

## Computerized Assessment Tool for Healthy Elderly Persons as a Predictor of Cognitive Function

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### ABSTRACT

**Objective :** Screening of healthy elderly persons for cognitive impairment is a worthwhile strategy for detecting cognitive impairment at the earliest possible stage. Simple, reliable tests are needed to evaluate cognitive function. We aimed to measure cognitive function with a new computerized assessment software program, the Higher Brain Functional Balancer (HBFB), in healthy elderly subjects. The objective of this study was to examine the effectiveness of HBFB.

**Methods :** A total of 48 healthy elderly subjects participated in this prospective study. In addition to the HBFB quotient, variables examined were age, length of education, and total scores of the Mini-Mental State Examination (MMSE).

**Results :** Pearson's correlation coefficient analysis showed that the state of cognitive function, according to the total scores of the MMSE, were significantly correlated with scores of "Orientation," the "modified Trail Making Test," "Route-99," and "Just Fit" of HBFB. The results of linear stepwise regression analysis indicated that "Orientation" and the "modified Trail Making Test" of HBFB were significant predictors of the total scores of the MMSE.

**Conclusions :** This study provides evidence for the predictive value of the HBFB with regards to cognitive function in elderly persons.

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**Key words :** cognitive impairment, Mini-Mental State Examination, computerized assessment, orientation, attention

### INTRODUCTION

Cognitive tests allowing the earliest possible detection of cognitive impairment are urgently required to support imminent putative disease-modifying treatments. Progressive impairment in cognition is both a hallmark and early indication of Alzheimer disease and the putative prodromal stage called mild cognitive impairment<sup>1-4</sup>. On neuropsychological examination, memory impairment is evident as poor performance on tests, such as the Mini-

Mental State Examination (MMSE). On the other hand, healthy elderly persons rarely undergo neuropsychological testing by a specialist before significant symptoms of dementia are noted. An environment that would allow healthy elderly persons to be screened for cognitive impairment is desirable. We aim to measure cognitive function with a new computerized assessment software program, the Higher Brain Functional Balancer (HBFB), in healthy elderly subjects. The objective of this study was to examine the effectiveness of the HBFB.

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## MATERIALS AND METHODS

The subjects of this study were 48 healthy elderly volunteers without any history of neuropsychological disorders. All subjects gave informed consent before participation.

The HBFB test and training personal computer (PC) software program developed by LEDEX Corporation<sup>5</sup> in 2008 includes 29 tasks designed to sample cognitive functions. A full description of the HBFB can be found and purchased for 3,800 yen at any bookstore or on the Internet. Our clinical experience suggests that 9 of these tasks are most useful in assessing cognitive function. These are: “Orientation,” “modified Trail Making Test (mTMT)” (Fig. 1), “Cancellation,” “Flash-light Memory,” “One-back Memory,” “Continuous Memory,” “Story Recall,” “Route-99,” and “Just Fit.” These tasks may be regarded as assessing reality-orientation, attention, working memory, delayed memory, information processing, higher executive function, and spatial

cognition, respectively. The analysis described in this paper is, therefore, focused on these variables. In addition to the HBFB tests, the MMSE was also administered.

To determine the correlations between the HBFB and the MMSE, the 48 elderly volunteers were tested consecutively with HBFB for 30 minutes and with the MMSE for 15 minutes at 2 volunteer centers for the elderly in Tokyo. Half of the subjects were tested with the MMSE first followed by the HBFB 15 minutes later, and the other half were tested with the HBFB first followed by the MMSE 15 minutes later. The values of speed (reaction time in milliseconds) and accuracy (percent correct) were calculated for each subject on all 9 HBFB tasks. In addition, the HBFB scores were calculated on the basis of the speed and accuracy on each task. The scores were divided by standard values to display quotients. Using Pearson’s correlation coefficient analysis, we examined the strength of the association between the total scores of the MMSE and the quotients of the 9

