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# Psychometric properties of a new occupational therapy cognitive outcome measure for Thai older adults with cognitive impairments

**Pachpilai Chaiwong**[1] **Phuanjai Rattakorn**[1] **Somporn Sungkarat**[2] **Natthachai Kattiya**[3] **Denis Tuttle**[4] **Peeraya Munkhetvit**[1*]

[1]*Department of Occupational Therapy, Chiang Mai University, Chiang Mai Province, Thailand.*
[2]*Department of Physical Therapy, Chiang Mai University, Chiang Mai Province, Thailand.*
[3]*Queen Savang Vadhana Memorial Hospital, Chonburi Province, Thailand.*
[4]*Department of Rehabilitation Science, University at Buffalo, Buffalo, USA.*

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**ABSTRACT**

**Background**: Occupational therapy (OT) cognitive interventions requires a standardised cognitive outcome measure to help explain the effectiveness of the interventions. Now, there is a lack of measures to use for Thai older adults with cognitive impairments. Therefore, a new Occupational Therapy Cognitive Outcome Measure (OTCOM) for Thai older adults with cognitive impairments was developed to support evidence-based OT cognitive interventions.

**Objectives**: To examine the psychometric properties including internal consistency, inter-rater and intra-rater reliability, known-group construct validity, concurrent validity, and responsiveness of the OTCOM.

**Materials and methods**: A prospective cohort design was used in this study. One hundred and ten older adults; sixty-one older adults with cognitive impairments and forty-nine older adults without cognitive impairments, were recruited. The Cronbach's alpha coefficient was calculated for internal consistency. Intraclass correlation coefficient (ICC) was used to analyse rater reliability. Analyses of concurrent and known-group construct validity were done using Pearson correlation and independent t-test, respectively. Both effect size (ES) and standardised response mean (SRM) were calculated for responsiveness of the OTCOM.

**Results**: The results showed good internal consistency ($\alpha$=0.88), and excellent inter-rater and intra-rater reliability (ICC=0.99). A high correlation between the OTCOM and the Dynamic Lowenstein Occupational Therapy Cognitive Assessment-Geriatric (DLOTCA-G) and the Thai Cognitive-Perceptual Test (Thai-CPT) was found, indicating good concurrent validity. There was a significant difference between older adults with cognitive impairments and without cognitive impairments, suggesting good construct validity by the known-group method. Responsiveness was shown as large ES and SRM in the total score.

**Conclusion**: The OTCOM showed good psychometric properties, making it useful in OT practice after revisions.

* **Corresponding author.**
**Author's Address:** *Department of Occupational Therapy, Chiang Mai University, Chiang Mai Province, Thailand.*

** **E-mail address:** peeraya.m@cmu.ac.th
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## Introduction

Due to increasing life expectancies, many countries have experienced an unprecedented and continued growth of senior citizens. In 2020, over 700 million persons worldwide were older adults aged 65 years and over.[1] In the same year, Thailand had over 17% of its population comprised of older adults, making it an aged society.[2] This growth is an essential transformation in the 21st century that affects society, family structure, financial market, and health goods and services. According to the 2030 Agenda for Sustainable Development of the United Nations, all segments of society, including older adults, cannot be left behind. Governments worldwide must address concerns about older adults' health and well-being.[1] A typical age-related health problem in older adults is cognitive impairments (CI) that can develop into dementia.[3] CI can affect the quality of life of older people due to a loss of functional ability, and the need to maintain their sense of independence.[4,5] Occupational therapists (OTs) have a role in maintaining the quality of life of older adults.[6] For evidence-based practice, the quality of occupational therapy (OT) service in cognition for clients with CI should be explained through standardised cognitive outcome measures.[7] Outcome measure explain the effectiveness of the overall intervention. Therapists can compare different interventions using the appropriate outcome measure during interventions and choose the best intervention. An appropriate outcome measure may help determine a suitable intervention plan.[8] There are currently fewer evidence-based cognitive interventions for clients with CI compared to other common diseases. Inappropriate or poorly chosen outcome measures may weaken or invalidate the result's interpretation.[9] Therefore, good psychometric properties regarding reliability, validity, and responsiveness based on careful research should be considered.[7,10] Since there is a lack of standardised OT cognitive outcome measures appropriate for older adults with CI in Thailand, Thai occupational therapists typically use cognitive screening tests such as the Thai Mental State Examination or assessment tools developed for neurological patients such as the Thai Cognitive-Perceptual Test. These tests might not sensitive enough to detect cognitive change over time.[11] This might bring confusion in interpreting the effectiveness of treatment.[8] Therefore, a reliable, valid, sensitive, and context-suitable outcome measure for evaluating cognitive function in Thai older adults is needed.

