Measuring Facial Movement*

Paul Ekman
Wallace V. Friesen**

ABSTRACT: A procedure has been developed for measuring visibly different facial movements. The Facial Action Code was derived from an analysis of the anatomical basis of facial movement. The method can be used to describe any facial movement (observed in photographs, motion picture film or videotape) in terms of anatomically based action units. The development of the method is explained, contrasting it to other methods of measuring facial behavior. An example of how facial behavior is measured is provided, and ideas about research applications are discussed.

INTRODUCTION

This article reports a new method of describing facial movement based on an anatomical analysis of facial action. Most research on facial behavior has not measured the face itself, but instead has measured the information that observers were able to infer from the face. Examples of the questions asked are: Can observers make accurate inferences about emotion? Can observers detect clinical change or diagnosis? Do observers from different cultures interpret facial expression differently? Are observers influenced by contextual knowledge in their judgments of the face? Do observers attend more to the face than to the voice, etc.?

*The research reported here was supported by a grant from NIMH, MH 167845. The authors are grateful to Wade Seaford, Dickinson College, for encouraging us to build our measurement system on the basis of specific muscular action. He convinced us that it would allow more precision, and that learning the anatomy would not be an overwhelming obstacle. Neither he nor we realized, however, how detailed and elaborate this undertaking would be. Seaford (1976) recently advanced some of the arguments we have made here about the value of an anatomically based measurement system. We are grateful also to those who first learned FAC and gave us many helpful suggestions as to how to improve the manual. We thank Linda Camras, Joe Hager, Harriet Oster, and Maureen O'Sullivan also for their comments on this report.

**The authors are affiliated with the Human Interaction Laboratory, University of California, San Francisco, Cal. 94143.

Few studies have measured the face itself. Examples of the type of questions which could be asked are: Which movements signal emotion? Do facial actions change with clinical improvement or differentiate among types of psychopathology? Do the same facial movements occur in the same social contexts in different cultures? Are certain facial actions inhibited in certain social settings? Which facial movements punctuate conversation, etc.? The differences between these two approaches to the study of facial behavior (i.e., observers inference vs. facial measurement) were discussed and the literature reviewed by Ekman, Friesen and Ellsworth (1972).

Research focused on the face has been impeded by the problems of devising an adequate technique for measuring the face. Over the years various procedures for facial measurement have been invented. Early work has rarely been cited by current investigators, e.g., Frois-Wittmann (1930), Fulcher (1942), Landis (1924), or Thompson (1941). More current approaches to facial measurement have varied in methodology, ranging from analogic notations of specific changes within a part of the face (Birdwhistell, 1970), to photographic depictions of movements within each of three facial areas (Ekman, Friesen, & Tomkins, 1971), to verbal descriptions of facial gestalts (Young & Decarie, Note 1).

No consensus has emerged about how to measure facial behavior. No tool has been developed which has become the standard, used by all investigators. Each investigator has almost been in the position of inventing his own tool from scratch. The only exception has been that the category lists of facial behavior described by some human ethologists (Blurton-Jones, 1971; Grant, 1969; McGrew, 1972) have influenced other human ethologists studying children.

Although different in almost all other respects, most facial measurement techniques have shared a focus upon what is visible, what a rater can differentiate when he sees a facial movement. An exception, Schwartz (in press) used electromyographic (EMG) measurement to study changes in muscle tone which are not visible. EMG could also be used to measure visible changes in muscle tone which do not involve a noticeable movement, but such work has not been done. EMG also could be employed to study visible movement, but we think it is unlikely that surface electrodes could distinguish the variety of visible movements which most other methods delineate.

Vascular changes in the face are another aspect of facial behavior which can occur without visible movement and which, like muscle tonus, could be measured directly with sensors. No such work has been published on coloration or skin temperature although Schwartz

(Note 2) in unpublished studies has found thermal measures useful in measuring affective responses. Some of the measurement procedures which utilize observers to rate visible movement have included a reference to a "reddened" face.

Elsewhere (Hager, Ekman, & Friesen, Note 3), we have compared other methods for measuring facial movement with our own method, contrasting the assumptions which underlie each method, explaining how units of measurement were derived, and providing point by point comparisons of the measurement units. Here, we will only selectively contrast other methods with our own to explain our technique.

