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The Symmetry of Emotional and Deliberate Facial Actions

Paul Ekman, Joseph C. Hager, and Wallace V. Friesen
University of California, San Francisco

ABSTRACT

Asymmetries of the smiling facial movement were more frequent in deliberate imitations than spontaneous emotional expressions. When asymmetries did occur they were usually stronger on the left side of the face if the smile was deliberate. Asymmetrical emotional expressions, however, were about equally divided between those stronger on the left side of the face and those stronger on the right. Similar findings were obtained for the actions involved in negative emotions, but a small data base made these results tentative.

DESCRIPTORS: Facial expression, Facial asymmetry, Emotion, Hemispheric specialization.

A number of recent studies have reported asymmetries in facial expression (Borod & Caron, 1980; Chaurasia & Goswami, 1975; Moscovitch & Olds, Note 1). Usually these asymmetries were stronger on the left than on the right side of the face. Since many of the pathways from the motor cortex cross over before reaching the facial nucleus, left stronger asymmetries suggest greater involvement of the right than of the left cerebral hemisphere. This is consistent with the claim that the right hemisphere has a special role in emotion (Carmon & Nachshon, 1973; Dimond, Farrington, & Johnson, 1976; Schwartz, Davidson, & Maer, 1975). Yet it is not certain whether the facial movements studied were actually emotional in nature. Not all facial actions are. Some are quite deliberate, such as the flirtatious or collusive wink. Some actions may be signs of cognitive more than emotional activity, as in the brow knitting with gaze aversion during concentration. (See Ekman, 1978, for a discussion of these and various other facial signal systems apart from emotion.)

Many investigators in psychology, neurology, and psychiatry have distinguished between voluntary and involuntary facial expressions. Study of certain neurological disorders (Kahn, 1966; Meihlke, 1973; Myers, 1976; Tschiassny, 1953) supports this distinction, suggesting that each type of expression may depend upon different, potentially independent neural pathways. Lesions in the pyramidal systems impair the ability to perform a facial movement on request such as the ability to smile when asked to do so, yet may leave emotional expressions intact so that the patient might smile if amused by a joke. Lesions in the nonpyramidal systems may produce the reverse pattern; so, for example, a patient could smile on request but might not do so spontaneously. While these behavioral differences are important, the voluntary (or deliberate) versus involuntary (or spontaneous) dichotomy is far too simple, glossing over many diverse behaviors which might depend upon different neural pathways. For example, involuntary facial expressions might include actions which are over-learned habits and unlearned reflexes, actions which are modulated by choice or habit and those which cannot be so controlled, and actions which are reported into awareness and those which are not.

Even among expressions which refer only to emotion, the voluntary-involuntary distinction does not capture all of the different types of behavior. *Spontaneous* emotional expressions appear quickly, seemingly without choice, although they may be modulated by choice or habit. Some of these expressions are considered to be innate because of similarities across cultures and among some primates. A *simulated* emotional expression is "a deliberate attempt to appear as if an emotion is being experienced. If it is well done, then most people who see it will be misled and think they are seeing a spontaneous emotional expression, not a simulation. A simulation is used either to conceal the fact that no emotion is felt or as a mask to cover one feeling with

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Address requests for reprints to: Paul Ekman, Human Interaction Laboratory, University of California, 401 Parnassus Avenue, San Francisco, CA 94143.

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the appearance of another. A *gestural* emotional expression resembles actual emotional expression, but it differs sufficiently in appearance to make it evident to the beholder that the person does not feel that emotion at this moment; he is just mentioning it" (Ekman, 1973, p. 183).

