# Effect of Social Skills on the Asymmetry in Facial Expressions

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**Abstract**

This study investigated the effect of social skills on the facial movement asymmetry in facial expressions. Three-dimensional facial landmark data of facial expressions (neutral, happy, and angry) were obtained from Japanese participants (n = 62). After the facial expression task, each participant completed KiSS-18 (Kikuchi's Scale of Social Skills; Kikuchi, 2007). Through a generalized Procrustes method, facial landmark coordinates and their mirror-reversed versions were represented as points on a hyperplane. The asymmetry of each face was defined as Euclidian distance on the plane. Subtraction of the asymmetry level of a neutral face of each individual from the asymmetry level of a target emotion face was defined as the index of "movement asymmetry" of each emotion. Correlation coefficients of Kiss-18 scores and movement asymmetry scores were computed for both happy and angry expressions. Significant negative correlations between Kiss-18 scores and movement asymmetries were found for both expressions. The results indicate that symmetric facial expressions are higher with higher level of social skills.

**Keywords:** facial expression; facial asymmetry; social skills; landmark-based 3D shape analysis.

## Introduction

Facial expressions provide various signals for social interactions. Although human faces and facial expressions are somewhat symmetrical, numerous studies have focused on facial bilateral symmetry: the degree to which one half of a face is similar to the other half. Facial asymmetry derives from two sources: structural asymmetry and movement asymmetry (Schmidt, Liu & Cohn, 2006). Structural asymmetry derives from physical variation in laterality of facial structure, while movement asymmetry derives from lateralized facial muscle movement during facial expressions. In this study, we focused on movement asymmetry in creating emotional expressions.

The primary source of facial movement asymmetry is brain lateralization in emotion processing. Several studies have shown that emotions are expressed more intensely in the left hemiface (Sackeim, Gur & Saucy, 1978; Borod, Haywood & Koff, 1997), because most facial muscles, particularly those in the lower part, are innervated by the contralateral hemisphere (Borod, 1993). Thus the dominance of the left hemiface in facial expressions has been interpreted as supporting the hypothesis of brain lateralization of emotional processing (Schwartz, Davidson & Maer, 1975; Sackeim, Greenberg, Weiman, Gur, Hungerbuhler & Geschwind, 1982). More recent studies have asserted that both hemispheres process emotion, but each hemisphere is specialized for particular types of emotion(Fusar-Poli, Placentino, Carletti, Allen, Landi, Abbamonte, Barale, Perez, McGuire & Politi, 2009) such as positive-negative emotion (Davidson, 1992; Gur, Skolnick & Gur, 1994), or approach-withdrawal (Davidson, 1999).

While the laterality in facial expressions, human face perception mostly relies on facial information contained in the right hemiface (Gilbert & Bakan, 1973; Grega, Sackeim, Sanchez, Cohen & Hough, 1988, Kanwisher, McDermott & Chun, 1997; Sergent, Ohta & MacDonald, 1992). When asked to judge the facial expression of a briefly presented chimeric face image, perceivers tend to base their decision more frequently on the expression contained within the right side of the face, i.e., the left hemiface for the viewer. Thus, the lateralization in facial expressions can lead to failure in conveying the face's real emotions to an observer. Although the role of asymmetry of facial expressions in social interactions is still unclear, asymmetric facial expression is possibly an important variable. Facial asymmetry has been proposed as a signal of developmental stability that can indicate mate quality (Grammer & Thornhill, 1994; Kowner, 1996; Penton-Voak, Jones, Little, Baker, Tiddeman, Burt & Perrett, 2001). In general, the less asymmetric a face is, the more attractive it appears (Grammer, Fink, Moller &

Thornhill, 2003; Grammer & Thornhill, 1994). This asymmetry is believed to reflect past developmental stresses and to be related to the likely quality of the individual as a potential mating partner (Fink, 2004). Such preference for symmetry may also extend to the preference for movement symmetry.

