Factor Structure of Benton's Perception Tests, and Normal Aging

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Abstract- A group of 120 healthy adults was divided into cohorts of 40 subjects each. The three cohorts for the study were distributed over three age groups. The present study was designed to discover any factor structures for five of Benton's perception tests, and to determine by use of factorial scores whether aging has an adverse effect on performance on these tasks. Principal component analysis revealed two factors, one related to ability for visuospatial perception, and the other involving visuoconstructive ability. Further data analysis with factorial scores indicates that only visuospatial perception was affected by age.

Key Words: Visuospatial function, Visuoconstruction, Aging

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INTRODUCTION

Evaluation of perceptual function in patients with CNS diseases, especially in those suspected dementia, is a routine but very essential part of neuropsychological examination[1,2]. A number of tests measuring this cognitive function, such as the Block Design and the Object Assembly subtests of Wechsler Adult Intelligence Scale-Revised (WAIS-R)[3], Facial Recognition Test (FRT) [4], and Judgment of Line Orientation (JLO) [4], have been developed and normative data for most of them are available. However, most of these tests were not initially constructed on the basis of a generally accepted theory or model. Perceptual ability is a complex behavior[5]. The question as to whether or not these perception tests measure a homogeneous psychological construct (e,g., visuospatial perception), however, seems to have received scant attention.

Dementia is not the necessary outcome of normal aging[6]. The distinction between the symptoms of mild dementia and the more benign manifestations of normal aging, however, is not well-defined, and it has been proposed that psychological deficits manifested in elderly people are associated with the cortical neuropathological changes of Alzheimer-type dementia to a greater or lesser degree[7]. The provision of valid cognitive models of normal functions derived from the normal elderly therefore must be of benefit to clinical practice in assessment. Because of methodological variations. especially sampling and measuring instrument differences, the previous studies[6,8-10] have failed to show whether there is a functional decrement in the perceptual process in normal aging. In order to clarify this unresolved issue and also to explore the practical utility of a short version of perception test battery in the clinical settings, we conducted this study in which we used principal component analysis to examine the psychological constructs of some of currently widely used Benton's perceptual tests

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including FRT, JLO, Visual Form Discrimination (VFD) [4], Tactile Form Perception (TFP) [4] and Three-Dimensional Block Constructional-Model (3-DBC) [4], which have been used in our Neuropsychology Laboratory. Using the subjects' factorial scores, we also made a cross-sectional investigation to determine whether aging affects this cognitive function.

METHOD

Subjects

120 subjects were normal healthy adult volunteers, who had no medical illness history (e.g., heart disease, diabetes, lung disease, hypertension, neurological and psychiatric disease, etc.) and were free of dementia and aphasia based on a semistructured neuromedical interview. They were divided into the three age groups. Group 1 consisted of 40 subjects with age range from 30 to 45 years old; group 2 included 40 adults with age range from 46 to 59 years; group 3 was composed of 40 subjects with age range from 60 to 78 years. For each age group, there were 20 males and 20 females.

Demographic data for the subjects are shown in Table 1. The mean differences in

Table 1: *Demographic Characteristics of Subject Groups*

		Group 1 (n=40)	Group 2 (n=40)	Group 3 (n=40)
Age	Mean	40.25	51.78	66.58
(Yrs)	SD	5.69	4.01	5.46
	Range	30-45	46-49	60-78
Education	Mean	9.30	9.30	9.30
(Yrs)	SD	3.85	3.40	3.59
	Range	6-16	6-16	6-16
	Male	20	20	20
Sex	Female	20	20	20

abbreviation: SD=standard deviation

years of education were not statistically significant. All subjects except 4 (1 in the Gp2 and 3 in the Gp3) were right-handed.

Tests and procedure

Each subject received 5 perception tests including JLO, FRT, VFD, 3-DBC and TFP[4] at Neuropsychology Lab., Department of Psychology, Chung Yuan University. With an attempt to minimize the speed component, subjects were allowed to take as much time as needed to accomplish each task. Although each subject had three scores (i.e., scores for the left and the right hands and the combination score of both hands) on the TFP, only the total score was submitted to the data analysis. Likewise, only the total correct score of the 3-DBC was considered for the analysis.

The testing procedure began by recording each subject's demographic data and medical history, followed by the JLO, FRT, VFD, 3-DBC and TFP. A total of 1 hour was needed for each subject to complete the testing. All subjects completed the testing in one session.