These three types of facial expression relevant to emotion probably differ in the involvement of pyramidal and nonpyramidal pathways. It is important that those interested in the differential role of the two cerebral hemispheres in the production of emotional expressions specify which type of facial expression they have studied—spontaneous, simulated or gestural. It is often difficult to be certain. The ability of observers to judge which emotion (fear, anger, etc.) is shown does not help since this judgment can usually be accomplished with all three types of expression. Considerable care must be taken to select circumstances which sample facial behaviors that are unambiguously spontaneous, simulated, or gestural emotional expressions. Often, researchers have sampled spontaneous facial behaviors which may have had nothing to do with emotion, such as brow and mouth movements which emphasize or punctuate speech, and have confused these with emotion expressions. Two recent studies illustrate these methodological problems.

Sackeim et al. (1978) claimed that their study showed "emotions are expressed more intensely on the left side of the face." Having made the pictures of facial expression which they used, we knew that they did not study spontaneous, simulated or gestural emotional expressions, but rather the deliberate performances of models whom we asked to move particular muscles. The only spontaneous emotional expressions included were happy faces we had obtained by catching the model off guard in a moment of actual amusement. These happy expressions did not show asymmetry. Other criticisms of this study, and a defense can be found in Ekman (1980) and in Sackeim (1980).

Schwartz, Ahern, and Brown (1979) intended to compare voluntary with involuntary (in our terms, spontaneous emotional) expressions. It is not certain whether each type of expression occurred when the authors said it did. The instructions intended to produce involuntary reactions—e.g., "Give me a synonym for the word 'terror'" to elicit fear; or "Visualize your face. What part of your face is most expressive of emotions such as excitement?" to elicit excitement—may have elicited considerable cognitive activity but little spontaneous, or even simulated, emotional expressions. Their instructions would not be likely to elicit behavior which is inescapable, irrevocable, difficult to control, automatic, difficult to verbalize, and not dependent on cognition, characteristics posited for emotional responses (e.g., Ekman, 1977; Tomkins, 1962; Zajonc, 1980). Their only evidence that these instructions produced involuntary emotions was self-report questionnaires which might well have reflected demand characteristics. The instructions for voluntary expressions—generate a happy, sad, fearful, etc. facial expression—may have inadvertently produced some involuntary spontaneous emotional expressions. When asked to pose an emotion, a person can either deliberately move particular facial muscles, or, like a Stanislavski actor, attempt to relive or imagine a situation to create the emotional experience from which the expression will flow. Allport (1924) found that subjects used one or the other or both techniques to pose emotions.

We analyzed the asymmetries shown in two types of facial expressions which were distinguished by the circumstances of their occurrence. They represented types of facial activity noted in lesion studies: spontaneous emotional expressions and non-emotional, deliberately performed facial actions. Our hypothesis about how these two types of actions would differ was based on Lynn and Lynn's (1938, 1943) findings that spontaneous smiles were largely symmetrical and our interpretation of the Sackeim et al. study. *Hypothesis*: Asymmetrical expressions will be more common in deliberately performed, non-emotional facial actions than among spontaneous emotional expressions. Among those expressions which are asymmetrical, the action most often will be stronger on the left side of the face if the expression was deliberately performed while expressions of spontaneous emotions will be more evenly divided between those stronger on the left or right sides of the face. Records of facial behavior were drawn from two experiments which had been conducted for other purposes: a study of children's ability to imitate facial actions and a study of adults' reactions to emotion-eliciting films.

Technique for Measuring Facial Asymmetry

The facial behavior in these studies had already been measured with Ekman and Friesen's Facial Action Coding System (1976, 1978). The scoring of each facial movement entailed decomposing the expression by specifying the muscles which had acted to produce it and locating the precise beginning and end of each muscular component. To measure asymmetry, each action was again viewed repeatedly in slowed and real time. The sides of the face were examined both together and separately. At the apex of each action, the movement was scored as symmetrical if the extent of muscular action was evaluated as the same on both sides of the face, or asymmetrical if the contraction was stronger on one side. One of us (JH) scored all the facial behavior in this and in the next study.