BACKGROUND TO THE DEVELOPMENT OF THE FACIAL ACTION CODE

Our primary goal in developing the Facial Action Code (FAC) was to develop a *comprehensive* system which could distinguish all possible visually distinguishable facial movements. Most other investigators developed their method just to describe the particular sample of behavior they were studying. Our earlier approach, the Facial Affect Scoring Technique (FAST) (Ekman, Friesen, & Tomkins, 1971), also had a more narrow objective. It was designed primarily to measure facial movement relevant to emotion. While we remain interested in describing the emotion signals, to do so we needed a measurement scheme that could distinguish among *all* visible facial behavior. We were also interested in a tool which would allow study of facial movement in research unrelated to emotion: e.g., facial punctuators in conversation, facial deficits indicative of brain lesions, etc. With comprehensiveness as our goal it was necessary to build the system free of any theoretical bias about the possible meaning of facial behaviors.

The interest in comprehensiveness also led us to reject an inductive approach to developing FAC. Most other investigators devised their descriptive system on the basis of careful inspection of some sample of the behavior they intended to measure. While their system might contain gaps, as long as its purpose was simply to measure a prescribed sample of events it was perfectly practicable. With comprehensiveness as a goal, an inductive method would require inspecting a very large and diversified sample of behavior.

We chose to derive FAC from an analysis of the anatomical basis of facial movement. Since every facial movement is the result of mus-

cular action, a comprehensive system could be obtained by discovering how each muscle of the face acts to change visible appearance. With that knowledge it would be possible to analyze any facial movement into anatomically based minimal action units.

No other investigator has so exclusively focused on the anatomy of facial movement as the basis for his descriptive measurement system.[1] Blurton-Jones (1971) considered anatomy in developing his descriptive categories, but it was not the main basis of his measurement system. He did not attempt to provide a description of the full range of minimal actions.

Our interest in comprehensiveness was motivated not only by the diverse applications we had in mind, but by an awareness of the growing need for a common nomenclature for this field of research. Comparisons of the measurement units employed by other investigators would be facilitated if the particular units used in each study could be keyed to a single comprehensible list of facial actions. Also, a complete list of facial actions would reveal to the potential investigator the array of possibilities, so he could better select among them. And, of course, there might be some investigators who, like us, would want to measure not just some facial behavior, but all possible movement they could observe.

A constraint in the development of FAC was that it deals with what is clearly *visible* in the face, ignoring invisible changes (e.g., certain changes in muscle tonus), and discarding visible changes too subtle for reliable distinction. In part, this constraint of measuring the visible was willingly adopted, based on our interest in what could have social consequences. In part, the constraint of dealing only with the visible was based on our interest in a method which could be applied to any record of behavior—photographic, film or video—taken by anyone. If our descriptive system included the nonvisible, we would be limited only to situations where we ourselves could attach the apparatus (e.g., the leads for EMG). The visibility constraint was also dictated by our belief that if subjects know their face is being scrutinized, their behavior may differ radically. The odd results obtained by Landis (1924) may have been due to this in part (cf., Ekman, Friesen, & Ellsworth 1972, pp. 79-84, for a discussion of the Landis studies). A method based on visible behavior would use video

[1]Since developing FAC and writing this report we have learned of another anatomically based system developed by Ermiane with additions by Gergerian (Ermiane, 1963; Ermiane & Gergerian, 1976). Their system agrees with FAC on most, but not all, of the anatomical units. Their system is less elaborate; it does not systematically consider many complex actions but instead focuses on interpreting personality on the bases of different facial movements.

or motion picture film records, which could be gathered without the subject's knowledge.

Another limitation was that FAC would deal with *movement,* not with other visible facial phenomena. These other facial signs would be important to a full understanding of the psychology of facial behavior, but their study requires a different methodology. (Elsewhere [Ekman, Note 4] we have distinguished a variety of static and slow facial signs contrasting the type of information they may contain with rapid facial movement.) FAC excludes visible changes in muscle tonus which do not entail movement. These changes can be measured through EMG or by having observers make global inferences about brightness, alertness, soberness, etc. Changes in skin coloration are not usually visible on black and white records. Facial sweating, tears, rashes, pimples, and permanent facial characteristics, were all excluded from FAC. As the name states, the Facial Action Code was developed to measure only movement of the face.

Ideally, the Facial Action Code would differentiate every change in muscular action. Instead, it is limited to what humans can reliably distinguish, since it is used by human operators viewing facial behavior, not a machine-based classification. FAC includes most but not all of the subtle differences in appearance which result from different muscle actions. The fineness of the scoring categories in FAC depends upon what can be reliably distinguished when a facial movement is inspected repeatedly, and in stopped and slowed action.

