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# A Comparative Assessment of One's Own Age from Facial Images of Others: Two Case Studies for the Americans and the Japanese

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**Abstract**—We have proposed a method for estimating the subjective age of a person; that is, a method that yields a person's age on the basis of estimations made by that person about the age of other people by observing their facial images. Thus far, experiments have shown that Japanese people tend to underestimate their subjective age. In this study, we focus on the socio-psychological effects that may influence the underestimation of subjective age. We conducted an international comparative study. In this study, experiments were performed in which American and Japanese participants viewed American facial images; in addition, the American participants also viewed Japanese facial images. Through these experiments, it was confirmed that the subjective age generally tended toward the negative direction despite differences in the nationalities and cultures of the Japanese and American participants and their facial images. Moreover, it was found that nationality and culture may have some effects on the estimation; for example, American males did not exhibit the tendency to underestimate the age, unlike Japanese male. When estimating facial images of different nationalities, the variance generally tended to be larger, although the average was similar. This study suggests that the underestimation of age occurs despite differences in Japanese and American societies and cultures; however, the tendency of underestimation of age is not related to facial images but to social and cultural factors that influence the participants.

**Keywords**— *facial images, subjective age, real age, non-linear regression analysis*

## I. INTRODUCTION

In face-to-face communication, people estimate the attributes of other people, such as age and gender, simply by looking at them and listening to their voices. Age is one of the most important factors in social interactions, and it assumes even greater significance with regard to first impressions. However, we often overestimate the age of another person and then say "I thought he was much older than I am!"

It has been observed that people generally tend to overestimate the age of other people and underestimate their own age. In this study, we assumed that people did not really estimate the ages of the other people incorrectly; instead, they simply found themselves to appear younger or older than they really were[1–3]. We rated the ability of participants to estimate a person's relative age based on whether they

estimated people in facial images shown to them as well as people they communicated with face-to-face to be older or younger than themselves. We calculated the "subjective age" from the obtained distribution data. As a result, we observed that the subjective age in the case of the Japanese was generally lower than their actual age. Moreover, it was indicated that the older the participants were, the closer the subjective ages were to the real age. The subjective age of males was lower than that of females.

In addition, we showed that two factors, namely the memory of our own facial images and socio-psychological effects such as social rank or confidence, were responsible for the underestimation of one's own age.

In this study, we carried out cross-national experiments in which Japanese and American subjects participated to investigate the factors determining the tendency to underestimate one's own age. We investigated the socio-psychological factors by comparing the results. We showed facial images of Americans to the Japanese and vice versa in order to investigate the effect of the difference in facial image stimuli.

## II. PREVIOUS WORKS

Several studies on the perception and estimation of age have been carried out using facial images [4–8]. One of the topics addressed in such studies is the accuracy of age estimation. For example, the existence of an "own age/race bias" [4] in that people have a superior ability to recognize the faces of people belonging to their own age/race group has been indicated. In addition, it has been reported that the accuracy of age estimation by elderly people is lower than that by young people, suggesting that the accuracy of age estimation is not necessarily enhanced with age or knowledge acquisition. As mentioned above, although many studies have focused on age estimation and perception, the mechanism of age estimation has not yet been clarified.

In developmental psychology, one's own age is termed as the "subjective age"; studies related to this topic can be found in references [9–10]. The topic of subjective age includes a variety of concepts; Barak and Stern have indicated the following five representative age types [9].

- (1) Identity Age: To determine this age, a person is asked to classify the subjective age of other people in terms of age groups.
- (2) Comparative Age: Here, a person is asked to rate himself/herself if younger/older in comparison to the actual age of that person.
- (3) Feel Age: Here, a person specifies his/her own age in terms of numerical values.
- (4) Cognitive Age: It is the average value of the feel age, look age, do age, and interest age.
- (5) Stereotype Age: Here, a person is asked to classify other people into one of the following three types: an old person, a middle-aged person, or a person in the same age group as himself/herself, by following the semantic differential method.

During the above experiments to determine the subjective age, it was observed that, the older the participants were, the younger they felt themselves to be.

