Disorders of the Facial Nerve, edited by
Malcolm D. Graham and William F. House.
Raven Press, New York © 1982.

Facial Expression and Facial Nerve Surgery

Paul Ekman

Department of Psychiatry, University of California, San Francisco, California 94143

This chapter summarizes new research findings from psychological studies of facial expression. It includes what has been learned about emotional expressions and conversational facial signals, and new developments in the capability to measure facial activity. Possible applications of this work to facial nerve surgery are discussed.

EMOTIONAL EXPRESSIONS

In the last 15 years a large body of evidence has been obtained that support Charles Darwin's long-ignored theory that human facial expressions of emotion have evolved, are innate, and are therefore universal (1).

While the issue of universality appears to be settled, many questions about facial expressions of emotion remain. There is evidence of a universal facial expression for happiness, anger, disgust, sadness, or distress, fear, and surprise, but we do not know how many more emotions have a universal facial expression. Another unexplored matter is how cultural and familial influences on facial expression become established. Children learn what we have termed "display rules," that is, norms or conventions about what kind of an emotional expression can be shown by whom, to whom, and when. For example, little boys are taught, implicitly and explicitly, that it is not masculine to show sadness or fear. How early these display rules are learned and exactly what these rules are for particular cultural groups remain to be determined. It is also not known how convincingly a person may be able to assume an unfelt expression or hide a felt expression. We believe it may be possible to detect such deceptive faces, but our studies are not yet complete (5,8).

CONVERSATIONAL SIGNALS

Relatively little is known about conversational facial signals that a speaker shows as part of the conversational process. For example, facial emphasis is usually marked by medial and lateral frontalis or corrugator muscles, and less often by orbicularis oculi, pars palpebralis, or levator palpebrae superioris. These and other facial muscles can also be used to provide punctuation. For example, facial actions some-times appear to function as commas, marking off the items listed in a series statement. Question marks are accomplished by action of the corrugator or medial and lateral frontalis. The nature of the question is related, it seems, to which of these muscles is recruited.

The person listening also provides many conversational signals. Perhaps most important are agreement responses that inform the speaker that he or she is understood and appreciated and keep him or her going. In addition to head nods, "mm-hmm" and "good" agreement signals also often involve the zygomatic major, or tightening of the lips by the orbicularis oris plus mentalis with head nodding. Alternatively, the listener may signal a call for information, letting the speaker know how he or she is not understood, needs to repeat, or explain further. The corrugator is the main call-for-information, but there are other ways to accomplish this signal.

Another type of conversational signal can be used in place of speech, although it can also accompany speech. We use the term "emblem" to describe symbolic actions that have a precise definition known to all members of a culture or subculture. Often emblems are used when people cannot converse because of noise, distance, or politeness. Emblems differ in meaning from culture to culture. The wink is an example of a facial emblem. The down-curved mouth with pushed-up chin boss, produced by the joint action of triangularis and mentalis, is an emblem for doubt or incredulity.

A facial expression of emotion may be employed deliberately as an emblem to make a statement about emotion, rather than as a sign of a spontaneously felt emotion. The smile is the most common of these emblems. An example is the smile that appears when someone is told he or she must undergo a painful medical treatment or pay an unexpectedly stiff bill. It is not a smile of happiness; instead, it is an emblem of compliance, the ability to accept without screaming, to grin and bear it (4).

FACIAL MEASUREMENT

Before the last decade, attempts to measure facial movement ignored the anatomical basis of facial movement and instead attempted to describe surface appearance, e.g., changes in the shape of features, wrinkles, and bags. These measurement systems were incomplete, vague, and influenced by individual and age-related differences in appearance.

In the last few years, three approaches to precise measurement of facial movement have been developed, each based on the anatomy of facial actions (6,7,10,12). Friesen and I turned to the literature on the neuroanatomy of facial movement to develop our measurement system. We expected to distinguish muscles on the basis of: differences in how they change appearance; capability for independent action; and feedback circuits that allow a person awareness of what has moved on his or her face. These issues have been considered but not studied systematically for the entire face. Anatomists have named muscles in the face largely on the basis of the appearance of difference strands or bundles of muscle fibers when the skin was removed. Duchenne (3), Hjortsjö (11), and Lightoller (14) were exceptions. Doing live anatomy, they named muscles on the basis of function in changing appearance.

Building upon their findings and incorporating other information on anatomy, Friesen and I used a number of methods to determine the independent units of facial action. We used Duchenne's procedure of stimulating a muscle in our own faces and recording the movement on film. We also moved a muscle and recorded the locus of activity with electromyography (EMG). We learned how to voluntarily contract each muscle singly and in combination. We developed our scoring system based on this work and on the study of many deliberate and spontaneous facial expressions. Any observed facial movement is scored in terms of the muscles that acted to produce it. Of course, certainty is not always possible, since the action of one muscle may hide if another muscle has been recruited unless the actions overlap in time.

We call our measurement system the Facial Action Coding System (FACS). More than a dozen investigators in four countries have learned it to study such diverse problems as facial actions of stutterers (13), sign language among the deaf (C. Baker, *in preparation*), and neonates (15). We are using FACS to study psychiatric patients, the nature of the startle reaction, asymmetries in facial movement, the particular actions that signal emotion, and conversational facial signals.

