
Estimates of Subjective Age Based on the Facial Images of Others: An Investigation of the Factors Determining the Younger Identity by Comparison between Koreans and Japanese

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We designed a method for estimating the subjective age of a person; using this method, one evaluates one's own age by estimating whether a person shown in a facial image looks older or younger than oneself. Thus far, experiments have shown that Japanese and American people tend to underestimate their subjective ages. In this study, we conducted estimation experiments involving subjects who were racially Japanese-some of whom were from Japan, and others who were raised in the Korean culture-and investigated the differences between the two groups' results. Experiments were performed in which Korean participants viewed Korean and Japanese facial images, and the Japanese participants also viewed Korean facial images. Through these experiments, it was confirmed that the bias values of the subjective ages were found to be negative, which indicated that a younger self-identity occurs despite differences in Japanese and Korean societies and cultures.

Keywords: facial images, subjective age, non-linear regression analysis

1. Introduction

When individuals engage in communication, they tend to make judgments about the attributes (e.g., age, gender, ethnicity, social status, or professional background) of those with whom they communicate based on their appearance⁽¹⁾⁻⁽²⁾. When forming attitudes during social interactions, age is one of the most important factors; first impressions are often significantly influenced by the fact that those with whom we communicate are older or younger than us. Individuals tend to unconsciously estimate the age of those around them on the basis of appearance and then use this to establish the appropriate attitude and language to adopt.

Despite this, studies have suggested that these judgments are often inaccurate; there are often instances where individuals overestimate the age of those with whom they communicate in the belief that the person with whom they are communicating is much older than themselves.

It has been observed that people generally tend to overestimate the age of other people. 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⁾⁽⁴⁾. 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 them. We calculated the "subjective age" from the obtained distribution data.

Thus, we observed that the subjective age, in the case of the Japanese, was generally lower than the actual age. American males, on the contrary, did not exhibit a tendency to underestimate their ages. The underestimation of age occurred despite the differences in the Japanese and American participants' nationalities, cultures, and facial images. These results suggested that the tendency toward a younger identity was influenced by misleading memories of their own facial images and socio-psychological factors. However, it was not clarified which factors (e.g., nationality and culture or race) relate to the young identity.

In this study, we conducted estimation experiments involving Koreans belonging to the same race as the Japanese but having a different culture, and we investigated the differences between the two. Experiments were performed in which Korean participants viewed Korean and Japanese facial images; in addition, the Japanese participants viewed Korean facial images. This experiment investigated the effects of differences in nationality (culture or race).

2. Previous Works

Numerous studies have been conducted so far regarding age estimation using faces^{(5)~(13)}. In particular, much of the research has focused on automatic age estimation by computer⁽⁵⁾⁽¹⁴⁾. The applications of this technology have recently been extended to a variety of fields, including biometrics, security, and digital consumer electronics. However, because of the particularity and complexity of faces, various technical issues with automatic age estimation remain which relate to sociology and psychology, as well as the biological or anthropometric perspective^{(15)~(16)}.

One of the most significant results to emerge from these studies is "subjective age bias," where individuals tended to overestimate

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the age of the facial images of others. Although the tendency to perceive another person's face as older than it is was often pointed out in various areas, it was not an intended topic of the research⁽⁷⁾ ~⁽⁹⁾.

We focused on the tendency of younger identity, and assumed that the perception that participants looked other people older than their actual age was because of the perception that participants felt themselves younger than their actual age. In our previous study, 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 bias 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 that Japanese and Americans tended to perceive themselves as younger (i.e., perceive other people to be older), as shown in Figures 1 and 2. Moreover, when we considered age perception on the basis of profile differences, Japanese males tended to underestimate their age to a greater extent than Japanese females. The tendency to underestimate age was strongest in the age group 25–34. The older the participants were, the closer the subjective ages were to the real ages. In addition, American males did not exhibit a strong tendency to underestimate age, unlike Japanese males⁽⁴⁾.

The scale used to determine the bias values of the subjective ages in Figure 2 is entirely different from that used traditionally; that is, the subjective age of young people was lowest and males tended to underestimate their own age to a greater extent than females.