A system for measuring visible facial movements can follow one of two approaches. The *minimal units* of behavior can be specified, which can in combination account for any total behavior. Or, a list of possible facial gestalts can be listed. The sheer variety of possible actions which the facial musculature allows argues for the minimal units solution rather than gestalts if comprehensiveness is the goal. There are too many different possible total facial actions to list all of the gestalts. If the method specifies facial gestalts (e.g., Young & Decaries' [Note 1] list of 42 facial gestalts), it cannot score facial actions which show only part of the gestalt or actions which combine some of the elements of three or four of the gestalts.

While most investigators have listed minimal units, they were not explicit as to how they derived their list. How did they determine how many separate facial actions are possible? How did they determine whether an action was minimal or, instead, a composite of two actions which might separately appear? Usually the decision was based on a hunch, speculation about signal value, or simply what was

observed in a limited sample of facial behavior. It seemed to us that an answer would come from knowledge of the mechanics of facial action. We would have to determine the number of muscles which can fire independently, and whether each independent muscular action results in a distinguishable facial appearance. Such an anatomically-based list of facial appearances should allow description and differentiation of the total repertoire of visibly different facial actions.

Some might argue that there is no need to make such fine distinctions among facial actions. Indeed, there may not be a need; many differently appearing facial actions may serve the same function or convey the same message. There may be facial synonyms. Yet such conditions should be established empirically, not on a priori grounds. Only a measurement scheme which separately scores visibly different facial actions will permit the research that can determine which facial actions should be considered equivalent in a particular situation.

Another consideration which guided our development of the Facial Action Code was the need to separate inference from description. We are interested in determining which facial behavior is playful, or puzzled, or sad, but such inferences about underlying state, antecedent, or consequent actions should rest upon evidence. The measurement must be made in noninferential terms that describe the facial behavior, so that the inferences can be tested by evidence. Almost all of the previous descriptive systems have combined inference-free descriptions with descriptions confounded with inference: e.g., "aggressive frown" (Grant, 1969); "lower lip pout" (Blurton-Jones, 1971); "smile tight—loose o" (Birdwhistell, 1970). Each of these actions could be described without inferential terms. Since humans make the measurement the possibility of inferences cannot be eliminated, but they need not be encouraged or required. If a face is scored, for example, in terms of the lip corners moving up in an oblique direction which raises the infraorbital triangle, the person scoring the face still may make the inference that what he is describing is a smile. Our experience has been that when people use a measurement system which is solely descriptive, as time passes they increasingly focus on the behavioral discriminations and are rarely aware of the "meaning" of the behavior.

Another problem which has plagued previous attempts to measure facial movement has been how to describe most precisely each measurement unit. Blurton-Jones (1971) noted that facial activity could be described in three ways: the location of shadows and lines;

the muscles responsible; or the main positions of landmarks, such as mouth corners or brow location. He opted for the last basis, although he said he used the other two as well. He decided not to base his descriptions on muscular activity because it would be "more convenient if description could be given which did not require that anyone who uses them should learn the facial musculature first, although knowledge of the musculature obviously improves the acuity of one's observations" (p. 369).

We have taken almost the opposite position. The user of FAC must learn the mechanics—the muscular basis— of facial movement, not just the consequence of movement or a description of a static landmark. FAC emphasizes patterns of movement, the changing nature of facial appearance. Distinctive actions are described—the movement of the skin, the temporary changes in shape and location of the features, and the gathering, pouching, bulging, and wrinkling of the skin.

FAC's emphasis on movement and the muscular basis of appearance change helps overcome the problems due to physiognomic differences. Individuals differ in the size, shape, and location of their features, and in the wrinkles, bulges or pouches which become permanent in midlife. The particular shape of a landmark may vary from one person to another; e.g., when the lip corner goes up, the angle, shape, or wrinkle pattern may not be the same for all people. If only the end result of movement is described, scoring may be confused by physiognomic variations. Knowledge of the muscular basis of action and emphasis on recognizing movements helps to deal with variations due to physiognomic differences.

THE DEVELOPMENT OF THE FACIAL ACTION CODE

Our first step in developing FAC was to study various anatomical texts to discover the minimal units. We expected to find a listing of the muscles which can fire separately, and how each muscle changes facial appearance. We were disappointed to find that most anatomists were seldom concerned with facial appearance. The anatomy texts for the most part described the location of the muscles. Capacity for separate action or visible changes in appearance was not the basis for the anatomists' designation of facial muscles. Instead, they distinguished muscles because of different locations, or if there was a simi-

lar location they separately named what appeared as separate bundles of muscle fibers.[2]

Duchenne (1862) was one of the first anatomists concerned with the question of how muscles change the appearance of the face. He electrically stimulated the facial muscles of a man, without pain sensation, and photographed the appearance changes. By this means he was able to learn the function of some of the muscles. His method was problematic for exploring the action of all of the facial muscles. Many of the muscles of the face lie one over the other, and surface stimulation will fire a number of muscles. Inserting a needle or fine wire through the skin to reach a particular muscle may fire others as well.