We focused our attention on this difference in perception and assumed that the perception of participants that other people are older than their actual age was not because of inaccuracies in the way the participants perceived other people but rather because of the perception of participants that they themselves were younger than their actual age [1–3]. In our previous study [3], we processed data obtained from relative age estimation, such as the classification of other people by participants as older or younger than themselves, using nonlinear regression analysis and then calculated the subjective age of each participant. Thus, we could apply the shift value of the subjective age of each participant to ANOVA and observe the relationship between the subjective age and the profile (gender and age group). The ANOVA analysis revealed the tendency of perceiving ourselves to be younger (i.e., perceiving other people to be older). Moreover, when we considered age perception on the basis of the differences in profiles, it was found that males tended to underestimate their age to a greater extent than females. In addition, the tendency to underestimate age was strongest in the age group 25–34, and the older the participants were, the closer the subjective ages were to the real age. Figure 1 shows the shift value of the Japanese subjective age using Japanese facial images. The scale used to determine the shift values of the subjective ages in this figure is entirely different from that used traditionally. The subjective age is obtained by estimating the actual age of other people that the participants consider to be of the same age, by rating if older or younger. Besides, this subjective age is described as “relative imaginary age” for example.

Moreover, it became clear that although there existed a significant difference in the gender and age groups of the participants, the degree of perception remained constant

Using the results stated above, we were able narrow down the factors responsible for the underestimation of one’s own age to the following two factors from the original four factors [4].

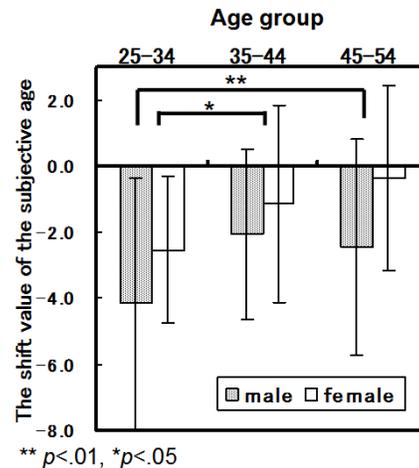


Figure 1. Shift values of subjective age (Participant: Japanese, Facial images: Japanese)

- (1) Remembering our own facial image. In face-to-face communication, other people’s images are always current, but our own facial image needs to be remembered.
- (2) Relationship between age and socio-psychological parameters, for example confidence related to age or social rank.

With regard to the subjective age, we cannot separately observe the two perceptions of participants that they are younger than their actual age and that other people are older than themselves at the present time. Because the two factors mentioned above supported the perception of participants that they are younger than their actual age, in this study, we assume that this perception is true; however, we do not discredit the perception of participants that other people are older than themselves.

In this study, we carried out subjective age estimation experiments on the Americans to investigate the relationship between the two abovementioned factors and the tendency to underestimate one’s own age. In experiment I, we carried out estimation experiments on the American subjects using facial images of Americans and compared the subjective age on a nationality basis (American and Japanese). In addition, in experiments II and III, we experimented on the Japanese subjects using facial images of Americans and vice versa, respectively, in order to investigate differences due to facial image stimuli.

### III. CONCEPT OF SUBJECTIVE AGE

We defined the three experiments in this study as follows:

- [Experiment I] Experiments on Americans subjects using facial images of Americans
- [Experiment II] Experiments on Japanese subjects using facial images of Americans
- [Experiment III] Experiments on Americans subjects using facial images of Japanese

### A. Participants

130 Americans (male: 58, female: 72) participated in experiment I, 125 Japanese (male: 57, female: 68) participated in experiment II, and 75 Americans (male: 35, female: 40) participated in experiment III. All participants were between 25 and 54 years old, and all American participants were Caucasians.

### B. Experimental stimuli

Facial images of both Americans and Japanese aged between 20 and 59 years were used as experimental stimuli, and the number of male and female images was almost equal. These images were divided into eight classes for each gender, and each class included more than five facial images. Figure 2 shows examples of the facial images. Each facial image was saved as a high-resolution color digital image having a resolution of  $300 \times 350$  pixels.

