



Research Article

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A Simple and Quantitative Neuropsychological Test of Face Perception: The Effects of Age and Gender on Perceiving Young Faces

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Abstract

Background and Objectives: Developing a new method of easily measure the images discrimination ability of subjects within a few minutes for medical and educational applications.

Methods: A touch-screen display panel (DP) of a personal computer was divided into nine cells, three columns and three rows, showing a different photograph of faces of early twenties. The central image was the target and the surrounding eight images were the references. A test participant was required to sit in front of the DP and to touch one of the references images that he/she considered to be the target within 10 secs, which were repeated for 30-times. The correct answer rate (%) and average response time (sec) were obtained according to the 234-participants, 6-85 years old.

Results: Participants in their early 20s showed peak capability of discrimination. Results were obtained when comparing participants' responses to images of the same and the opposite gender. Female faces were always better identified than male faces by participants of both genders for aged under 40 years. For participants aged over 40 years, the capabilities were reversed: male faces were a little better identified than female faces by both genders. Discrimination capabilities for different facial imaging angles were also clarified.

Limitations: Most of the composition of tested participants were young, under 24 years old.

Conclusions: The results suggest that these phenomena represent the age-related neuropsychological characteristics for perceiving the same and the opposite gender. An easy and quantitative method for images perception was developed applicable to medical and education purposes.

Abbreviations

FEAST	:	The Facial Expressive Action Stimulus Test
DP	:	Touch-screen display panel
TG	:	Central target image
RF	:	Surrounding reference image
N-Cs	:	Images of numerical characters
Cov-H.	:	Shower cap, hat, and coat for emphasizing face itself

Introduction

Visually understanding and identifying physical objects is a very fundamental neural activity for humans. These capabilities change depending on age and gender. Recognition of the faces of people around us, not merely simple objects, is a highly important ability in our daily life. Neuropsychologists have recently been discussing various experiments associated with face perception. The speed and accuracy of such recognition provide us with a wealth of information related to mental growth and decline, not only for the general characteristics of people but also for personal differences,

especially associated with the onset of mental diseases.

In face identification, it has already been proposed that everyone has a standard based on his/her face. Perception and discrimination abilities depend on their previous experiences and are influenced by how participants have similarities and differences in their identities. Face identity ‘aftereffects’ are also considered convincing evidence for identification [1]. Mown face is the criterion of recognition of the face, interpersonal multi emotional stimulation is used to cause a change in self-identification. Conscious experience of these changes has been investigated using principal component analysis which identifies whether resemblances and similarity are significant [2]. To evaluate the effects of geometrically distorted faces, image operations such as inversion, elongation and expanding are used. To distinguish distances of facial components, unlike conventional facial perception, face images from participants themselves are used in experiment of identification [3]. As for relationship between rotation of planar image and discrimination speed [4], for interpolation between 2-dimensional images, which is important for object recognition [5], for dependent difference in recognizing familiar faces [6] and for the conspicuous defenses in geometrical face construction and in hairlines [7], these were already examined and reported. The Facial Expressive Action Stimulus Test (FEAST) has been developed by de Gelder et al. [8]. It consists of neutral and emotional facial memory tasks. Face and shoe identity matching tasks, a face and house part-to-whole matching task, and a human and animal facial expression matching task were examined for 61 healthy participants of two groups, i.e. young adult and middle aged. There, emotional changes in the target image and differences in age of the participants are observed. Similarly, Huis in ‘t Veld et al. [9] applied FEAST to emotional expressions of the face and body, and found the difference between 10 prosopagnosia and 10 controls. The influences on the image identification state were investigated, and constituent perception and facial memory, and the context effect of the face were fundamentally cleared. The set of bodily expressive action stimulus test examined the images of the four emotions, the images of actors expressing anger, fear, happiness, and sadness, by de Gelder and Van den Stock [10] for 46 participants. The result showed that sadness was most easily identified, fear continued, and happiness was the most difficult.

Regarding the deteriorating situation of face recognition ability related to aging of participants, there were many results reported, i.e., decreasing the mental image discrimination ability with age [11], disturbing the aging communication of nerves which leads to comprehensive identification of facial images [12], test of facial recognition ability in aging and loss of vision [13], influences of secular change on face identification and holistic face treatment [14], receiving first impression from the elders and young people’s face, especially about favorability [15], age differences in distinguishing between trait impressions from face [16], both

age and physical activity level affecting eye and hand adjustment [17], interaction between aged face and race in Ghana [18] and degradation of visual discrimination ability due to aging [19].

