INTRODUCTION

Recent neuroscience research has investigated the mechanisms and neural bases of emotion processing. In these experimental studies, images of facial expressions pertaining to various specific emotions have often been used, because facial expressions are one of the most powerful means of communication between human beings.\(^1\) The importance of facial expressions in social interaction and social intelligence is widely recognized in anthropology and psychology.

In 1978, Ekman and Friesen\(^2\) developed images of 110 facial expressions of emotions that included Caucasians and African Americans of various ages. Following this, Matsumoto and Ekman\(^3\) developed the Japanese and Caucasian Facial Expressions of Emotion (JACFEE) instrument, whose reliability has been demonstrated.\(^4\) Additionally, Gur et al.\(^5\) developed and validated a set of three-dimensional color facial images expressing five emotions.

To date, facial data developed for the affective neuroscience studies have typically been restricted in ethnicity and age range. Although substantial research has documented the universality of some basic emotional expressions,\(^6,7\) recent findings have demonstrated cultural differences in levels of recognition and ratings of intensity.\(^8,9\) Further, neural responses to emotions processing have been suggested to be different among different ethnicities.\(^10,11\) These reports suggest that appropriate facial emotional data are needed for each ethnic group.

Our group in Korea published the standardized ChaeLee Korean Facial Expressions of Emotions tool that consists of 44 color facial pictures of 6 professional actors.\(^12\) Subsequently,
other groups of researchers have developed sets of Korean facial emotional expressions. These include Lee et al.’s set of 6125 expressions in the Korea University Facial Expression Collection (KUFEC) that used 49 amateur actors (25 females and 24 males, age range 20-35 years). These pictures were taken from three angles (45°, 0°, -45°), and the subject gazed in five directions (straight, left, right, upward, and downward). However, the validity data of the raters were not published, and the ages of the performers were all relatively young. Recently, Park et al. reported 176 expressions in their Korean Facial Expressions of Emotion (KOFEE) tool that used 15 performers (7 males, 8 females) and showed at least 50% of consistency by the 105 raters. Again, the performers of the KOFEE were limited to young ages. Also, facial expressions were elicited by activating muscles related to each specific emotion.

In the present study, we report the development of the extended ChaeLee Korean facial expressions of emotions and its validation study.

METHODS

Acquisition of facial expressions
For this study, we trained 50 professional actors (25 males, 25 females) to appropriately express seven facial expressions: happiness, sadness, anger, surprise, disgust, fear, and neutral. All participants joined the study voluntarily after being fully informed of its purpose and procedure, and all of them signed a written informed consent to our use of their portraits. This study was approved by the St. Mary’s Hospital, The Catholic University of Korea, Institutional Review Board.

The facial expressions were recorded by a high-definition camcorder (TRV-940, Sony, Japan). Eight well-trained medical college students (4 males, 4 females; mean age 23.4 ± 1.4 years) reviewed the video clips and extracted frames of facial expressions that portrayed the intended emotions. Confusing or possibly misleading facial expressions were not included. The entire procedure was repeated for all facial images until a consensus of researchers and students was reached. Finally, 283 images from 40 actors were selected for the study. Remarkable characteristics of the facial images such as blemishes and moles were removed, and other properties of the images such as background, eye position, and facial brightness were adjusted to make them uniform.

Validation of the facial expressions
Selection of subjects
One hundred and four subjects were recruited in the present study who had no past history or current diagnosis of psychiatric disorder, no medical disorder possibly affecting brain function, and who had not taken any drugs influencing motor function. Subjects who scored above the cutoff scores on the Beck Depression Inventory (BDI) or on the Spielberger’s State Anxiety Inventory (SAI) were excluded from participation in the validation study. The cutoff scores for the BDI were 23 for male and 24 for female participants, and it was 61 for the SAI for both sexes.

All subjects participated voluntarily, with the objective and procedures of the experiment thoroughly explained to them prior to the study. All who agreed to participate signed an informed consent and were paid for their participation.

Facial emotion identification task
Prior to the main session, the subjects had practice sessions with 7-14 stimuli selected from the ChaeLee Korean Facial Expressions of Emotion images which were validated in our previous study. Then, in the main session, a randomly selected image of facial expression (720×480 mm) was displayed on a screen for 5 seconds. Subjects were asked to select an emotion label for the facial expression and rate its valence and arousal as quickly as possible. We used a forced-choice method for emotion labeling in which the subject selected one emotion from the seven given choices (happiness, sadness, anger, surprise, disgust, fear, or neutral).