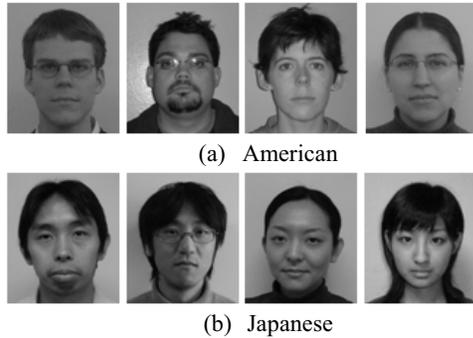


Figure 2. Examples of facial images (Class: 25–29 years)  
(We have obtained individual permissions to publish these photographs.)

### C. Rating experiment

For both male and female participants belonging to different age and gender groups, we selected facial images from their own age class as well as the next younger and older classes. For example, for a 32-year-old male participant, 5 male and 5 female images were selected from the same age class (30–34) and from the next younger (25–29) and older (35–39) classes. Therefore, the total number of facial images used was 30 (5 images/class  $\times$  3 classes  $\times$  2 genders).

Next, we experimented with a rating scale for the facial images used as stimuli. The participants were shown random facial images on the computer monitor, and they evaluated whether the person shown in the image looked older or younger than themselves. The evaluation had 5 ranks: “Definitely older than myself (2),” “Probably older than myself (1),” “Not able to estimate (0),” “Probably younger than myself (–1),” and “Definitely younger than myself (–2).” A range of responses was adopted in order to determine the relative position to other ages as opposed to estimating the chronological ages of the people whose facial images were shown.

## IV. SUBJECTIVE AGE QUANTIFICATION

Subjective ages were calculated in order to quantify the result of the rating experiments. When we plotted the results on a two-dimensional plane with the x-axis as the relative age

(difference between the chronological ages of the person whose facial image was shown and the subject) and the y-axis as the estimation result, we obtained an upper-right distribution. This distribution indicated that the certainty factor for selecting “Definitely older than myself (2)” increased as the other people’s age increased. Since this distribution converged at rating values of 2 (Definitely older) and –2 (Definitely younger), and increased monotonically, we assumed that this distribution was approximated by a logistic function and hence applied nonlinear regression analysis to the distribution for each participant.

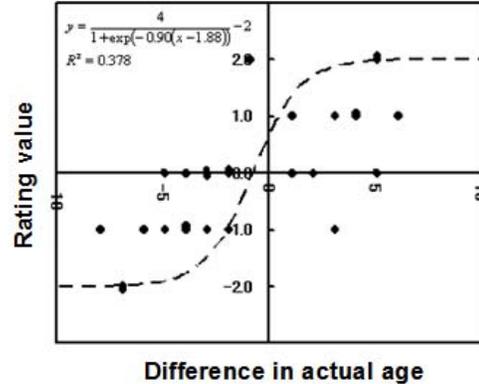


Figure 3. Example of non-linear regression

Here, the logistic function, which converged to the rating values of  $\pm 2$ , was defined by the mathematical formula

$$y = \frac{4}{1 + \exp(-a(x - b))} - 2 \quad (1)$$

where  $a$  is the slope of the curve and  $b$ , the zero crossing point in the approximation curve with the x-axis.  $a$  and  $b$  were estimated by a nonlinear regression analysis; we defined  $b$  as “the shift value of the subjective age” and the addition of the shift value to the actual age as “the subjective age”. In the case of Figure 3, if the values of  $a$  and  $b$  were 0.90 and –1.88, respectively, the shift value of the subjective age of a participant was –1.88. This implies that this participant perceived himself/herself as 1.88 years younger than his/her actual age. After the shift values of the subjective age were calculated on the basis of the data obtained from each participant, these values were categorized into six groups on the basis of gender (male and female) and age groups (25–34, 35–44, and 45–54).

We eliminated data whose multiple coefficients of determination of the regression curve approximated for each participant were extremely low ( $R^2 < 0.10$ ) and finally processed data of 89, 84, and 58 individuals in experiments I, II, and III, respectively.