Hjorstjö (1970) provided the most help. An anatomist interested in describing the visible appearance changes for each muscle, Hjorstjö learned to fire his own facial muscles voluntarily. He photographed his own face and described in drawings and words the appearance changes for each muscle. His aim was not to provide a measurement system, and so he did not consider many of the combinations of facial muscles, nor did he provide a set of rules necessary for distinguishing between appearance changes which are in any way similar.

Following Hjorstjö's lead, we spent the better part of a year with a mirror, anatomy texts, and cameras. We learned to fire separately the muscles in our own faces. When we were confident we were firing intended muscles we photographed our faces. Usually there was little doubt as to whether we were firing the intended muscle. The problem instead was how to learn to do it at all. By feeling the surface of our faces we could usually determine whether the intended muscle was contracting. By checking Hjorstjö's account we could see whether the appearance on our faces was what he had described and showed in his drawings. There were a few areas of ambiguity, and here we returned to a variation on Duchenne's method. A neuroanatomist placed a needle in one of our faces, inserting the needle into the muscle we were uncertain about. With the needle in place, the muscle was voluntarily fired, and electrical activity from that needle placement verified that indeed it was the intended muscle. As this method was uncomfortable, we used it rarely, and only when we were in doubt.

[2]We are grateful to Washburn (Note 5) for explaining why the standard anatomy texts were of so little help and for encouraging our attempt to explicate the muscular basis of facial action.

One limitation of this method of deriving facial units must be noted. If there are muscles which cannot be fired voluntarily, we cannot study them. This seems to be the case only with the Tarsalis muscle, and, as best as we can determine, its action and effect on appearance are not different from those of one of the voluntarily controlled muscles, Levator Palpebrae.

Our next step was to examine the photographs taken of each of our faces, scrambling the pictures so we would not know what muscle had been fired. Our purpose was to determine if all the separate muscular actions could be distinguished accurately from appearance alone. Often, it was easy to determine, although it usually required comparing the appearance change with the resting or baseline facial countenance.

There were instances in which we found it difficult to distinguish among a set of muscles in accounting for a photograph of a facial appearance. Sometimes we could tell one muscular action from another, but the differentiation seemed so difficult that we prejudged it as not likely to be reliable. Sometimes the appearance changes resulting from two muscles seemed to differ mostly in intensity of the action, not in type of appearance. In either instance we designated and described one action unit which could be produced by two or three different muscles.

Note that we call the measurements *action,* not muscle units. As just explained, this is because a few times we have combined more than one muscle in our unitization of appearance changes. The other reason for using the term *action unit* is because we also have separated more than one action from what most anatomists described as one muscle. For example, following Hjorstjö's lead, the Frontalis muscle which raises the brow was separated into two action units, depending upon whether the inner or outer portion of this muscle lifts the inner or outer portions of the eyebrow.

Table 1 lists the names, numbers and anatomical basis of each action unit. Most of the action units involve a single muscle. The table indicates where we have collapsed more than one muscle into a single action unit, or where we have distinguished more than one action unit from a single muscle. The FAC names given in the table are a shorthand, not meant to describe the appearance changes, but a convenience to call them to mind.

Table 2 lists an example of how each action unit (AU) is described in the FAC manual. The description includes four types of information:

1. The muscular basis of each AU is given in words and diagrams.

TABLE 1
Single Action Units (AU) in the Facial Action Code*

AU Number	*FAC Name*	*Muscular Basis*
1.	Inner Brow Raiser	Frontalis, Pars Medialis
2.	Outer Brow Raiser	Frontalis, Pars Lateralis
4.	Brow Lowerer	Depressor Glabellae; Depressor Supercilli; Corrugator
5.	Upper Lid Raiser	Levator Palpebrae Superioris
6.	Cheek Raiser	Orbicularis Oculi, Pars Orbitalis
7.	Lid Tightener	Orbicularis Oculi, Pars Palebralis
9.	Nose Wrinkler	Levator Labii Superioris, Alaeque Nasi
10.	Upper Lid Raiser	Levator Labii Superioris, Caput Infraorbitalis
11.	Nasolabial Fold Deepener	Zygomatic Minor
12.	Lip Corner Puller	Zygomatic Major
13.	Cheek Puffer	Caninus
14.	Dimpler	Buccinnator
15.	Lip Corner Depressor	Triangularis
16.	Lower Lip Depressor	Depressor Labii
17.	Chin Raiser	Mentalis
18.	Lip Puckerer	Incisivii Labii Superioris; Incisive Labii Inferioris
20.	Lip Stretcher	Risorius
22.	Lip Funneler	Orbicularis Oris
23.	Lip Tightner	Orbicularis Oris
24.	Lip Pressor	Orbicularis Oris
25.	Lips Part	Depressor Labii, or Relaxation of Mentalis or Orbicularis Oris
26.	Jaw Drop	Masetter; Temporal and Internal Pterygoid Relaxed
27.	Mouth Stretch	Pterygoids; Digastric
28.	Lip Suck	Orbicularis Oris