In this study, an outcome measure to assess cognitive functions of Thai older adults aged sixty years and over who had CI has been developed by the researchers. This outcome measure is named the Occupational Therapy Cognitive Outcome Measure (OTCOM). The OTCOM employs both subjective and objective approaches. The subjective method is necessary to understand the client's perception and expected standard. It is based on personal feelings. The subjective measure is often obtained through questionnaires having degrees of agreement; consequently, it may be interpreted as a quantitative score. The objective approach is based on an individual's performance. Its strength is that the client's performance can be defined in quantitative terms. The value is that the score results can efficiently and reliably be compared with others.[12] Furthermore, the OTCOM employs a dynamic measurement approach. As a dynamic measure, therapists can learn what components can be extended and which strategies can encourage each client[13,14] because the dynamic measures focus on the degree of change resulting from introducing the mediation during assessment.[15] It is believed that therapists could observe the client's responses while receiving mediation and gain information about the processing strategies of the clients. As a result, the dynamic measure can help the therapist create a suitable intervention program.[13,14]

This study aimed to examine the psychometric properties of the OTCOM when used in Thai older adults with CI so that it can be used to support evidence-based OT interventions

## Materials and methods

**Participants**. One hundred and ten older adults aged sixty years and older were recruited with purposive sampling from five settings: communities in Chiang Mai, Chiangmai Neurological Hospital, Queen Savang Vadhana Memorial Hospital in Chonburi, Geriatric Medical Center in Chiang Mai, and Ishii Stroke Rehabilitation Center in Bangkok. Sixty-one of the older adults had cognitive impairments (CI) and there were forty-nine older adults without CI (Non-CI). The inclusion criteria of the CI group were: 1) had a CI as initially screened by a physician or psychiatrist 2) received a score of 10-24 as determined by the Montreal Cognitive Assessment (MoCA) or the Montreal Cognitive Assessment Basic (MoCA-B) (Copyright Z. Nasreddine MD. Reproduced with permission) 3) Self-identified as now requiring minimal assistance for ADLs and being independent previously and 4) no depression as assessed by the Thai Geriatric Depression Scale-15 (TGDS-15). Inclusion criteria of the Non-CI group included: 1) never had diagnosis of a CI and 2) received a score of 25-30 on the MoCA or the MoCA-B.

**Instrumentation.** Instruments were categorized into three groups.

*Screening instruments.* Cognitive screen tools and depression screen tools were used. The cognitive screening tools for mild cognitive impairments are the Montreal Cognitive Assessment (MoCA) Thai version, 2011 and the Montreal Cognitive Assessment Basic (MoCA-B) Thai version, 2014. They have 81-99% rating for sensitivity and specificity.[16] The MoCA was used when the participant's education was 5 years or more and the MoCA-B was used if their education was less than 5 years. The short screening tool used for detecting depression in older adults was the Thai Geriatric Depression Scale-15 (TGDS-15). It has a sensitivity of 0.92 and a specificity of 0.87.[17]

