High Frequency of Facial Expressions Corresponding to Confusion, Concentration, and Worry in an Analysis of Naturally Occurring Facial Expressions of Americans

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College students were instructed to observe symmetric and asymmetric facial expressions and to report the target’s judgment of the “emotion” she or he was expressing, the facial movements involved, and the more expressive side. For both asymmetric and symmetric expressions, some of the most common emotions or states reported are neither included in standard taxonomies of emotion nor studied as important signals. Confusion is the most common descriptor reported for asymmetric expressions and is commonly reported for symmetrical expressions as well. Other frequent descriptors were think–concentrate and worry. Confusion is characterized principally by facial movements around the eyes and has many properties usually attributed to emotions. There was no evidence for lateralization of positive versus negative valenced states.

There is much evidence suggesting that there is a set of basic emotions, as defined and evidenced by a number of investigators (Ekman, 1992; Ekman & Friesen, 1975; Izard, 1971, 1979). A cornerstone of this work is evidence for recognition and expression of the “basic” six emotions (anger, disgust, fear, happiness, sadness, and surprise) by people in a number of cultures. Because of the distinctly different facial expressions for each of the basic emotions, and the capability of scoring these expressions in an objective, reliable, and quantitative way with the Facial Action Coding System (Ekman & Friesen, 1975), facial expressions have become the gold standard in emotion research. They occupy a central role in both Izard’s (1971, 1979) and Ekman’s (1992) emotion taxonomies. The main consequence of the present study, though not its intended purpose, is to note that some of the most common facial expressions reported by untrained undergraduate observers have not been the subject of systematic investigation. This may result, in part, from the fact that these expressions do not correspond to generally recognized emotions.

Ironically, although Paul Ekman, more than anyone else, is responsible for the importance of facial expression in the conception and measurement of emotion as studied by psychologists, he has also emphasized that many facial expressions do not correspond to emotions (e.g., Ekman, 1978, 1979). Ekman (1978) listed 18 types of information conveyed by facial expressions, of which emotion is only one. With respect to one set of facial expressions, brow movements (Ekman, 1979), he has analyzed in detail the different types of information conveyed, with emphasis on the use of facial expressions as conversation enhancers and to explicitly convey certain types of information outside of conversational context (emblems). In spite of this, facial expression, in the literature, is almost always studied as a manifestation of emotion. Because almost all work on affect is done under the umbrella of “emotion,” affective states, except for pain, and facial expressions that do not classify as “emotions” have received little scholarly attention.
This study began in the context of lateralization of emotional valence in the cerebral hemispheres. Facial expressions are a principal output measure used to test many hypotheses about this specialization. For right-handers, there are suggestions that the right hemisphere dominates in expression and recognition of negative emotions, and the left hemisphere dominates in the expression (but not recognition) of positive emotions, but the evidence is mixed, as indicated in two recent reviews (Borod, Haywood, & Koff, 1997; Skinner & Mullen, 1991). The issue is more complex than it appears because, among other things, there is a notably greater tendency for posed as opposed to spontaneous emotions to be asymmetrical (Hager & Ekman, 1985), and this distinction is often not made in the relevant studies. Evidence for localization of affect in accordance with valence is not limited to studies of facial expression; instead, there are a number of lines of evidence, including differential activation of the two hemispheres by opposite-valenced stimuli or, what may be a more appropriate distinction, by stimuli that tend to elicit approach versus avoidance (Davidson, 1992).

The present study was motivated originally as an introductory psychology class observation study, carried out by the students, to test the valence lateralization hypothesis. Students, blind to the hypothesis (before the issues were discussed in class), were asked to record up to five instances of spontaneous, asymmetric, facial expressions and indicate, among other things, the emotion expressed, when possible the emotion reported by the participant, handedness of the participant, and the more expressive side. The term emotion was almost certainly taken by the participants in a nontechnical sense to refer to whatever they thought was going on “inside” when the expression was occurring. The results, based on over 2,000 observations, provided no evidence for lateralization of valence. But, more surprisingly, a few of the most common reported emotions were from neither the standard basic emotions nor the most frequently cited, other, more complex emotions (e.g., shame). In the following year, the study was repeated, using greater care in listing a set of emotion terms to prompt designations from the students (the list of possible emotions came directly from the most frequently mentioned emotions in the first study) and including symmetric facial expressions as well as asymmetric expressions. The results reported here come from this second, better balanced and better designed study.

