Original Article

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The relationship between face recognition and behavior in the elderly with cognitive disorders

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ABSTRACT

The purpose of this study is to find the degree of recognition of known faces in the elderly and to identify its relationship with the level of activities of daily living. The subjects were 43 elderly clients living in the geriatric health service facility. The degree of recognition of known faces (classified as semantic memory) was studied in addition to other neuropsychological examinations and assessment of activities of daily living using Paracheck Geriatric Rating Scale (PGS). Evaluation of face recognition includes Japan Famous Faces Test (JFFT) in which faces of famous people were used and Staff Faces Test (SFT) where the staff faces familiar to the subjects were used. Strong correlation was observed between PGS and SFT, indicating that face recognition in the living environment affects their activities of daily living.

KEY WORDS

Face recognition, Cognitive disorder, Memory, Behavior, Activities of daily living

Introduction

Memory of faces is indispensable ability to live in the society. It is an important component to support communication as is memory of language. There are two types of faces, known faces of friends and faces of celebrities and unfamiliar persons. Tulving[1] classified them as semantic memory and episodic memory, respectively. The memory of faces of famous people has been tested as distant semantic memory[2].

On the other hand, it is known that the memory of faces changes with aging. Bartlett et al[3]. studied the effect of aging on face recognition between the young and old subjects, finding the results of the elderly were poorer than the young. The major cause of error was false recency where unknown faces are recognized as known ones. Other researchers also reported the effect of aging on face recognition[4-9]. Another report suggested that the face recognition and memory were deteriorated more in the demented Alzheimer's patients than in the healthy peers[10]. They all suggest problem of distant memory[11-13]. Recognition including face recognition, however, does not show any clear difference between Alzheimer's patients and vascular dementia patients[14-19].

Decline in face recognition among the demented results in difficulty in daily living. They cannot remember faces of the therapists, or remember wrong names. This is identical to what we experience in our clinical practice. Impairment of recognition including face recognition as well as memory disturbance and emotional disturbance interferes their daily living[20], making rehabilitation urgently needed in the aging society.

Bruce & Young[21] who identified face recognition model reported that face recognition requires not only analysis of shapes of faces but also that of expressions and speech. Face recognition we studied this time focuses memory of known faces or process of recognition, identification of faces and finding names of the persons. The elderly subjects were not grouped

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Table 1. Demographic characteristics

(n=43)

age	83.3±8.5/86.0
sex(male/female)	11/32
education(years)	6.8±2.7/6.0
Length of Stay(months)	26.5±15.2/28.0

Value represents the arithmetic means ± standard deviation/median.

Table 2. Result of Paracheck Geriatric Rating Scale

(n=43)

	all	MMSE≦10	10<MMSE
Total	36.6±6.7	34.2±5.3	37.4±7.0
Physical Condition	11.6±1.7	11.1±2.0	11.7±1.6
Ambulation	2.7±1.2	2.8±1.2	2.6±1.2
Eyesight	4.4±0.7	4.2±0.6	4.5±0.8
Hearing	4.5±0.7	4.1±0.8	4.7±0.6*
General Self-care	14.2±3.7	14.2±3.9	14.2±3.9
Toilet	3.7±1.6	3.6±1.7	3.7±1.6
Eating	4.7±0.7	4.9±0.3	4.6±0.8
Hygiene	2.3±1.2	2.1±0.8	2.3±1.3
Grooming	3.5±1.1	3.5±0.9	3.5±1.7
Social Behaviors	10.9±2.7	9.0±2.4	11.5±2.6**
Help	3.6±1.3	3.4±1.4	3.6±1.3
Individual	3.6±1.1	2.8±0.9	3.9±1.1**
Group	3.7±0.9	2.8±0.9	3.9±0.9**

Value represents the arithmetic means ± standard deviation. *$p<0.05$; **$p<0.01$ by Mann-Whitney's U test.

by the types of cognitive impairment based upon the previous reports on types of dementia in face recognition. This study aims at identifying relationship between memory of familiar faces and activities of daily living in the elderly clients living in the geriatric facility.

Methods

1. Subjects

Subjects are 43 elderly clients living in the geriatric health service facility with cognitive impairment identified with either of the two neuropsychological tests shown below. The average age was 83.2 (65-101). Demographic characteristics of the subjects were summarized in Table 1. There were 11 males and 32 females. And their average length of stay was 26.5 months (3-54).

Neuropsychological tests used were Mini Mental State Examination (MMSE)[22] and Rivermead Behavioral Memory Test (RBMT)[23]. The activities of daily living were assessed with Paracheck Geriatric Rating Scale (PGS) developed by Miller & Paracheck[24]. PGS consists of 10 items in three areas of physical function, self care and social behavior. It is assessed in 5 point scale with full total score of 50. PGS assessment was used by the occupational therapist working in the facility. The survey was conducted during 6 months between September 2002 and March 2003.