*The numbers are arbitrary and do not have any significance except that 1-7 refers to brows, forehead or eyelids.

TABLE 2
An Example of the Information Given in the FAC for Each Action Unit

ACTION UNIT 15—Lip Corner Depressor

The muscle underlying AU 15 emerges from the side of the chin and runs upwards attaching to a point near the corner of the lip. In AU 15 the corners of the lips are pulled down. Study the anatomical drawings which show the location of the muscle underlying this AU.

(1) Pulls the corners of the lips down.

(2) Changes the shape of the lips so they are angled down at the corner, and usually somewhat stretched horizontally.

(3) Produces some pouching, bagging, or wrinkling of skin below the lips' corners, which may not be apparent unless the action is strong.

(4) May flatten or cause bulges to appear on the chin boss, may produce depression medially under the lower lip.

(5) If the nasolabial furrow* is permanently etched, it will deepen and may appear pulled down or lengthened.

The photographs in FAC show both slight and strong versions of this Action Unit. Note that appearance change (3) is most apparent in the stronger versions. The photograph of 6+15 shows how the appearance changes due to 6 can add to those of 15. Study the film of AU 15.

How To Do 15

Pull your lip corners downwards. Be careful not to raise your lower lip at the same time—do not use AU 17. If you are unable to do this, place your fingers above the lip corners and push downwards, noting the changes in appearance. Now, try to hold this appearance when you take your fingers away.

When To Score Slight Versions of 15

Elongating the mouth is irrelevant, as it may be due to AU 20, AU 15, or AU 15+20.

(1) If the lip line is straight or slightly up in neutral face, then the lip corners must be pulled down at least slightly to score 15.

or (2) If lip line is slightly or barely down in neutral face, then the lip corners must be pulled down slightly more than neutral and not the result of AU 17 or AU 20.

*A wrinkle extending from beyond the nostril wings down to beyond the lip corners.

2. Detailed description of the appearance changes are keyed to illustrative still photograph and film examples.

3. Instructions are given as to how to make the movement on one's own face. This aids in learning the appearance changes particularly if FAC is learned by a group of people who can observe the variations in appearance on each other's faces. Learning how to do each AU also provides the user with a technique for later analyzing movements to be scored into their component parts. The user imitates the movement to be scored, noting which muscles he had to move in his own face to produce the movement to be scored. By this means the scoring of any novel, complex facial action can be determined.

4. A rule is given specifying the minimal changes which must be observed in order to score a slight version of each AU.

The determination of the single AUs (Table 1) and their description (as shown in Table 2) was the first step in developing FAC. The procedure of moving muscles, photographing the movement, and inspecting the pictures was reiterated with all the possible combinations of two AUs. There was no need to describe AU combinations which could not interact. For example, pulling the lip corners down is done by a muscle which cannot affect the muscles which control the position of the eyebrows. Two-way combinations were performed separately for the AUs controlling the brows, forehead, and upper and lower eyelids, and for those AUs controlling the lower eyelids, cheeks, and lower regions of the face.

There were a few hundred combinations to perform and examine, for only in a very few instances did we discover that two AUs could not occur simultaneously. We have called such AUs *antagonistic;* e.g., the lips cannot be pressed and opened simultaneously.

Study of the photographs of the AU combinations showed that most of the appearance changes were additive. The characteristic appearance of each of the two AUs was clearly recognizable and virtually unchanged. There were a few AU combinations which were not additive. The appearance change may have incorporated some of the evidence of the single AUs, but also new appearance changes from their joint action were evident. All of these distinctive combinations were added to the FAC, each described in the same detail as were the single AUs.

Inspection of the photographs of the AU combinations revealed that the appearance changes may be neither additive nor distinctive, but there may be a relationship of dominance, competition, or substitution among the two AUs. In *dominance,* the strong AU overshadows the weak one. It may completely conceal the appearance

due to the subordinant AU, or it may make the evidence of the subordinant AU very difficult to detect. In order to enhance agreement in scoring, rules were established which prohibit the scoring of subordinant AUs when there is clear evidence of a dominant AU.

