

Color Words Pick-out Test and Its Evaluation

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Abstract— In the future of super aging society, it is predicted that the problem of disuse dementia becomes more serious all over the world. The screening is very important medical procedure for recovery. In Japan, KANA Pick-out Test(KPT)¹⁻²⁾ have been used as the most useful method of screening. As KPT isn't suitable for internationalization and self-screening, Color Meaning and Matching Test(CMMT) was invented first³⁾, and Color Word Pick-out Test(CWPT)⁴⁾ follows as an advanced method. In this paper, the sensitivity of CWPT on the basis of KPT was measured as the first evaluation. As the second evaluation, the work of prefrontal lobe was examined during the tests using a near infrared spectroscopy. These evaluations are led to appropriateness of CWPT to the screening test of early dementia.

Keywords— Early dementia, Brain function, Color Word Pick-out Test, Color Meaning and Matching Test, KANA Pick-out Test

I. INTRODUCTION

The population of the elderly is predicted to grow rapidly until 2020 by Ministry of Health, Labour and Welfare in Japan. 1/3 of Japanese will be the elderly in 2050. And the number of dementia patient is predicted to become over three million people in 2025. And, this isn't the problem only in Japan.

MD.Kaneko's activity⁵⁾ shows that almost 90% of dementia is disuse dementia that can recover by brain rehabilitation, and almost 2% of dementia is Alzheimer's disease (AD). Therefore, it is very important to find out the early stage of dementia using a simple and economical screening test. As disuse dementia carries degradation of prefrontal lobe function at the early stage of dementia, neuropsychological tests of prefrontal lobe function is useful.

We presented CMMT in the last academic meeting of WC2003⁶⁾. CMMT was made for the purpose of internationalization and judgment by computer, but the sensitivity is not so good. So, we evaluated Color Word Pick-out Test (CWPT) this time. In this paper, we did two evaluations. As the first evaluation, the sensitivity of CWPT on the basis of KPT was measured⁷⁾. As the second evaluation, the work of prefrontal lobe was examined during the tests using a near infrared spetroscopy⁸⁾.

II. NEUROPSYCHOLOGICAL TESTS

Many neuropsychological tests have been used for judgment of dementia. However, Mini-mental State Examination (MMSE) and Hasegawa's Dementia Scale (HSD-R) in them aren't specialized in measuring prefrontal lobe function. On the other hand, our KPT, CMMT and CWPT are quite fit it.

A. Kana Pick-out Test(KPT)

KPT (Fig.1) is a basic neuropsychological prefrontal lobe test that devised by Mitsuo Kaneko. In this test, there is a story written in KANA. The procedure of KPT is to read a story, picking out all Japanese vowels and remembering the contents of the story simultaneously. After reading it, it is requested to write the memorized story. The judgment is done using the number of pick-out characters and written memorized story by clinical psychologists.

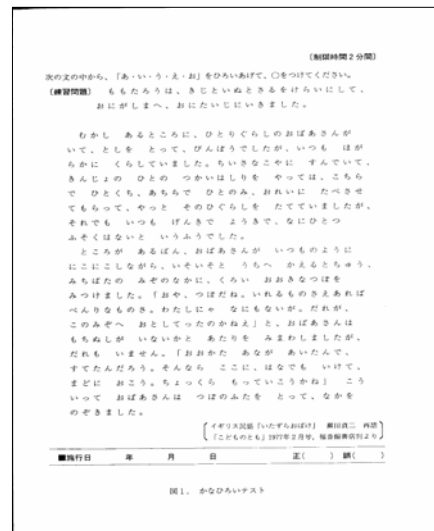


Fig.1 Kana Pick-out Test, 406 Japanese KANA characters involving 61 vowels.

B. Color Word Pick-out Test (CWPT)

In CWPT (Fig.3), there is a story that is written in hiragana and kanji characters and 12 questions. In kanji character 25 color words are involved and they are printed in 5 different color. The procedure of CWPT are to read a story, remembering the meaning, picking-out color kanji characters and marking a circle to kanji character if the meaning is matched to its color, and marking a cross to kanji character if the meaning is not matched to its color. After reading it, it is requested to answer the questions about the contents of the story.