The valence and arousal were rated on a Likert scale from 1 to 5. For the valence rating, images that conveyed the most positive or appealing feeling corresponded to 5, and the most negative to 1. Similarly, for the arousal rating, participants were directed to give a rating of 5 to an image if they were greatly aroused by it, and 1 if they felt completely relaxed and calm. To lessen the fatigue effect, the images were divided equally into two runs with a 10-minute break between them. The tasks were done in a quiet environment so that the subjects would not be distracted. The facial stimuli were presented and responses were obtained using E-PRIME v1.1 (Psychology Software Tools, Pittsburgh, PA, USA).

Statistical analysis
The demographic data for participants in the validation study were summarized as “mean ± standard deviation” or n (%) depending on their type.

The consistency of labeling for each facial expression was estimated by computing the percentage of each emotion answered as intended. The valence and arousal ratings were summarized as mean ± standard deviation. In order to obtain differences of valence and arousal among emotion types, one-way ANOVA analysis and post-hoc analysis were conducted. All analysis was conducted using SAS/PC version 9.2 (SAS Institute Inc., Cary, NC, USA).
RESULTS

Demographic characteristics of the participants for validation study

Data from 94 subjects were included in the validation study analysis, after exclusion of 8 subjects with missing data due to technical problems of the computerized emotion identification program. The average age of subjects was 29.4±9 years, 49 (52.1%) were males, and 45 (47.9%) were females. Regarding occupations, students were the majority of the subjects at 70.2%, followed by office employees (7.4%), housewives (7.4%), service workers (6.4%), and professionals (5.3%). The average number of years spent in education was 18.6±7.7, and 94.7% of subjects were right-handed. The participants were within the normal ranges of depression and anxiety scores (Table 1).

Demographic characteristics of facial expressions of emotions

Based on the validation study results, we made a final selection of 259 pictures of 37 actors for inclusion in the Extended ChaeLee Korean Facial Expressions of Emotions tool, after excluding 3 actors’ pictures due to low ratings consistency (Figure 1). The average age of the actors whose facial images were ultimately selected was 38±11.1 years (range 26-60 years), with 11 people in their 20’s (29.7%), 14 in their 30’s (37.8%), 5 in their 40’s (13.5%), 5 in their 50’s (13.5%), and 2 in their 60’s

Table 1. Demographic characteristics of subjects who participated in the ratings of the Extended ChaeLee Korean Facial Expressions of Emotions (N=94)

| Characteristic                  | Value          |
|---------------------------------|----------------|
| Age (year)                      | 29.4±9         |
| Sex                             |                |
| Male                            | 49 (52.1)      |
| Female                          | 45 (47.9)      |
| Occupation                      |                |
| Student                         | 66 (70.2)      |
| Housewife                       | 7 (7.4)        |
| Office worker                   | 7 (7.4)        |
| Service                         | 6 (6.4)        |
| Professional specialty          | 5 (5.3)        |
| Self-employed                   | 1 (1.1)        |
| None                            | 1 (1.1)        |
| Other                           | 1 (1.1)        |
| Education (year)                | 18.6±7.7       |
| Handiness                       |                |
| Right                           | 89 (94.7)      |
| Left                            | 2 (2.1)        |
| Both                            | 3 (3.2)        |
| Beck Depression Inventory       | 5.3±4.8        |
| State Anxiety Inventory         | 36.6±10.1      |

Numbers represent mean±SD or n (%). SD: standard deviation

Figure 1. Some examples from the Extended ChaeLee Korean Facial Expressions of Emotions.

Figure 2. Age and sex distribution of actors in the final selections for the Extended ChaeLee Korean Facial Expressions of Emotions.
(5.4%). The numbers of female and male participants were 20 (52.6%) and 18 (47.4%), respectively (Figure 2).

Consistency of emotion labeling
Judgments of the emotion for each facial expression image are summarized in Table 2. The average consistency, i.e., the mean percent of people who recognized a facial expression as the intended emotion, was 95.5% (80.9-100%) for happiness, 89.2% (62.2-98.9%) for sadness, 87.6% (25.8-97.8%) for anger, 85.5% (64.0-95.6%) for surprise, 69.1% (21.1-92.1%) for disgust, 49.0% (22.2-83.1%) for fear, and 92.2% (78.7-98.9%) for neutral facial expression. Consistency for fearful expressions