This study investigates the relationship between social skills and facial movement asymmetry in emotional expressions. Social skills are generally defined as the set of skills that enable a person to interact and communicate with others in verbal and nonverbal forms of communication. If higher social skills are related to more symmetrical facial movements in emotional expressions, symmetrical facial expressions can be considered an appropriate approach to present the face owner's emotions to receivers in social interactions.

## Method

### Facial Expression Task

Japanese undergraduate and graduate students (n = 62: 20 men and 42 women; age: 19 to 26 years, mean age = 21.3, SD = 1.37) provided three-dimensional facial shape data of neutral, happy, and angry expressions. First, the participants were instructed to show and maintain a neutral facial expression. Then, they were asked to recall their experiences in which they had felt the target emotions (happy or angry) and to describe the experience after taking each 3D image. The participants were not instructed to pose or maintain any expression of target emotion. The order of target emotions was counterbalanced among the participants. Three-dimensional (3D) shapes and textures of facial expressions of each face were captured using a 3D picture measurement device (TRiDY-S: JFE Techno-Research Corp.) based on pattern-projection method.

### Assessment of Participants' Social Skill

After the facial expression task, each participant completed KiSS-18 (Kikuchi's Scale of Social Skills; Kikuchi, 2007), an 18-item self-report measurement of social skills with higher scores indicating high level of social skills. This scale is based on six categories of social skills proposed by Goldstein (1980); basic skills, advanced skills, emotional management skills, stress management skills, offence management skills and planning skills. Basic skills include 'talking with others', 'maintaining a conversation' and 'introducing oneself'. Advanced skills include 'asking for help', 'giving instructions', 'obeying instructions', 'apologizing' and 'persuading'. Emotional management skills include 'managing fear', 'emotional expression' and 'managing others' anger'. Stress management skills include 'managing criticism' and 'managing a contradiction in message'. Offence management skills include 'helping others', 'conflict resolution' and 'managing trouble'. Planning skills include 'staying on target' and 'taking initiative'. The scale has demonstrated high reliability and validity in previous studies (Kikuchi 2007).

### Facial Shape Measurement

Thirty-six facial landmarks were selected on the basis of our previous studies (Kamide, Komori, Kawamura & Nagaoka, 2011; Figure1, Table 1). All 3D coordinates of the landmarks were visually measured using a computer program (Rapid Form 2004: INUS Technology) by referring to each of the 3D shape data and texture.

Table 1: Set of 36 facial landmarks.

| No. | Location |
|---|---|
| 1 | hairline |
| 2 | forehead |
| 3 | forehead |
| 4 | outer corner of eyebrow |
| 5 | upper point of maximum width of eyebrow |
| 6 | lower point of maximum width of eyebrow |
| 7 | innner corner of eyebrow |
| 8 | innner corner of eyebrow |
| 9 | upper point of maximum width of eyebrow |
| 10 | lower point of maximum width of eyebrow |
| 11 | outer corner of eyebrow |
| 12 | root of nose |
| 13 | side of root of nose |
| 14 | side of root of nose |
| 15 | lateral angle of eye |
| 16 | center of upper eyelid |
| 17 | center of lower eyelid |
| 18 | medial angle of eye |
| 19 | medial angle of eye |
| 20 | center of upper eyelid |
| 21 | center of lower eyelid |
| 22 | lateral angle of eye |
| 23 | zygomatic |
| 24 | zygomatic |
| 25 | apex of nose |
| 26 | ala of nose |
| 27 | ala of nose |
| 28 | subnasal point |
| 29 | angle of mouth |
| 30 | upper lip (philtrum edge) |
| 31 | central upper lip |
| 32 | upper lip (philtrum edge) |
| 33 | angle of mouth |
| 34 | stomion |
| 35 | bottom of lower lip |
| 36 | chin |

Figure. 1: Landmark locations. Photographs were formed by warping average facial texture.