## V. RESULTS

### A. Experiment I

Table 1 and Figure 4 show the experimental results of experiment I (participant: American, facial images: American). The shift value of subjective age  $b$  generally tended to be in the negative direction despite the differences in nationality and

cultures of participants and facial images. Thus, it was concluded that in a manner similar to the Japanese, the Americans also perceived themselves to be younger. In addition, a two-way ANOVA was performed using the gender and age group as independent variables and the shift value of subjective age  $b$  as the dependent variable. This analysis revealed that the main effects of each gender and age group were insignificant.

In addition, because we investigated the difference in subjective age between nationality, we combined the data obtained from a previous study (participant: Japanese, facial images: Japanese) and performed two-way ANOVA using the gender and nationality as independent variables. This analysis revealed a significant interaction between the gender and nationality ( $F(1, 254) = 6.97, p < .01$ ). The simple main effect test was conducted on the interaction between gender and nationality, where a significant difference between an American male and a Japanese male was confirmed ( $F(1, 254) = 6.67, p < .05$ ). This showed that an American male did not exhibit the tendency of underestimating his own age, unlike a Japanese male.

### B. Experiment II

Table 2 and Figure 5 show the experimental results of experiment II (participant: Japanese, facial images: American). It was confirmed that the subjective age of Japanese people generally tended toward the negative direction despite the difference in the nationalities (Japanese and American) of the people whose facial images were used. In addition, two-way ANOVA was performed using the gender and age group as independent variables. This analysis revealed that the main effects of age group were significant ( $F(2, 78) = 6.33, p < .01$ ) and a significant interaction did not exist between the gender and age group ( $F(2, 78) = 1.87, n.s.$ ). In addition, Tukey's HSD test was performed for age group. This test revealed a significant difference between young (25–34) and young-middle (35–44) at 5%, and young (25–34) and middle (45–54) at 1%. Thus, it became clear that the Japanese tended to underestimate the age despite the nationality of the facial images shown, and the older the participants were, the closer the subjective ages were to the real age.

In addition, we combined the data obtained from a previous study (participant: Japanese, facial images: Japanese) and performed a two-way ANOVA using the gender and nationality of facial images as independent variables. This analysis revealed that the main effects of each factor and the interaction between the two were insignificant. Therefore, it was confirmed that the tendency to underestimate subjective age identified in the previous study existed despite the difference in the nationalities (Japanese and American) of the people whose facial images were used.

### C. Experiment III

Table 3 and Figure 6 show the experimental results of experiment III (participant: American, facial images: Japanese). A two-way ANOVA was performed using the gender and age

group as independent variables. This analysis revealed that the main effects of age group were significant ( $F(2, 52) = 4.81, p < .05$ ), and a significant interaction did not exist between the gender and age group ( $F(2, 52) = 0.45, n.s.$ ). In addition, Tukey's HSD test was performed for age group, and a significant difference between young (25–34) and middle (45–54) at 1% was confirmed.

In addition, we combined the data obtained from experiment I (participant: American, facial images: American) and performed a two-way ANOVA using the gender and nationality of facial images as independent variables. This analysis could not confirm a significant difference between the two factors.

### D. Summary results

It was confirmed that the subjective age was generally found to be in the negative region in all experiments, and the underestimation of age occurred despite the differences in the nationalities and cultures of Japanese and American participants and their facial images. However, American males

Table 1. Experiment I  
(Participant: American, Facial images: American)  
Statistics related to the shift value of subjective age  $b$

		25-34	35-44	45-54	total
male	$M$	-2.17	-1.13	-0.73	-1.32
	$SD$	(2.29)	(2.88)	(3.45)	(2.88)
	$N$	10	15	10	35
female	$M$	-1.71	-2.70	-1.44	-1.90
	$SD$	(2.75)	(2.73)	(3.09)	(2.87)
	$N$	17	16	21	54

Table 2. Experiment II  
(Participant: Japanese, Facial images: American)  
Statistics related to the shift value of subjective age  $b$

		25-34	35-44	45-54	total
male	$M$	-4.93	-1.41	0.14	-2.85
	$SD$	(4.22)	(4.81)	(2.19)	(4.54)
	$N$	17	10	7	34
female	$M$	-2.47	0.33	-1.58	-1.32
	$SD$	(3.25)	(3.62)	(4.40)	(3.83)
	$N$	20	16	14	50

