	trial_1			trial_2			trial_3								
	normal	MCI	all	normal	MCI	all	normal	MCI	all						
school X	47	68	13	15	143	143	45	65	15	16	141	30	45	10	97
/	87.0	97.1	86.7	93.8	92.3	92.3	83.3	92.9	100.0	100.0	91.0	55.6	64.3	66.7	62.6
glass X	49	63	13	11	136	136	39	52	13	12	116	44.4	35.7	33.3	37.4
/	90.7	90.0	86.7	68.8	87.7	87.7	72.2	74.3	86.7	75.0	74.8	57.4	61.4	80.0	61.9
fan X	42	59	13	14	128	128	22	34	12	12	81	42.6	38.6	20.0	38.1
/	77.8	84.3	86.7	87.5	82.6	82.6	40.7	48.6	80.0	81.3	52.3	92.6	88.6	86.7	91.0
relax X	52	70	15	16	153	174	28	44	10	9	91	18	29	5	62
/	96.3	100.0	100.0	100.0	98.7	98.7	51.9	62.9	66.7	56.3	58.7	33.3	41.4	33.3	40.0
payabat X	47	63	14	15	139	139	23	34	6	9	72	23	29	8	66
/	87.0	90.0	93.3	93.8	89.7	89.7	42.6	48.6	40.0	56.3	46.5	42.6	41.4	53.3	42.6
moutain X	33	49	11	10	103	103	37	54	7	10	108	23	22	5	57
/	61.1	70.0	73.3	62.5	66.5	66.5	68.5	77.1	46.7	62.5	69.7	42.6	31.4	33.3	36.8
	21	21	4	6	52	52	17	16	8	6	47	31	48	10	98
	38.9	30.0	26.7	37.5	33.5	33.5	31.5	22.9	53.3	37.5	30.3	57.4	68.6	66.7	63.2

/ = correct answer, X = wrong answer

**Table 6: Picture naming classified by FAST** (normal n=55, possible (F2) n=70, MCI (F3) n=15, dementia (F4) n=16)

Picture		N (%)				
		normal(n=54)	possible(n=70)	MCI(n=15)	dementia(n=16)	All (n=155)
garland	x	8(14.8)	18(25.7)	4(26.7)	7(43.8)	37(23.9)
	/	46(85.2)	52(74.3)	11(73.3)	9(56.3)	118(76.1)
tuk-tuk	x	11(20.4)	23 (32.9)	2(13.3)	13(81.3)	49(31.6)
	/	43(79.6)	47 (67.1)	13(86.7)	3(18.8)	106(68.4)
flipper	x	6(11.1)	10(14.3)	3(20.0)	7(43.8)	26(16.8)
	/	48 (88.9)	60 (85.7)	12 (66.7)	9 (56.3)	129 (83.2)
jug	x	22(40.7)	36(51.4)	6(40.0)	11(68.8)	75(48.4)
	/	32(59.3)	34(48.6)	9(60.0)	5(31.3)	80(51.6)
seahorse	x	27(50.0)	47(67.1)	9(60.0)	13(81.3)	96(61.9)
	/	27(50.0)	23(32.9)	6(40.0)	3(18.8)	59(38.1)
chadaa	x	6(11.1)	8(11.4)	0	4(25.0)	18(11.6)
	/	48(88.9)	62(88.6)	15(100)	12(75.0)	137(77.4)

/ = correct answer, x = wrong answer

was also observed in the SCWT. The CW score could identify dementia from normal aging in the clinical setting as reported by others. The accuracy of CW to classify normal individuals from MCI was comparable to that of Yagi et al

in the clinical setting.<sup>16</sup> However, normal cut-off values for DS-IL and SCWT have not been obtained in the Thai elderly population yet.

In addition, delayed recall, CAT and SCWT had comparable accuracy in both settings to