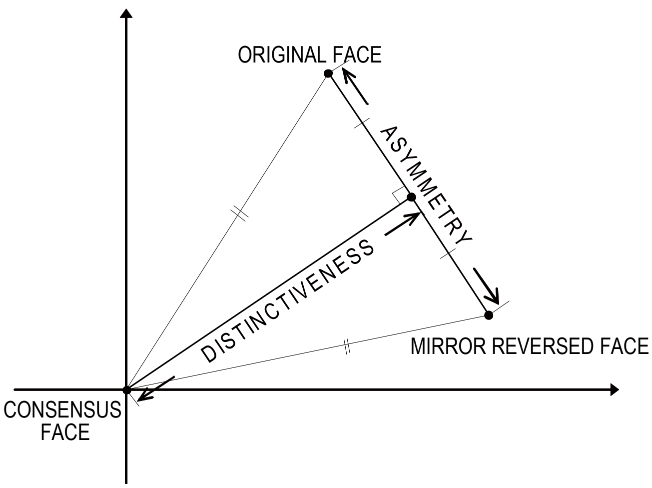


Figure 2: Schematic illustration of asymmetry. Each facial shape and its mirror-reversed version are represented as points on the tangent hyperplane. Only two axes are represented for ease of illustration. The "consensus face" is the origin of the space. Asymmetry is defined as the Euclidean distance from each original version to the mirror-reversed version.

## Facial Shape Standardization

Each face differed in location, size, and orientation. To standardize them, we performed a generalized Procrustes analysis (GPA) on the facial landmarks of all faces irrespective of the gender of the face. A GPA is an analytical method used for multivariate statistical analysis of landmark locations expressed in Cartesian coordinates. This method preserves information about the relative spatial relationships of landmarks throughout the standardization, and that has recently been applied to psychological research on human faces (Komori, Kawamura & Ishihara, 2009, 2011).

For the standardization of location and size, we used the centroid size technique (Bookstein, 1991). All facial shapes were translated into the same origin (centroid) and scaled to the unit centroid size, which is the sum of the squared distances from the centroid to each landmark. For alignment of orientation, rotations around the centroid of the faces were performed (Dryden & Mardia, 1998) such that the sum of the squared distances among corresponding landmarks between samples was minimized. Using the GPA, each facial shape was represented as a point on a linear tangent hyperplane of 108 dimensions ($36 \times 3$), which allowed us to treat the faces as multidimensional, normally distributed values.

The "Shapes" statistical package written by Dryden and Mardia (1998), which runs in an R statistical analysis environment, was employed for the analyses. In addition to the coordinates of 62 facial shapes, the mirror-reversed versions of the same faces were used in the facial shape analysis.

## Calculation of Facial Asymmetry

Through a generalized Procrustes method, each of the facial shapes and their mirror-reversed versions were represented as a point on the tangent hyperplane. We defined asymmetry (the converse of symmetry) of each facial shape as the Euclidean distance between the face and its mirror-reversed face on the hyperplane (Figure 2), according to our previous study (Komori, Kawamura & Ishihara, 2009). Furthermore, all original faces and their mirror-reversed faces were combined to create a consensus face. This was the average of all facial shapes and represented the origin of the tangent hyperplane. The distance from a given original face to the origin was the same as that from its mirror image to the origin. This distance can be regarded as an index of facial distinctiveness (the converse of facial averageness). Therefore, asymmetry and distinctiveness can be measured independently through this procedure; in other words, facial variations can be separated into distinctiveness and asymmetry.

## Calculation of Local Asymmetry

To investigate the degree of asymmetry in each facial part, such as eyebrows, eyes, and mouth, facial subspaces were constructed from the standardized landmark coordinates of eyebrows (from No. 4 to No. 12 of Table 1), eyes (from No. 15 to No. 22), and mouth (from No. 29 to No. 34). Asymmetry in each part of a face was defined as the Euclidian distance from the original version to the mirror-reversed version of each part in each subspace.