*Research instruments*. Three instruments were used; the Dynamic Lowenstein Occupational Therapy Cognitive Assessment-Geriatric (DLOTCA-G), the Thai Cognitive-Perceptual Test (Thai-CPT), and the cognitive training program. The DLOTCA-G has excellent inter-rater reliability ($r$=0.98), and internal consistency at $\alpha$=0.26-0.85.[18] In this study, five subtests of the DLOTCA-G, Orientation of Time, Orientation

of Place, Copy Geometric Forms, Motor Imitation, and Pictorial Sequence A, were used to study for a relationship with the OTCOM. The Thai-CPT is a perceptual-cognitive outcome measure for patients with brain injuries in Thailand. It has acceptable internal consistency ($\alpha$=0.78-0.96), good to excellent test-retest reliability (ICC=0.83-0.97), and excellent inter-rater reliability (ICC=0.91-1.00).[19] Four subtests of the Thai-CPT, Auditory Object Name Memory, Object Recognition, Categorization, and Problem Solving, were used in this study. Finally, the cognitive training program described in the study of Munkhetvit, Rattakorn, Apikomonkorn and Punyanon[20] was used. This efficacious intervention includes 15 sessions, with three sessions a week for 60 minutes each.

The Occupational Therapy Cognitive Outcome Measure (OTCOM) was developed by the researchers based on information processing theory,[21] the Toglia's Dynamic Interactional Approach,[22] the Cognitive Disabilities Reconsidered Model,[23] DSM-5,[24] relative cognitive assessment tools, and the researchers' clinical experience. The measure contains two parts: the self-report section and the performance-based measure. The self-report section is a subjective questionnaire containing 26 subtests. The performance-based section is a bottom-up objective cognitive measure with a dynamic prompt. The performance-based section includes 24 subtests in seven cognitive domains: Orientation, Attention, Memory, Perceptual-Motor Function, Language, Executive Functions, and Social Cognition, as a static measure. Out of seven domains, five domains and 15 subtests are dynamic measures (Table 1). The performance-based section has an acceptable content validity (IOC=0.67-1.00) as determined by three experts: a psychiatrist who has experience in cognitive intervention, and more than five years of assessing the psychometric properties of cognitive tests; an occupational therapy lecturer who has experience in cognitive assessments and interventions, and more than five years of experience teaching about cognitive impairments in the elderly; and an occupational therapist who has more than five years of experience in cognitive interventions and assessments for the elderly with CI. In this study, the self-report section and seven domains in the performance-based section were studied for their psychometric properties.

**Table 1** Structure of the Occupational Therapy Cognitive Outcome Measure (OTCOM).

| **Self-report section:** | **26 subtests questionnaire** | | |
|---|---|---|---|
| **Performance-based section:** | **Domain** | **Subtest** | **Mediation** |
| | Orientation | Orientation of Time | - |
| | | Orientation of Place | - |
| | Attention | Selective Attention A | 3 level |
| | | Selective Attention B | 3 level |
| | | Processing Speed | - |
| | Memory | Immediate Recall Memory | - |
| | | Recognition Memory | - |
| | | General Semantic Memory | 2 level |
| | | Delayed Recall Memory | 2 level |
| | Perceptual-Motor Function | Geometric Copy | 2 level |
| | | Pantomime Praxis | 2 level |
| | | Imitation Praxis | 4 level |
| | | Using Object Praxis | 3 level |
| | Language | Naming | - |
| | | Semantic Fluency | - |
| | | Receptive Language | - |
| | Executive Functions | Flexibility | 4 level |
| | | Abstract Thinking | 2 level |
| | | Categorization | 4 level |
| | | Sequencing A | 4 level |
| | | Sequencing B | 4 level |
| | | Problem Solving | 2-3 level |
| | Social Cognition | Recognition of Emotions | 2 level |
| | | Theory of Mind | - |
| | Awareness | Awareness of Cognitive Decline | - |
| | | Awareness of Memory | - |

**Procedures**

To examine the psychometric properties of the OTCOM, a prospective cohort design was utilized. Ethical approval was obtained by the follow review boards: Ethics Committee at the Faculty of Associated Medical Sciences, Chiang Mai University (approval # AMSEC-61FB-001), the Research Ethics Committee No. 2, Faculty of Medicine, Chiang Mai University (approval # 6928), the Ethics Committee at Chiangmai Neurological Hospital (approval # 021-63), and the Institution Review Board at Queen Savang Vadhana Memorial Hospital (approval # 001/2564). All participants signed a consent form after verbal and written explanation of the study was provided.