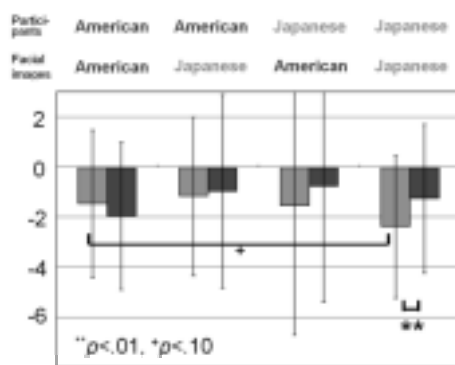


Fig. 1. Bias values of subjective age (Japanese and American).

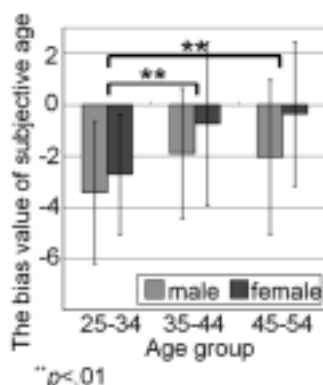


Fig. 2. Bias values of subjective age.

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, we found that the subjective age remained the same regardless of the stimuli's expression, or the gender or age group of the participants. 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⁾.

- Memory may be misleading, and people may not remember the most recent image of themselves. In face-to-face communication, other people's images are always current, but our own facial image needs to be remembered.
- As Barak and Stern have made clear, there seems to be a link between age and socio-psychological parameters; for example, the confidence and social rank of an individual have been found to be related to other people's perception of their age.

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.

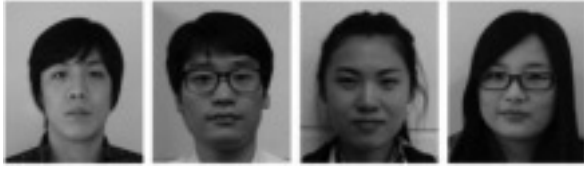
In this study, we conducted estimation experiments, using Korean participants, to investigate the effects of the cultural and racial factors that could not be distinguished in the comparative study between the Japanese and the Americans.

3. Subjective Age Estimation Using Facial Images

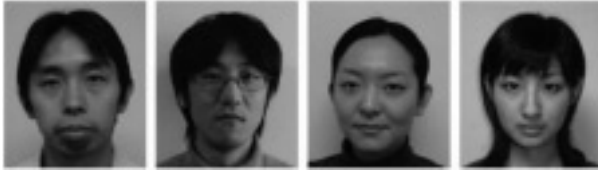
3.1 Experimental Stimuli Facial images of both Koreans and Japanese aged between 20 and 59 years were used as experimental stimuli, and the number of male and female images was almost equal. These images were divided into eight classes for each gender, and each class included more than five facial images. Figure 3 shows examples of the facial images. Each facial image was saved as a high-resolution color digital image having a resolution of 300 × 350 pixels.

3.2 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 × 3 classes × 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)." Then, we limited the facial images to only of people who are around the same age in order to raise the efficiency of the experiments.



A) Korean



B) Japanese

Fig. 3. Examples of facial images (Class: 25-29 years).
(We have obtained individual permissions to publish these photographs.)

We defined the three experiments in this study as follows:

[Experiment I] Experiments on Koreans subjects using facial images of Koreans

[Experiment II] Experiments on Koreans subjects using facial images of Japanese

[Experiment III] Experiments on Japanese subjects using facial images of Koreans

3.3 Participants 112 Koreans (male: 60, female: 52) participated in experiment I, 93 Koreans (male: 48, female: 45) participated in experiment II and 135 Japanese (male: 69, female: 66) participated in experiment III. All participants were between 25 and 54 years old. Table 1 shows the statistics associated with the experiments.