Despite these efforts, it is felt that healthy participants themselves need to quantitatively measure the differences and changes in the general abilities that they originally possess, depending on their wide age and gender. For these purposes, we will develop a new method for easily measuring and quantifying the speed and precision of recognizing and identifying faces. Here, we will introduce the new method and results using young male and female faces.

Materials and Methods

Measurements

A personal computer with a large touch-screen display panel (DP) was prepared. The DP was divided into nine cells of three columns and three rows, as shown in Figure 1.

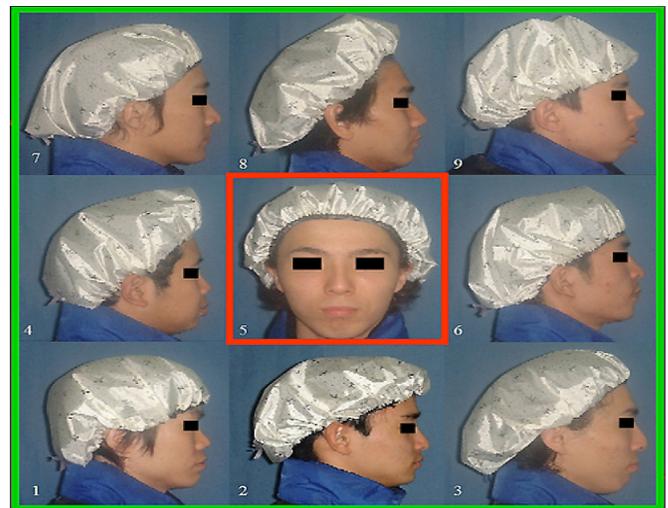


Figure 1: Basic view of a touch-screen display panel and a Test-set. A target image (TG) is placed always at the center and eight reference images (RFs) are arranged circumferentially. Participants were required to select one RF that they considered was the same as the TG by touching the appropriate image with a finger. The correct answer in this case is image 3 (right bottom corner). The shower cap and coat (Cov-H.) were used to minimize the effects of the subjects’ hairstyles and necks. The subjects’ eyes are covered to protect personal identity for publication (the real Test-set had no eye-covers).

This is an example of a ‘Test-set’: a combination of a proposed test. A central image surrounded by a red line is the target (TG), and the peripheral eight images surrounded by a green line are the references (RFs). A test participant was required to sit just in front of DP, and to touch one RF image with finger; at that point, the Test-set was quickly closed, and the next new Test-set commenced with 0.5 sec interval. The procedure for each Test-set generally

takes 3-7 sec for a normal participant. Whether the selected RF image was or was not of the same face as the TG, participant's response was taken as the result of the test. Different combinations of test-set were provided up to 30 times. These variations included four Test-sets images of simple numerical characters (N-Cs) instead of faces. The reason for using N-Cs of numerals; 0-9, was to enable new participants to become acquainted with the testing method, and to refresh the mental imaging system of participants by using simple and easy images. Moreover, there were basic verification of participant's seriousness for joining this test and avoiding abnormal participants with mental diseases, who might have needless fear.

Photographed Subjects

14 male and female students, aged 21-23 years, were recruited to be the subjects of the photographs used in the Test-sets (Figure 1). Their different hairstyles and the necks of their shirts were further signs of identifying items. Hence, to focus on simple face identification, we used the same shower cap, hat, weaves and coat (Cov-H.) for each subject, to minimize the effect of such extra sign. The photographed subjects seated systematically on a mechanized turning chair for shooting at strictly accurate angles, as shown in Figure Ap.-1. Most of photographs utilized in this test had Cov-H with bare eyes, and eye-covers in Figure 1 were only for this publication. Twelve or more color photographs of each subject - a total of about 320 - were coordinated according to the subject's number, gender, and the shooting angle. These were strictly arranged with the same photo-contrast and brightness as shown in Figure 1, and used to construct the Test-set of the program.

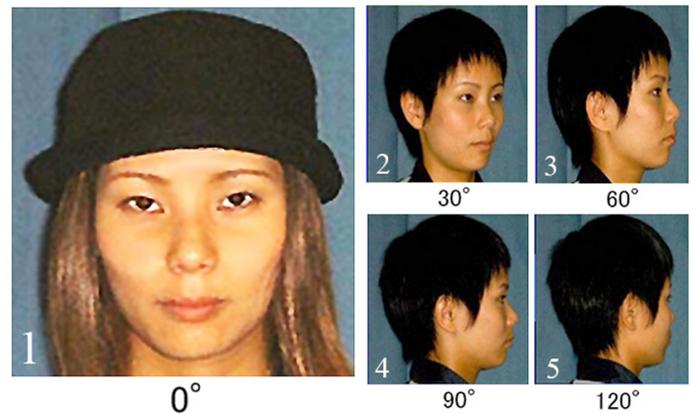


Figure Ap.-1: Imaging angles of photographs. Five shooting angles were used for face photographs, ranging from 0° (front face in 1) to 120° (slightly backward in 5). The hat, weaves and Cov-H were used to avoid any effects of hairstyle. Photographs 2 to 5 on the right side excluded Cov-H to clarify angle images only for this publication. The actual face, without any eye-cover, was approved for publication by the subject (one of the authors).