In *competition,* it is almost impossible for the action of two AUs to be maintained. One action overcomes the other action. The winner of the competition is the AU of which appearance change remains evident. Unlike a relationship of dominance, among competitive AUs there is no way to predict ahead of time which AU will win. It depends upon which AU acts first or which acts more strongly. Rules were established which do not allow scoring one member of a competitive pair if there is clear evidence of the other member.

In *substitution,* the appearance of two different AU combinations is so similar that, in order to avoid disagreements, we designated only one of the combinations as the score to be used for either of the combinations.

After analyzing the pictures of all the combinations of two AUs, the process of performing, photographing, and then inspecting was reiterated, but this time with combinations of three AUs. Instead of hundreds there were thousands to so examine. Those which produced a distinctive rather than an additive combination of AUs were alloted their own entry in FAC with full descriptions as per Table 2. When we were ready to explore the combinations of four AUs, the number to consider was so great that we decided to make only selective study. On the basis of what we had learned from the two-AU combinations and three-AU combinations, we extrapolated which further combinations were likely to result in distinctive facial movements. In total, between four and five thousand facial combinations were performed and examined. These included *all* the possible combinations of AUs in the upper regions of the face, and *all* two-way and three-way combinations in the lower face, plus *some* of the *4-, 5-, 6-, 7-,* and *8-*AU combinations in the lower region of the face.

The *Manual for the Facial Action Code* (Ekman & Friesen, in press) was written in a self-instructional format, to serve as an initial tutor and subsequently as a reference in scoring facial behavior. The manual contains the following information:

1. Textual material describing each single AU listed in Table 1. Each AU is described in terms of its muscular basis, appearance changes, instructions for making the movement, and requirements which must be met for scoring slight versions (cf. example in Table 2).

2. The same information for each of more than 40 combinations of AUs.

3. A simple, less precise account of 19 additional single AUs listed in Table 3. Many of these AUs do not involve the facial muscles. We have not described them as finely as was done in Table 2

4. Descriptors which can be used to measure head and eye position.

5. Still photographic and motion picture film examples of all the single AUs in Tables 1 and 3, of the 43 AU combinations, and the head and eye position descriptors.

6. Tables comparing and contrasting AUs (or AU combinations) which differ only subtly. More than 400 such subtle differences are tabled.

TABLE 3
More Grossly Defined AUs in the Facial Action Code

AU Number	*FAC Name*
19.	Tongue Out
21.	Neck Tightener
29.	Jaw Thrust
30.	Jaw Sideways
31.	Jaw Clencher
32.	Lip Bite
33.	Cheek Blow
34.	Cheek Puff
35.	Cheek Suck
36.	Tongue Bulge
37.	Lip Wipe
38.	Nostril Dilator
39.	Nostril Compressor
41.	Lid Droop
42.	Slit
43.	Eyes Closed
44.	Squint
45.	Blink
46.	Wink

7. Scoring rules based on the Dominance, Antagonism, Competition, and Substitution relationships among AUs.

8. A scoring sheet and a step-by-step procedure to follow in measuring a facial movement. The procedure contains a number of internal checks designed to increase interrater reliability.

9. Still photographs and motion picture film examples of facial behavior to practice scoring facial movement. Correct scores are given, with commentary about the source of possible errors in scoring.

In addition to the manual, a separate publication, *An Atlas of Facial Action,* is in preparation (Note 6). This describes in detail the development of FAC, reliability, validity, results from experiments using FAC, and possible areas of application. Theoretically based predictions about the particular AUs and AU combinations which signal emotions and emotion blends are also included.

AN EXAMPLE OF SCORING FACES

It is not feasible in a short article and without film or video to illustrate the actual use of FAC to score a facial movement. The logic which underlies FAC can be illustrated, however, with still photographs. See the seven facial behaviors shown in Figure 1. They all involve some common elements in appearance, in particular the down curve to the line of the mouth. They also differ. Analysis of these faces in terms of the single AUs involved will allow precise differentiation among them.

These seven faces include three single AUs and the four combinations among these AUs. Figure 1-A is the appearance change due to AU 15 described earlier in Table 2. Figure 1-B shows AU 17, described in Table 4; Figure 1-C shows AU 10, described in Table 4. If one reads these verbal descriptions matching them to the photographs, one should then be able to "dissect" the other four faces in Figure 1 into their component AUs. Figure 1-D combines AU 10 and 15; Figure 1-E combines AU 10 and 17; Figure 1-F combines AU 15 and 17; and Figure 1-G combines AU 10, 15, and 17.