Table 3. Factor analysis of PGS

(n=43)

	Factor1 Individual activity	Factor2 Ambulatory activity	Factor3 Group activity
Individual	.905	-.074	.235
Help	.844	-.016	-.085
Grooming	.682	.151	.048
Toilet	.513	.415	-.303
Eating	.489	.257	-.143
Eyesight	.373	.091	.284
Hygiene	-.105	.944	.145
Ambulation	-.054	.834	.105
Group	.336	.042	.535
Hearing	-.123	.159	.525
Variance explained	4.046	1.632	1.207

Factor analysis used the principal factor method and the promax rotation. Value represents the factor loading.

Table 4. Result of two face recognition tests

(n=43)

	all	MMSE≦10	10<MMSE
JFFT	20.2±15.3	10.0±7.9	23.7±15.7**
Recognition	9.4±6.2	4.8±3.7	11.0±6.2**
Identification	8.7±6.6	4.4±3.4	10.1±6.8
Naming	2.1±3.3	0.8±1.3	2.6±3.7**
SFT	7.4±6.0	5.8±6.5	8.0±5.9
Recognition	3.6±2.9	2.8±3.2	3.8±2.6
Identification	3.4±2.8	2.8±3.2	3.6±2.7
Naming	0.4±1.1	0.2±0.6	0.5±1.2

Value represents the arithmetic means ± standard deviation. **p<0.01 by Mann-Whitney's U test.
SFT=Staff Faces Test; JFFT=Japan Famous Faces Test.

2. Evaluation of Face Recognition

1) Japan Famous Faces Test (JFFT)

This is the test developed by Hodges & Ward[25] to evaluate known face recognition. It uses photographs of famous people between 1940's and 1980's. The subjects were asked to recognize, identify and name the people. Four monochromatic photographs (12.4 x 8.4cm) were randomly arranged in A4 size paper. The questions given were "Do you know anyone of them? (recognition)", "What kind of person is he/she? Why do you know the person? (identification)" and "What is his/her name? (naming)". The order of the que: tions is as shown above. Level of chance in recogn tion task is 25%. The people shown in the phot graph were selected in the preliminary tests and fi persons were selected in each decade. A person in t photograph is given one point for each task, maki total score of 75 (5 persons x 3 levels x 5 decades).

2) Staff Faces Test (SFT)

Staff Faces Test uses the procedure similar Famous Faces Test. Here the photographs of t

Table 5. Correlations between four neuropsychological tests and PGS

(n=43)

	MMSE	RBMT	JFFT	SFT	PGS
MMSE	1.000	.747**	.485**	.400**	.452**
RBMT	.747**	1.000	.363*	.550**	.427**
JFFT	.485**	.363*	1.000	. 292	. 216
SFT	.400**	.550**	.292	1.000	.648**
PGS	.452**	.427**	.216	.648**	1.000

MMSE=Mini Mental Examination; RBMT=Rivermead Behavioral Memory Test; SFT=Staff Faces Test; JFFT=Japan Famous Faces Test; PGS=Paracheck Geriatrics Rating Scale. *p<0.05; **p<0.01 by Spearman's rank correlation.

staffs of the facility were used to assess face recognition. 10 staffs (nurses, care workers, occupational therapists and physiotherapists) were chosen and tested at three levels of recognition, identification and naming. All staffs have been working at the facility for over three years, and all of them had daily attachment in their facility. The total score is 30.

3. Statistical Analysis

Difference in PGS among groups of different severity of cognitive impairment was studied using Mann-Whitney U test. The relationship between neuropsychological evaluation including two face recognition tests and behavior were explored for JFFT, SFT, MMSE, RBMT and PGS. Correlation between PGS and SFT were investigated by the sub items and the severity of cognitive impairment. Spearman's order correlation was used for this analysis. In order to characterize PGS, factor analysis was performed to identify common factors. Principal factor method was used to extract factors for the analysis. Promax rotation allowed rotation of factorial axes. Partial correlation was determined to identify the relationship between face recognition and PGS factors by controlling age, level of education, length of stay and results of MMSE and RBMT. The software the authors used were SPSS 11.0 with level of significance as 5%.

4. Informed Consent

According to the "Ethical Guideline for Epidemiological Studies" 26) , the purpose and the methodology of the study was informed verbally and in a written form to take informed consent of the subjects. The consent of the facility was obtained by submitting the research plan for approval.