Program Supplying the Test-sets

The flow chart of a program for the DP and for creating a Test-set is shown in Figure Ap.-2. Participants had to decide on the correct answer to the TG for each Test-set and to touch the DP with a finger no later than the turnover time, T_0 , otherwise the answer was an error. Thereafter, the Test-set was changed to a new one. The T_0 was usually set at 10 secs, but it was extended to 20 secs for the elderly participants, over 70 years of age. Different Test-

sets were repeated 30 times. Details of a 30 Test-sets construction are shown in Table Ap.-1. Four sets in the 30 Test-set were applied to N-Cs. The remaining 26 sets were applied to identify faces of various pairs of angled faces. The eight RFs were taken at the same angle. To construct a Test-set TG and RFs were statistically selected from Photo-Files according to the rules of Table Ap.-1. In practice, elderly participants found facial angles of 90° and 120° rather difficult to discriminate; however, this test system was originally planned to apply to normal young people. It was only in the later stages of our experiments that we thought of applying it to elderly participants. Furthermore, to compare quantitative evaluations and results, the content of the rules was not changed throughout the study except T_0 .

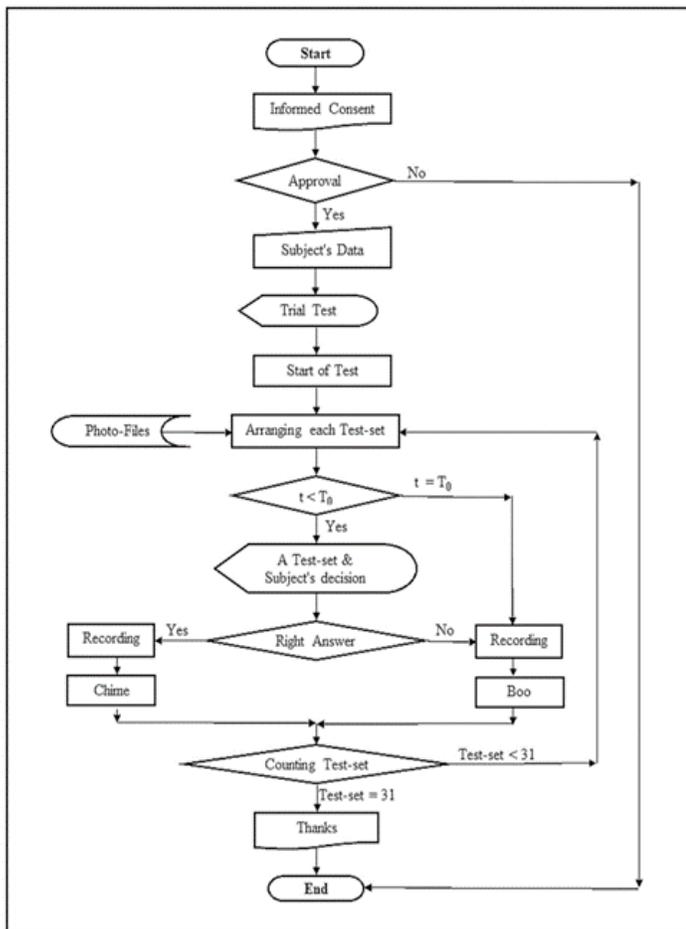
The details of development environment were as follows, i.e., computer language was Visual Basic 4.0, computer specification was Pentium 4 CPU, 128MB memory and a touch-screen display panel (DP). All participants seated squarely in front of DP, of which size and capabilities were 17-inches, 1.67M maximum displaying colors, brightness: 200cd/m², contrast rate: 200-1 and resolution: 1024×768 pixels.

Figure Ap.-2: Flow chart of the program for supplying Test-set. The ‘Trial test’ comprised three easy Test-sets: one numerical character (N-C), two simple Test-sets, i.e., the first: the target (TG): at an angle of 0° to references (RFs): 0°, and the second: TG: 0° to RFs: 30°. The turnover time (T_0) of the Test-set was normally 10 secs, but for participants aged over 70 years it was extended to 20 secs.

