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Paper

Estimates of Subjective Age Based on the Facial Images of Others: Comparative Studies of Koreans and the 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 Americans 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 negative, indicating that a younger self-identity occurs despite differences in Japanese and Korean societies and cultures.

Keywords : facial images, subjective age, non-liner 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 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 we are. Individuals tend to unconsciously estimate the ages of those around them on the basis of appearance and then use this to establish the appropriate attitude and language to adopt.

Nevertheless, studies suggested that these judgments are often inaccurate; there are often instances when individuals overestimate the ages of those with whom they communicate in the belief that the people are much older than themselves.

People generally tend to overestimate the ages of other people. In this study, we assumed that people did not really estimate the ages of 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 themselves. We calculated "subjective age" from the obtained distribution data.

Thus, we observed that subjective ages, in the case of the Japanese, were generally lower than the actual ages. American males, on the contrary, did not exhibit a tendency to underestimate their ages. The underestimation of age occurred despite 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) related to the young identity.

It is believed that investigating the psychological features of subjective age may be useful for improving the design of systems for the human interface and human system interaction fields. For instance, designing agents' behavior (such as manner of expressing courtesies) is one of the more important issues in the development of various agent systems such as self-development and client services. Findings concerning "objectivization of subjectivity" such as subjective age bias can be applied to the evaluations of emotions and feelings in many fields.

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 explored age estimation using faces[(5)-(13)]. In particular, much of the research 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 that 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 ages of the facial images of others. Although the tendency to perceive another person's face as older was often pointed out in various areas, it was not an intended topic of the research[7]-[9].

We focused on the tendency of claiming younger identity and assumed that the perception that participants viewed other people as older than their actual ages was because of the perception that participants felt themselves younger than their actual ages. 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 as 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 ages to a greater extent than did 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 ages of young people were lowest, and males tended to underestimate their own ages to a greater extent than did females.

The subjective ages were obtained by estimating the actual ages of other people whom the participants considered to be of the same age by rating whether they perceived the subjects as older or younger. These subjective ages were described as "relative imaginary ages". Moreover, we found that the subjective ages remained the same regardless of stimulus expression, gender, or age group. Using the results stated above, we were able to 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 made clear, there seems to be a link between age and socio-psychological parameters; for example, confidence and social rank of an individual are related to other people's perceptions of their age.

With regard to 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 assumed that this perception is true; however, we did 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 cultural and racial factors that could not be distinguished in the comparative study between the Japanese and the Americans.

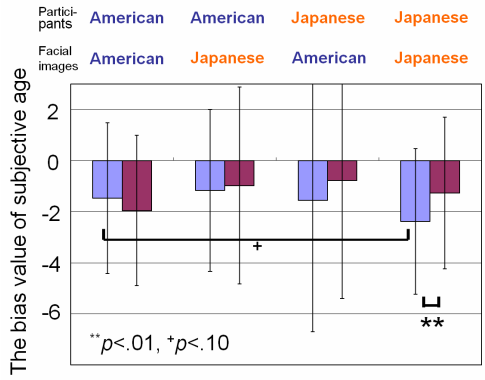


Fig. 1. Bias values of subjective age (Japanese and American).

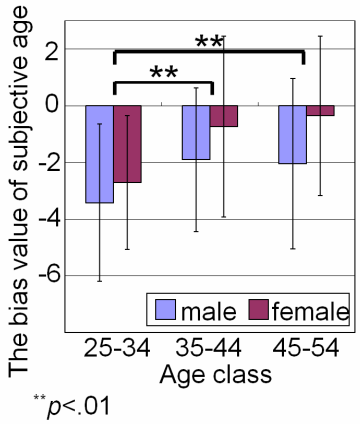
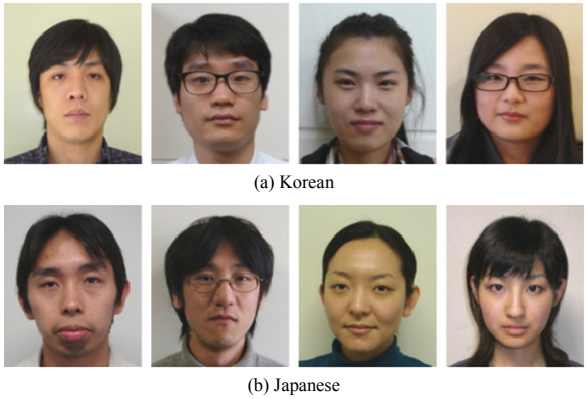


Fig. 2. Bias values of subjective age (age class).