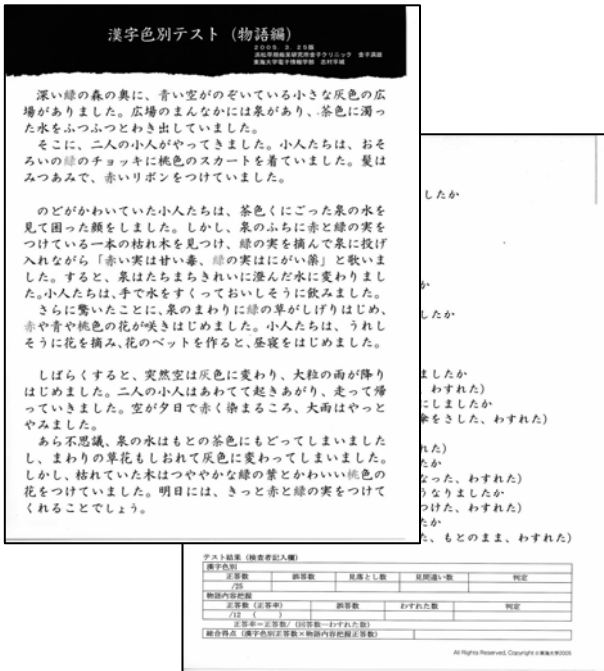


Fig.3 Color Word Pick-out Test, 548 Japanese characters

III. THE METHOD

A. The sensitivity of CWPT

• Subject

Subjects are 127 in the 60's and 70's that have been taken examination since 2005. Tests were carried out to the volunteers who are living in the countryside (Kouta-chou, Aichi-ken), the local city (Hamamatsu-shi, Shizuoka-ken), the suburbs of Tokyo (Sagamihara-shi, Kanagawa-ken) and the downtown of Tokyo (Edogawa-ku and Arakawa-ku). Subjects took CWPT and KPT. Thereafter, subjects were selected as the normal and the abnormal using KPT. The result is shown in Table2.

Table2 Subjects

Era	Normal	Abnormal
60's	33	31
70's	29	34

• Experiment Procedure

Subjects took KPT after CWPT. A rest was put between the tests. The time of reading story is two minutes for both KPT and CWPT. Tests were done under the limitation of 30 people a room. During two tests, two examiners were arranged for ten subjects to help them.

• Judgment by performance index

The performance index is used to judge the normal person or the abnormal person. A formula of the performance index is obtained by

$$A * B = C, \quad (1)$$

where A is the number of correct answers by picking-out the color kanji, B is the number of correct answers about recalling the story and C is performance index. If the performance index is lower than criteria of each era, the judgment of abnormal is done. The criteria is obtained by

$$D - E = F, \quad (2)$$

where D is average of performance index, E is standard deviation of performance index and F is the criteria. Obtained criteria are shown in Table3.

Table 3 Standard value

Era	Criteria
60' s	60
70' s	30

• Judgment by flowchart

Only the number of correct answers about picking-out the color kanji and the number of correct answers about recalling the story were used for judgment by performance index. As new factors, correct answer rate about recalling the story, miss-answer rate about picking-out the color kanji and miss-answer rate about recalling the story were used in decision flowchart (Fig4) for judgment. A₀ and B₀ are obtained by

$$A_0 = A - SD_A \quad (\text{or } A_0 = A - 1.5SD_A), \quad (3)$$

$$B_0 = B - SD_B \quad (\text{or } B_0 = B - 1.5SD_B), \quad (4)$$

where A is the average of the number of correct answers about picking-out the color kanji and SD_A is the standard deviation of it, and B is correct answer rate about recalling the story and SD_B is the standard deviation of it. As for C₀

and D_0 , they were decided arbitrarily after looking whole data. Finally criteria are shown in Table4 and Table5.

Table 4 Criteria using SD

	A_0	B_0	C_0	D_0
60's	17	40	1	20
70's	11	30	1	20

Table 5 Criteria using 1.5SD

	A_0	B_0	C_0	D_0
60's	14	30	1	20
70's	8	20	1	20

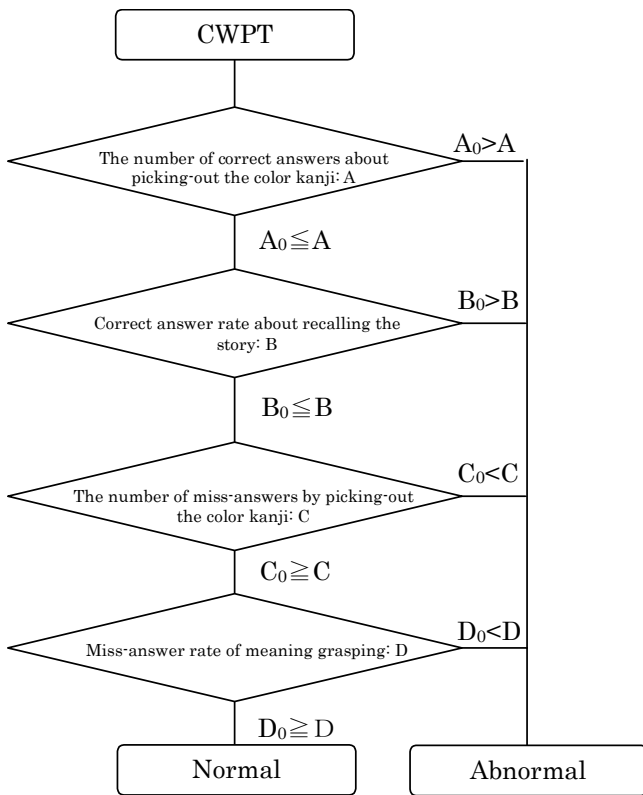


Fig.4 Judgment decision flowchart. A_0 , B_0 , C_0 and D_0 are Criteria.