N. of Test-set	Type of Image	Central Target Image		Periferal References	
		Angle	State	Angle	State
1	N-C	0°	normal	0°	normal
2	N-C	0°	normal	0°	normal
3	Female	0°	normal	0°	normal
4	Female	0°	Cov-H.	0°	Cov-H.
5	Male	0°	Cov-H.	0°	normal
6	Male	0°	Cov-H.	0°	Cov-H.
7	Female	0°	Cov-H.	0°	Cov-H.
8	Male	30°	Cov-H.	0°	Cov-H.
9	Female	30°	Cov-H.	0°	Cov-H.
10	Female	60°	Cov-H.	0°	Cov-H.
11	Male	60°	Cov-H.	0°	Cov-H.
12	Male	90°	Cov-H.	0°	Cov-H.
13	Female	90°	normal	0°	Cov-H.
14	Male	30°	normal	90°	normal
15	Female	30°	normal	90°	Cov-H.
16	Female	0°	normal	0°	Cov-H.
17	Female	0°	normal	0°	Cov-H.
18	Male	0°	Cov-H.	0°	Cov-H.
19	Male	0°	Cov-H.	0°	Cov-H.
20	Female	0°	Cov-H.	0°	Cov-H.
21	Female	30°	Cov-H.	60°	Cov-H.
22	Male	30°	Cov-H.	60°	Cov-H.
23	Female	0°	Cov-H.	90°	Cov-H.
24	Male	0°	Cov-H.	90°	Cov-H.
25	Male	0°	Cov-H.	120°	Cov-H.
26	Female	0°	Cov-H.	120°	Cov-H.
27	Female	120°	Cov-H.	0°	Cov-H.
28	Male	120°	Cov-H.	0°	Cov-H.
29	Male	0°	normal	0°	Cov-H.
30	N-C	0°	normal	0°	normal

State: ‘normal’ indicates without any modification.

Table Ap.-1: Details of a 30 Test-sets construction.



Participants in Measurements

Practical measurements were recorded over 2 years, at a sideshow for campus festival healthy guests and at a nursing home for elderly individuals. The experiments were approved by the Ethics Committee of Soka University (approval No. 27046) and the authority of Hachioji City Nursing Home, Japan. Informed consent was obtained at the time of testing from all participants. Only their ages and genders (not names) were stored for the results.

All of 234 participants of both genders and wide ages were examined as Figure 2. Given the practical testing environments, most of the participants were young. However, the system was especially executed to test at the nursing home and some 15 participants were enrolled up to 85 years of age. We are aware that we obtained fewer results for the elderly participants than we had hoped. The main reason for this was the free and self-motivating candidate system and the need for informed consent. There were many potential elderly healthy candidates, but most of them were not willing to participate, and simply observed the procedure and did not volunteer for testing. The elderly participants who were tested were self-confident, assured, and not the average type of residents in the nursing home.

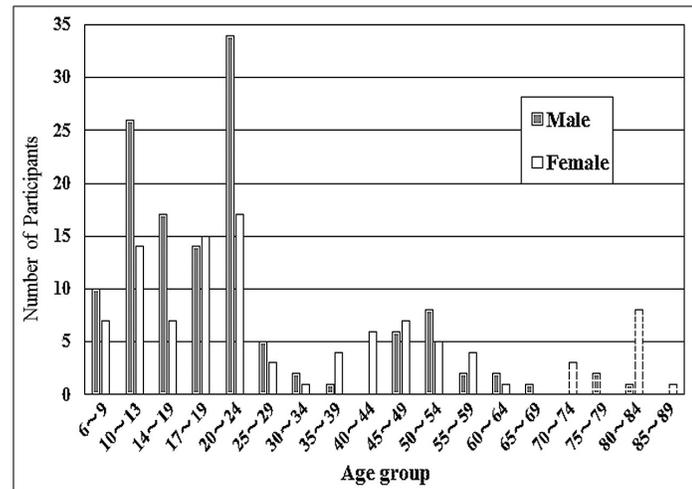


Figure 2: Details of the 234 participants (male: 131, female: 103) involved in this study of face perception. The dotted outlier symbols more than 70 years old participants at the right side are shown for references.

Results

Basic Verification of Participants by N-Cs

Although we planned to ignore the records of two or more wrong answers among the four basic N-C tests, they did not exist. One wrong answerer was a few, but we understood that he/she was not accustomed to the testing method or was in a hurry, and

adopted the result. The average response time only for N-Cs was 1.5 - 4.1 (sec) depending on the ages of participants.