To check reliability and to demonstrate that knowledge of the hypothesis did not influence scoring, two studies were conducted. In the first, 47 randomly selected, deliberately performed actions were scored by a technician not familiar with the purposes of the study. The two scorers agreed 87% of the time (Kappa = .63, $p < .001$) and the results of the scoring by the naive technician were identical to the results reported below. A second check was made on whether knowledge of the hypothesis might bias scoring by having another naive person score a sample of behavior drawn randomly from both of the studies reported below. When only this naive, novice coder's scores were analyzed, the same findings with comparable significance levels were obtained as those reported below.

Another possible source of bias in measurement could have resulted from the tendency of observers to rate intensity of emotion higher for the side of the face in the left visual field (Campbell, 1978). Since the proportion of actions stronger on the left and right sides of the face was not found to be constant, but varied for both naive and informed scorers with whether the action was spontaneous or deliberate, this bias was probably nonexistent or minimal in importance.

Study One: Children

Facial actions were selected from a study of the development of the ability to imitate facial movements (Ekman, Roper, & Hager, 1980). Male and female children (N=36), aged 5, 9, and 13 were asked to imitate each of a series of 15 facial actions shown to them one at a time on a television screen. From the videotaped record of the children's imitations, we selected performances of six facial actions which involve both upper and lower regions of the face for symmetry measurement. Table 1 lists the actions, identified both by muscle and by appearance change. A child's imitation of an action was included in the analysis only if it was performed correctly.

Only one emotional reaction, a happy face involving the *zygomatic major* muscle, occurred spontaneously with sufficient frequency to compare with these deliberate facial imitations. These smiles typically occurred in response to the experimenter's jokes and encouragement. To increase the likelihood that these smiles would be spontaneous emotional expressions rather than more socially required smiles, only those instances were selected in which the *zygomatic major* muscle action began within one second of the end of a joke or encouragement. Any such expressions which included the action of *triangularis, mentalis,* or *orbicularis oris* in addition to *zygomatic major* were deleted, since other studies (Ekman, Friesen, & Ancoli, in press) suggest that these are usually not spontaneous happy expressions.

TABLE 1

The deliberate facial actions selected for symmetry measurement

Muscle	Appearance Change
Triangularis	Corners of lips pulled down
Levator labii superioris, alaque nasi	Raises medial portion of upper lip and wrinkles skin along side and bridge of nose
Lateral frontalis	Raises only outer portion of eyebrow
Medial and lateral frontalis	Raises entire eyebrow
Zygomatic major	Pulls lip corners in an upward angle (smile)

A contrast between the deliberate and spontaneous emotional use of a specific muscle could be made only for the *zygomatic major* (smiling) muscle. Of the 36 children, 30 produced at least one movement of each type of *zygomatic major* action. As many *zygomatic major* actions as met selection criteria were scored, up to a maximum of four per subject. When imitating *zygomatic major*, 24% of the 114 deliberate actions were asymmetrical, and they were usually stronger on the left side (.89 left stronger, $p < .01$, two-tailed binomial test). When this same action emerged in a spontaneous emotional expression only 6% of the 78 actions were asymmetrical and these asymmetrical expressions were about equally divided between those stronger on the left and right sides of the face.[1] A signed ranks test showed that the 30 subjects who produced both spontaneous and deliberate actions had significantly more ($p < .01$, two-tailed) asymmetries in deliberate than in spontaneous movements of this muscle.

The first correct imitations of the other five actions besides *zygomatic major* were scored for asymmetry. Each of the 36 children contributed at least two of these actions to the analysis. The results were similar to the deliberate smiles: 20% of these 106 imitations were asymmetrical, and the asymmetrical actions were usually stronger on the left side (.76 left stronger, $p < .05$, two-tailed binomial test).[1]

While there was little ambiguity about the nature of the deliberate actions, since they all occurred on

[1]Analyses by subject based on proportions of symmetrical and right versus left asymmetries displayed by each subject yielded significant results identical to the analysis by actions reported here.

request as imitations, question could be raised about whether all of the spontaneous emotional expressions were actually so. Despite the selection procedure, some non-emotional, more social smiles might have been included. This would, of course, work against the hypothesis and therefore should increase confidence in the significance of the findings obtained. The second study offered the opportunity to study smiles where there was less ambiguity about whether they were spontaneous emotional expressions.

