

# Evaluation of the Tokyo Cognitive Assessment for Predicting Cognitive Impairment in Rehabilitation Users

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## Abstract

[Purpose] This study aimed to evaluation of the Tokyo cognitive assessment (Toca) for predicting cognitive impairment in rehabilitation users. [Method] The variables of age, BMI, educational background, Toca for 36 rehabilitation users and 22 healthy elder were assessed. We compared cognitive functions in rehabilitation users who need support and healthy elders. [Results] Of the Toca 1 to 11 trials, there was a significant difference other than 9, 10 rials. The Toca scores with 8 points higher were significantly higher in healthy elders than in rehabilitation users. The area under the receiver-operator curve (AUC) for predicting mild cognitive impairment (MCI) by the Toca was 0.874. Using a cut-off point of 19/20, the Toca demonstrated a sensitivity of 83.9% and a sensitivity of 85.0% in diagnosing MCI. [Conclusion] The Toca is a brief cognitive screening tool with high sensitivity and specificity for detecting MCI as currently conceptualized in rehabilitation users.

## Keywords

Tokyo Cognitive Assessment, Mild Cognitive Impairment, Rehabilitation Users

## 1. Introduction

Ministry of Health, Labor and Welfare has published that the number of people with dementia will exceed 7 million by 2025 [1]. This is a calculation that one in five elderly people over the age of 65 will have dementia in Japan. Mild cognitive impairment (MCI) is a transitional level between the normal state of the brain and dementia [2], and the prevalence of MCI in adults aged  $\geq 65$  years is 10% - 20%. Although MCI is associated with a high risk of dementia, it sometimes re-

mains normal or slightly decreases cognitive function without any notable interference in daily life activities [3].

The National Institute on Aging and Alzheimer's Association (NIA-AA) created an AT (N) diagnosis scheme [4]. These biomarkers are expensive and invasive [5] and cannot be used widely for screening.

A range of cognitive assessment tasks that are sensitive to cognitive impairment are available, but many are domain specific and time-consuming in actual clinical practice [6]. Thus, community screening for MCI is a great challenge globally, and this is no difference in Japan.

ToCA-MCI (Tokyo Cognitive Assessment-MCI) test [7] is a method that improves MCI judgment ability by incorporating non-verbal (operability) tasks such as copy of triangle, draw clock, and composition tasks into the conventional dementia screening test. Toca is a brief, useful and validated cognitive screening instrument with a cut-off score of 17/18 to differentiate mild cognitive impairment (MCI) or dementia from normal [1]. There is a one-point adjustment for individuals with formal education of 9 years or fewer. Systematic review highlighted the necessity for cross-cultural considerations when using the Toca as a screening tool. The Toca studies have revealed that the originally recommended cutoff score of 17/18 leads to a higher false positive misclassification especially on those with increasing age and/or low education [7]. Moreover, the one-point correction for education has been debated as insufficient to compensate for educational differences [8].

In Tokyo, the Toca was validated in Japanese elders [7]. A score of less than 18 is considered positive for screening and calls for further diagnostic assessment. This result advised against the use of single cutoff scores of the Toca on elders with cognitive impairment due to Alzheimer's disease (AD). However, the applicability of these findings to other patients with non-AD causes is not known.

Thus, this study aimed to evaluation of the Toca for predicting cognitive impairment in rehabilitation users.

## 2. Subject and Methods

### 2.1. Participants

Thirty-six rehabilitation users ( $81.3 \pm 5.7$  years; 11 males and 26 females) and 31 healthy elders ( $74.4 \pm 7.9$  years; 7 males and 24 females) participated in this study. 68 subjects accepted the invitation of which 67 subjects could be included in the present study. The remaining 1 subjects were excluded owing to missing details about the Toca ( $n = 1$ ) (Table 1).

The present investigation was approved by Kurume Rehabilitation Hospital Ethical Review Board for Medical Research Involving Human Subjects (ethical number: 21-001).

### 2.2. Methods

Cognitive function was assessed using a 30-question of the Montreal Cognitive

**Table 1.** Comparison of variables between rehabilitation users and elder.

variables	Rehabilitation		p Value
	Users (n = 36; 11 males and 25 females)	Elder (n = 31; 7 males and 24 females)	
Age (year)	81.3 ± 5.7	74.4 ± 7.9	0.001
BMI (kg/m <sup>2</sup> )	23.9 ± 3.9	23.1 ± 2.4	0.35
Toca overview			
1. erase characters (2 points)	0.16 ± 0.56	1.19 ± 0.98	0.001
2. copy of triangle (1 points)	0.38 ± 0.49	0.93 ± 0.25	0.001
3. draw clock (3 points)	2.19 ± 0.88	2.67 ± 0.47	0.008
4. composition (1 points)	0.30 ± 0.46	0.83 ± 0.37	0.001
5. read of digits (2 points)	0.69 ± 0.66	1.38 ± 0.71	0.001
6. serial 7 (3 points)	0.86 ± 1.07	2.38 ± 0.76	0.02
7. go/no-go (3 points)	0.16 ± 0.62	1.19 ± 0.104	0.003
8. word recall (3 points)	1.94 ± 0.82	2.54 ± 0.62	0.001
9. orientation day (4 points)	3.50 ± 0.91	3.80 ± 0.40	0.08
10. orientation place (1 points)	0.88 ± 0.31	0.90 ± 0.30	0.85
11. story reproduction (7 points)	2.27 ± 2.67	5.16 ± 2.25	0.001
Add 1 points if ≤ 9 yr. education	0.38 ± 0.49	0.12 ± 0.34	0.02
Toca (total 30 points)	16.69 ± 5.61	24.67 ± 4.17	0.001

Values are means and SDs.