| Subject no. | Sex | Age | Happy | Sad | Angry | Disgust | Fear | Surprise | Neutral |
|-------------|-----|-----|-------|-----|-------|---------|------|----------|---------|
| 1           | M   | 36  | 92.1  | 86.5| 85.4  | 79.8    | 37.1 | 84.3     | 96.6    |
| 3           | F   | 60  | 100   | 98.9| 94.4  | 75.3    | 78.7 | 64       | 84.3    |
| 4           | F   | 37  | 91    | 96.6| 95.5  | 65.2    | 33.7 | 93.3     | 83.1    |
| 7           | F   | 41  | 97.8  | 98.9| 94.4  | 92.1    | 62.9 | 79.8     | 83.1    |
| 8           | F   | 49  | 96.6  | 96.6| 89.9  | 43.8    | 60.7 | 93.3     | 94.4    |
| 11          | F   | 57  | 84.3  | 96.6| 25.8  | 82      | 51.7 | 79.8     | 95.5    |
| 12          | M   | 31  | 96.6  | 96.6| 95.5  | 92.1    | 39.3 | 94.4     | 96.6    |
| 13          | M   | 45  | 95.5  | 98.9| 95.5  | 56.2    | 30.3 | 93.3     | 96.6    |
| 14          | M   | 30  | 95.5  | 88.8| 94.4  | 60.7    | 52.8 | 85.4     | 95.5    |
| 16          | F   | 49  | 97.8  | 78.7| 73    | 71.9    | 42.7 | 88.8     | 86.5    |
| 17          | M   | 57  | 94.4  | 92.1| 89.9  | 82      | 53.9 | 78.7     | 87.6    |
| 18          | M   | 38  | 97.8  | 73  | 92.1  | 77.5    | 24.7 | 93.3     | 93.3    |
| 19          | M   | 34  | 100   | 92.1| 86.5  | 79.8    | 67.4 | 91       | 97.8    |
| 21          | F   | 32  | 95.5  | 94.4| 51.7  | 86.5    | 62.9 | 91       | 86.5    |
| 22          | F   | 28  | 95.5  | 97.8| 96.6  | 85.4    | 37.1 | 93.3     | 82      |
| 23          | F   | 54  | 80.9  | 96.6| 95.5  | 53.9    | 47.2 | 85.4     | 91      |
| 24          | M   | 30  | 96.9  | 87.6| 89.9  | 86.5    | 40.4 | 87.6     | 97.8    |
| 25          | F   | 40  | 94.4  | 89.9| 97.8  | 76.4    | 83.1 | 68.9     | 78.7    |
| 26          | F   | 55  | 96.7  | 65.6| 92.2  | 74.2    | 25.6 | 92.2     | 94.4    |
| 27          | F   | 58  | 95.6  | 96.7| 80    | 66.3    | 74.4 | 78.9     | 85.6    |
| 28          | M   | 30  | 96.7  | 83.3| 88.9  | 78.7    | 63.3 | 74.4     | 95.6    |
| 29          | F   | 26  | 96.7  | 94.4| 95.6  | 60.7    | 22.2 | 87.8     | 98.9    |
| 30          | F   | 26  | 97.8  | 96.7| 94.4  | 64      | 58.9 | 93.3     | 95.6    |
| 31          | M   | 29  | 92.2  | 91.1| 97.8  | 71.9    | 71.1 | 71.1     | 97.8    |
| 32          | F   | 38  | 98.9  | 92.2| 94.4  | 53.9    | 33.3 | 93.3     | 95.6    |
| 34          | F   | 27  | 96.7  | 62.2| 96.7  | 79.8    | 43.3 | 67.8     | 92.2    |
| 35          | M   | 27  | 98.9  | 87.8| 95.6  | 79.8    | 25.6 | 93.3     | 98.9    |
| 36          | M   | 29  | 96.7  | 93.3| 94.4  | 79.8    | 52.2 | 70       | 93.3    |
| 38          | F   | 27  | 96.7  | 92.2| 93.3  | 30.3    | 55.6 | 87.8     | 96.7    |
| 39          | F   | 34  | 97.8  | 81.1| 93.3  | 84.3    | 38.9 | 92.2     | 96.7    |
| 41          | M   | 60  | 83.3  | 96.7| 47.8  | 48.3    | 22.2 | 88.9     | 95.6    |
| 43          | M   | 31  | 97.8  | 63.3| 94.4  | 95.5    | 47.8 | 87.8     | 81.1    |
| 44          | F   | 29  | 96.7  | 91.1| 85.6  | 86.5    | 70   | 84.4     | 97.8    |
| 45          | F   | 34  | 98.9  | 97.8| 96.7  | 97.8    | 74.4 | 95.6     | 91.1    |
| 48          | F   | 31  | 98.9  | 73.3| 96.7  | 97.8    | 45.6 | 88.9     | 93.3    |
| 49          | M   | 29  | 98.9  | 84.4| 90    | 91      | 47.8 | 85.6     | 92.2    |
| 50          | M   | 29  | 95.6  | 95.6| 70    | 70.8    | 41.1 | 86.7     | 92.2    |

M: male, F: female
was the lowest among the emotions. A confusion matrix of the facial expressions showed that fear was most often confused with surprise (43.1%). Also, disgust facial expressions were sometimes confused with happiness, anger, or other emotions (Figure 3).