Correct Answer Rates and Response Times

Using the age divisions shown in Figure 2, the correct answer rate (%) and the average response time (sec) for 26 face Test-sets were plotted as shown in Figure 3, where the genders of participants are not classified. The results for the participants aged over 70 years were a little different, so these outlier values have been plotted using dotted symbols as references. For not only because of the insufficiencies in the results, but also because these participants were not representative of the elderly healthy population in the nursing home as described in the latter half of section 2.4.

A correct answer rate of lower than 12.5%, which is the actual proportion of TG to RFs, i.e. 1/8, was meaningless and was used as references. The coefficients of determination of the two quadratic approximated curves except for the dotted outlier symbols in Figure 3 were as $R^2 = 0.864$ for the correct answer rate and as $R^2 = 0.904$ for the response time.

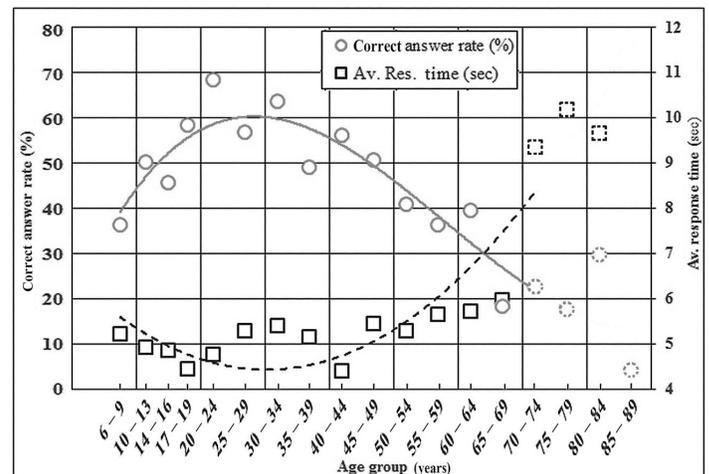


Figure 3: The results of the measuring system for all age groups. Values for male and female responses for 26 face Test-sets were averaged. The dotted outlier symbols for elderly participants at the right side are shown for references. Av.: average; Res.: response.

Cross-gender Analysis

Another objective of this measuring method was to determine any differences in facial discrimination capability depending on age and gender. Hence, Figures 4 and 5 are shown side by side, and the details of discriminating female or male faces by both genders are presented. In Figure 4, the coefficients of determination were as $R^2 = 0.959$ for F faces and as $R^2 = 0.953$ for M faces. While, in Figure 5, $R^2 = 0.906$ for F faces and $R^2 = 0.871$ for M faces.

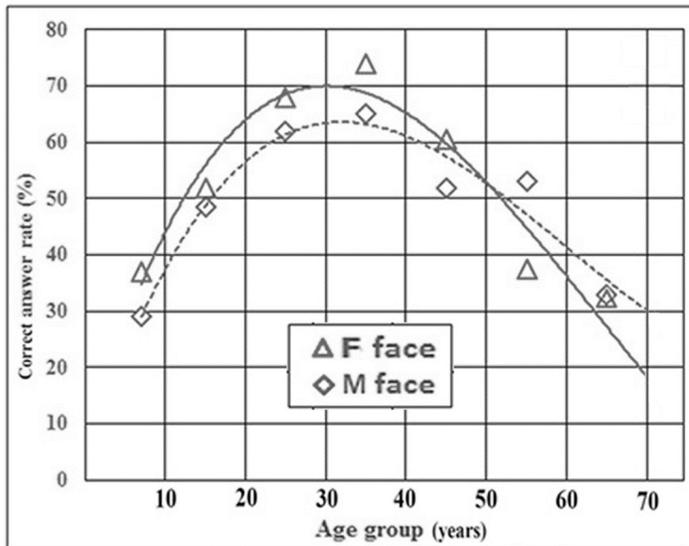


Figure 4: Details pertaining to the discrimination of female (F) or male (M) faces by male participants.