Assessment (Moca) [3]; each correctly answered question was awarded one point, whereas incorrect or no answers were awarded zero points. The total score ranged from 0 to 30 points.

The Toca consists of 11 trials, and **Table 2** presents the instructional content of each trials. One of the differences in the Toca is the inspection method of listening to the instruction of the trials from the headphones and responding on the touch panel. The Toca 11 trials (story reproduction) do not score in immediate playback, but in 11 trials delayed playback, score by the number of words or synonyms in the recalled story. The Toca 1 trials (erase characters) correspond to the Moca 1 trials (trail making test). The Toca 2 trials (copy of triangle) correspond to the Moca 2 trials (copy of cube). The Toca 3 trials (draw clock) correspond to the Moca 3 trials (draw clock). The Toca 4 trials (composition) are no present in Moca. The Toca 5 trials (read of digits) correspond to the Moca 6-1 trials (read of digits). The Toca 6 trials (serial 7) correspond to the Moca 6-3 trials (serial 7). The Toca 7 trials (go/no-go) correspond to the Moca 6-2 trials (tap of letters). The Toca 8 trials (word recall) correspond to the Moca 8 trials word recall). The Toca 9, 10 trials (orientation day, place) correspond to

**Table 2.** Comparison of Toca and Moca in terms of the studied areas of cognition and scoring.

Cognitive function	Toca (No. of points)	Moca (No. of points)
Alternating Trial Making	1. erase characters (2 points)	1. trail making test (1 points)
Visuospatial functions	2. copy of triangle (1 points) 3. draw clock (3 points)	2. copy of cube (1 points) 3. draw clock (3 points)
Composition	4. composition (1 points)	no present
Attention	5. read of digits (2 points) 6. serial 7 (3 points) 7. go/no-go (3 points)	6-1. read of digits (2 points) 6-3. serial 7 (3 points) 6-2. tap of letters (1 points)
Word recall	8. word recall (3 points)	8. word recall (1 points)
Orientation	9. orientation day (4 points) 10. orientation place (1 points)	11. orientation day (6 points)
Story reproduction	11. story reproduction (7 points) Add 1 points if $\leq 9$ yr. education	no present Add 1 points if $\leq 12$ yr. education

the Moca 11 trials (orientation). The Toca 11 trials (story reproduction) are no present in Moca. One point was added to the Toca score for subjects with an education of less than 9 years.

The Toca was administered to all participants (**Table 2**).

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### 2.3. Statistics

IBM SPSS Statistics version 26.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. In this study, Pair analyses were carried out using unpaired Student's t-tests. Sensitivity and specificity of the Toca in detecting MCI were assessed. The level of significance was set as  $P < 0.05^*$ .

### 3. Results

**Table 1** compared of the Toca between the participants (rehabilitation users, 36 and healthy elders, 31). Of the Toca 1 to 11 trials, there was a significant difference other than 9, 10 trials. The Toca scores with 8 points higher were significantly higher in healthy elders than in rehabilitation users. Collected data included the socio-demographic characteristics (e.g., age, educational background), Body mass index (BMI) was calculated by dividing the weight in kilogram by height in meter squared (**Table 1**).

Using a cut-off point of 19/20, the Toca demonstrated a sensitivity of 83.9% and a sensitivity of 85.0% in diagnosing MCI (**Table 3**).

The area under the receiver-operator curve (AUC) for predicting mild cognitive

**Table 3.** Tokyo Cognitive Assessment (ToCA) score during the acute phase for prediction cognitive function in elders.

Cut-pff*	Sensitivity	1-Specificity
4	1	0.972
9	1	0.917
11	1	0.861
13	1	0.778
14	1	0.722
15	0.968	0.611
16	0.935	0.528
17	0.935	0.417
18	0.871	0.361
19	0.839	0.278
20	0.839	0.25
21	0.806	0.167
22	0.742	0.139
24	0.645	0.083
25	0.613	0.083
26	0.452	0.028
27	0.355	0.028
28	0.161	0.028
29	0.065	0.028
30	0	0