One hundred and sixteen older adults were recruited with one hundred and ten older adults meeting the inclusion criteria. The participants were divided into two groups: the cognitive impairment (CI) group (61 older adults) and the Non-CI group (49 older adults).

*Internal consistency.* All participants in the CI group were assessed by the OTCOM. The data was calculated using Cronbach's alpha coefficient. A Cronbach's alpha coefficient lower than 0.50 was considered unacceptable, 0.50-0.59 is poor, 0.60-0.69 is questionable, 0.70-0.79 is acceptable, 0.80-0.89 is good, and 0.90-1.00 is excellent.[25]

*Validity.* Construct and concurrent validity were examined. For the known-group construct validity, all participants were assessed by the performance-based section of the OTCOM. The data of the two groups were compared using independent t-test. For concurrent validity, the CI group were assessed by three measures; the OTCOM, the DLOTCA-G, and the Thai-CPT. Fifty-seven older adults with CI completed the Thai-CPT and the DLOTCA-G, four older adults were unable to complete the assessments. The data from the three measures were analysed for correlation using the Pearson Correlation Coefficient. Correlation is poor at <0.40, modest at 0.40–0.74, and excellent at >0.75.[26]

*Reliability.* Rater reliability has two examination methods: inter-rater reliability and intra-rater reliability. Only the performance-based section of the OTCOM was used to examine for rater reliability. For inter-rater reliability, ten participants in the CI group were independently assessed by two assessors who are occupational therapists and passed intensive training in using the OTCOM by an author. Ten participants were chosen based on research following Washington and Moss.[37] The two sets of scoring were analysed by the intraclass correlation coefficient (ICC). For intra-rater reliability determination, ten participants were re-assessed 10-14 days later by the same assessor. The two sets of data were analysed using the ICC. The ICC values that were less than 0.50 indicated poor reliability; between 0.50 and 0.75 were moderate, between 0.75 and 0.90 was good, and greater than 0.90 is considered excellent.[27]

*Responsiveness*. To examine internal responsiveness, change in measure between pre- and post-intervention was considered.[28] After pre-intervention assessment by the performance-based section of the OTCOM was done, thirty-four out of sixty-one subjects in the CI group participated in the cognitive training program. Thirty-two subjects completed the program. Within a week of finishing the program, they received a re-assessment. The scores from pre-intervention and post-intervention were calculated by effect size (ES) and standard response mean (SRM). The ES can be calculated by dividing the mean of the difference between pre- and post-intervention by the standard deviation of pre-intervention. The SRM is the mean of difference between pre- and post-intervention divided by the standard deviation of change. When considering the ES and SRM, 0.20 is indicated as small, 0.50 is medium, and over 0.80 is large.[29,30]

## Results

The average age of the CI group was 71±9 years, and the non-CI group was 66±4 years. Over 60% of both groups were female. A large proportion of both groups (67.30% for the non-CI group and 73.80% for the CI group) had a disease, such as hypertension disease. All participants in the non-CI group had at least one year of education. Both groups had many participants with more than nine years of education with CI Group at 49.30% and the non-CI group at 81.70%. Most participants in the CI group had a cognitive impairment with mild symptoms with MoCA score 18-24 (n=44, 72.13%).

Internal consistency was acceptable for the self-report section (α=0.72) and good for the performance-based section (α=0.86). The findings of known-group construct validity found that the CI group had a lower score from the OTCOM in every single subtest compared with the Non-CI group. The difference in scores of both groups was significant ($p$<0.05) except for the subtest Using Object Praxis and Imitation Praxis. Table 2 illustrates the difference of the subtest Imitation Praxis (t=1.964, $p$=0.052) that was more than the subtest Using Object Praxis (t=0.895, $p$=0.373). In Table 3, the correlation between the OTCOM and the Thai-CPT was a poor to modest correlation on the subtests; Auditory Object Name Memory, Object Recognition, Categorization and Problem Solving ($r$=0.36-0.56, $p$<0.01). The OTCOM and the DLOTCA-G showed excellent correlation in the subtest Orientation of Time ($r$=0.77, $p$<0.01) and a modest correlation in the subtest Orientation of Place and Sequencing A and B ($r$=0.39-0.62, $p$<0.01). A poor correlation was found in the subtest Geometric Copy ($r$=0.27, $p$=0.05). Only the subtest Imitation Praxis had no correlation ($r$=0.14). Table 4 shows excellent intra-rater and inter-rater reliability (ICC=0.99).