Table 3. Experiment III  
(Participant: American, Facial images: Japanese)  
Statistics related to the shift value of subjective age  $b$

		25-34	35-44	45-54	total
male	$M$	-3.62	-0.32	-0.60	-1.41
	$SD$	(3.19)	(1.31)	(3.88)	(3.42)
	$N$	7	6	11	24
female	$M$	-3.48	-1.62	0.34	-1.07
	$SD$	(4.20)	(4.44)	(3.09)	(3.94)
	$N$	9	7	18	34

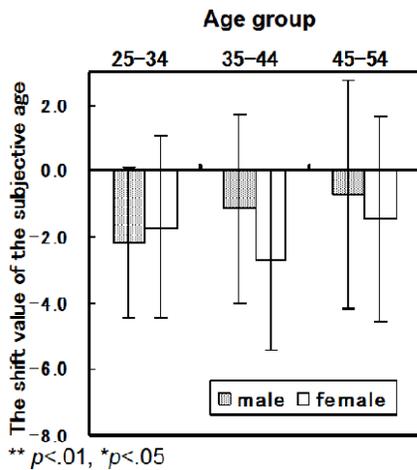


Figure 4. Shift values of subjective age in Experiment I (Participant: American, Facial images: American)

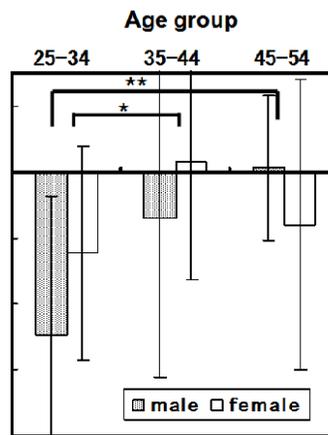


Figure 5. Shift values of subjective age in Experiment II (Participant: Japanese, Facial images: American)

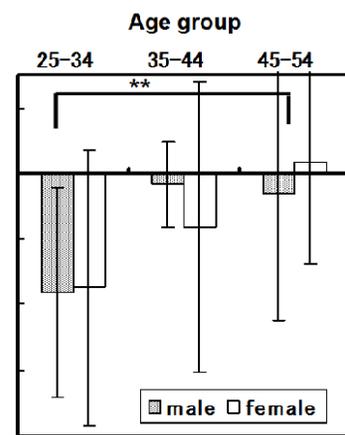


Figure 6. Shift values of subjective age in Experiment III (Participant: American, Facial images: Japanese)

did not exhibit a tendency to underestimate the age, unlike Japanese males, and it was indicated that a significant difference existed in nationality and culture between the males. During the estimation of the facial images of people of different nationalities, although the mean value of the ratings could not confirm a significant difference in the nationalities of the facial images, the variance generally tended to be large.

## I. DISCUSSIONS

### A. Universality of the younger identity

First, we investigated the universal factors influencing the tendency to underestimate one's own age. Using the abovementioned results, it is confirmed that the shift value of the subjective age generally tends toward the negative direction despite the differences in the nationalities and cultures of Japanese and American participants and their facial images. It is suggested that remembering one's own facial image may be a factor influencing this tendency despite differences in nationality and culture. Estimating one's own age (or that of another known person) involves remembering previous facial images. However, when estimating the age of strangers, only currently observed information is available. We suggest that when estimating one's own age, although we remember our own image, we tend to perceive others as being older than they actually are.

A comparison of the mean rating values obtained in experiment II and the previous study as well as experiments I and III did not confirm a significant difference due to the nationality of facial images. Therefore, the factors resulting in the underestimation of age may not be the facial images used as stimuli but the participants. Factors influencing the participants could include remembering one's own facial image and socio-psychological effects. The relationship between the two factors or the separation and extraction of the factors will be studied in the future. In addition, to obtain more accurate results, it is

necessary to increase the number of participants.

