



Research Article

Derivation of Diagnostic Criteria for a Slight Cognitive Impairment using CKPT (Japanese Version of CWPT)

Takaki Shimura^{1*}, Eriko Okuyama² and Hironori Ohsugi³

¹BME Research Lab, Sosei Ltd., Japan

²Hamamatsu Human Research Lab Ltd., Japan

³Josai International University, Japan

Abstract

Objective: CWPT, which is able to detect a slight cognitive impairment in PCSD (Preclinical Stage of Dementia) or MCI (Mild Cognitive Impairment), is attracting attention as a neuropsychological test that allows screening at the stage where we must rely on expensive testing equipment such as PET, MRI and X-CT. CWPT is a test for identifying colors and remembering episodes while reading a story containing Color Words, so it can be easily translated and used in various languages. Therefore, the purpose of this paper is to show foreign researchers how to derive the diagnostic criteria in Japan.

Methods: Diagnostic criteria were derived by analyzing large-scale data. At this time, since it is impossible to perform MMSE on all the subjects, CKPT was performed after receiving a report that I was normal. As shown in the evidence in the previous paper, the CKPT results show a normal distribution for each age, so a method to check the distribution by subjecting the subjects who disturb the normal distribution of the resulting histogram to trial and error is achieved.

Results: The total number of subjects used for the diagnostic criteria was 1325, and 199 subjects were excluded. The average value \pm SD, and the average value \pm 1.5SD were derived as the diagnostic criteria for male and female in their 60s, 70s, and 80s.

Conclusion: Using the derived diagnostic criteria, we have gained a foothold to develop various CKPT applications.

Keywords: CWPT; CKPT; Neuropsychological test; PCSD; MCI; Slight disorder

*Corresponding author: Takaki Shimura, BME Research Lab, Sosei Ltd., Japan, Tel: +81-53-525-8804; E-mail: tshimura@tuba.ocn.ne.jp

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History of the Research

Before the concept of MCI and PCSD was denominated in the field of dementia [1], our research started to detect slight declines in brain function. From the viewpoint of brain function measurement, the initially applied instruments were an electro encephalograph (EEG) and a near-infrared spectroscopy (NIRS [2]). Then, we reached the hypothesis that the slight decline in cognitive function should be measured as a decline in the prefrontal lobe, because the prefrontal lobe is the commander of human behavior.

As final goal was to find any methods used at the screening, I noticed neuropsychological tests instead of measuring instruments. Then color words discern test (CWDT) and Color words pick-out test (CWPT [3-7]) were invented.

In CWDT, color words are shown using different colors like Figure 1. Subjects should discern if the meaning and the printed color of the word is matched or not. If mismatched, make a cross (X) and if matched, make a circle (O). Although this test is an application of Stroop Test [8] which is well-known as one of the prefrontal lobe tests, it cannot totally extract light declines of the prefrontal lobe functions.

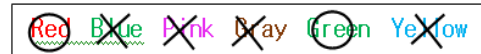


Figure 1: Sample of CWDT in English.

In CWPT, a story including color words are shown first like Figure 2A. Subjects should read the story memorizing the episode of it, and simultaneously pick-out color words discerning the matching of meaning and printed color of them. After a certain period of time, the subjects stop the task of determining the color words of Story, and answer Questions (Figure 2B) regarding the episode memorized without seeing Story. As explained above, CWPT is an improved version of CWDT with a short-term memory function examination.

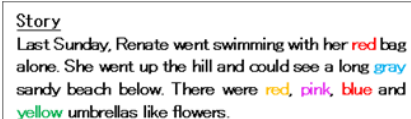


Figure 2A: Sample of Story of CWPT.

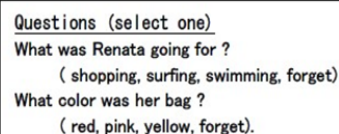


Figure 2B: Sample of Questions.

After two presentations at international conferences [9,10], we published a paper [11] on the evidences of CWPT. Then we developed an English version of conducting CWPT and published a mini review [12] seeking collaborators who used it. Since the third international conference [13] was postponed due to the new coronavirus and the opportunity for announcement was lost, I decided to make that presentation on this paper.

Objective

CWPT, which is able to detect a slight cognitive impairment in PCSD (Preclinical Stage of Dementia) or MCI (Mild Cognitive Impairment), is attracting attention as a neuropsychological test that allows screening at the stage where we must rely on expensive testing equipment such as PET, MRI and X-CT. CWPT is a test for identifying colors and remembering episodes while reading a story containing Color Words, so it can be easily translated and used in various languages. Therefore, the purpose of this paper is to show foreign researchers how to derive the diagnostic criteria in Japan.