**Table 2** Difference in the OTCOM score between the cognitive impairment (CI) and the without cognitive impairment (non-CI) group calculated by the t-test for independent subjects.

| Domain | Subtest (maximum score) | Group | n | Mean±SD | *t* | Sig. (2-tailed) |
|---|---|---|---|---|---|---|
| Orientation | Orientation of Time (5) | CI | 61 | 4.36±1.14 | -3.686 | 0.000** |
| | | Non-CI | 49 | 4.92±0.28 | | |
| | Orientation of Place (4) | CI | 61 | 3.72±0.61 | -2.549 | 0.013* |
| | | Non-CI | 49 | 3.94±0.24 | | |
| Attention | Selective Attention A (8) | CI | 61 | 7.69±0.99 | -2.028 | 0.046* |
| | | Non-CI | 49 | 7.96±0.29 | | |
| | Selective Attention B (16) | CI | 61 | 13.79±3.29 | -3.172 | 0.002** |
| | | Non-CI | 49 | 15.37±1.87 | | |
| | Processing Speed (10) | CI | 61 | 9.11±1.66 | -3.389 | 0.001** |
| | | Non-CI | 49 | 9.90±0.51 | | |
| Memory | Immediate Recall Memory (6) | CI | 61 | 4.62±1.08 | -2.197 | 0.030* |
| | | Non-CI | 49 | 5.04±0.91 | | |
| | Recognition Memory (10) | CI | 61 | 8.89±1.74 | -3.524 | 0.001** |
| | | Non-CI | 49 | 9.73±0.64 | | |
| | General Semantic Memory (5) | CI | 61 | 4.61±0.82 | -3.233 | 0.002** |
| | | Non-CI | 49 | 4.96±0.20 | | |
| | Delayed Recall Memory (5) | CI | 61 | 2.48±1.68 | -2.893 | 0.005** |
| | | Non-CI | 49 | 3.33±1.40 | | |
| Perceptual-Motor Function | Geometric Copy (5) | CI | 61 | 3.84±1.56 | -4.545 | 0.000** |
| | | Non-CI | 49 | 4.82±0.56 | | |
| | Pantomime Praxis (10) | CI | 61 | 9.54±0.69 | -4.463 | 0.000** |
| | | Non-CI | 49 | 9.96±0.20 | | |
| | Imitation Praxis (10) | CI | 61 | 9.39±1.05 | -1.964 | 0.052 |
| | | Non-CI | 49 | 9.71±0.64 | | |
| | Using Object Praxis (10) | CI | 61 | 9.97±0.25 | -0.895 | 0.373 |
| | | Non-CI | 49 | 10.00±0.00 | | |
| Language | Naming (13) | CI | 61 | 12.85±0.40 | -2.299 | 0.024* |
| | | Non-CI | 49 | 12.98±0.14 | | |
| | Semantic Fluency (10) | CI | 61 | 5.70±2.35 | -3.486 | 0.001** |
| | | Non-CI | 49 | 7.20±2.09 | | |
| | Receptive Language (5) | CI | 61 | 1.59±1.54 | -4.699 | 0.000** |
| | | Non-CI | 49 | 2.92±1.38 | | |
| Executive Functions | Flexibility (12) | CI | 61 | 8.15±3.90 | -6.303 | 0.000** |
| | | Non-CI | 49 | 11.61±1.60 | | |
| | Abstract Thinking (5) | CI | 61 | 3.61±1.68 | -5.485 | 0.000** |
| | | Non-CI | 49 | 4.84±0.42 | | |
| | Categorization (5) | CI | 61 | 3.98±1.47 | -4.366 | 0.000** |
| | | Non-CI | 49 | 4.86±0.45 | | |
| | Sequencing A (5) | CI | 61 | 4.16±1.33 | -4.171 | 0.000** |
| | | Non-CI | 49 | 4.90±0.30 | | |
| | Sequencing B (5) | CI | 61 | 4.31±0.94 | -2.779 | 0.007** |
| | | Non-CI | 49 | 4.69±0.46 | | |
| | Problem Solving (12) | CI | 61 | 10.51±1.76 | -5.141 | 0.000** |
| | | Non-CI | 49 | 11.73±0.53 | | |
| Social Cognition | Recognition of Emotions (5) | CI | 61 | 4.49±0.67 | -2.431 | 0.017* |
| | | Non-CI | 49 | 4.78±0.55 | | |
| | Theory of Mind (5) | CI | 61 | 4.92±0.27 | -2.315 | 0.024* |
| | | Non-CI | 49 | 5.00±0.00 | | |