Scores of valence and arousal rating

The mean valence and arousal ratings for the facial expressions are summarized in Table 3. The mean valence ratings were 4.0 ± 0.2 (3.3-4.4) for happy facial expressions, 2.6 ± 0.1 (2.3-2.8) for surprise, 2.1 ± 0.2 (1.9-2.5) for fear, 1.9 ± 0.2 (1.8-2.4) for sadness, 1.9 ± 0.1 (1.6-2.1) for anger, 1.9 ± 0.1 (1.7-2.1) for disgust, and 2.7 ± 0.1 (2.5-3.1) for neutral. ANOVA and post-hoc analysis categorized 4 groups from positive to negative: happiness, surprise and neutral, fear, and others (sad, angry and disgust) (F=372.261, p<0.001).

The mean arousal ratings were 3.7 ± 0.2 (3.3-4.3) for anger, 3.7 ± 0.1 (3.3-4.0) for fear, 3.4 ± 0.2 (3.0-3.7) for sadness, 3.4 ± 0.1 (3.2-3.7) for disgust, 3.4 ± 0.1 (3.2-3.6) for surprise, 2.9 ± 0.1 (2.7-3.1) for happiness, and 2.5 ± 0.1 (2.3-2.7) for neutral. ANOVA and post-hoc analysis revealed 4 groups from highest to lowest arousal rating: anger and fear, sadness and disgust, surprise and happiness, and neutral (54.227, p<0.001).

DISCUSSION

In the present study, the authors obtained a set of facial emotional expressions to create the Extended ChaeLee Korean Facial Expressions of Emotions tool (ChaeLee-E), composed of images of 37 actors of a wide age range (26-60 years). About 40% of the actors were in their thirties, 5 were in their 50’s, and 2 were in their 60’s. To our knowledge, the ChaeLee-E is the first to include Korean facial expression images for a wide range of ages. Previous neuroscience studies have used facial expressions only of young actors, yet previous findings have suggested an aging effect on facial emotion recognition. However, no data have been available about the emotion recognition of older people when they see facial expressions of younger people or people their own age, even though this is an interesting research topic. Using the ChaeLee-E could foster the examination of the interaction effects of age in the images with age in the observers.

For the validation study, 94 healthy subjects approximately evenly distributed in sex provided data for analysis. The average consistency for each emotion was similar to that in our previous study and in other studies. Specifically, happiness showed the highest consistency, and fear and disgust showed the lowest. Previous studies have consistently reported the finding that happy expressions are the most accurately recognized of all the emotions. This may be because happiness was the only positive emotion in the study, and all the others presented were negative emotions. Also, according to Ekman and Friesen, the happiness expression is produced by using only the zygomatic major muscle while other negative emotions are produced by combinations of overlapping facial muscles, which leads to difficulty in differentiating among negative emotions.

Following happiness, the consistency for sadness was the next highest among the emotional expressions (89.1%). Shioiri et al. suggested that sadness may draw sympathetic responses from others, while other negative emotions such as anger, disgust, and fear seem to elicit negative responses from observers. This may help to explain why sadness had more consistent recognition than the other negative emotions.

The consistency ratings for disgust and fear were the lowest among the emotional expressions, showing a wide variation in labeling. This may be because emotion judgments might be affected by the degree of complexity of the facial components involved in the expressions. As compared to happy emotion, fear expression is complex, given the number of muscles innervated. Also, previous studies that showed low recognition rate for negative emotions such as fear, anger and disgust
### Table 3. Ratings of valence and arousal for each photograph