B. The work of prefrontal lobe

• Subject and the experimental device

Subjects are 16 students in Tokai University in the 20's(20-24 years old).

The experimental device is OM-220 that is the product of SHIMADZU CORPORATION. It is a kind of near infrared spectroscopy (NIRS).

NIRS receives near infrared rays backscattering and traveling through the brain, which catches the information oxy Hb and deoxy Hb in blood.

• Experiment

OM-220 has two probes whose location during this ex-

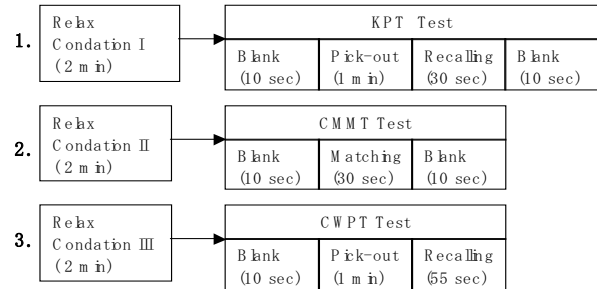


Fig5. The protocol of measurement, Blank is reference value that to observe the change of Hb.

periment is in the right and the left of prefrontal lobe. And, the protocol of the experiment is shown in the Fig5.

• Method of data processing

In this research, only total Hb was used because the change in concentration of total Hb is an important index to know the brain activity in the prefrontal lobe. The calculation of activated value $AV(t)$ and $\overline{AV(t)}$ are done according to

$$AV(t) = \overline{TotalHb_{rest}(t)} - \overline{TotalHb_{relax}(t)},$$

$$\overline{AV(t)} = \frac{\int_{t_1}^{t_2} AV(t)dt}{t_2 - t_1}$$

Determination of the activated location, the right (R) or the left (L) of prefrontal lobe, is decided according to

at $\overline{AV_R(t)} > \overline{AV_L(t)}$, determination = R,
 at $\overline{AV_L(t)} > \overline{AV_R(t)}$, determination = L.

IV. RESULT

A. The sensitivity of CWPT

• Judgment by performance index

TN(true negative), FP(false positive), FN(false negative) and TP(true positive) are calculated basing on the result of KPT. The results are shown on Table6. FN is too large, so this judgment by performance index seems to be not available for early dementia screening test.

Table6 Result of judgment by performance index

	FN	TN	FP	TP
60's	71.0% (22 people)	81.8% (27)	18.2% (6)	29.0% (9)
70's	61.8% (21 people)	79.3% (23)	20.7% (6)	38.2% (13)

• Judgment by flowchart

The evaluation result of judgment by flowchart was shown in Table7 and Table8. There is a possibility that FN will be reached at 5%, so this judgment by flowchart may be used as screening test.

Table 7 Result of Judgment by flowchart using SD

	FN	TN	FP	TP
60's	6.5% (2 people)	12.1% (4)	87.9% (29)	93.5% (29)
70's	11.8% (4 people)	27.6% (8)	72.4% (21)	88.2% (30)

Table 8 Result of Judgment by flowchart using 1.5SD

	FN	TN	FP	TP
60's	6.5% (2 people)	18.1% (6)	81.8% (27)	93.5% (29)
70's	14.7% (5 people)	31.0% (9)	69.0% (20)	85.3% (29)

B. The work of prefrontal lobe

The determination of the prefrontal lobe during the tests was shown in Table9.

Table 9 Result of the determination of the prefrontal lobe

Subject	Pick-out	Pick & Match	Matching	Recalling	
	KPT	CWPT	CMMT	KPT	CWPT
1	L	R	R	L	L
2	R	R	R	L	L
3	L	L	L	L	L
4	R	R	R	R	L
5	L	L	L	L	L
6	R	R	R	L	L
7	R	L	R	L	L
8	R	R	R	L	L
9	R	R	R	L	L
10	R	R	R	R	L
11	R	R	R	L	L
12	L	R	R	L	L
13	R	R	R	L	L
14	L	L	R	L	L
15	R	R	L	L	L
16	R	R	R	L	L

V. CONCLUSION

As the screening test, FN is an important term, whose value should be below about 5%. On using the judgment by performance index, FN was too large. It seems not to be suitable for early dementia screening. On using the judgment by flowchart, FN become near 5% and seemed to degrade it by using some other criteria. Therefore, CWPT with the judgment by flowchart will become a useful neuropsychological test for early stage of dementia.

At KPT, activating the brain is chiefly the right during pick-out, and the left during recalling. At CMMT, activating the brain is chiefly the right during matching. At CWPT, activating the brain is chiefly the right during pick-out, and the left during recalling. These data gives us several investigation, (1) Picking-out and matching behavior lead mainly the activation of the right prefrontal lobe, (2) Recalling behavior leads mainly the activation of the left prefrontal lobe and (3) CMMT seems to make the almost the same activation as KPT which is already recognized to be a useful neuropsychological test for the early stage of dementia.

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