Methods

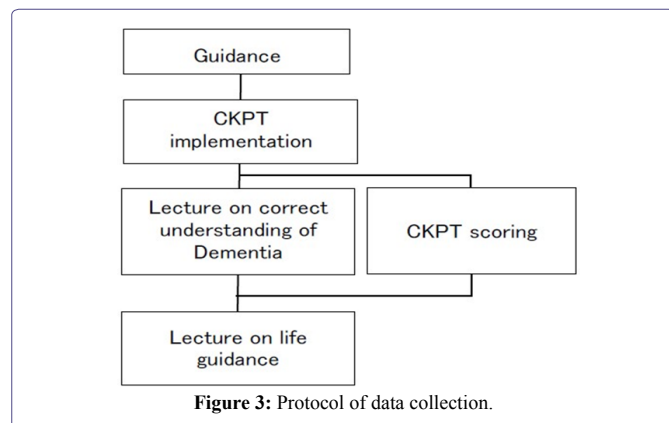
Essential consideration on data collection

Analytical data for deriving diagnostic criteria require uniformity and randomness in collection of analysis data. Uniformity means that the test tools used when applying CKPT to subjects are the same, that the testers who explain the subject using the tools are trained to be at the same level and that the environment in which the test is performed, such as the brightness and the distance from the adjacent subject, must meet certain criteria.

Randomness of data collection should be taken into consideration that the areas where the CKPT data was collected, are random such as urban areas and rural areas, and that the occupations of the subjects are varied.

Data collection method

As for the CKPT data collection method, Guidance, CKPT implementation, Lecture on correct understanding of dementia, and CKPT scoring were performed according to the protocol shown in Figure 3, where CKPT scoring and Lecture on correct understanding of Dementia is done at the same time. What we devised is that the subjects can receive Lecture on life guidance while looking at their own results of CKPT.



The right column is the venue where the subjects are, and the left column is the room where the supporters score.

Scoring method and Index1

The criteria for Story scoring are based on the following rules of Table 1.

Division	Scoring criteria
Correct answer	Correct ○ or X is attached to color words
Wrong answer	Wrong ○ or X is attached to color words
Oversight	Color words that the subject forgets to attach ○ or X
Mistaken answer	○ or X is attached to characters other than color words

Table 1: White cell count level throughout the months of the study period.

The diagnostic value Index1 of CKPT was obtained by multiplying the number of correct answers and the correct answer rate of episodic memory.

Selection of healthy people

Only the data of healthy subjects are required for analysis of the diagnostic criteria of CKPT. At the time of evidence examination [11], MMSE [14] was applied to all subjects, and the cut-off value was 27 points. However, large-scale data collection is required to obtain the diagnostic reference value, making it impossible to perform MMSE on all subjects. Therefore, we decided to exclude the person who says “I have no brain disorder” but disturbs the normal distribution by applying hisIndex1 to the histogram of his age. This work was accomplished by trial and error of exclusion and normal distribution examinations. Finally, the exclusion conditions are completed.

Ethical Consideration

For this paper, all subjects have agreed to use their data while keeping their personal information confidential.

Result

Analysis data collected

Total analysis data collected was 1325, and the breakdown of the regions is shown in Table 2. In the case of urban area, small cities and rural areas are mixed.

Regions	Number
Urban area of big cities (Tokyo)	82
Urban area of middlecities (Hamamatsu, Okayama etc.)	256
Small cities (Iwata, Fukuroi, Mishima etc.)	559
Rural area	428

Table 2: The breakdown of regions collected.

Exclusion and used data for analysis

Exclusion was performed by trial and error as shown in 3-4, and the exclusion conditions obtained from the examinations are summarized on Table 3. With regard to the task of adding ○X to the color words of STORY, the exclusion conditions of Wrong answer, Oversights and Mistaken answer in Table 1 are shown. The condition of QUESTIONS for memory is where the correct answer is zero.

The number of subjects excluded from collected data was 199, even if one of the exclusion conditions was met. Eventually, the number of subjects used in the analysis is shown in Table 4 by gender and age.

No.	Items	Conditions
1	Story scoring	Wrong answ. ≥ 2
2		Oversight ≥ 4
3		Mistaken answ. ≥ 1
4		Wrong answ. =1 and Oversight ≥ 2
5	Questions	No correct answer

Table 3: Exclusion conditions.