| No. | ID  | Valence Score | Arousal Score |
|-----|-----|---------------|---------------|
| 1   | 01A | 1.9±0.7       | 3.8±0.9       |
| 2   | 01D | 2.0±0.7       | 3.2±0.8       |
| 3   | 01F | 2.1±0.7       | 3.3±0.8       |
| 4   | 01H | 4.0±1.0       | 2.9±1.1       |
| 5   | 01N | 2.6±0.6       | 2.5±0.8       |
| 6   | 01S | 2.1±0.7       | 3.1±0.9       |
| 7   | 01Su| 2.5±0.6       | 3.4±0.8       |
| 8   | 03A | 1.8±0.6       | 3.8±0.9       |
| 9   | 03D | 1.9±0.6       | 3.6±0.8       |
| 10  | 03F | 1.9±0.8       | 4.0±0.9       |
| 11  | 03H | 4.0±1.0       | 3.1±1.2       |
| 12  | 03N | 2.5±0.7       | 2.7±0.9       |
| 13  | 03S | 1.8±0.7       | 3.5±1.0       |
| 14  | 03Su| 2.3±0.8       | 3.5±0.8       |
| 15  | 04A | 1.9±0.7       | 3.8±0.8       |
| 16  | 04D | 1.9±0.6       | 3.2±0.9       |
| 17  | 04F | 1.9±0.7       | 3.7±0.8       |
| 18  | 04H | 3.7±1.0       | 2.9±1.1       |
| 19  | 04N | 2.7±0.6       | 2.6±0.8       |
| 20  | 04S | 1.8±0.7       | 3.5±1.0       |
| 21  | 04Su| 2.6±0.5       | 3.4±0.8       |
| 22  | 07A | 1.8±0.7       | 3.8±0.9       |
| 23  | 07D | 1.9±0.7       | 3.5±0.8       |
| 24  | 07F | 2.0±0.7       | 3.7±0.8       |
| 25  | 07H | 4.2±0.6       | 2.7±1.1       |
| 26  | 07N | 3.1±0.6       | 2.6±0.7       |
| 27  | 07S | 1.8±0.7       | 3.7±1.0       |
| 28  | 07Su| 2.5±0.7       | 3.5±0.9       |
| 29  | 08A | 1.8±0.6       | 3.6±0.8       |
| 30  | 08D | 2.0±0.7       | 3.3±0.9       |
| 31  | 08Fm| 2.2±0.7       | 3.6±0.9       |
| 32  | 08H | 4.2±0.8       | 2.7±1.2       |
| 33  | 08N | 2.7±0.6       | 2.3±0.8       |
| 34  | 08S | 2.0±0.6       | 3.4±0.8       |
| 35  | 08Su| 2.6±0.6       | 3.4±0.8       |
| 36  | 11A | 2.0±0.7       | 3.7±0.9       |
| 37  | 11D | 1.9±0.6       | 3.5±0.9       |
| 38  | 11F | 2.1±0.7       | 3.8±0.9       |
| 39  | 11H | 3.6±0.8       | 2.8±0.9       |
| 40  | 11N | 2.5±0.7       | 2.5±0.9       |
| 41  | 11S | 1.8±0.8       | 3.5±1.0       |
| 42  | 11Su| 2.4±0.7       | 3.5±0.8       |
| 43  | 12A | 1.7±0.7       | 3.8±0.9       |
| 44  | 12D | 1.9±0.7       | 3.6±0.8       |

### Table 3. Continued

| No. | ID  | Valence Score | Arousal Score |
|-----|-----|---------------|---------------|
| 45  | 12F | 2.2±0.7       | 3.5±0.9       |
| 46  | 12H | 3.8±0.8       | 2.9±0.9       |
| 47  | 12N | 2.7±0.6       | 2.6±0.8       |
| 48  | 12S | 1.9±0.6       | 3.3±0.9       |
| 49  | 12Su| 2.8±0.7       | 3.4±0.8       |
| 50  | 13A | 2.0±0.6       | 3.7±0.8       |
| 51  | 13D | 2.0±0.6       | 3.4±0.8       |
| 52  | 13F2| 2.3±0.6       | 3.4±0.8       |
| 53  | 13H | 4.1±0.9       | 3.0±1.1       |
| 54  | 13N | 2.8±0.6       | 2.5±0.8       |
| 55  | 13S | 1.9±0.6       | 3.2±0.9       |
| 56  | 13Su| 2.6±0.6       | 3.4±0.8       |
| 57  | 14A | 1.8±0.7       | 3.8±0.9       |
| 58  | 14D | 1.9±0.6       | 3.4±0.9       |
| 59  | 14F | 2.1±0.6       | 3.6±0.9       |
| 60  | 14H | 4.1±0.8       | 3.1±1.1       |
| 61  | 14N | 2.7±0.6       | 2.6±0.8       |
| 62  | 14S | 1.9±0.6       | 3.3±1.0       |
| 63  | 14Su| 2.6±0.7       | 3.5±0.9       |
| 64  | 16A | 2.1±0.7       | 3.4±0.8       |
| 65  | 16D | 2.0±0.5       | 3.4±0.8       |
| 66  | 16F | 1.9±0.7       | 3.8±0.8       |
| 67  | 16H | 4.4±0.7       | 3.0±1.2       |
| 68  | 16N | 3.0±0.7       | 2.3±0.9       |
| 69  | 16S | 2.4±1.1       | 3.3±1.0       |
| 70  | 16Su| 2.6±0.6       | 3.4±0.8       |
| 71  | 17A | 1.8±0.7       | 3.6±0.9       |
| 72  | 17D | 2.1±0.6       | 3.4±0.8       |
| 73  | 17F | 2.3±0.7       | 3.8±0.8       |
| 74  | 17H | 4.0±0.9       | 2.8±1.1       |
| 75  | 17N | 2.8±0.6       | 2.5±0.8       |
| 76  | 17S | 1.9±0.6       | 3.4±0.8       |
| 77  | 17Su| 2.6±0.6       | 3.2±0.8       |
| 78  | 18A | 1.9±0.7       | 3.7±0.9       |
| 79  | 18D | 1.9±0.6       | 3.4±0.8       |
| 80  | 18F | 2.2±0.6       | 3.5±0.7       |
| 81  | 18H | 4.2±0.7       | 2.9±1.1       |
| 82  | 18N | 2.6±0.7       | 2.5±0.8       |
| 83  | 18S | 2.3±0.9       | 3.0±0.9       |
| 84  | 18Su| 2.7±0.6       | 3.2±0.9       |
| 85  | 19A | 1.9±0.6       | 3.5±1.0       |
| 86  | 19D | 1.8±0.6       | 3.7±0.9       |
| 87  | 19F | 2.1±0.7       | 3.6±0.9       |
| 88  | 19H | 4.3±0.7       | 2.9±1.2       |
Table 3. Continued