### B. Socio-psychological effects

Next, we investigate the underestimation of age from the viewpoint of socio-psychological factors. Experiment I revealed that although Americans tended to underestimate their own age, American males did not exhibit a tendency of underestimating their own age, unlike Japanese males. We also observed the following: (1) In the case of female participants, it was observed that there was no significant difference in the shift values of the subjective ages of people according to nationality. (2) In the case of Japanese people, it was observed that there was a difference in the shift values of the subjective ages of people according to gender. (3) It was also observed that there was a difference between the shift values of the subjective ages of American and Japanese males. From the three points mentioned above, it can be inferred that, in the case of female participants, the shift values are baseline; thus, the subjective age of American males is higher than that of Japanese males. We also made two additional observations. First, the subjective age of Japanese participants tends toward the negative direction irrespective of the nationalities (Japanese or American) of the people whose facial images were used. Second, the older the participants are, the closer their subjective ages are to their real age. From the abovementioned results and the two additional observations, we conclude that the shift value is related to socio-psychological factors such as an attitude of modesty or social rank. Modesty toward elderly people is more common in Japan than in American society; we suggest that this tendency is more significant in males in particular. Further, whether modesty is considered to be a virtue depending on social and cultural factors may influence the age estimation of strangers.

### C. Age estimation of different nationality

The following relationships between nationality and underestimation of age were evident:

- (1) It is not confirmed whether the variance of the mean value of the ratings for the estimation of facial images of people of different nationalities (Japanese and American) is large.
- (2) However, differences tend to exist between the variances. Specifically, the variance of estimation for a different nationality is higher than that for the same nationality.

A possible reason for the absence of a significant difference between the mean values of the ratings could be the small number of participants sampled. Therefore, we formed a hypothesis that the difference between variances (result (2)) is related to difficulty of age estimation for a different nationality. According to Meissner's study [11] on the perception of faces and race, it is easier to perceive or memorize the face of a person belonging to the same race as opposed to that of someone from a different race; this is called own-race bias. Because the participants in this study were Caucasian Americans, the difficulty of age estimation cannot be attributed to factors such as nationality and culture or race. However, it is shown that own-race bias possibly affects age estimation. In the future, we will conduct estimation experiments involving Koreans belonging to the same race as the Japanese but having a different nationality, and investigate the differences between the two.

## II. CONCLUSIONS

In this study, we compared the results of subjective age estimation by American and Japanese participants, and investigated the factors determining the tendency to underestimate one's own age. We made the following observations:

- (1) It was confirmed that the subjective age generally tended toward the negative direction despite differences in the nationalities and cultures of Japanese and American participants and their facial images. Further, it was shown that Americans tended to underestimate their own age.
- (2) The subjective age of Japanese males was much lesser than that of American males.
- (3) The difference in the nationalities of people whose facial images were used as stimuli is not related to the subjective age.
- (4) In the estimation of facial images of people of different nationalities, the variance generally tended to be bigger.

The results of this study indicate that the factors influencing the underestimation of age are (1) universal despite nationality or race because it is necessary to remember one's own facial image and (2) cultural factors such as modesty or social rank, or socio-psychological factors such as confidence. (3) It is possible that the tendency to underestimate one's own age is not influenced by the physical properties of the facial images but by the internal properties of the participants.

It is believed that the accuracy of age estimation or face recognition can be improved by investigating the psychological features of participants through facial studies and human-machine interactions. Besides, the subjective age is self-image, thus, by finding the mechanism of self-image, we can use the

concept of subjective age in the development of various socio-psychological applications such as self-development and client services. In addition, discussions regarding cultural effects such as comparison of subjective ages at an international level are useful in achieving breakthroughs in mechanisms of a variety of other psychological measures. Particularly, these discussions are expected to be useful in studies regarding the "objectivization of subjectivity", such as subjective time and distance estimations.

In the future, we intend to investigate circumstantial factors such as the ability of participants to remember their own facial images, because the subjective age tended toward the negative direction despite differences in the nationalities and cultures of Japanese and American participants. In this regard, we suggest a comparative experiment of one's own facial image and that of others (to determine which is perceived to be older), and a comparative experiment of facial images of two strangers. In addition, we will conduct estimation experiments involving Koreans belonging to the same race as the Japanese but having different nationality and different cultures in terms of modesty. Moreover, we will investigate the underestimation of age in other age groups, separately observe the perception of oneself as younger and others as older, and determine the effect of makeup on the objective age (age estimated by others) of females.

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