Data Collection

Data collection was performed as a class project by students (n = 255) in an Introduction to Psychology class at the University of Pennsylvania. Their instructions were as follows:

During the next two days, try to observe 5 cases of asymmetric facial expressions, where one side of the face is more expressive than the other. Asymmetric facial expressions may be hard to observe, and you may not find five to report, but get as close to five as you can. Also try to observe 5 cases of symmetric facial expressions, where both sides of the face are equally expressive.

We are referring to expressions, facial actions that last seconds. These are active expressions; we are not interested in the fact that an individual has a “resting” face in which one side (for example, one lip or eye), is lower than the other. Do not use an expression of the same person more than once. And do not record more than one expression in the same situation. That is, if you are sitting around watching TV with some friends, that would count as one situation, and would generate at most one expression. These rules hold only within type (symmetric or asymmetric). You may record symmetric and asymmetric expressions in the same situation (one of each in the same situation).

When you observe a facial expression in another person, write down the following information, whenever possible. Use separate charts for the symmetric and asymmetric expressions. [charts were provided]

1. Which side of the face is more expressive. [for asymmetric expressions]
2. The handedness of the person (right, ambidextrous, left, or undetermined). You may not be able to get this information, since you may not be able to speak to the person. That is OK. Then just leave this blank.
3. The “emotion” that you believe the person is expressing. MAKE SURE YOU MAKE THIS JUDGMENT BEFORE ASKING THE PERSON (4 below).

The following is a list of possible emotions you might note, but you are free to include other words that are more appropriate than any on the list. Afraid (fearful, anxious, apprehensive, scared), agreement, amused (giddy, humor, silly, joke, laugh, mischievous, secretive, sly, teasing), anger (annoyed, insult, irritated), ashamed (embarrassed, sheepish, shy, timid), attracted, awed, awkward, bored (indifferent), concentration, concerned (worried), confident (proud), confused (consternation, puzzled, uncertain), content (fulfilled, pleased, relaxed, satisfied), pensive (contemplative, thoughtful), contempt (disdain), cool, curious (inquisitive, interested, intrigued), desperate, disappointed, sad (unhappy), disapproving (dislike), discomfort (pain), disgust (grossed out), envious (jealous), excited, flirtatious (sexy, coy), frustrated, guilty, happy (joyful), sarcastic (wry), surprised (shocked), skeptical, sympathetic, tired, upset, and worried (upset, nervous). (This list was derived from
the most common words generated in a previous study of the same general design, with a class of similar size, but with free report of the emotion terms.)

4. The ‘emotion’ that the PERSON claims to be expressing. Depending on the situation, you may not be able to interview the person. That is OK. Then just leave this blank. [The target person was NOT given the emotion list]

5. Your description of the nature of the facial expression.

6. Description of the situation in which the expression occurs.

7. Your judgment of whether the emotion is positive, negative, or neutral.

In the charts provided to the students for data reporting, a sample row was filled in the separate charts for symmetric and asymmetric emotional expressions. The emotion in both cases was happiness, and the expression was “smile.”

In class, students were presented with a few slides of famous people making asymmetric facial expressions, and a few were demonstrated by the lecturer. It was emphasized to the students that the more expressive side of the face (for asymmetric expressions) referred to the target’s face–side, and not that of the observer.

Data Analysis

The emotion reports of both the observer and the participant were categorized before analysis, in accordance with the groupings presented in the list above. Although students were not always able to obtain the observed persons’ judgment of the emotion, the large n provided us with a sufficient sample size to perform our analysis on the participant’s (target’s) judgment, as a more direct indicator of affective state.

Results

The class reported 1,245 symmetric and 996 asymmetric expressions (observer n = 254), or a mean of 4.9 (SE = 0.58) symmetric expressions and 4.1 (SE = 1.12) asymmetric expressions per observer. The average number of positive asymmetric expressions per observer was 1.9 (SE = 0.06), neutral was 1.3 (SE = 0.06), and negative was 1.6 (SE = 0.06). For asymmetric expressions, corresponding means were 1.3 (SE = 0.07) positive, 1.3 (SE = 0.06) neutral, and 1.6 (SE = 0.07) negative.

Of over 2,000 observations, on 419 occasions (less than 20%), the observer reported an emotion but did not collect the participant’s self-reported emotion. Given the high incidence of self-reported emotions, we elected to use the participant self-reports in our analysis.