Table 1. Statistics associated to the experiments. ('M', 'SD' and 'N' represent mean of the bias values of subjective age, standard deviation and the number of participants, respectively)

(a) Experiment I (Participant: Korean, Facial images: Korean)

		25-34	35-44	45-54	total
male	<i>M</i>	-4.70	-2.24	-2.44	-3.11
	<i>SD</i>	(2.43)	(3.42)	(3.55)	(3.29)
	<i>N</i>	15	20	10	45
female	<i>M</i>	-3.81	-3.95	-3.89	-3.87
	<i>SD</i>	(2.15)	(2.36)	(3.22)	(2.49)
	<i>N</i>	16	11	11	38

(b) Experiment II (Participant: Korean, Facial images: Japanese)

		25-34	35-44	45-54	total
male	<i>M</i>	-6.10	-2.49	-1.17	-3.38
	<i>SD</i>	(2.18)	(2.82)	(4.62)	(3.74)
	<i>N</i>	13	15	10	38
female	<i>M</i>	-5.20	-2.52	-2.25	-3.22
	<i>SD</i>	(2.44)	(3.75)	(3.40)	(3.44)
	<i>N</i>	11	12	14	37

(c) Experiment III (Participant: Japanese, Facial images: Korean)

		25-34	35-44	45-54	total
male	<i>M</i>	-2.89	-1.74	-1.96	-2.40
	<i>SD</i>	(2.85)	(2.49)	(4.59)	(3.20)
	<i>N</i>	30	14	12	56
female	<i>M</i>	-3.01	-2.68	-2.23	-2.69
	<i>SD</i>	(2.60)	(2.33)	(2.74)	(2.55)
	<i>N</i>	24	15	17	56

3.4 Concept of Subjective Age Figure 4 depicts the concept of subjective age, as discussed in this paper, and how it is calculated on the basis of whether participants assessed the faces of other people depicted in images as looking older or younger than themselves. From these results, we obtain data regarding the "difference in actual age between participants and others" and "participant estimation regarding the age of others." We plot these results on a two-dimensional plane with the x-axis as the difference in actual age and the y-axis as the estimation result. The data lying in the positive area should be plotted in the positive sphere, and the data lying in the negative area should be plotted in the negative sphere; thus, the graph is supposed to give a right/up and left/down curve and the center of the graph is supposed to be located near the origin of the x-axis. Here, if the participant's tend to judge the persons shown in the facial images as being younger than their real age, then the entire distribution of the data shifts toward the right (in the positive area). Conversely, if the participant's tend to judge the persons shown in the facial images as being older than the real age, then the entire distribution of the data shifts toward the left (the negative area). The shifting of the distribution toward the positive/negative area would indicate the participant's tendency to significantly underestimate/overestimate the age of others. We assume that one of the factors behind this tendency is that the participant's subjective age is often more or less than his/her real age. Specifically, we calculate a gap between the center of the distribution and the origin of the coordinate for the x-axis, and define this gap as the bias value of subjective age; thus, subjective age can be calculated by adding the bias value to the participant's actual age.

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 me (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 5 shows an example of the estimation curves from 18 female individuals from the middle age group with a neutral expression.

Here, the logistic function, which converged at a rating value of ± 2 , was defined by the mathematical formula:

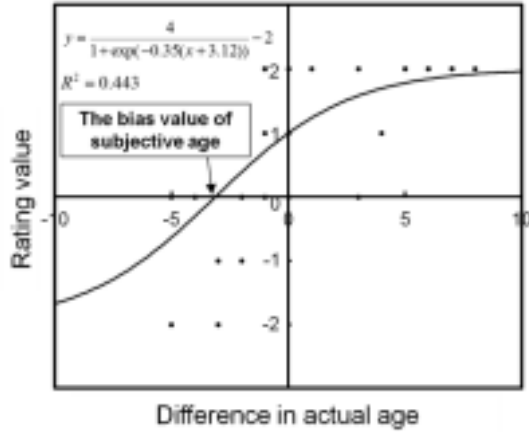


Fig. 4. The concept of subjective age. The x-axis is the difference between the actual age of the participant and the actual age of the facial images. A positive/negative value for x indicates that the facial images are older/younger than the participant. The y-axis is the rating value. A positive/negative value for y indicates that the participant tended to estimate the facial images as being older/younger than himself/herself. A distribution centered in the negative part of the graph would indicate that participant tended to perceive the younger facial images as about his/her own age.