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. To easily collect the facial images, no special conditions for shooting, lighting, makeup or hairstyles were set; this policy is consistent with the collection of facial images in our previous research.



(a) Korean

(b) Japanese

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

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 classes 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 each 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 people around the same ages in order to raise the efficiency of the experiments.

We defined the three experiments in this study as follows:

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

[Experiment II] Experiments on Korean 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.

3.4 Subjective Age Quantification 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 obtained data regarding the "difference in actual age between participants and others" and "participant estimation regarding the age of others". We plotted 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 participants tended to judge the people shown in the facial images as younger than their real ages, the entire distribution of the data shifts toward the right (in the positive area). Conversely, if the participant's tend to judge the people shown in the facial images as older than their real ages, 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 participants' tendency to significantly underestimate/overestimate the ages of others. We assumed that one of the factors behind this tendency was that each participant's subjective age was often more or less than his/her real age. Specifically, we calculated a gap between the center of the distribution and the origin of the coordinate for the x-axis and defined 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.

Table 1. Statistics associated with 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 (Participants: Korean, Facial images: Korean)

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

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

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

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

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

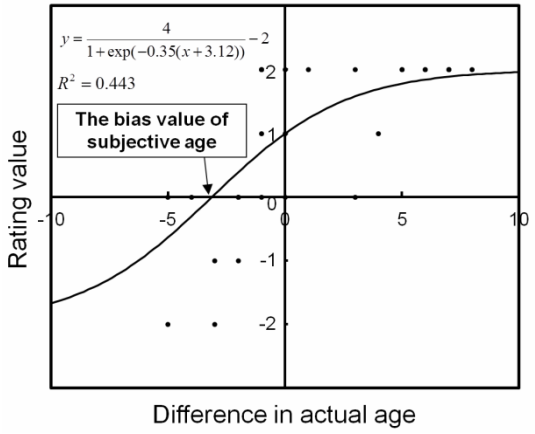


Fig. 4. The concept of subjective age. The x-axis is the difference between the actual age of the participant and the actual age of the facial images. The y-axis is the rating value. A distribution centered in the negative part of the graph would indicate that a participant tended to perceive the younger facial images as about his/her own age.

Subjective ages were calculated in order to quantify the results 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 person's age increased. Since this

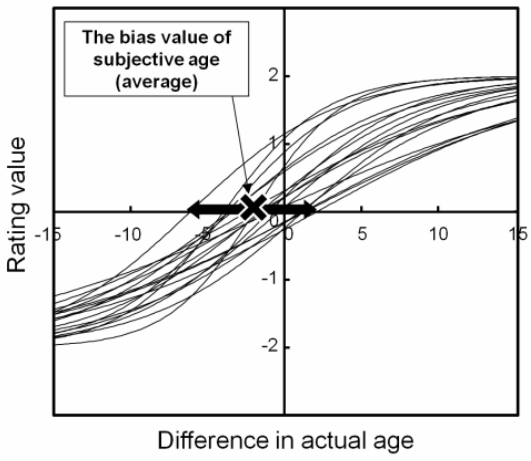


Fig. 5. Estimation curves for 18 female individuals in the middle age group with a neutral expression.

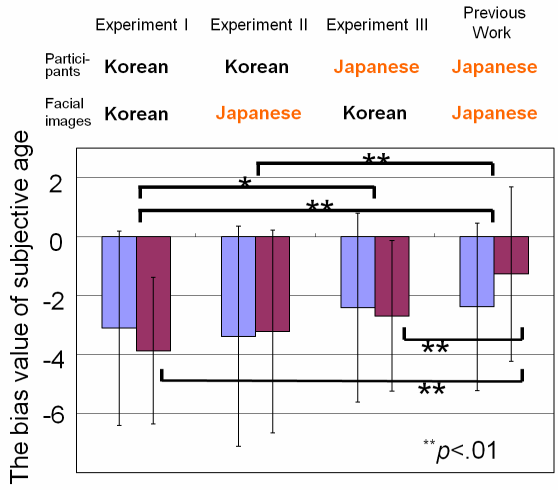


Fig. 6. Bias values of subjective age (Japanese and Korean).