Lateralization and Valence

Of the asymmetric expressions, 487 were left-side more expressive, and 509 were right-side more expressive, a nonsignificant difference. Our first question was whether there is a different valence distribution of asymmetric and symmetric emotions. We restricted the analysis to right-handed participants. The results, presented in Table 1, indicate that 41% of symmetric expressions are positive (as opposed to negative or neutral), but only 31% of asymmetric expressions are positive (for the overall distribution, including neutral as a third category, right-handers only, χ²(2, n = 1,561) = 15.42, p < .001.

Next, we tested the hypothesis that there is a relation between the more expressive side of the face and the valence of the emotion, for right-handers. The results showed no significant relation, with 36% negative for left-side more expressive and 37% negative for right-side more expressive (see data in Table 1), χ²(2, n = 693) = 1.55, p = .46 (right-handers only).

A tabulation of the frequency of emotion categories for symmetric and asymmetric expressions (see Table 2) reveals few major differences (i.e., at least double relative incidence level for moderately common emotions) between asymmetric and symmetric expressions.

Occurrence of Relatively Unstudied Facial Expressions

We offered observers an extended list (see the Method section) of exemplars of emotions. These were the most frequent descriptors used in an open-ended pilot study. The types and categories of emotions reported, as was the case in our large earlier pilot study, included a number of terms that are not normally listed by psychologists under the rubric of emotions. Table 2 reports the proportion of each type of

Table 1

<table>
<thead>
<tr>
<th>Valence</th>
<th>Symmetric</th>
<th>Asymmetric (more expressive side)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Left</td>
</tr>
<tr>
<td>Negative</td>
<td>276</td>
<td>113</td>
</tr>
<tr>
<td>Neutral</td>
<td>240</td>
<td>110</td>
</tr>
<tr>
<td>Positive</td>
<td>352</td>
<td>93</td>
</tr>
<tr>
<td>Total</td>
<td>868</td>
<td>316</td>
</tr>
</tbody>
</table>

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emotion for both symmetric and asymmetric expressions for all types whose mention amounts to at least 1% of the total.

The most striking “nonstandard emotion” is confusion (based on target’s categorization), scoring highest of all asymmetric emotions (14%) and ranking 7.5 (5%) among the symmetric emotions. Overall, a full 44% of asymmetric and 32% of symmetric emotions fall into the “anomalous” or nonstandard categories. (We judged that some emotion descriptors, although not using the “standard” emotion names, could be assimilated under the standard terms as follows: joke–amusement under happiness, disappointment under sadness, and frustration under anger; these are not counted as nonstandard emotions.) Two other relatively common nonstandard emotions are thinking–concentration and worry, and less common reports include excitement, skepticism, flirtatious, tired, indifferent, and pain (see Table 2). The most common nonstandard emotion, confusion, appeared 70% of the time in asymmetric expressions; worry and concentration were represented about equally frequently in symmetric and asymmetric forms.

Although we did not use the emotion judgments made by the observers, one can ask about the extent to which these were in accord with emotion reported by the person being observed. Of the 51 symmetric cases where the target reported confusion, the observer reported the same in 37 cases. Corresponding numbers for asymmetric confusion expressions were 119 for targets, with a corresponding report from observers in 87 cases. For thinking–concentration (and worry), the corresponding numbers are 64/53 (49/32) for symmetric expressions, and 66/51 (51/34) for asymmetric expressions.

**Elicitors of confusion.** Observers were asked to describe the eliciting situation. We categorized these descriptions for those cases in which the target reported confusion (143 cases available, including both symmetric and asymmetric expressions). Many of the descriptions were too vague to classify usefully (40 cases; e.g., watching TV or discussing the bible), and some (19 cases) were descriptions or interpretations of the response rather than the situation (e.g., not understanding what someone said). The categories of elicitors of the remaining 84 descriptions were fol-
lowing being asked a question (30 times), doing homework or studying (23 times); in class, listening to a professor (16 times), occurrence of something unexpected or weird (11 times), and making a decision–planning–thinking (4 times).