RESULTS

Since the factorial structures of the three age groups based on the 5 tests were similar, the score of 120 subjects on these tests were submitted to SAS's principal component analysis with oblique rotation program again for factorial structure study. The scree plot of

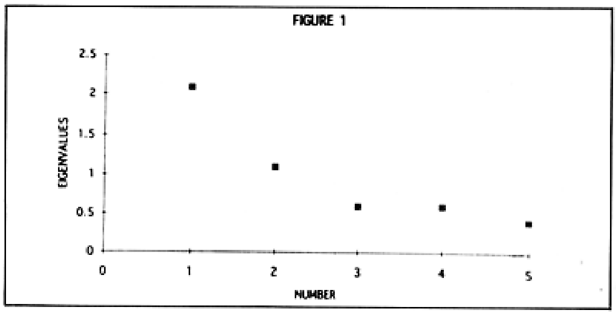

Fig 1. The scree plot of the factors derived from the five Benton's perception tests

Table 2: *Correlation Matrix of Benton's Perception Tests*

	Correlation Among Variables				
Variable	FRT	VFD	JLO	TFP	3-DBC
FRT	1.000	0.484	0.292	0.365	0.095
VFD		1.000	0.394	0.434	0.143
JLO			1.000	0.221	-0.052
TFP				1.000	0.367
3-DBC					1.000

abbreviations: FRT=Facial Recognition Test; VFD=Visual Form Discrimination; JLO=Judgment of Line Orientation; TFP=Tactile Form Perception; 3-DBC=Three-Dimensional Block Construction the factors is shown in Figure 1. Table 2 indicates the correlation matrix among the five tests. Two factors based on the criteria of eigenvalue (i.e.,>1) and the scree test were identified and these could explain about 70% of the total variance. Each test measure loaded (>|.40|) on factors was identified by the oblique rotation procedure. The tests with high loadings (>.70) on Factor 1 include FRT, VFD and JLO while 3-DBC has a high loading (about .90) on factor 2. TFP, however, has nearly equal loadings on the two factors (i.e., .58 on Factor 1 and .69 on Factor 2). Factor 1, which appear to be related to an ability of visuospatial perception, can account for about 41% of the total variance while Factor 2, which might be interpreted as one involving a visuoconstructive ability, explains about 29% of the variance. These data are shown in Table 3. In order to examine whether there exist normal aging processes affecting normal elderly performance on these perceptual function tests, the two factorial scores of the three age subject groups were subjected to the one-way ANOVA. The results show significant differences among the three subject groups on Factor 1 but not Factor 2 (see Table 4). In fact, a further data analysis with Pearson-Product Moment Correlation procedure show a significantly negative relationship between Age and Factor 1 (Table 5). Post-hoc pairwise contrasts (see Table 6) with Duncan's procedure were subsequently conducted and

Table 3: *Oblique Rotated Factor Matrix of Benton's Perception Tests*

Variable	Factors (1)	(2)	Communality
FRT	0.741	0.254	0.614
VFD	0.805	0.304	0.741
JLO	0.726	-0.139	0.547
TFP	0.576	0.687	0.804
3-DBC	0.034	0.890	0.794
Sum of Squares (eigenvalue)	2.058	1.441	3.499
Percent of Variance Explained	41.166	28.816	69.982

abbreviations: FRT=Facial Recognition Test; VFD=Visual Form Discrimination; JLO=Judgment of Line Orientation; TFP=Tactile Form Perception; 3-DBC=Three-Dimensional Block Construction

Table 4: *Benton's Perception Tests: ANOVA of Factorial Scores by Group*

Factor 1: Visuospatial perception				
Source	DF	SS	MS	F
Model	2	20.585	10.292	11.81*
Error	117	101.954	0.871	

abbreviations: DF=degree of freedom; SS=sum of squares; MS=mean square; F=F value
* p < .05

Factor 2: Visuospatial perception				
Source	DF	SS	MS	F
Model	2	1.069	0.535	0.50n.s.
Error	117	125.383	1.072	

abbreviations: DF=degree of freedom; SS=sum of squares; MS=mean square; n.s.=no significance