Results

1. Neuropsychological Evaluation

Average MMSE was 15.7±5.7and only three were not subjected to cutoff of 24 points. There were 11 subjects whose scores were below 10. For RBMT, standard profile score (SPS) was 3.7±4.4 and screening score (SS) was 1.0±1.6, making all subjects below the cut off points. Based upon the MMSE results, those over 11points were classified as mild impairment, those below 10 points as sever impairment. The behaviors and face recognition were analyzed for these two groups.

2. Behavioral Evaluation

Average PGS was 36.6±6.7, with physical function 11.6, self care 14.2 and social behavior 10.9 (Table 2). Comparison by the severity showed that social behavior was remarkably deteriorated in the severe impairment group. Factorial analysis extracted three common factors. Factor loading of over 0.35 was selected. The first factor was "individual activity", the second was "ambulatory activity" and the third was "group activity" (Table 3).

3. Evaluation of Face Recognition

Table 4 illustrates the results of two face recognition tests. Total score for JFFT was 20.2±15.3, with recognition 9.4, identification 8.7, and naming 2.1. Naming score was significantly lower than the other two. The highest score was 54 and the lowest was 0.

Total score for SFT was 7.4±6.0, with recognition, identification and naming 3.6, 3.4 and 0.4,

Table 6. Correlations between SFT and the elements of PGS

(n=43)

	all	MMSE≦10	10<MMSE
SFT	1.000	1.000	1.000
Physical Condition	.552**	.413	.607**
Ambulation	.168	.225	.209
Eyesight	.671**	.331	.755**
Hearing	.356*	.396	.242
General Self-care	.562**	.777**	.503**
Toilet habits	.414**	.621*	.348
Eating	.443**	.316	.578**
Hygiene	.344*	.465	.328
Grooming	.593**	.855**	.529**
Social Behaviors	.555**	.077	.648**
Helps with work	.470**	.338	.498**
Individual response	.585**	.349	.650**
Group activities	.260	-.669*	.392*

*p<0.05; **p<0.01 by Spearman's rank correlation.

respectively. The maximum scores for recognition and identification were 10, while that for naming was 4. In the recognition task, 16 subjects obtained scores below the chance level of 2.5. The highest total score was 20.

Comparison of the two groups presented significant difference in total, recognition and naming scores for JFFT. No significant difference, however, was observed in SFT, though the mildly impaired got higher scores.

4. The Relationship between Face Recognition and Behavior

Table 5 shows relationship among four neuropsychological tests and PGS. MMSE showed strong correlation with RBMT (r=0.747) as well as with JFFT and SFT. On the other hand, PGS showed correlation with MMSE and RBMT, but the strongest correlation was identified with SFT (r=0.648). There was no significant correlation observed with JFFT (r=0.216).

SFT, which was rather strongly correlated with PGS, was looked at in its relationship with sub items (Table6). Physical condition, general self-care and social behavior all were correlated in the whole subjects. In subgroup analysis, strong correlation was observed with social behavior in the mild impaired subjects and with general self-care for the severely impaired. Three factors extracted through factor analysis were evaluated in their relationships with SFT. For the whole subjects, it was strongly correlated with the first factor (r=0.697 (p<0.01)) Subgroup analysis revealed that it was correlated strongly with the first factor for both groups (r=0.61(for the severely impaired and r=0.736 for the mildly impaired). No significant correlation was observed either with factor 2 or 3.

In order to identify the relationship with two face recognition tests and three factor scores of PGS, partial correlation was obtained with age, level of education, length of stay, MMSE and RBMT controlled (Table 7). Correlation was observed between SFT and the first factor of PGS (r=0.595 (p<0.01)) and with the second factor (r=0.328 (p<0.05)). JFFT and PGS factors were not correlated.

Discussion

The initial objective of this study was to explor level of recognition of known faces. The tests wer composed of pictures of famous persons in the pa and of the staffs of the facility. The former

Table 7. Partial correlations between SFT, JFFT and 3 factors of PGS

(n=43)

	SFT	JFFT	factor1	factor2	factor3
SFT	1.000	.075	.595**	.328*	.226
JFFT	.075	1.000	-.052	-.126	-.019
factor1	.595**	-.052	1.000	.464	.100
factor2	.328*	-.126	.464	1.000	.077
factor3	.226	-.019	.100	.077	1.000

Controlling for age, education, length of stay, MMSE and RBMT. *p<0.05; **p<0.01.

considered to test distant memory and the latter near memory.