Study Two: Adults

Facial actions were selected from a study of the expressions which correlate with retrospective reports about the subjective experience of emotion (Ekman et al., in press). The facial reactions of 35 adult females watching a pleasant film and a stress inducing film were recorded on videotape without their knowledge. Actions of the *zygomatic major* muscle during the pleasant film were considered spontaneous signs of positive emotion. An expression was considered to be a spontaneous sign of negative emotion if facial muscular movements which have been found to be related to the experience of negative emotion occurred in response to the stress inducing film. These included the actions of medial *frontalis* with *corrugator* (relevant to distress), *levator labii superioris alaque nasi* (relevant to disgust), *levator labii superioris caput infraobitalis* (also relevant to disgust), and *risorius* (relevant to fear).

All of the eligible *zygomatic major* muscle movements during the positive film were measured for asymmetry. A total of 110 such actions were contributed by 28 women (mean of 3.9 actions per subject, SD = 2.0). Consistent with the results from the children, asymmetries in these spontaneous happy expressions were rare (4% for the adults, 6% for the children), and the asymmetrical expressions were about equally divided between those stronger on the left side of the face and those stronger on the right.[1] All of the eligible muscle movements during the negative film were measured for asymmetry. A total of 24 actions were performed by 13 women. Asymmetries occurred in 25% of these negative emotional expressions, and they were evenly split between those stronger on the left and the right.

The incidence of negative emotional expressions was much lower than the incidence of positive emotional expressions, weakening the test of the hypothesis for spontaneous negative emotional expressions. The editing of the film intended to induce negative emotions probably weakened its impact, since other versions of this film and other stress films have yielded more responses in other studies. In any case, future research must obtain more instances of spontaneous negative emotional expressions to estimate the incidence of asymmetry and any consistent laterality.

Since the facial measurement technique used in this study, the Facial Action Coding System (FACS), is relatively new (Ekman & Friesen, 1978), question might arise as to whether it is sufficiently sensitive to detect most asymmetrical facial actions. Ekman and Schwartz (Note 2) found that FACS scoring was highly correlated with EMG measures of the intensity of action (Pearson $r = .85$), and was sensitive to small changes in electrical activity associated with subtle changes in appearance. While FACS cannot measure invisible asymmetries which EMG may detect, it has the advantage of being less obtrusive, not focusing the subject's attention on his or her face, thus avoiding the possibility of thereby changing the nature of the actions shown. Most of the literature on facial asymmetry has been concerned with the visible actions which are measured by FACS.

Another way to address concerns about sensitivity of the facial measure was to analyze additional data on the FACS scoring of the most subtle traces of asymmetry the facial scorers had observed. These *trace* asymmetries were not counted as asymmetries in the data analysis reported so far because they would rarely be noticed by untrained observers, and are therefore unlike the asymmetries reported in the past literature. Even for these subtle asymmetries, reliability between scorers was significant ($p < .001$), although it was slightly lower. When these subtle traces of asymmetry were included in the analysis, the incidence of asymmetries was, of course, increased, but the pattern of results was unchanged (see Table 2). There were more asymmetrical actions in the deliberate than spontaneous

TABLE 2

Percent of asymmetrical actions obtained when subtle actions are included or excluded as asymmetries