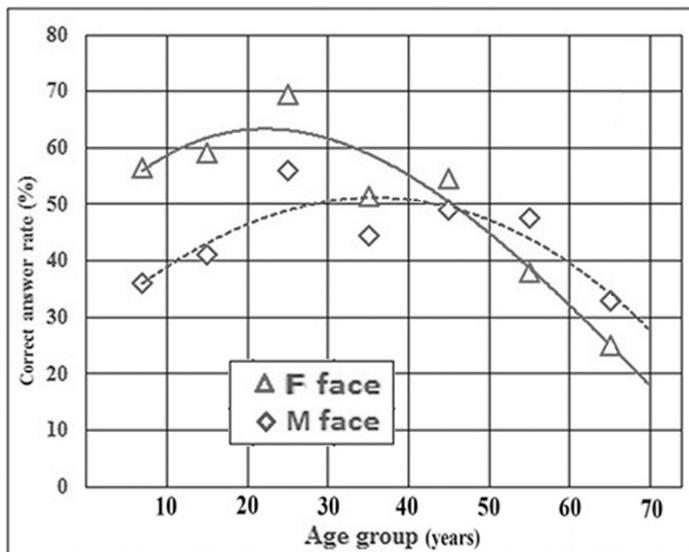


Figure 5: Details pertaining to the discrimination of female (F) or male (M) faces by female participants.

Effects of Angled Faces

Data for correct answer rates based on different shooting angles are presented in Figure 6. The RF face angle was fixed at 0° while the TG face angles were changed from 0° to 120°, i.e. 18 Test-sets for each participant. Perception ability used in neuropsychological image processing of faces, and quantitative differences between perceptions of face angles were measured.

The coefficient of determination of the quadratic approximated curve in Figure 6 was as $R^2 = 0.995$.

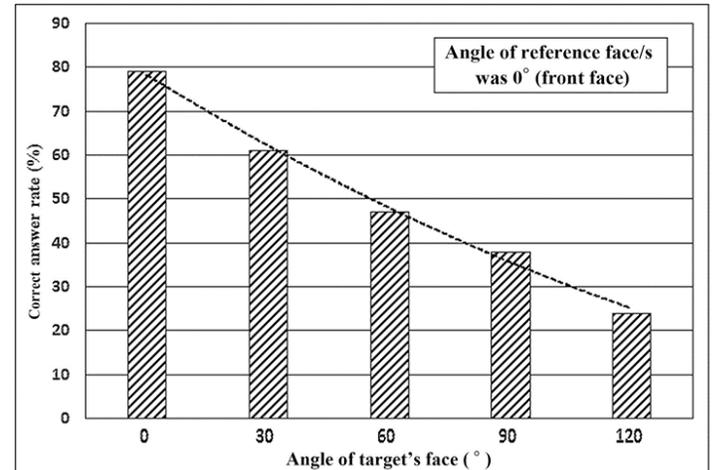


Figure 6: Comparing face discrimination for different shooting angles. Perception accuracy for different face angles (as shown in Figure Ap.-1). Data for all ages and both genders were averaged. The RF face angle was fixed at 0°. The TG face angles were changed from 0° to 120°.

Discussion

Face Identification Time by Brain Using N-Cs Results

Due to the number of the same age's participants the detailed statistical records of some representing ages were shown in Table 1. Another age such as elder than later 20's years old had few participants in the same age, then the values of standard deviation (σ) were improper for comparison. The response time for N-Cs were almost similar by age, but the response time for faces decreased clearly, and significance probabilities, p-values, between response time for faces and correct answer rates were 0.045 with 23 years old and 0.000 with 24 years old. The same p-values with younger than 18 years old were 0.26 - 0.60 and dispersed.

In the measurement of N-Cs, if the time required for N-Cs identification by brain is thought as zero, the response time for N-Cs represents the exercising time of hand with which participants touch DP. Then, the pure face identification time required with the brain activities, which is like the 'reaction time' by Hannah et al. [19], is expressed by the following equation.

$$\text{face identification time by brain} = \text{response time for faces} - \text{response time for N-Cs} \quad (1)$$

where both response time are shown in Table 1. The results of Eq.1 are exhibited in Figure 7. As seen in Figure 3, face identification time by brain shows the lowest value in the late 20s years old and tends to increase with age after that.

Age	number of parti.	response time (sec)				correct answer rate (%)	
		Numerical characters		faces		faces	
		Av.	σ	Av.	σ	Av.	σ
8	7	1.67	0.5	5.23	1.28	40.6	15.6
10	13	1.77	0.73	5.06	1.02	50.4	12.3
13	10	1.77	0.83	4.9	1.1	42.3	16
16	10	1.59	0.41	4.77	1.03	51.1	7.6
18	12	1.47	0.41	4.54	1.01	69.3	15.2
23	14	1.9	0.72	4.93	0.66	63.4	11.3
24	26	1.87	1.43	4.53	1.5	67.5	21.9

parti.: participants; Av.: average; σ : standard deviation

Table 1: Detailed statistical records of representing ages.