| Photographs | Valence score | Arousal score |
|-------------|---------------|---------------|
| No. | ID |               |               |
| 89 | 19N | 2.6±0.6 | 2.5±0.8 |
| 90 | 19S | 1.8±0.7 | 3.4±1.0 |
| 91 | 19Su | 2.4±0.6 | 3.2±0.9 |
| 92 | 21A | 2.0±0.6 | 3.5±0.9 |
| 93 | 21D | 1.7±0.7 | 3.6±0.8 |
| 94 | 21F | 2.2±0.8 | 3.8±0.8 |
| 95 | 21H | 3.9±1.0 | 3.1±1.2 |
| 96 | 21N | 2.7±0.6 | 2.6±0.8 |
| 97 | 21S | 2.0±0.7 | 3.3±0.8 |
| 98 | 21Su | 2.6±0.7 | 3.5±0.8 |
| 99 | 22A | 1.8±0.6 | 3.8±0.8 |
| 100 | 22D | 1.9±0.7 | 3.5±0.9 |
| 101 | 22F | 2.3±0.7 | 3.6±0.9 |
| 102 | 22H | 4.4±0.7 | 3.0±1.2 |
| 103 | 22N | 2.7±0.6 | 2.5±0.8 |
| 104 | 22S | 1.8±0.8 | 3.5±0.9 |
| 105 | 22Su | 2.7±0.6 | 3.4±0.8 |
| 106 | 23A | 1.8±0.6 | 3.7±0.9 |
| 107 | 23D | 1.9±0.7 | 3.6±0.8 |
| 108 | 23F | 2.0±0.7 | 3.7±0.9 |
| 109 | 23H | 3.3±1.0 | 2.8±0.9 |
| 110 | 23N | 2.5±0.6 | 2.6±0.9 |
| 111 | 23S | 1.8±0.7 | 3.6±0.9 |
| 112 | 23Su | 2.4±0.6 | 3.4±0.8 |
| 113 | 24A | 1.9±0.6 | 3.8±0.8 |
| 114 | 24D | 1.9±0.6 | 3.4±0.8 |
| 115 | 24F | 2.3±0.6 | 3.5±0.8 |
| 116 | 24H | 4.0±0.9 | 3.0±1.2 |
| 117 | 24N | 2.6±0.6 | 2.5±0.9 |
| 118 | 24S | 2.0±0.5 | 3.3±0.8 |
| 119 | 24Su | 2.7±0.7 | 3.4±0.8 |
| 120 | 25A | 1.8±0.7 | 3.9±0.9 |
| 121 | 25D | 1.8±0.6 | 3.6±0.9 |
| 122 | 25F | 2.0±0.7 | 3.7±1.0 |
| 123 | 25H | 3.7±0.9 | 2.9±1.0 |
| 124 | 25N | 2.5±0.7 | 2.5±0.9 |
| 125 | 25S | 1.8±0.7 | 3.6±1.0 |
| 126 | 25Su | 2.3±0.7 | 3.4±0.9 |
| 127 | 26A | 1.9±0.7 | 3.8±0.8 |
| 128 | 26D | 2.0±0.6 | 3.3±0.8 |
| 129 | 26F | 2.4±0.7 | 3.5±0.8 |
| 130 | 26H | 4.1±0.7 | 2.8±1.1 |
| 131 | 26N | 2.8±0.6 | 2.4±0.9 |
| 132 | 26S | 2.0±0.6 | 3.2±0.8 |