Groups and Muscles	Percent of Asymmetrical Actions	
	Subtle Traces Excluded	Subtle Traces Included
Children's Deliberate (N = 36 children)		
Zygomatic Major Actions (N = 114)	24%	48%
Negative Muscle Actions (N = 106)	20%	46%
Children's Spontaneous (N = 30 children)		
Zygomatic Major Actions (N = 78)	6%	29%
Women's Spontaneous (N = 28 women)		
Zygomatic Major Actions (N = 110)	4%	24%
Negative Muscle Actions (N = 24)	25%	46%

expressions, and it is only in deliberate actions that the preponderance of asymmetry was stronger on the left side of the face. No laterality trend emerged for spontaneous actions even though there were many more asymmetries. This ensures that failure to find laterality for spontaneous actions in the main analysis was not due simply to a low incidence of asymmetry. This analysis of trace asymmetries is particularly germane to the actions involved in the spontaneous expression of negative emotions, since the previous analysis had furnished only a small number of asymmetries to examine for laterality.

A number of findings emerged from the two studies which bear further study. Unilateral expressions were rare. Research is necessary to determine if the side used in a unilateral expression would be related to the side which is stronger in asymmetrical expressions. The asymmetries observed in both studies usually involved only a small difference in the intensity shown on the two sides of the face. We doubt that most people engaged in conversation would notice them, but this too needs to be determined. Some subjects showed more asymmetrical actions than others. We did not have data on the handedness of subjects, but this should be determined in future work. Some muscular actions were more frequently asymmetrical than others, and this was not related to whether the muscles were in the forehead or mouth region.

Discussion

Taken together, the data from the children and adults provided consistent evidence that asymmetry in *zygomatic major* actions, the principal muscle involved in a smile, was a function of whether the smile was a non-emotional deliberate imitation or a spontaneous expression of emotion. The asymmetrical deliberate smiles were usually stronger on the left side of the face, but asymmetrical spontaneous smiles were evenly divided between those stronger on the left and right sides. Asymmetries of sufficient magnitude to be readily noticed were rare for spontaneous happy expressions, but more frequent for deliberate use of the *zygomatic major* muscle. Even the most subtle signs of asymmetry were more frequent among deliberate than spontaneous smiles. Lynn and Lynn (1938, 1943) forty years ago reported results for spontaneous happy expressions entirely consistent with ours. Campbell (1978) and Chaurasia and Goswami (1975) reported results for deliberate actions which are consistent with ours.

While the findings for actions involved in negative emotions were consistent with these results on smiling, the data were incomplete. Deliberate performances of these negative actions by the children showed the same incidence of asymmetry and the same preponderance of left side stronger asymmetry as was found for deliberate smiles. However, there were no spontaneous occurrences of negative emotional expressions to contrast with the deliberate ones for the children, and relatively few for the adults. These spontaneous negative actions shown by the adults evidenced the same pattern as noted for spontaneous *zygomatic major* actions, but there were too few instances to be conclusive. The incidence and extent of left side stronger asymmetries for spontaneous negative emotional expressions remains to be determined.

It seems reasonable to expect that the pathway from the motor cortex to the facial nerve would be involved in deliberate facial actions more than in spontaneous emotional expressions, unless the person attempts to control or cover these emotional reactions. The preponderance of left stronger asymmetries in the deliberate facial actions suggests greater involvement of the right hemisphere. Perhaps the right motor cortex is more involved than the left in *any* cortically directed nonverbal facial movement. While spontaneous emotional expressions may not be cortically directed, the right hemisphere may play a special role in controlling spontaneous emotional expressions, and thereby have better connections to the facial nucleus.[2] This conjecture is consistent with the finding that asymmetries are usually stronger on the left side of the face in previous studies (Borod & Caron, 1980; Chaurasia & Goswami, 1975; Moscovitch & Olds, Note 1; Sackeim et al., 1978; Schwartz et al., 1979) where subjects thought, imagined, or talked about emotion. Our own preliminary studies of other facial actions which are *not* spontaneous emotional expressions—such as the use of the facial muscles to punctuate speech or to deliberately conceal a felt expression—also revealed a preponderance of left stronger asymmetries.

[2]This explanation arose in discussion with David Galin.

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