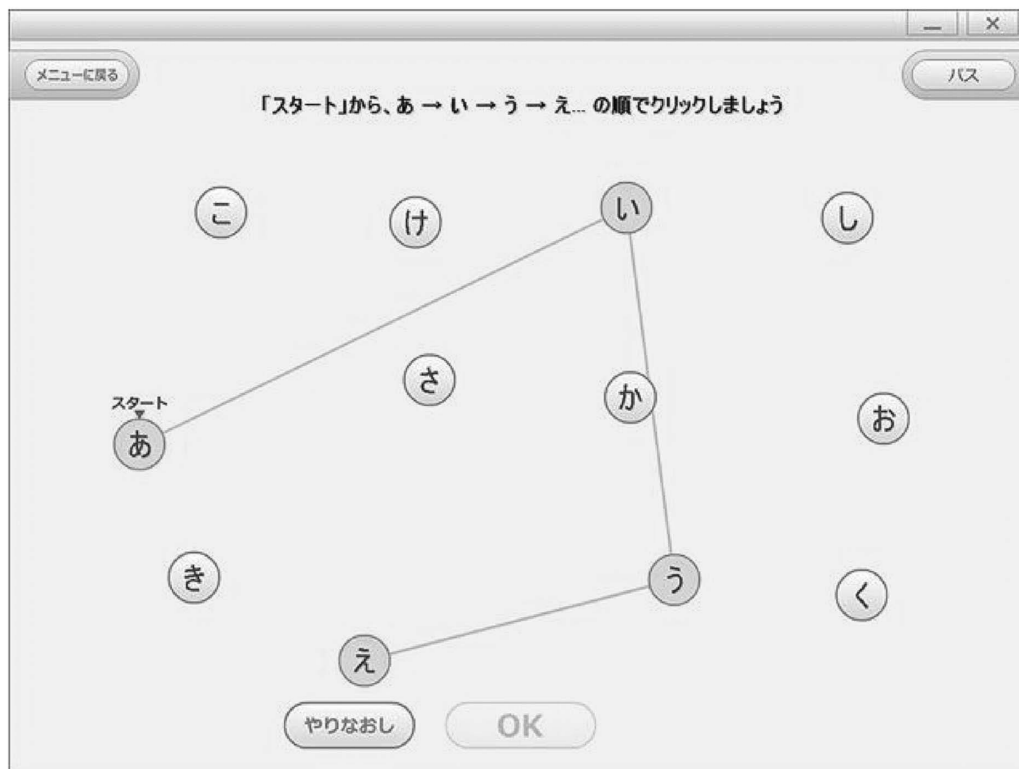


Fig. 1. Example of a screen for the “mTMT”: Subjects must click all the Japanese characters in turn. The HBFB can calculate scores automatically on the basis of the speed and accuracy of each task.

HBFB tasks. Additional variables included age and length of education, which were correlated with the MMSE. We also used stepwise regression analysis to identify factors predicting the total scores of the MMSE. Data were analyzed with the SPSS 12.0 J software program (SPSS Japan, Inc., Tokyo).

This study was performed in accordance with the Ethics Committee of the LEDEX Corporation.

## RESULTS

The subjects were 48 healthy elderly volunteers (19 men and 29 women) aged 63 to 82 years. Mean data for subjects and descriptive statistics for MMSE scores and each of the 9 HBFB performance measures (quotients) are described in Table 1. Pearson's correlation coefficient analysis showed that scores of "Orientation," the "mTMT," "Route-99," and "Just Fit" of the HBFB were significantly correlated with the total score of the MMSE (Table 1). Linear stepwise regression analysis showed that "Orientation" and "mTMT" of the HBFB were significant predictors of the total score of the MMSE ( $R=0.564$ ,  $R^2=0.318$ ,  $p=0.002$ ). The stepwise regression equation is as follows: (MMSE score) =  $22.850 + 0.020 \times (\text{"Orientation" score}) + 0.025 \times (\text{"mTMT" score})$ .

## DISCUSSION

Several recently studies have shown that computerized cognitive tests may provide reliable indications of cognitive function. For example, Cho et al.<sup>6</sup> developed the Computerized Dementia Screening Test to be easily used in a primary care setting in Korea and concluded that this test is valid, reliable, and useful as a screening tool to identify mild cognitive impairment and early dementia. Tamura et al.<sup>7</sup> have developed an mTMT using a PC and have demonstrated its usefulness as a screening test for frontal lesions of early Alzheimer disease. However, the effectiveness of computerized cognitive tests for serial testing with PC software programs sold to the general public has not been demonstrated. The present study indicates that the HBFB battery provides a measurement of cognitive function that is reliable when administered serially to healthy elderly persons. An important point is that the HBFB can be purchased inexpensively at any bookstore or on the Internet. Consumers can easily install the program on a Microsoft Windows PC. The convenience of the HBFB makes it appropriate for elderly persons and their families who wish to screen for cognitive impairment at early stage without visiting a hospital.

The results suggest that in healthy elderly persons, measures of orientation and attention (e.g., the

Table 1. Mean data for MMSE score, HBFB performance quotients, age, and length of educations in 48 healthy elderly persons

	Data ( $n=48$ )			Pearson's Correlation with MMSE	
	Mean $\pm$ SD	Minimum	Maximum	$r$	$p$
MMSE	28.0 $\pm$ 2.0	22	30		
Age (years)	71.3 $\pm$ 5.9	63	82	-0.182	NS
Length of education	12.9 $\pm$ 2.6	6	17	0.138	NS
Orientation	130.0 $\pm$ 33.0	39.3	174.7	0.416	<0.01
mTMT	98.5 $\pm$ 31.4	13.8	147.9	0.463	<0.01
Cancellation	118.4 $\pm$ 16.3	44.4	143.3	0.169	NS
Flush-light Memory	49.8 $\pm$ 36.0	2.6	121.5	0.126	NS
One-back Memory	118.4 $\pm$ 16.3	0	161	-0.06	NS
Continuous Memory	105.4 $\pm$ 37.3	32	145	0.049	NS
Story Recall	99.6 $\pm$ 23.9	29	148.5	0.073	NS
Rout-99	73.1 $\pm$ 30.6	11.3	139.6	0.427	<0.01
Just Fit	71.7 $\pm$ 36.3	22.7	149.5	0.334	<0.05

SD: standard deviation, NS: not significant

“mTMT”) are more valuable as predictors of cognitive function (as measured with the MMSE) than are other variables. One reason that “Orientation” was found to be of predictive value is that similar kinds of question are included in the MMSE. Performing well on the “mTMT” requires basic information-processing that is necessary for various cognitive functions.

For elderly persons, completing all 9 tasks of the HBFB at once is difficult ; therefore, an easier system of computerized cognitive testing system is desirable. We are also concerned that the current version of HBFB is difficult for patients with Alzheimer disease to try and that they might not be able to complete all the tasks. We are now planning to establish a new computerized cognitive testing system consisting of 2 or 3 tasks of the HBFB. According to the results of the present study, the items “Orientation” and “mTMT” are most useful for assessing cognitive function in elderly persons. We are planning a Web site with computerized cognitive tests that elderly persons and their families could use to easily assess cognitive function by themselves ; all the data would be stored on a server developed by the LEDEX Corporation. By using this system, elderly persons and their families could detect early changes in cognitive function and the progression of cognitive impairment, so that cognitive function could be maintained and dementia could be prevented. On the other hand,

before a Website is opened to the public, we must establish a manual that the patient and family can understand easily and standard normal values for a Web version of the HBFB to determine the cut-off values between healthy subjects and patients with Alzheimer disease.

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