Any complex facial behavior can be so analyzed into its component elements, if the single AUs have been learned, and if rules regarding combinations have been studied. The scoring procedure leads the user to break down any action into a set of single AU scores. When he is in doubt, he is encouraged to consult the verbal descriptions, photographic and film examples, and tables of contrasting subtle differences. The person is also encouraged to imitate the action he sees,

1A

1B

1C

1D

1E

1F

1G

FIGURE 1

TABLE 4
Appearance Changes Due to AU 10 and to AU 17

ACTION UNIT 10

The muscle underlying AU 10 emerges from the center of the infraorbital triangle* and attaches in the area of the nasolabial fold.** In AU 10 the skin above the upper lip is pulled upwards and towards the cheek, pulling the upper lip up.

(1) Raises the upper lip. Center of upper lip is drawn straight up, the outer portions of upper lip are drawn up but not as high as the center.

(2) Causes an angular bend in the shape of the upper lip.

(3) Raises the infraorbital triangle; and may cause the infraorbital furrow to appear, or if it is evident in neutral, to deepen.

(4) Deepens the nasolabial furrows and raises the upper part of this furrow producing a shape as  .

(5) Widens and raises the nostril wings.

(6) When the action is strong the lips will part.

ACTION UNIT 17

The muscle underlying AU 17 emerges from an area below the lower lip and attaches far down the chin. In AU 17 the skin of the chin is pushed upwards, pushing up the lower lip.

(1) Pushes chin boss upward.

(2) Pushes lower lip upward.

(3) May cause wrinkles to appear on chin boss as skin is stretched, and may produce a depression medially under the lower lip.

(4) Causes shape of mouth to appear  .

(5) If the action is strong the lower lip may protrude.

---

*Roughly the cheek area.

**A wrinkle extending from beyond the nostril wings down to beyond the lip corners.

observing his own face and noting what AUs he must use in order to reproduce the action he observes.[3]

It has been shown how FAC scoring differentiates the seven facial behaviors shown in Figure 1. They are not visibly the same. Are these seven the same functionally, psychologically, communicatively? Is one a sadness expression, another a pout, another a disbelief gesture, etc.? It is only if the facial measurement distinguishes among these behaviors that we can determine empirically how many of the distinctions are useful. Once we can measure their separate occurrence, we can examine the contexts in which the behaviors occur, or we can study preceding or consequent actions of other persons, isolate concomitant behavior in the person showing the behavior, study observers' inferences from viewing each behavior, etc.

CONCLUDING COMMENTS

Six people have learned FAC. It required about 40 hours for them to learn and practice scoring. Reliability in scoring was satisfactory. The formula used was to divide the number of AU scores on which two persons agreed by the sum of the number of AUs scored by each person. If there was perfect agreement on a facial movement the score would be 1.00. The average coefficient of agreement among all possible pairings of the six persons across the faces they measured was .83. More information on ways to measure reliability is provided in Ekman and Friesen (Note 6).

FAC far exceeded our initial anticipation of what would be required to provide a comprehensive descriptive system for measuring facial action. Certainly, FAC is a very elaborate system, more comprehensive than any previous system by quite a margin. There is no facial action described by other systems which cannot be described by FAC, and there are many behaviors described by FAC not previously distinguished by others. FAC allows for measuring facial asymmetries, when different AUs appear on each side of the face. FAC does not include a measure of the intensity of action for every AU, although it does so for four of the AUs listed in Table 1. It would be possible for others to follow the procedure used for these AUs to elaborate intensity of action scoring for the others AUs.

[3]It is important not to be misled by this example into thinking FAC is designed for scoring still photographs. FAC emphasizes movement, and its chief purpose is to score facial actions seen on motion records, although it can be used with stills if there is also a picture of a "neutral" face.

We are reasonably confident that FAC is complete for scoring the visible, reliably distinguishable actions of the brows, forehead, and eyelids. FAC probably does not include all of the visible, reliably distinguishable, actions in the lower part of the face. The hinged jaw and rubbery lips allow a nearly infinite number of actions. We have included everything we could see, everything anyone else has included, and what are probably the most common elements and combinations of actions in the lower part of the face among children and adults. As we and others use FAC, we expect that some other AUs may need to be added; hopefully, not many. Others may well be interested in more finely discriminating separate AUs from the list of gross AUs in Table 3.