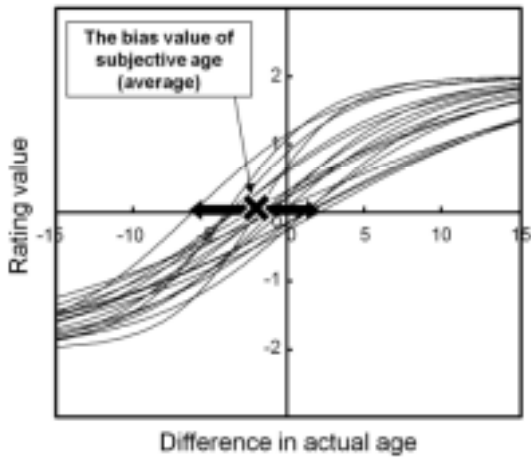


Fig. 5. Estimation curves for 18 female individuals in the middle age group with a neutral expression.

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

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 bias value of the subjective age” and the addition of the bias value to the actual age as “the subjective age”. In the case of Figure 4, if the values of a and b were 0.35 and -3.12 , respectively, the bias value of the subjective age of a participant was -3.12 . This implies that this participant perceived himself/herself as 3.12 years younger than his/her actual age. After the bias 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 83, 75, and 112 individuals in experiments I, II, and III, respectively.

4. Result

4.1 Summary results Figure 6 shows a comparison of the average bias values of the subjective age in the experimental results of experiment I (participant: Korean; facial images: Korean), experiment II (participant: Korean; facial images: Japanese), experiment III (participant: Japanese; facial images: Korean), and the previous work (participant: Japanese; facial images: Japanese). It was confirmed that the subjective age was generally in the negative region, in all experiments.

An ANOVA was performed between experiments, using nationality as an independent variable; it showed that the influence of nationality was highly statistically significant ($F[1, 259] = 18.44$, $p < .01$). There were also significant differences between experiment I and experiment III, experiment II and the previous work ($F[1, 191] = 4.96$, $p < .05$, $F[1, 251] = 11.81$, $p < .01$).

In addition, we performed a two-way ANOVA using gender and nationality as independent variables. This analysis revealed a significant interaction between gender and nationality in experiment I and the previous work ($F[1, 254] = 6.97$, $p < .05$). A simple main effect test was conducted on the interaction between gender and nationality, and a significant difference between Korean females and Japanese females was confirmed ($F[1, 259] = 21.31$, $p < .01$). There was also a significant interaction between gender and nationality in experiment III and in the previous work ($F[1, 288] = 4.00$, $p < .05$). A simple main effect test was also conducted on the interaction between gender and nationality, showing no significant difference in Japanese males but a significant difference between Korean and Japanese facial images ($F[1, 288] = 8.30$, $p < .01$).

4.2 Experiment I Table 1a and Figure 7a show the experimental results of experiment I (participant: Korean; facial images: Korean). A two-way ANOVA was performed, using gender and age group as independent variables and the bias value of subjective age b as the dependent variable. This analysis revealed that the main effects of each gender and age group were insignificant.

4.3 Experiment II Table 1b and Figure 7b show the experimental results of experiment II (participant: Korean; facial images: Japanese). A two-way ANOVA was performed, using gender and age group as independent variables. This analysis revealed that the main effect of age group was significant ($F[2, 69] = 9.86$, $p < .01$), and a significant interaction did not exist between gender and age group ($F[2, 69] = 0.54$, n.s.). In addition, Tukey's HSD test was performed for age group, confirming a significant 10% difference between young (25–34) and young-middle (35–44) and a 1% difference between young (25–34) and middle (45–54).

4.4 Experiment III Table 1c and Figure 7c show the experimental results of experiment III (participant: Japanese; facial images: Korean). A two-way ANOVA was performed using gender and age group as independent variables and the bias value of subjective age b as the dependent variable. This analysis revealed that the main effects of gender and age group were insignificant.