Types of facial actions. We tabulated the facial movements described for the three most common terms that are not on normal emotion lists (confusion, concentrate, and worry). Of course, the movements described by observers were in nontechnical terms, such as “eyebrows raised,” “eyes squinted,” “frown,” “lips pursed,” or “bite lip.” We did not convert these to facial action units but rather used the terms reported by observers. However, for ease in summarizing results, we combined a set of reports all amounting to “eyes narrowed” (eyebrow lower, furrowed, or scrunch, frown, and squint), even though some of these are produced by different facial actions with potentially different communicative significance. These reports are presented separately in Table 3, but we suspect that many participants confused these different actions. Across these three states (confusion, concentration, worry), two types of expressions are much more common in the asymmetrical expression: eyebrow raise (11 cases in symmetrical expressions, 57 in asymmetric) and tongue protrude or lip bite (10 cases in symmetrical expressions, 29 in asymmetric). The unilateral eyebrow raise is surely less common in incidence than bilateral–symmetric eyebrow raising in randomly sampled facial expressions, but strikingly not so for these three nonstandard emotions. Single eyebrow raised seems to have a different meaning from both eyebrows raised. However, both tongue protrusion and lip biting would be expected to be more common in asymmetric form, simply because there are many locations along the lips where both can occur, and only one (midline) would qualify as symmetrical.

There was wide variation in the facial actions attributed by our amateur observers to the three nonstandard emotions (see Table 3). For symmetrical confusion, the dominant expression was the combined category of narrowing of the eyes (23 out of 56 total expressions). For the 122 asymmetric expressions listed, one eyebrow raised was most common (41 times) followed by eye narrowing (32 times). For

<table>
<thead>
<tr>
<th>Facial action</th>
<th>Confusion</th>
<th>Worry</th>
<th>Concentrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eyebrow raise–arched</td>
<td>11</td>
<td>41</td>
<td>3</td>
</tr>
<tr>
<td>Eyebrow furrow–arched down–come together–knitted</td>
<td>10</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Eyebrow lower</td>
<td>2</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Eye closed</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Eye squint</td>
<td>7</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Stare</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eyebrows together–scrunch</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Frown</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Eyes look up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eyes wide open</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Mouth area</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Side mouth stretch</td>
<td></td>
<td></td>
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<tr>
<td>Lips–mouth raise</td>
<td>2</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Lips purse–scrunch</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Smile</td>
<td>5</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Lip corner lower</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Lip press</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Tongue protrude–move on teeth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Bite lip</td>
<td>2</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Face scrunch</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Note. Specific facial expressions are listed in this table only if reported at least eight times across the three nonstandard emotions or at least five times for any particular category of emotion and symmetry (Symmet.). Asymm. = asymmetry.
symmetrical worry, eye narrowing was the dominant report (14 of 46 total expressions), whereas for asymmetrical worry, the most common response was biting the lip (16 of 48 reports). For symmetrical thinking–concentrating, the most common report was narrowing of the eyes (22/72), whereas for 79 asymmetrical expressions, most common were narrowing of the eyes (14 times) and raising of the eyebrows (13 times). It is notable that for asymmetrical concentration expressions, there were six cases of lip biting and five cases of tongue protrusion. Tongue protrusion has been reported in the early literature as common in situations in which the expressor is concentrating, or at a moment when a decision–choice is being made (Smith, Chase, & Lieblich, 1974).

Discussion

We report two different findings in this study. One is the lack of evidence for a bias (for right-handers) for negative facial expressions to be more intense and frequent on the left side of the face (right hemisphere) and positive facial expressions to be more intense on the right side (left hemisphere). As indicated in the introduction, there is now a substantial and conflicted literature on the mapping of hemispheric valence to asymmetric facial expressions (Borod et al., 1997; Skinner & Mullen, 1991). Our study is a minor contribution to this debate, adding one more voice that suggests, under some conditions, the valence–hemisphere link does not appear. Given the mode of data collection that we used, the database includes both spontaneous and posed expressions, in proportions that we cannot estimate. Furthermore, it is important to note that hemispheric valence is a conception that is only indexed by facial expressions; it is quite conceivable that facial expressions are, in at least some ways, problematic as indicators of hemispheric valence (Davidson, 1993).

Our more interesting, though unexpected, finding is that many facial expressions do not correspond to basic emotions, or even anything usually called an emotion. This suggests that either facial expressions are used to a great degree to express things other than emotions or that we should expand our category of emotions. As we noted in the introduction, Ekman (1978, 1979) has clearly indicated that though he sees facial expressions as an integral part of emotions, facial expressions often exist independent of emotion. Thus, our report of the high frequency of interpretations such as confusion for facial expression does not stand in conflict with Ekman’s view of emotion. Confusion, concentration, and worry could just be non-emotional forms of expression.