JFFT, which tests distant memory, produced average score as low as 20.2 out of full score of 75. The score for severely impaired with MMSE below 10 showed poorer results than those with mild impairment. Among three levels of cognition, naming was extremely worse than recognition and identification. SFT is considered to test both distant and near memories and the average score of the subjects was 7.4 out of 30. Like JFFT, naming was as poor as 0.4 out of 10 and more than half of the subjects could not name at all. In the recognition task, 16 subjects gained scores lower than the chance level. The results clearly reflected the state of dementia in which subjects cannot recognize faces of the staffs in the facility they lived

According to Hodges and Greene[27] who used Faces Tests to study face recognition and compare Alzheimer's patients with age-matched healthy subjects, the healthy control answered correctly in recognition, identification and naming in 90%, 80% and 60% respectively, while Alzheimer's patients answered approximately 80%, 50% and 20%. They were extremely poor in naming task. It is not possible to make simple comparison of the results since Alzhei mer's patient had MMSE score of 23.5. It is, however, clear that face recognition as distant memory was deteriorated in Alzheimer's patients than their healthy peers and naming was especially difficult. Our results also underlined the difficulty. Difficulty in naming over recognition and identification was supported in reports not only by Hodges & Greene[27] but also by others[12,28]. The cause is low activation at the stage of processing name after recall as proven in the field of psychology[29]. In the face recognition model by Bruce & Young[21] name generation is thought to occur after making access to the person identity nodes. Hodges & Greene[27] conducted another survey on healthy elderly and Alzheimer's patients. They reported naming without semantics would not occur, indicating name recall (generation) is the most difficult task. And it was supported in our study.

The second objective of the study is to see the relationship between face recognition and activities of daily living. It was identified that SFT was more strongly related to the level of activities in daily life but JFFT was not. In other words, it was supposed that the recognition of faces they saw in their daily life would affect their level of activities. SFT was strongly correlated with the first factor of PGS or individual activity but not with ambulatory activity (the second factor) and group activity (the third factor). It is because individual activity is involved with personal contact to the staffs. As Bruce[30] reported, people can make appropriate social behavior to others in proportion to familiarity. Impairment of facial recognition as in the case of prosopagnosia, people may suffer from lots of difficulties in daily life[31]. In other words, people become more active when they know the faces and names of the persons they meet in their living environment and feel familiarity toward them. It is expected that face recognition promote interpersonal communication, improving the quality of life of a person in the facility. Glosser et al[32]. paid attention to the visual function of the elderly. They reported that visual function of the demented elderly including face memory was related to their visual instrumental

activities of daily living (IADL). We cannot deny the possibility, therefore, that visual function included in the first factor of PGS affect cognitive function and activities of daily living.

Analysis by the severity showed that the severely cognitively impaired with MMSE below 10 was poor in face recognition and that they could not utilize face recognition in their daily lives. The mildly to moderately impaired in the geriatric facility, on the other hand, could improve their levels of activity in daily living through active training of face and name memory.

In terms of memory types, face memory as semantic memories was not highly related to the severity of dementia as shown in MMSE and RBMT and to episodic memory. It was also reported by Greene & Hodges[12] that correlation between severity of dementia and distant memory was weak. Our data supported their finding. SFT correlates better with RBMT than MMSE, which suggests the characteristics of face memory in daily life. Face memory in the living environment has both features of semantic memory and episodic memory. This is an interesting feature to study process of face memory formation as well as to develop plans of care in the future.

Lastly, the authors will discuss the limitation of the study. First, the level of cognition of the subjects was generally low. There were 11 subjects whose MMSE score was below 10. It was very doubtful if they understood all the tests they were given. Another problem relates to appropriateness of PGS as index of activities of daily living. Effects of face recognition and naming on daily life might be studied using such behavioral index as the quantity of communication.

The authors plan to study further the effects of face recognition on daily living after solving the issues listed above. And we would like to see if any improvement in face recognition and activities is possible through occupational therapy.

Conclusions

In this study, two familiar face recognition test batteries were developed for the elderly with cognitive disorders; JFFT and SFT. A strong correlation was observed between SFT and PGS. SFT particularly showed a strong correlation with the individual activity obtained as the factor 1 by a factor analysis of PGS. This result suggests that people become more active when they know the faces and names of the persons they meet in their living environment. A better understanding of face recognition deficits could help clarify the basis of functional deficits in some activities of daily life and lead to practical solutions for interpersonal communication behavior.

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認知障害のある高齢者における相貌認知と行動の関係

能登　真一

要　旨

本研究の目的は高齢者における既知相貌についての認知の程度を調べ，日常生活上の行動レベルとの関係を検討することである。対象は介護老人保健施設に入所する高齢者43名とし，意味記憶に分類されている既知の顔について認知の程度を調べ，他の神経心理学的検査とともにParacheck Geriatric Rating Scale（PGS）を用いて日常生活上の行動を評価した。相貌認知の評価には有名人をターゲットにしたJapan Famous Faces Testと当該施設の職員をターゲットにしたStaff Faces Test（SFT）を作成した。その結果、PGSとSFTとの間に強い相関関係を認めた。本研究の結果から，日常生活場面における相貌認知が日常生活上の行動に何らかの影響を与えている可能性が示唆された。