** p<0.05, **p<0.01*

**Table 3** Correlation between OTCOM and Thai-CPT and between OTCOM and DLOTCA-G was calculated by Pearson correlation (n=57).

| Subtest | OTCOM vs. Thai-CPT | | | OTCOM vs. DLOTCA-G | | |
|---|---|---|---|---|---|---|
| | OTCOM | Thai-CPT | *r* | OTCOM | DLOTCA-G | *r* |
| | mean±SD | mean±SD | | mean±SD | mean±SD | |
| Orientation of Time | | | | 4.42±1.13 | 7.39±1.26 | 0.77** |
| Orientation of Place | | | | 3.77±0.54 | 7.72±0.94 | 0.62** |
| Immediate Recall Memory | 4.63±1.03 | 5.26±1.09 | 0.50** | | | |
| Recognition Memory | 9.02±1.59 | 9.35±1.67 | 0.36** | | | |
| Geometric Copy | | | | 3.88±1.51 | 4.75±0.64 | 0.27* |
| Imitation Praxis | | | | 9.42±1.03 | 6.67±1.34 | 0.14 |
| Categorization | 4.12±1.35 | 2.51±0.63 | 0.49** | | | |
| Sequencing A & B | | | | 8.70±1.79 | 4.35±1.17 | 0.39** |
| Problem Solving | 10.67±1.47 | 13.68±1.65 | 0.56** | | | |

*Note: OTCOM: Occupational Therapy Cognitive Outcome Measure, Thai-CPT: Thai Cognitive-Perceptual Test, DLOTCA-G: Dynamic Lowenstein Occupational Therapy Cognitive Assessment-Geriatric, *p<0.05, **p<0.01.*

**Table 4** Rater reliability of the OTCOM calculated by intraclass correlation coefficient (ICC).

| Domain | Inter-rater reliability | | | Intra-rater reliability | | |
|---|---|---|---|---|---|---|
| | n | ICC | Interpretation | n | ICC | Interpretation |
| **Total** | 10 | 0.99 | excellent | 10 | 0.99 | excellent |
| Orientation | 10 | 1.00 | excellent | 10 | 0.99 | excellent |
| Attention | 10 | 0.99 | excellent | 10 | 0.99 | excellent |
| Memory | 10 | 0.99 | excellent | 10 | 0.99 | excellent |
| Perception-Motor Function | 10 | 0.99 | excellent | 10 | 0.99 | excellent |
| Language | 10 | 0.99 | excellent | 10 | 0.99 | excellent |
| Executive Function | 10 | 0.99 | excellent | 10 | 0.99 | excellent |
| Social Cognition | 10 | 0.99 | excellent | 10 | 0.99 | excellent |

For responsiveness of the OTCOM, it was found that the thirty-two CI participants had positive change, and there was large effect of both ES (0.83) and SRM (1.42) in total score (Table 5). This was also the case in the Language domain (ES =0.89 and SRM=1.01) and Executive Functions domain (ES=0.90 and SRM=1.32). Three domains; Memory, Perception-Motor Function, and Social Cognition, had a medium effect at ES=0.50-0.66 and SRM=0.54-0.78.