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 following mathematical formula:

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

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 in which 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 ages in the experimental results of experiment I (participants: Korean; facial images: Korean), experiment II (participants: Korean; facial images: Japanese), experiment III (participants: Japanese; facial images: Korean), and the previous work (participants: Japanese; facial images: Japanese). It was confirmed that the subjective ages were generally in the negative region in all experiments.

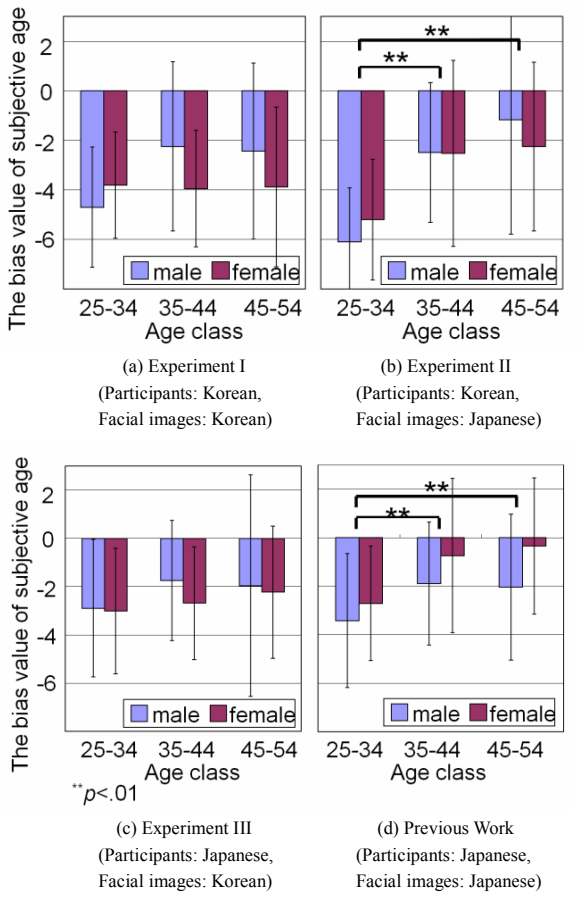
An ANOVA was performed between experiments using nationality as an independent variable; it showed that the influence of nationality was highly statistically significant ($F[1, 259] = 18.44$, $p < .01$). There were also significant differences between experiment I and experiment III and between experiment 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 (participants: 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 (participants: 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 (participants: Japanese; facial images: Korean). A two-way ANOVA was performed using gender and age group as independent variables and the bias value



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

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

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

(d) Previous Work (Participants: Japanese, Facial images: Japanese)

Fig. 7. Bias values of subjective age.

of subjective age b as the dependent variable. This analysis revealed that the main effects of gender and age group were insignificant.

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 above results, it was confirmed that the bias value of subjective age generally tends toward the negative direction despite differences in 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 ages of strangers, only currently observed information is available. We suggest that when we can estimate our real age, our remembered image tends toward the previous direction; this gap causes us to perceive others as 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 investigated 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, subjective ages were notably lower for Korean females than for Japanese females. These results indicated the possibility of differences in the cultural environments surrounding Korean and Japanese females (e.g., social status or expected attitude).

There was also 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 ages for those of a different nationality in Experiment III. This indicated a possible difference in "look age" between Koreans and Japanese; this may be a cultural effect on age estimation.

6. Conclusions

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

The results of this study showed that (1) Koreans also tend toward underestimation, which indicates that subjective ages generally tend 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.

The accuracy of age estimation or face recognition can be improved by investigating 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 subjective ages tended toward the negative direction despite differences in 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 ages (ages estimated by others) of females.

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