Table 5: *Benton's Perception Test: Correlation of Age and Factors (N=120)*

Variable	Mean	SD	r (with Age)
Age	52.867	11.973	
F1	-0.018	1.015	-0.353*
F2	0.031	1.031	-0.011

abbreviation: SD=standard deviation * p < .05

Table 6: *Mean Differences of Factorial Score among Groups*

Factor 1: Visuospatial perception				
	Mean	Group 1	Group 2	Group 3
Group 1	0.562	---	---	---
Group 2	-0.234	*	---	---
Group 3	-0.381	*	n.s.	---

abbreviation: n.s.=no significance * p < .05

Factor 2: Visuospatial perception				
	Mean	Group 1	Group 2	Group 3
Group 1	0.140	---	---	---
Group 2	0.049	n.s.	---	---
Group 3	-0.090	n.s.	n.s.	---

abbreviation: n.s.=no significance

indicated that the mean differences between Gps1 and 2, and Gps 1 and 3 reached a statistically significant level while there is no difference between Gps2 and 3.

DISCUSSION

The present results suggest the following conclusions to the posed questions.

Do the wisely-used Benton's perceptual tests including FRT, JLO, VFD, TFP and 3-DBC measure a homogeneous construct? Data from this study indicate a negative answer. The results from the principal component analysis with oblique rotation of the subjects' performance on the five Benton's perceptual tests yielded two components. Component 1 can be interpreted as visuospatial perception and component 2 may be viewed as a visuoconstructive ability. The component of visuospatial perception, as identified in the present study, is defined by performance on the Judgment of Line Orientation, Facial Recognition Test, and Visual Form Discrimination. The common feature of these tasks is that all have a component of visual orientation to allocentric (extrapersonal) space which is specified by visual judgments of the relationships external objects have to one another[11]. The second component, visuoconstructive function, is defined by performance on the Three-Dimensional Block Constructional-Model Test and partially on the Tactile Form Perception both requiring the subjects to assemble by joining parts to form a single, unitary structure[4]. The principal feature of these tasks is a component of visual guidance of action. Thus the difference between these two factors is that the first factor mainly involves perceptual processing while the second essentially depends upon a motor execution ability[12]. The present results interpreted in this manner seem to provide an elucidation of the underlying constructs of these five perceptual tests. Meanwhile, knowing that some of these tests measure the same psychological constructs can help us select a subset of tests which have the highest loading on the factor of interest. This is very useful provided that time restrictions prohibit the administration of the whole battery of the five perceptual tests.

Is there a decrement of perceptual function in the elderly? This question can be answered according as the components. With regard to the component of visuospatial perception, the answer is partially positive whereas the answer for the component of visuoconstruction is negative. The results indicating a functional decrement of visuospatial perception in association with the increment of age further support earlier observations[13-16]. Because these visuospatial perception tests are not timed, the present results seems also to provide corroboration for the proposal of Doppelt and Wallace (1995) [14] and Klodin (1975) [17] that the impairment of visuospatial perception manifested in the elderly is an age-related rather than a speed-associated deficit. Although the functional change of visuospatial perception is age-related, the prior observation of normal aging process particularly having an adverse effect on such a psychological function[16] seems not fully confirmed from the present study. Instead we did notice that this functional change initially occurs in the subjects with age around 50 to 59 years old, but did not observe any remarkable functional deterioration beyond 59 in the elderly. These inconsistent findings might be due to the different modes of data analysis in the previous study[16] in which they analyzed the data mainly based on every single visuospatial perception test while in our study, we did the data analysis in terms of factorial scores of the three age groups. Furthermore, the age groups included in these two studies are not comparable in that our subjects are younger than those in the Eslinger and Benton's study[16]. Further study with an inclusion of more wide-ranged age groups, and with the similar procedure of data analysis used here might clarify these matters. With regard to the component of visuoconstructive ability, no evidence of functional decrement with the increase of age was noted. This result indicates that the construct mainly measured by Benton's Three-Dimensional Block Constructional-Model Test is different form that of the Block Design subtest of WAIS-R[3] and other two-dimensional constructional tasks; the former construct involves visuoconstruction in the absence of visuospatial perception while the latter is multifold (at least involving visuoconstruction and visuospatial perception). Provided that the present results are replicable, that Benton's Three-Dimensional Block Constructional-Model Test has been considered as a visuospatial perception measure in the neuropsychological literature appears to be incorrect. Further investigation of this issue seems appropriate.

In summary, the present results indicate two factors, visuospatial perception and visuoconstructive praxis as components of Benton's perceptual test. With factorial scores subjected to further data analysis, the results show only the component of visuospatial perception is sensitive to aging effect. Thus our findings to a certain extent provide explanations for the controversial issue regarding whether there is a perceptual

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