**Table 5** Effect size (ES) and standardized response mean (SRM) of responsiveness in CI group with mild and moderate symptoms.

| Domain (Maximum Score) | n | Pre-intervention score | Post- intervention score | Change score | ES | SRM |
|---|---|---|---|---|---|---|
| | | mean±SD | mean±SD | mean±SD | | |
| Orientation (9) | 32 | 8.06±1.46 | 8.53±1.05 | 0.47±0.95 | 0.32 | 0.49 |
| Attention (34) | 32 | 29.31±5.86 | 31.75±4.04 | 2.44±3.84 | 0.42 | 0.63 |
| Memory (26) | 32 | 20.94±3.52 | 23.25±2.98 | 2.31±3.03 | 0.66 | 0.76 |
| Perceptual-Motor Function (35) | 32 | 32.56±2.40 | 33.75±1.81 | 1.19±1.53 | 0.50 | 0.78 |
| Language (28) | 32 | 20.00±3.35 | 22.97±3.63 | 2.97±2.95 | 0.89 | 1.01 |
| Executive Functions (44) | 32 | 33.84±7.47 | 40.59±4.70 | 6.75±5.12 | 0.90 | 1.32 |
| Social Cognition (10) | 32 | 9.53±0.72 | 9.91±0.30 | 0.38±0.71 | 0.53 | 0.54 |
| **Total score** | 32 | 154.25±19.93 | 170.75±14.67 | 16.50±11.61 | 0.83 | 1.42 |

## Discussion

The purpose of this study was to examine the psychometric properties of a new cognitive outcome measure for Thai older adults known as the Occupational Therapy Cognitive Outcome Measure (OTCOM). Internal consistency, known-group method of construct validity, concurrent validity, rater reliability, and responsiveness were all investigated.

*Internal consistency*. Cronbach's alpha coefficient of inter-item correlation of the OTCOM were between 0.72-0.86 which indicated an acceptable and good internal consistency.[25] High inter-item correlation shows that items of the test measure the same construct.[31] Hence, it can be noted that the items in the OTCOM measured the same attributes, that is cognitive function. This reflects that the constructs of the OTCOM were developed based on cognitive theories.[32]

*Validity*. For known-group construct validity, the significant difference between the CI group and Non-CI group was found in every subtest except Imitation Praxis (t=1.964, $p$=0.052) and Using Object Praxis (t=0.895, $p$=0.373). Examining the known-group validation demonstrates how the measure can differentiate members of one group from another group based on their scale scores. Its main concern is presenting evidence that the test measures what it claims to measure.[31] Based on significant differences found in this study it can be interpreted that the OTCOM can measure cognitive functions of older adults with CI. The reason why no significant difference was found in the subtest Imitation Praxis and Using Object Praxis might be due to a difference in the gestures used in the assessment. In the OTCOM, the participants were asked to imitate five transitive gestures and five intransitive gestures that were uncomplicated and are familiar to the participants in their daily lives. As a result of imitating familiar gestures, both CI and Non-CI older adults could perform them automatically rather than trying to imitate. In the same way, the reason that no significant difference in the subtest Using Object Praxis was found might be because large numbers of the CI group had mild symptoms. Furthermore, they had almost had no problem in using those familiar objects, as shown in Table 2. These results suggest that the two subtests need to be revised. For Concurrent validity, there is a method of criterion-related validity that is a determination of an association of the target test with some criterion or gold standard test. To find the association, scores from the target test and the gold standard test must be gathered in the same period of time.[33] In this study, the correlation between the OTCOM and the DLOTCA-G and the Thai-CPT was determined. It was found that four subtests of the OTCOM, Immediate Recall Memory, Recognition Memory, Categorization, and Problem Solving, had a significant correlation with the Thai-CPT ($r$=0.36-0.56, $p$<0.01). Similarly, a significant correlation between the OTCOM and the DLOTCA-G was found in three subtests ($r$=0.39-0.77, $p$<0.01). However, the subtest Geometric Copy of the OTCOM had poor correlation ($r$=0.27) with the subtest Copy Geometric Forms of the DLOTCA-G. The poor correlation might be due to the difference of the geometric form and the number of copying used in the two tests. In the DLOTCA-G, there are three geometric objects that are copied; a circle, a triangle, and a rhombus; all forms are two-dimensional shapes whereas the OTCOM employed a copying of a three-dimensional shape, a pyramid. Griffiths, Cook and Newcombe[34] described that a person with a brain injury will likely have problems in three dimensional shapes compared with two-dimensional shapes. Three-dimensional shapes require more visual perception, visuospatial ability, and visuo-constructional skills. Dridan[35] indicated in recent studies that three-dimensional shapes can be useful in the clinical examinations for clients with a cognitive impairment. Another finding of the correlation was that there was no significant correlation between the subtest Imitation Praxis of the OTCOM and the subtest Motor Imitation of the DLOTCA-G. The possible reason might be the same as previously mentioned concerning different types of gestures used in the two tests. The gestures used in the OTCOM are five transitive gestures that are nailing with a hammer, writing with a pen, drinking a glass, combing hair, and brushing teeth, and five meaningful uncomplicated intransitive gestures that are a Thai greeting (Sawasdee), waving a hand to say "Bye-bye!", clapping hands, a thumbs up (a "good job!" sign), and a beckoning hand gesture. While the gestures used in the DLOTCA-G are four meaningless complicated intransitive gestures; such as "place palm on the neck of the same side and then on the opposite shoulder".[18] The study of Lesourd, Osiurak, Baumard, Bartolo, Vanbellingen and Reynaud[36] reported that imitating the meaningless gestures involves more brain areas than meaningful gestures. It should be noted that the subtest Imitation in the two measures was designed to test the different skills of praxis.