The second most common descriptor (“emotion” or “facial expression correlate”) reported by our observers (equally weighting asymmetric and symmetric displays and combining happiness and joke–amusement into the single largest category) is confusion, a term that is virtually nonexistent in the affect or emotion literature. Yet, in many respects, we believe confusion would qualify as an emotion according to the criteria set out by Ekman (1992). It is surely valenced (negative), has a distinct facial expression and a distinct internal state (“qualia”). It is, perhaps, under more voluntary control than the standard emotions. The significance of classifying confusion as an emotion results from the fact that almost all the attention in modern affective science is focused on emotions, so that membership in that category promotes scholarly attention.

A disproportionate number of instances of the three most common descriptors involve asymmetrical facial expressions. The canonical expressions of the six standard emotions are symmetrical, but a reasonable candidate for a seventh basic emotion, contempt (Ekman & Friesen, 1986), is principally asymmetrical. Indeed, there is a clear relation in terms of elicitors, meanings, and expressions, between skepticism, one of the less common descriptors our observers reported, and contempt.

The facial actions we report as most common in confusion, worry, and concentration involve the eyes and eyebrows: narrowing of the eyes, lowering and bringing together of the eyebrows. These actions, often characteristic of frowns, are seen in a number of facial expressions, and as we noted above, Ekman (1979) has discussed the many meanings of eyebrow movements. A link between frowning and “motivational incongruence” and “perceived goal-obstacles” has been reported by Pope and Smith (1994). These situations are, of course, related to puzzlement and confusion.

These results in no way question the important link between basic emotions and facial expressions; rather, they remind us that as Ekman (1978, 1979) pointed out, facial expressions should not be exclusively aligned with basic emotions. Of course, according to the position on facial expressions taken by Fridlund (1994), where facial expressions are framed as indicators of likely action (Smith, 1975), the common responses we reported, such as confusion and thinking–concentration are indicants of likely inaction. The confusion expression may be designed to encourage
social interaction, whereas the concentration expression may discourage such interaction (“Don’t bug me now, I’m thinking”). Ekman (1978) explicitly referred to this situation and linked it with lowering the brows and bringing them together (Action Unit 4). Ekman (1979) also mentioned disbelief and skepticism as examples of nonemotional facial expression and differentiated expressions of this sort from others that are signs of emotions on the grounds that emotions and their expressions are more coherent, are more organized, occur earlier in life, are less under voluntary control, occur more frequently when not observed, have more complex meanings, and have a different time course (Ekman 1979, 1992). We believe that confusion might well qualify as an emotion under these criteria and that a case may be made for concentration, worry, and skepticism. Concentration fits better under an information-communication conception of emotion.

We suggest that, as valuable as the basic emotions idea has been and continues to be, we should extend the study of affect and expression to some of the most common situations, faces, elicitors that have been previously ignored. A beginning has been made in this regard by research on emotions that are common and taxonomized in non-Western cultures (see reviews by Kitayama & Markus, 1994; Mesquita & Frijda, 1992). As an example, the Hindu emotion taxonomy is somewhat broader than the Western and more differentiated on the positive side (Hejmadi, 1999). Furthermore, it is closely tied to expressive gestures of the hands and body as well as the face. Recent work suggests that some of the distinctively Hindu expressions are accurately recognized by Americans (Hejmadi, Davidson, & Rozin, 2000). Some affective states not typically categorized as emotions, such as pain, have frequently associated facial expressions, but in any case, pain is the subject of a great deal of scholarly attention. What characterizes the affective—signaling states that we refer to, particularly concentration and confusion, is that they are very common and almost unstudied.

The results we have reported are subject to criticism because the data were collected by untrained undergraduate students and hence were almost certainly less accurate and reliable than judgments made by trained observers. However, there is no reason to think the results are biased in any way with respect to our findings about unstudied facial expressions. It is possible that certain expressions that are very subtle or very brief (as may be the case especially for some asymmetric expressions) are underrepresented in the reports we have analyzed. It would certainly be important to do this sort of study with experienced observers. We consider our main contribution of this study as one to call attention to some relatively ignored but quite common facial displays that have affective content and/or important informational value. At least one of these displays, confusion, has many of the properties of an emotion. But whether or not they are emotions, their high frequency suggests that they are deserving topics for further research.

References


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