**Table 7: Average means score of tests and 95% confident interval (95% CI) in community setting**

Neurological test	mean (SD), 95% CI				
	group classified by FAST				
	normal n=54	possible n=70	MCI n=16	dementia n=17	total
WLL	13.3(4.4)	10.2(3.9)	9.5(4.4)	7.6(4.2)	10.9(4.5)
	12.0,14.5	9.2,11.1	7.1,12.0	5.4,9.9	10.2,11.6
learn	2.0(1.8)	2.1(1.4)	2.0(1.3)	1.5(1.5)	2.0(1.6)
	1.5,2.5	1.8,2.5	1.8,2.5	0.7,2.4	1.8,2.3
forget	-41.4(39.4)	-63.4(36.6)	-72.1(37)	-90.1(19.4)	-59.1(39.2)
	-52.1,-30.6	-72.3,-54.6	-93.0,-51.3	-100.9,-79.3	-65.4,-52.8
CAT	1.9(1.3)	1.1(1.2)	0.8(1.3)	0.3(0.7)	1.3(1.3)
	1.6,2.3	0.8,1.4	0.1,1.5	0.1,0.7	1.1,1.5
WREC	19.7(4.5)	18.2(4.2)	16.2(6.1)	13.8(5.5)	18.1(4.9)
	18.5,20.9	17.2,19.2	12.8,19.5	10.8,16.7	17.3,18.9
delayed	3.2(2.2)	1.7(1.8)	1.4(2.0)	0.4(0.8)	2.1(2.1)
	2.6,3.8	1.2,2.1	0.3,2.5	0.0,0.9	1.7,2.4
NT_6	4.5(1.5)	4.0(1.4)	4.4(1.5)	2.6(1.4)	4.0(1.5)
	4.1,4.9	3.6,4.3	3.5,5.2	1.8,3.3	3.8,4.3
Digit_F.R.II	2.0(3.2)	0.4(1.6)	0.3(1.0)	0	0.9(2.3)
	1.2,3.9	0.0,0.8	-0.3,0.8	0	0.5,1.3
CW	14.3(11.5)	7.4(8.7)	6.8(7.6)	3.7(5.2)	9.4(10.1)
	11.2,17.5	5.4,9.5	2.6,11.0)	0.9,6.5	7.8,11.0
second.1	22.8(14.6)	12.9(10.1)	12.3(9.5)	6.5(5.8)	15.6(12.7)
	18.8,26.8	10.5,15.3	7.0,17.6	3.4,9.6	13.6,17.7
second	22.9(14.6)	13.9(9.9)	13.5(8.6)	7.8(6.5)	16.4(12.4)
	18.9,26.9	11.6,16.3	8.7,18.2	4.4,11.3	14.4,18.4

WLL = sum WLM3 rounds, learn= WLM 3- WLM1, CAT= food category recall, WREC= word recognition, NT\_6 = 6-picture naming, CW= Stroop color word, second.1 = sum (NT\_6 + CAT + Digit\_F.R.II + CW), second = sum (NT\_6 + learn + Digit\_FR.II + CW)

**Table 8: Area under ROC (AUC) among groups classified by FAST in the community** (normal n=55, possible (F2) n= 70, MCI (F3) n=16, dementia (F4) n= 17)

neuropsychological test	AUC 95%CI			
	Possible FAST2	dementia		
		MCI (FAST3)	Dementia(FAST4)	Dementia+MCI
WLL	0.70(0.61,0.78)	0.74(0.62,0.84)	0.83(0.72,0.91)	0.78(0.68,0.86)
<b>Delayed recall</b>	<b>0.71(0.62,0.79)</b>	<b>0.74(0.62,0.84)</b>	<b>0.85(0.75,0.93)</b>	<b>0.80(0.70,0.88)</b>
WREC	0.64(0.55,0.72)	0.69(0.56,0.79)	0.83(0.72,0.91)	0.76(0.66,0.85)
<b>CAT</b>	<b>0.68(0.59,0.76)</b>	<b>0.74(0.62,0.84)</b>	<b>0.84(0.73,0.92)</b>	<b>0.79(0.69,0.87)</b>
learn	0.53(0.44,0.62)	0.50(0.32,0.68)	0.57(0.45,0.69)	0.54(0.42,0.64)
NT_6	0.62(0.52,0.70)	0.52(0.40,0.64)	0.83(0.72,0.91)	0.68(0.57,0.78)
<b>CW</b>	<b>0.69(0.60,0.77)</b>	<b>0.70(0.57,0.80)</b>	<b>0.79(0.67,0.87)</b>	<b>0.74(0.63,0.83)</b>
Digit_FR.II	0.62(0.53,0.71)	0.63(0.51,0.75)	0.66(0.53,0.77)	0.64(0.53,0.74)
Second	0.69(0.60,0.77)	0.68(0.56,0.79)	0.83(0.72,0.91)	0.76(0.65,0.84)
<b>second.1</b>	<b>0.71(0.62,0.79)</b>	<b>0.71(0.59,0.81)</b>	<b>0.85(0.75,0.93)</b>	<b>0.78(0.68,0.86)</b>

WLL = sum WLM3 rounds, learn= WLM 3- WLM1, CAT= food category recall, WREC= word recognition, NT\_6 = 6-picture naming, CW= Stroop color word, second.1 = sum (NT\_6 + CAT + Digit\_FR.II + CW), second = sum (NT\_6 + learn + Digit\_FR.II + CW)

distinguish people with MCI and dementia from normal persons. However, the accuracy of these tests in the clinical setting tended to be higher than those in the community setting due to clinical cases having obvious deficits and the ability of the hospital to provide a proper room for neuropsychological assessment. For the combination, “second.1” was recommended for use in case of long term follow up or for care monitoring. The “second” was not recommended because the forgetting rate would be infinity if the WLM3 was zero.

In conclusion, word list and picture naming could be used as the reference study for dementia in the clinical setting in order to evaluate the incidental learning memory parallel to the other standard tests (DS-IL, SCWT). These tests could also be used to evaluate or to monitor clinical outcomes of treatment in other group of patients such as people with traumatic brain injury.

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## DISCLOSURE

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