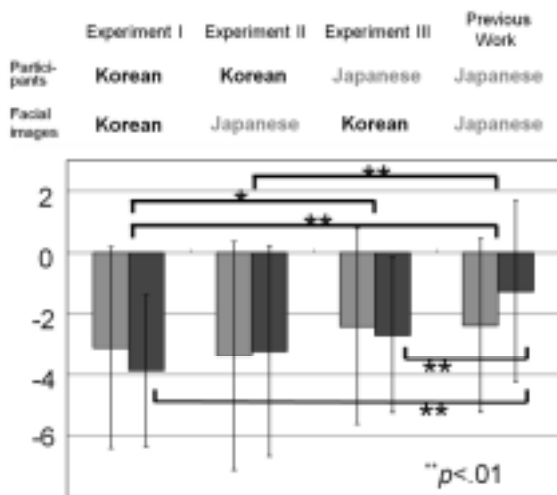


Fig. 6. Bias values of subjective age (Japanese and Korean).

5. Discussion

5.1 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 bias value of the subjective age generally tends toward the negative direction despite the differences in the nationalities and cultures of 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 we can estimate our real age, although remembered our own image tends toward the previous direction, this gap cause us to perceive others as being older than they actually are. 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.

5.2 Summary results Next, we investigate the underestimation of age from the viewpoint of socio-psychological factors. Experiment I revealed that the tendency toward a younger identity was stronger for Koreans than for Japanese. In particular, the subjective age was notably lower for Korean females than for Japanese females. These results indicated the possibility of differences in the cultural environments surrounding the Korean and Japanese females (e.g., social status or expected attitude).

It was also observed that there was no age-group dependence in subjective age regarding facial images of a different nationality in Experiment II. Conversely, there was an age-group dependence in subjective age for those of a different nationality in Experiment III. This indicated a possible difference in "look age" between the Koreans and the Japanese; this may be a cultural effect on age estimation.

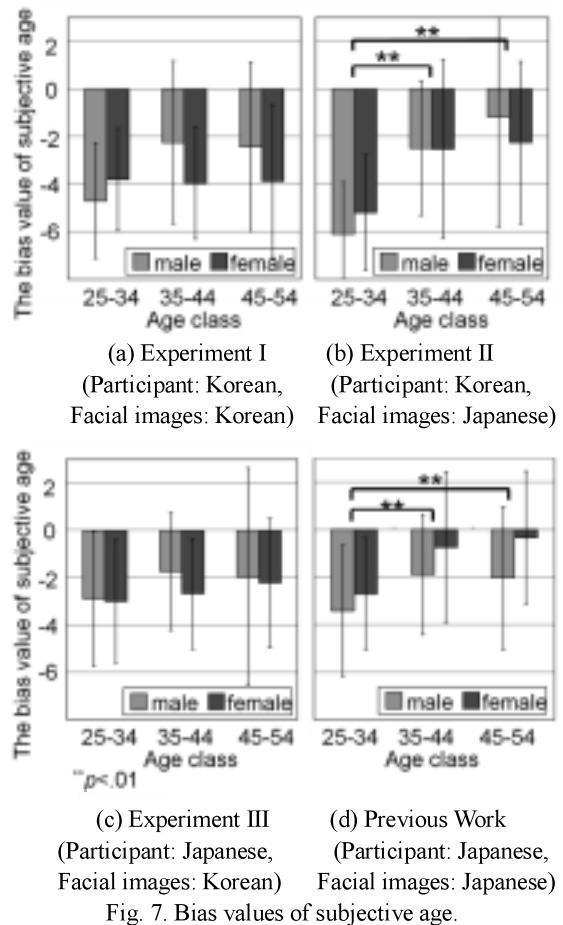


Fig. 7. Bias values of subjective age.

6. Conclusions

In this study, we compared the results of subjective age estimation by Korean and Japanese participants, and investigated the factors determining the tendency to underestimate one's own age.

The results of this study show that (1) Korean also tend toward underestimation, which indicates that subjective age generally tends toward the negative direction, despite nationality or race; (2) the tendency toward a younger identity was significantly stronger for Koreans than for Japanese; and (3) there are probably cultural effects on the tendency toward a younger identity.

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 "objectification 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. 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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