# Results

## Social Skill Score

Some studies have reported that males and females differ in facial shape (Little, Jones, Waitt, Tiddeman, Feinberg, Perrett, Apicella & Marlowe, 2008) and facial muscle reactivity (Dimberg & Lundquist, 1990). It is possible that gender differences in social skills could be a potential confound in the analysis of the relationships between social skills and facial expressions. However, the Kiss-18 scores were not significantly different between males and females ($t(60) = -.57$, $p = .57$).

## Facial Asymmetry

The mean morphological asymmetry in each facial expression is shown in Figure 3. To examine the relationship between facial expressions (neutral, happy, and angry) and facial asymmetry levels, we conducted repeated measures ANOVA with facial asymmetry levels as the dependent variable. There was no significant effect of facial expression on the facial asymmetry levels ($F(2,122) = .36$, $p = .72$).Local Asymmetries

The local asymmetries were calculated for eyebrows, eyes, and mouth (Figure 4). A repeated measures ANOVA was performed for each facial part, and a significant effect of

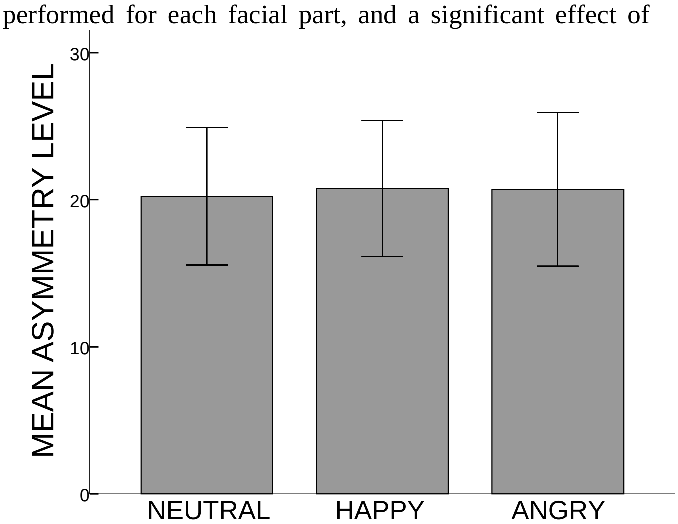


Figure 3: Mean facial asymmetry level. Error bars represent 1 S.D.

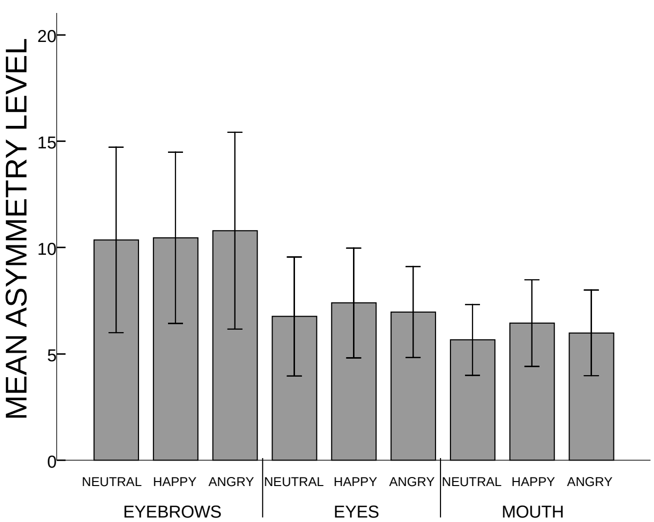


Figure 4: Mean facial asymmetry levels of facial parts. Error bars represent 1 S.D.

facial expressions on the asymmetry in mouth shape was found ($F(2,122) = 4.10$, $p = .019$). However, there was no effect of facial expressions on the asymmetries in eyebrows or eyes (eyebrows: $F(2,122) = .06$, $p = .94$; eyes: $F(2,122) = .16$, $p = .21$).