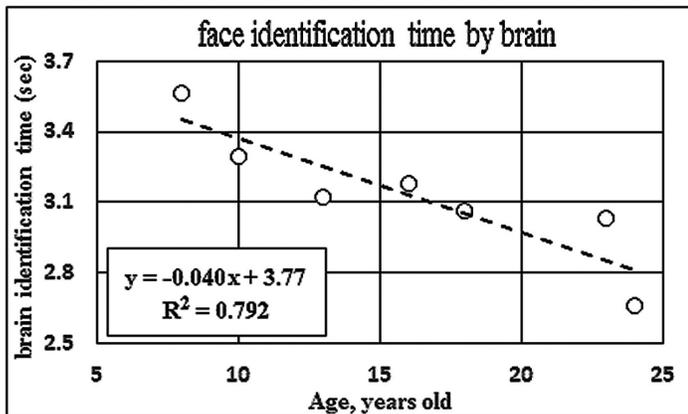


Figure 7: Face identification time by brain (sec), which is excluding hand exercise time to touch display panel, according to Eq. 1.

Proposal of a simple and quantitative testing method and practice

The main differences between our study and the former reports, such as by de Gelder et al. [4], Huis in 't Veld et al. [5] and Van den Stock [6], were following 3 points. First, they aimed to clarify the precise medical mechanisms of emotions and special disease, prosopagnosia. While, our purpose was to understand the familiar general lives for healthy people with a very easy technique. Based on the obtained results with wide individuals, we focused on grasping the average and fundamental trends comparing to finely analyzing. Second, the method of FEAST by de Gelder et al. [4] applied to examine the “memory” of face, but ours used direct visual comparison in a same image on DP. How effected these differences might be due to the purpose of each studies. Third,

the ability of normal face perception for healthy people might be related to sexual maturation, decline and conscious awareness, so we applied the photographs of early 20’s students. Its processes after childhood might be also closely depend on ages and gender of each participant. As for our purposes the obtained results, i.e. especially Figures 3, 4, 5 and 6, were acceptable.

By applying such a simple testing method, many evaluating results can be obtained easily from a large number of participants with both genders and wide ages. We will be able to know more about the details of the daily activities of people through face identification.

Regarding the composition of participants, as shown in Figure 2, it was rather hard to evenly distribute the sex and age hierarchy among participants who voluntarily came along the test with free will. In these relations, the participants in the test were mostly young, as 69 % of them were under 24 years of age. Hence, the obtained results were most reliable for a young age group. Among the large number of participants in this study (234), the following valuable phenomena associated with neuropsychological face perception, which have not been observed to date, were determined semi-quantitatively.

General Face Perception Abilities

As evident from Figure 3, the facial discrimination capabilities of individuals increase from childhood until their early 20s, where reach a peak, and then slowly decrease. This is thought to be strongly associated with sexual maturation and decline. Thereafter, from the late 30s onwards, the capabilities gradually decreased until the 60s. The dotted outlier symbols in Figure 3 indicate the references as described in section 2.4. Comparing Figure 3, Figure 7 and Table 1, one can understand the mechanisms of the distributed plots of the results. The values of standard deviation in Table 1 indicate how varied individual participants at the time of test. There were some outlier cases which simply depended on the variety of personal capability. In other words, the face perception ability is very personal characteristics as mentioned already by Russell R. et al. [20] as “Super-recognizers”, who have excellently recognizing ability than normal people. Thinking about fundamentally scattered characteristics of face perception with normal healthy people, the results in Figure 3, not only the two quadratic approximated curves but also the coefficients of determination of them, i.e. $R^2 = 0.864$ for the correct answer rate and $R^2 = 0.904$ for the response time, were well appreciated. Also, the lowest p-values (0.045, 0.000) in Figure 7 between response time for faces and correct answer rates in 23-24 years old respectively, indicated the reliability of the measurement method.

The ability changes with ages were already mentioned by de Gelder et al. [4] and Hannah et al. [19], but their divided age groups were different. The continuous changes of face perception

along ages from 6 years old to 70 or more were examined and compared here.

The Gender Differences

As already mentioned, according to the relationship with sexual maturation, further detailed studies for cross-gender analysis yielded the following results, as shown in Figures 4 and 5, where female and male faces were identified by participants of the same and the opposite genders. In Figure 4 when approximated to quadratic curves, the coefficient of determination, R^2 , value was 0.86 for F-faces and was 0.92 for M-faces, respectively. Similarly, In Figure 5, R^2 value was 0.90 for F-faces and was 0.72 for M-faces, respectively. R^2 values for the same gender had higher values than the opposite gender. All faces used in this Test-set were those aged 21–23 years. Thus, the photographs used in Figures 1 were key elements for this study compared with what we might find, if we were to use the faces of some elderly or mixed-aged people as the photograph subjects.