Gender	Age	Number
Mail	Sixties	126
	Seventies	109
	Eighties	34
Female	Sixties	433
	Seventies	357
	Eighties	67

Table 4: Exclusion conditions.

Normality examination

Prior to analysis of diagnostic criteria, a normality test of the histogram of each group was performed. The examination was done using Shapiro-Wilk Test. The results are shown in Table 5. When the significance probability p shown in the table is less than 5%, it is judged as “not significantly following the normal distribution”. If the opposite p is 5% or more, it is determined that “this data cannot be said not to follow a normal distribution”, that is, “follows a normal distribution”.

Gender	Age	Statistics	Degrees of freedom	Significance of probability p
Mail	Sixties	0.981	126	0.078
	Seventies	0.985	109	0.255
	Eighties	0.981	34	0.791
Female	Sixties	0.994	433	0.091
	Seventies	0.993	357	0.117
	Eighties	0.970	67	0.107

Table 5: Normality of Index1.
If p value is 0.05 or more, it follows normal distribution.

Diagnostic Criteria

Distribution parameter of Index1, such as the average value, the average value \pm SD, and the average value \pm 1.5SD, were calculated using the data shown in Table 5 whose normality was confirmed. It is shown in Table 6.

The diagnostic criteria using Index1 were set as shown in Figure 4 using Average \pm SD and Average \pm 1.5SD. In the figure, the values of Index1 which are shown in Table 7 are applied to derive the actual

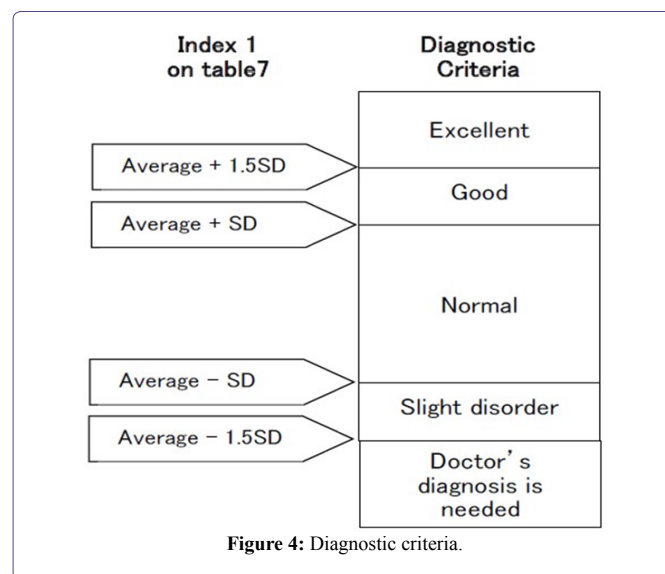
diagnosis criteria. For example, in the case of sixties male, if Index 1 is 18.3 or more, it is Excellent, if Index1 is 16.1 or more and less than 18.3, Good, if Index1 is 7.3 or more and less than 16.1, Normal, and if Index 1 is 5.1 or more and less than 7.3, Slight disorder, respectively. Furthermore, when Index1 is less than 5.1, it is determined that doctor's diagnose is needed.

Male	Average -1.5 SD	Average -SD	Average	Average + SD	Average +1.5 SD
Sixties	5.1	7.3	11.7	16.1	18.3
Seventies	5	7	10.7	14.4	16.2
Eighties	3	4.9	8.6	12.3	14.2

Table 6: Distribution Parameter of Index1.
Average-1.5SD or less: 0.067, Average-SD or less: 0.159

Female	Average -1.5 SD	Average -SD	Average	Average + SD	Average +1.5 SD
Sixties	5.9	7.9	11.9	15.9	17.9
Seventies	4.6	6.6	10.6	14.6	16.5
Eighties	2.3	4.5	8.8	13.1	15.3

Table 7: Distribution Parameter of Index1.
Average-1.5SD or less: 0.067, Average-SD or less: 0.159



Summary

Following the procedure for deriving the diagnostic criteria for CKPT, the data collection of 1325 subjects, the extraction of subjects without brain disorder, and the examination of normal distribution were described in this order, and finally the diagnostic criteria were derived.

Conclusion

In this paper, the method of deriving the Japanese CWPT (CKPT) diagnostic criteria in Japan was described. We are looking for

collaborators to spread CWPT in the world, and if you are interested, please refer to this derivation method and decide to give me e-mail. It is also noted that the English version of the CWPT test form, PowerPoint and manuals for the test are already prepared [14].

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