*Reliability*. The OTCOM revealed an excellent inter-rater and intra-rater reliability (ICC=0.99-1.00). This might be attributed to the OTCOM's manual and training. There is a clear explanation about operating and scoring in the manual. Before assessing, the assessors underwent an intensive training by the researcher. In addition, re-assessment within 10-14 days did not change the participant's cognitive function.[37]

*Responsiveness*. Overall, the OTCOM showed a medium to large effects (ES=0.50-0.90, SRM=0.54-1.32) in all domains except Attention and Orientation. This indicated that the Memory, Perceptual-Motor Function, Language, Executive Functions, and Social Cognition domains of the OTCOM could detect subtle changes of cognitive function of the participants in this study. However, the Attention domain had a small to medium effect (ES=0.42, SRM=0.63). This might be because the subtest Selective Attention B and Processing Speed in the Attention domain require inhibitory control and flexibility to perform the task whereas the cognitive training program used in this study[20] had no specific training in inhibitory skills. A large progression in this skill might not be detected. In addition, one limitation of this study is that there is no confirmation whether the participants had an inhibitory deficiency. In further revisions, an inhibitory subtest should be added. The findings that the Orientation domain revealed only a small change is

similar to the study of Carrion, Folkvord, Anastasiadou and Aymerich,[38] which systematically reviewed many cognitive training programs specifically on orientation and found just a small improvement in orientation. However, after the cognitive training program had been completed, several participants in this study used a shorter time for answering the oriented questions of the OTCOM. Perhaps the scale used in the Orientation domain might need more explanation in further revisions. For instance, it should add more points for a shorter time in answering or re-scale by integrating the four orientation levels, including x1, x2, x3, and x4 in scoring.[39]

Due to the COVID-19 pandemic and the social distancing countermeasures, the older adults with cognitive impairments did not receive occupational therapy services as they are non-emergency clients. As a result, the small sample size is a limitation of this study. Consequently, the factor analysis could not be examined. In future research, a larger sample size should be used to allow factor analysis to be done and the inhibitory subtest should be developed. Furthermore, the Orientation domain, the Attention domain, and Perceptual-Motor Function domain should be revised.

## Conclusion

The OTCOM showed good reliability, validity, and responsiveness. It might be applied to assess cognition in older adults with cognitive impairment after revisions have been made.

## Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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## Data Availability

The data are not publicly available. Please request the corresponding author at pachpilai.c@cmu.ac.th for information on access to data.

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