We have spent so much of our time in the last few years in developing and writing the FAC manual that we have had little time to use FAC to answer substantive questions. Its utility will have to await further research by us, and hopefully by others, now that it is available. A few studies underway by others using FAC have been encouraging. FAC has been used successfully to isolate facial syntax signs among deaf persons using sign language (Lidell, Note 7) and to measure clinical change in brain-damaged children (Johnson, Note 8). These and other uses of FAC will be reported in Ekman and Friesen (Note 6).

Some will ask the question whether FAC is too elaborate, too comprehensive and detailed. We believe it has been useful to attempt an approximation of the total repertoire of facial action, to isolate minimal action units which can combine to account for any facial movement. At the least, FAC provides a means to cross-reference with a common nomenclature the different scoring categories used by others. It may also serve to alert the investigator as to his choices, so he may, if he so chooses, be more explicit in his decisions about what to ignore when he does his measurement. No one knows at the outset how many of the variations in facial behavior can be ignored in any research study without losing important information. In preliminary observations, or pilot studies, investigators may wish to use FAC to comprehensively measure, and then, based on these results, more selectively score only certain AUs or AU combinations in their main study.

Apart from these more selective uses of FAC, there will be some who need a comprehensive measurement system. If we wish to learn all the facial actions which signal emotion (and those that do not), or whether facial emphasis markers are the same regardless of the content of speech so emphasized (to mention just two of our current interests), then a method such as FAC is needed.

REFERENCES

Birdwhistell, R. L. *Kinesics and Context.* Philadelphia: University of Pennsylvania Press, 1970.

Blurton-Jones, N. G. Criteria for use in describing facial expressions in children. *Human Biology,* 1971, *41,* 365-413.

Duchenne, B. *Mecanisme de la physionomie humaine ou analyse electrophysiologique de l'expression des passions.* Paris: Bailliere, 1862.

Ekman, P., & Friesen, W. V. *Manual for the facial action code.* Palo Alto: Consulting Psychologists Press, in press.

Ekman, P., Friesen, W. V., & Tomkins, S. S. Facial affect scoring technique (FAST): A first validity study. *Semiotica,* 1971, *3*(1), 37-58.

Ekman, P., Friesen, W. V., & Ellsworth, P. *Emotion in the human face: Guidelines for research and a review of findings.* New York: Pergamon Press, 1972.

Ermiane, R. *Le Visage et le caractère.* Paris: Sabri, 1963.

Ermiane, R., & Gergerian, E. *Atlas of Facial Expressions. Album des expressions du visage.* In press.

Frois-Wittmann, J. The judgment of facial expression. *Journal of Experimental Psychology,* 1930, *13,* 113-151.

Fulcher, J. S. "Voluntary" facial expression in blind and seeing children. *Archives of Psychology,* 1942, *38,* 5-49.

Grant, E. C. Human facial expression. *Man,* 1969, *4,* 525-536.

Hjortsjö, C. H. *Man's face and mimic language.* Lund: Student-litteratur, 1970.

Huber, E. *Evolution of facial musculature and facial expression.* Baltimore: Johns Hopkins, 1931.

Landis, C. Studies of emotional reactions: II. General behavior and facial expression. *Journal of Comparative Psychology,* 1924, *4,* 447-509.

McGrew, W. C. *An ethological study of children's behavior.* New York: Academic Press, 1972.

Schwartz, G. Facial muscle patterning to affective imagery in depressed and nondepressed subjects. *Science,* in press.

Seaford, H. W., Jr. Maximizing replicability in describing facial behavior. American Anthropological Association Convention, Nov. 1976.

Thompson, J. Development of facial expression of emotion in blind and seeing children. *Archives of Psychology,* 1941, *37,* 5-47.

Reference Notes

1. Young, G., & Decarie, T. G. An ethology-based catalogue of facial/vocal behaviors in infancy. Educational Testing Service, Princeton, N.J., 1974.
2. Schwartz, personal communication, 1976.
3. Hager, J., Ekman, P., & Friesen, W. V. A comparison of facial measurement procedures. In P. Ekman & W. V. Friesen (Eds.), *An atlas of facial action.* Book in preparation.
4. Ekman, P. Facial signs. In T. Sebeok (Ed.), *New approaches in semotics.* Book in preparation.
5. Washburn, S. L. Personal communication, October, 1975.
6. Ekman, P., & Friesen, W. V. (Eds.). *An atlas of facial action.* Book in preparation.
7. Lidell, S. K. Restrictive relative clauses in American sign language. In E. Klima & U. Bellugi (Eds.), *The signs of language.* Cambridge: Harvard University Press, in press.
8. Johnson, H. J. Facial changes in response to treatment of children with Lesch-Nyhan syndrome. In P. Ekman & W. V. Friesen (Eds.), *An atlas of facial action.* Book in preparation.