Table 3. Continued

| Photographs | Valence score | Arousal score |
|-------------|---------------|---------------|
| No. | ID |               |               |
| 133 | 26Su | 2.7±0.6 | 3.3±0.7 |
| 134 | 27A | 2.0±0.8 | 3.7±0.9 |
| 135 | 27D | 2.1±0.7 | 3.3±0.7 |
| 136 | 27F | 2.0±0.7 | 3.9±0.8 |
| 137 | 27H | 4.0±0.9 | 3.1±1.2 |
| 138 | 27N | 3.0±0.6 | 2.3±0.9 |
| 139 | 27S | 1.9±0.6 | 3.5±0.9 |
| 140 | 27Su | 2.7±0.7 | 3.2±0.8 |
| 141 | 28A | 1.8±0.7 | 3.8±0.8 |
| 142 | 28D | 2.1±0.5 | 3.4±0.8 |
| 143 | 28F | 2.1±0.9 | 3.8±0.9 |
| 144 | 28H | 4.0±0.9 | 3.0±1.1 |
| 145 | 28N | 2.8±0.5 | 2.5±0.9 |
| 146 | 28S | 2.0±0.6 | 3.2±0.9 |
| 147 | 28Su | 2.5±0.7 | 3.6±0.8 |
| 148 | 29A | 1.9±0.7 | 3.9±0.8 |
| 149 | 29D | 1.9±0.6 | 3.4±0.8 |
| 150 | 29F | 2.4±0.8 | 3.5±0.8 |
| 151 | 29H | 4.1±0.9 | 3.0±1.3 |
| 152 | 29N | 2.8±0.5 | 2.5±0.8 |
| 153 | 29S | 1.9±0.8 | 3.5±0.9 |
| 154 | 29Su | 2.5±0.7 | 3.4±0.9 |
| 155 | 30A | 2.0±0.6 | 3.6±0.9 |
| 156 | 30D | 2.1±0.7 | 3.5±0.8 |
| 157 | 30F | 2.1±0.6 | 3.5±0.9 |
| 158 | 30H | 4.2±0.8 | 2.8±1.3 |
| 159 | 30N | 2.8±0.5 | 2.5±0.8 |
| 160 | 30S | 2.0±0.6 | 3.3±0.8 |
| 161 | 30Su | 2.6±0.6 | 3.4±0.8 |
| 162 | 31A | 1.8±0.7 | 3.8±0.9 |
| 163 | 31D | 2.1±0.6 | 3.3±0.9 |
| 164 | 31F | 1.9±0.8 | 3.9±0.9 |
| 165 | 31H | 3.7±1.0 | 2.8±0.9 |
| 166 | 31N | 2.8±0.4 | 2.4±0.8 |
| 167 | 31S | 1.9±0.8 | 3.5±0.8 |
| 168 | 31Su | 2.6±0.7 | 3.4±0.8 |
| 169 | 32A | 1.9±0.6 | 3.7±0.9 |
| 170 | 32D | 1.8±0.6 | 3.4±0.9 |
| 171 | 32F | 2.2±0.7 | 3.4±0.8 |
| 172 | 32H | 4.2±0.8 | 3.0±1.3 |
| 173 | 32N | 2.9±0.4 | 2.4±0.8 |
| 174 | 32S | 2.0±0.8 | 3.4±0.9 |
| 175 | 32Su | 2.6±0.6 | 3.3±0.8 |
| 176 | 34A | 1.8±0.8 | 4.0±0.9 |
Table 3. Continued