## Relationship between Social Skills and Facial Asymmetry

Since there was no significant correlation between the Kiss-18 scores and facial asymmetry levels of neutral expression, facial structural asymmetry is considered potentially unrelated to social skills ($r = .20$, $p = .13$). Thus, the subtraction of the asymmetry level of a neutral face of each individual from the asymmetry level of a target emotional face can be defined as the index of movement asymmetry that derives from facial muscle movement. Here we refer to the value as the "movement asymmetry score."

To assess whether higher social skills are linked to facial movement asymmetry, correlation coefficients of the Kiss-18 scores and movement asymmetry scores were computed for both happy and angry expressions. Figure 5 shows the relationship between social skills and movement asymmetries. There was a significant negative correlation between the Kiss-18 scores and movement asymmetries for both expressions (happiness: $r = -.30$, $p = .017$; angry: $r = -.30$, $p = .018$), indicating that the higher a participant scored on the social skills test, the more symmetric their facial expressions were.

The partial correlation coefficients between social skills and movement asymmetries, using gender of the participants as control variables, were also significant for both expressions (happiness: $r = -.30$, $p = .015$; angry: $r = -.30$, $p = .017$). This suggests that the relationship between facial movement asymmetry and social skills was not caused by the gender differences in social skills.

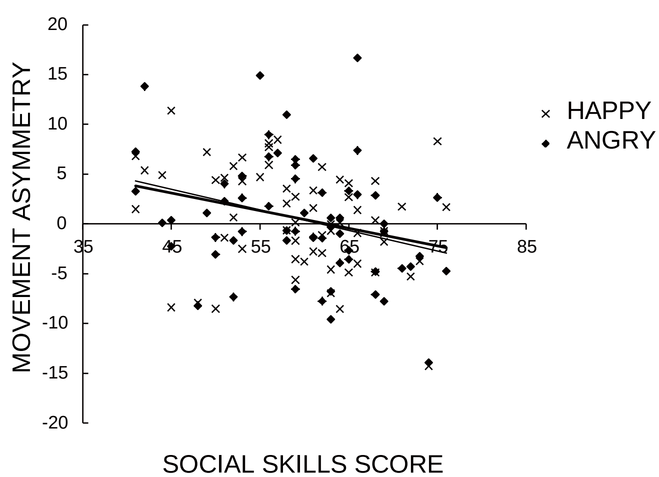


Figure 5: Relationship between social skill score and degree of facial asymmetry.

The correlation coefficient of the Kiss-18 score and movement asymmetry in each facial part was calculated for each target emotion. For a happy expression, movement asymmetry of none of the parts was significantly correlated with social skills (eyebrows: $r = -.16$, $p = .21$; eyes: $r = -.13$, $p = .33$; mouth: $r = -.02$, $p = .89$). On the other hand, for an angry expression, only movement asymmetry of mouth was found to be negatively correlated with social skills (eyebrows: $r = .03$, $p = .82$; eyes: $r = -.17$, $p = .19$; mouth: $r = -.26$, $p = .04$).

## Discussion

This study provides evidence that facial movement asymmetry in emotional expressions is linked to low social skills. Some studies have shown that a spontaneous smile is symmetrical, but a posed (voluntary) smile is asymmetrical (Gazzaniga & Smylie, 1990; Frank, Ekman & Friesen, 1993), suggesting a possibility that symmetrical facial expression is recognized as spontaneous facial expression derived from the facial owner's emotion. In fact, Ozono, Watabe, Yoshikawa, Nakashima, Rule, Ambady & Adams (2010) have reported that Japanese participants rated faces with greater smile symmetry as more trustworthy. Thus, the results of this study may reflect the connection between symmetrical facial expressions and trustworthiness.

The results also show that the relationship between low social skills and facial movement asymmetry is especially observed in the lower face region. Neurologically, movements of the lower face region follows voluntary muscle control, while upper face area movements follow automatic control (Rinn, 1994; Gazzaniga & Smylie, 1990). It is possible that the different effect of social skills on the asymmetry in the upper or lower facial areas is caused by such differential motor control.

The results of the study also suggest that the asymmetry quantification method of this study is an effective method for evaluating 3D facial asymmetry.

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