We found that young female faces were always better identified than young male faces by participants of both genders aged under 40 years. Among those participants aged over 40 years, the capabilities were reversed: male faces were better identified than female faces by both genders.

In terms of the peak of correct answer rates for female faces, it differed slightly between Figures 4 and 5. There were three points of interest: first, the value of the peak height; second, the positions of the peaks with ages; and third, the shapes of the four curves (two in each of the two figures). The peak heights of correct answers for the female and male faces were much higher for the male participants (Figure 4) than for the female participants (Figure 5). The differences - ca. 6% for female faces, ca. 12% for male faces - were meaningful.

Regarding the positions of peaks of correct answers for the male participants (Figure 4), the peaks for the age groups in their late 20s and early 30s were similar, but for the female participants (Figure 5), the peak was wide and much differed for recognizing female and male faces, i.e. early 20s for female faces and middle 30s for male faces. So, female participants could identify male faces that much older than female faces.

The shapes of the four curves of correct answers with ages were characteristically different, being sharper for male participants than for female participants. This provided an interesting contrast. In the case of the age group under 40 years, the results obtained for the two genders were very different. Female participants were able to identify female faces better than male faces (Figure 5), while the male participants identified female faces slightly better than male faces (Figure 4).

These neuropsychological phenomena are thought to be associated with sexual maturation and its decline. They are

considered as fundamental characteristics that play a role in recognizing the same and opposite gender. Female participants are more aware of female faces than of male faces, and this was most evident in the group aged under 40 years (Figure 5). However, in the group aged over 40 years, gender recognition capabilities were similar for both male and female participants. Regarding the cross-gender differences of the response time for the same and opposite gender, the female participants under the age of twenties, the time for F-faces was 0.3 - 0.4 sec faster than that for M-faces, which were not different with male participants.

Comparative consciousness of faces is an important characteristic of human nature and has been very difficult to examine and clarify. We might now be able to quantify and to evaluate the characteristics and processes associated with age and gender.

Crossing the Perception Abilities at 40 - 50 years' Old

In Figures 4 and 5 one can observe the two quadratic curves crossed between 40 to 50 years old. Namely, for male participants crossing point was at 50 years (Figure 4) and at ca. 45 (Figure 5) for female participants. In the younger ages and in the elder ages the characteristics of people for the same and the opposite gender fundamentally changed. The main reason is estimated as the shifting circumstances of sexual activities, consciousness and latent behaviors for rivals and friends with fundamentally active or passive characteristics. Including the peak points of four quadratic curves in Figures 4 and 5, which might be also related to the same activities, these phenomena are attributed to sexual maturation and decline. In other words, face perception abilities for normal healthy people are shifting along their lives with their sexual function.

Utilization of Young Faces

The differences observed in Figures 4 and 5 were attributed mainly to sexual maturation and its subsequent decline. Therefore, the utilization of young faces of both genders, aged 21-23, was reasonable for this experiment. The use of faces of children or elderly people, which are thought to be "sexless" but are really very different between individuals, might give more complicated and dispersed results. Regarding gender-based differences, the subject's faces utilized in this study had much uniformity than the varied faces of children or elderly people.

Imaging Angled Faces

In Figure 6, face discrimination was determined for different face angles. Data for all ages and genders were averaged because of the similar reasons as Figures 4 and 5. The coefficient of determination of the approximate curve, $R^2 = 0.995$, indicated that the statistical relationships were robust. We applied only one direction of angle and there might be some further delicate mechanisms of angled faces perception with both sides. Leuthard J et al. [21] had reported stimulus-response compatibilities of hands,

but not angled faces. These delicate abilities might be much more personalized and be different to each tested participant.

Characteristics of the Local Region

All these studies were performed in Hachioji city, a west suburban area of Tokyo, Japan. The obtained and clarified general characteristics of face perception by normal healthy people might be well related to the local regional culture or domestic habits. However, the sexual maturation and its decline of people, which is the fundamental elements of human lives, are not so much different with the locations on the earth. Then, some further similar studies will be expected to understand the different regions as reported by Alonso-Prieto et al. [18] in Garner.

This simple test system might be also useful for medical and educational applications, especially for evaluating an individual's mental maturation and decline with age, such as the diagnosing early stages of mental diseases, or such as aptitude tests of driver's license for the elderly people, and for professional abilities. Furthermore, although face images were used in this measurement, it is possible to easily change them arbitrarily to images of animals, plants, urban landscapes, angled abstract paintings and so on, according to the purpose of new testing measurements.

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