| No. | ID | Valence score | Arousal score |
|-----|----|---------------|---------------|
| 177 | 34D | 1.9±0.6 | 3.5±0.8 |
| 178 | 34F | 2.3±0.7 | 3.6±0.8 |
| 179 | 34H | 4.1±0.8 | 2.9±1.2 |
| 180 | 34N | 2.7±0.6 | 2.6±0.8 |
| 181 | 34S | 2.0±0.7 | 3.3±0.9 |
| 182 | 34Su | 2.3±0.7 | 3.6±0.7 |
| 183 | 35A | 1.8±0.6 | 3.9±0.8 |
| 184 | 35D | 2.0±0.5 | 3.4±0.7 |
| 185 | 35F | 2.5±0.7 | 3.6±0.8 |
| 186 | 35H | 4.3±0.7 | 2.9±1.2 |
| 187 | 35N | 2.8±0.5 | 2.5±0.8 |
| 188 | 35S | 1.9±0.7 | 3.3±0.9 |
| 189 | 35Su | 2.5±0.6 | 3.3±0.8 |
| 190 | 36A | 1.8±0.8 | 4.0±0.8 |
| 191 | 36D | 1.9±0.6 | 3.4±0.8 |
| 192 | 36F | 2.3±0.7 | 3.7±0.8 |
| 193 | 36H | 4.1±0.8 | 2.8±1.2 |
| 194 | 36N | 2.8±0.6 | 2.6±0.8 |
| 195 | 36S | 1.9±0.7 | 3.3±1.0 |
| 196 | 36Su | 2.4±0.7 | 3.4±0.9 |
| 197 | 38A | 2.0±0.7 | 3.7±0.9 |
| 198 | 38D | 2.0±0.6 | 3.4±0.8 |
| 199 | 38F | 2.2±0.8 | 3.7±0.8 |
| 200 | 38H | 4.1±0.7 | 2.8±1.1 |
| 201 | 38N | 2.8±0.5 | 2.5±0.8 |
| 202 | 38S | 1.9±0.5 | 3.4±0.8 |
| 203 | 38Su | 2.6±0.7 | 3.5±0.8 |
| 204 | 39A | 1.8±0.6 | 3.7±0.8 |
| 205 | 39D | 1.8±0.7 | 3.6±0.8 |
| 206 | 39F | 2.2±0.6 | 3.5±0.8 |
| 207 | 39H | 4.2±0.7 | 2.9±1.1 |
| 208 | 39N | 2.8±0.5 | 2.4±0.9 |
| 209 | 39S | 2.0±0.6 | 3.4±0.8 |
| 210 | 39Su | 2.5±0.6 | 3.3±0.7 |
| 211 | 41A | 2.1±0.7 | 3.5±0.8 |
| 212 | 41D | 1.9±0.5 | 3.4±0.7 |
| 213 | 41F | 2.5±0.7 | 3.5±0.8 |
| 214 | 41H | 3.7±0.9 | 2.8±1.0 |
| 215 | 41N | 2.9±0.5 | 2.6±0.8 |
| 216 | 41S | 1.8±0.7 | 3.4±0.9 |
| 217 | 41Su | 2.4±0.7 | 3.3±0.7 |
| 218 | 43A | 1.6±0.7 | 4.3±0.8 |
| 219 | 43D | 1.9±0.6 | 3.6±0.8 |

In the photo IDs, the digits represent subject number, and the letters represent emotion types. H: happiness, S: sadness, N: neutral, A: anger, D: disgust, F: fear, Su: surprise.
in Japanese and Chinese population might suggest the presence of similar cultural influence on the recognition of facial expressions in Korean population.\(^2,3\) The confusion matrix of the facial expressions shows that fear was most often confused with surprise (43.2\%). Also, the disgust facial expressions were sometimes confused with happiness, anger, or other emotions (Figure 3).

In addition to labeling discrete emotions for each facial expression, we also measured how the participants perceived the internal state of the actors in terms of the broad bipolar dimensions of valence and arousal. Regarding the valence of the facial expressions, positive pictures were rated as positive, and negative pictures were rated as negative, while neutral pictures were rated as a little negative. Surprise facial expressions were rated as having valences similar to those of neutral expressions. Sad, angry, and disgust facial expressions were most negatively perceived by participants. These findings are consistent with previous research that differentiated the valence of facial expressions as positive, neutral, and negative (sad, anger, and fear were seen as having negative valence).\(^2,4\)

Regarding the arousal ratings, the highest arousals were for fear and anger, while the lowest were for neutral, with sadness, disgust, surprise, and happiness falling between them.

A previous study showed that fear and anger were highly arousing emotions, as evidenced by the degree of heart rate increase.\(^2,5\) Also, earlier work has shown that fear is a negatively valenced, highly activating emotion.\(^2,6\)

In conclusion, the authors were able to obtain high quality standardized Korean facial expressions of emotions. This set of Korean facial expressions can be used as a tool for the affective neurosciences and for cultural psychiatry, and it thus contributes to the investigation of mechanisms of emotion processing in healthy individuals as well as patients with various psychiatric disorders.

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