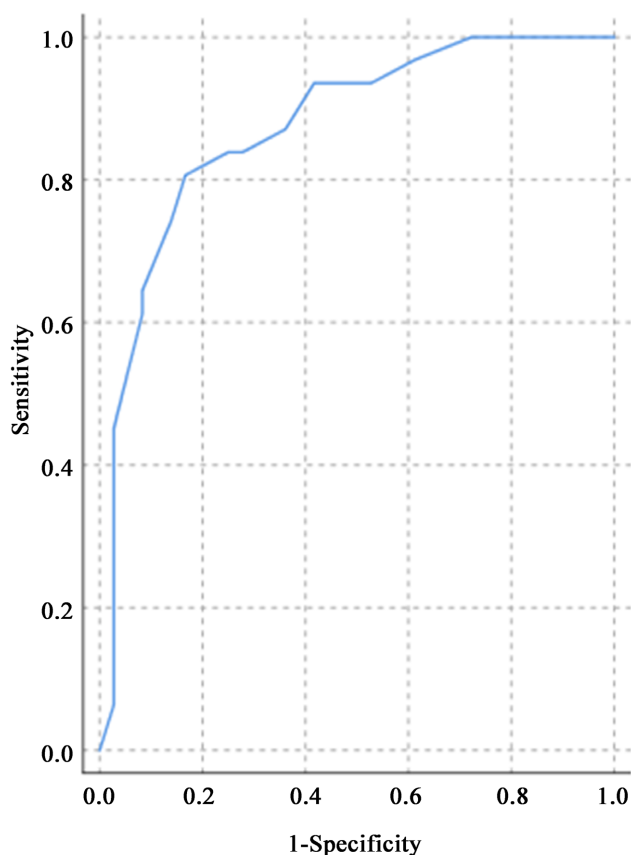
\*Positive test when score  $\leq$  Cut-off; optimal cut-off score calculated using the Youden index. The Toca demonstrated a sensitivity of 83.9% and a sensitivity of 85.0%

impairment (MCI) by the Toca was 0.874 (**Figure 1**).

Receiver operating characteristic (ROC) curves of Tokyo Cognitive Assessment (ToCA) score in the prediction cognitive function in elders. The area under the receiver-operator curve (AUC) for predicting mild cognitive impairment (MCI) by the Toca was 0.874.

#### 4. Discussion

In the present study, we examined cognitive functions among rehabilitation users and healthy elders. The previous studies have shown that from the discriminative trait analysis of the control group (79 subjects), it was extracted that MCI can set the cut-off value of Toca score to 17/18, and the Toca demonstrated a sensitivity of 90.4% and a sensitivity of 83.5% in diagnosing MCI. The area under the receiver-operator curve (AUC) for predicting mild cognitive impairment (MCI) by the Toca was 0.949 [7].



**Figure 1.** A ROC curve is a plot of the true positive rate (Sensitivity) in function of the false positive rate (1-Specificity) for different cut-off points of a parameter. Each point on the ROC curve represents a Sensitivity/Specificity pair corresponding to a particular decision threshold. The Area Under the ROC curve (AUC) is a measure of how well a parameter can distinguish between two diagnostic groups (MCI/normal).

Likewise, The Toca 9, 10 trials is a question of orientation. The question is, “What year, month, day, and day of the week is today? Where is this place?”. Amnesic symptoms from the core of Alzheimer’s disease, and disorientation appears from the early stages, so it is an indispensable task for the diagnosis of MCI, Alzheimer’s disease is dementia in which memory impairment appears and higher-order functions are progressively impaired. According to the progression classification of Benson & Cummings [9], there was mild forgetfulness and, mild disorientation, and responsiveness became anxious and depressed, or aggressively. It is a period of mental and psychological instability, such as becoming even. Kopp reported that the inferior temporal gyrus of the frontal cortex responded to word recall [10].

In this study, there was no significant difference in the Toca 9, 10 trials. It is necessary to investigate whether the Toca 9, 10 trials, which asks orientation, is useful for early detection of only for early detection of Alzheimer’s disease.

The area under the receiver-operator curve (AUC) for predicting mild cognitive impairment (MCI) by the Toca was 0.874. Using a cut-off point of 19/20, the Toca demonstrated a sensitivity of 83.9% and a sensitivity of 85.0% in diagnos-

ing MCI. The Toca is a brief cognitive screening tool with high sensitivity and specificity for detecting MCI as currently conceptualized in rehabilitation users.

Using biomarkers for diagnosing neurodegenerative illnesses in the elderly is expensive and invasive, and it is impractical to screen for cognitive impairment. MCI and dementia will be diagnosed based on detectable cognitive impairments, and simple cognitive screening, such as Toca remains important. It is important that the cutoff criteria at different frail levels and ages are established to aid in the detection and diagnosis of neurodegenerative illness. Our results presented here provide the optimal cutoff scores for MCI and dementia for frail elderly using the Toca which are easily administered. Meanwhile, we have presented these results across different frail levels and ages to guide screening decisions. Future work needs to be carried out in larger samples to examine the interaction between age and frail levels and establish the screening cutoff points for elderly Japanese individuals.

## 5. Conclusion

The Toca could be a useful cognitive test for screening for MCI. It could be recommended for geriatric health screening in the community as a multiplayer participation-type screening tool, and for the early detection of MCI in a primary clinical setting.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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