One study of the ability to perform facial actions may have particular relevance to facial nerve surgery (9). Children aged 5, 9, and 13 years were given our Requested Facial Action Test (REFACT), which shows facial muscle actions, one at a time, on videotape. The subject is asked to imitate each action. Subjects take the test twice; the second time they have the benefit of seeing their own attempts in a mirror. We found that performance improved with age and was better with a mirror, but only for some facial actions. Without a mirror, even the 5-year-olds could imitate the movement resulting when the entire frontalis or zygomatic major was contracted. The performance of other muscles, such as levator labii superioris alaeque nasi, improved with age. Certain actions, such as that of the triangularis or activating the medical or just lateral portions of frontalis, could not be done by most of the children, regardless of age, even when seeing themselves in a mirror.

APPLICATIONS TO FACIAL NERVE SURGERY

Diagnosis

REFACT, which can be used as a presurgical measure of the status of the facial musculature, is a comprehensive examination of whether each of the facial muscles appears to be working. The strength of action can be noted, as well as any peculiarities in the resulting appearance. REFACT provides different information from EMG. REFACT, which focuses upon movement, evaluates muscles in terms of appearance changes. REFACT is quicker to administer than the usual EMG examination. It is more comprehensive, allowing a fairly quick assessment of many more muscles than is practical with EMG. REFACT can be used as a screening procedure, followed by EMG measurement of specific muscles that REFACT identified as needing study. In a study of a 17-year-old patient with acrocephalosyndactyly (Pfeiffer's syndrome) by K. Vargervik and A. Miller, we found that REFACT showed no sign of a triangularis action. This was subsequently confirmed by EMG by Drs. Vargervik and Miller.

Evaluation of Change

While still photographs allow observation of changes in static facial appearance, stills cannot reveal changes in the capability or quality of facial movements. The usual clinical practice of asking the patient to make a few facial movements (smile, lift brows, etc.) suffers from two problems. First, it is not comprehensive, and thus may not reveal deficits or weaknesses in specific muscles. Second, without a videotaped record of the patient's performance, only very large, dramatic, all-or-nothing changes will be remembered. Videotaped performances on REFACT, repeatedly, over time, can help to solve these problems.

In a collaborative project with Crumley, we studied changes over time in a 21-year-old patient with congenital facial paralysis who had undergone cross-face nerve grafting and a facial sling procedure. When we compared her performance on REFACT at 3- or even 6-month intervals, whether improvement had occurred was uncertain. Comparisons spanning 9 months or a year were convincing: steady, slow improvement was occurring.

If improvement in facial action on REFACT is to be precisely measured rather than just documented, a number of features must remain constant, such as head position, focal length of the camera lens, positioning of the camera on the tripod, and distance from the patient.

Rehabilitation

Facial muscle exercises to aid rehabilitation are a third application of recent research on facial expression to facial nerve surgery. While such exercises have been used by facial nerve surgeons (2), a wider array is now available based on recent work on measuring facial action (6,7). These exercises can strengthen weak muscles, thereby improving the appearance of the static or dynamic aspects of facial appearance. Exercises can also teach the patient to weaken customary usage of unimpaired muscles.

For example, one set of exercises was devoted to building up the mentalis muscle on the previously paralyzed side of a patient's face. Alice, the patient, had some use of this muscle after a cross-face graft procedure, but it was weaker on the right than on the left side. She was told to push up her chin and lower lip while she applied counter pressure pushing down with her finger. Our aim was to increase the muscle mass on the right side so that her lower lip would not droop as much on that side, thus making her static appearance more attractive.

Alice made use of the levator labii superioris alaeque nasi as a conversational signal to mark emphasis. Momentary wrinkling of the sides and bridge of the nose is often used by young women to accent speech. Its bilateral appearance is pleasing, but its unilateral appearance is unappealing and noticeable. Facial signals like this are established habits that usually occur without the patient's awareness. Simply telling Alice not to do it would not work. Instead, we taught her to stop doing it by making her aware of it. This was accomplished by placing a small strip of transparent tape—small enough to be hardly visible to others—between her brows and the bridge of her nose. Each time she began to tighten this muscle, she would feel the pressure of the tape and interrupt the movement.

We used two different procedures with zygomatic major, the principal muscle that produces the smile. One exercise was to strengthen the muscle on the previously paralyzed side. Alice was told to contract this muscle, pulling her lip corner up while her fingers applied counter pressure. The other exercise aimed at teaching her to make more symmetrical social smiles. Her smile was always asymmetrical, much stronger on the intact than the previously paralyzed side of her face. We had her practice making deliberately symmetrical smiles, requiring her to lessen the action on the intact side of the face so that it would equal the partially impaired side. She was told to attempt a symmetrical smile, then check it in the mirror and correct any asymmetry while looking in the mirror. Alice did this exercise 20 times a day. She has become skilled in making deliberately symmetrical smiles. Her spontaneous smile is, of course, still asymmetrical.

CONCLUSIONS

Recent research underscores the importance of the face as a multisignal system. Impairment of the facial nerve interferes with the conveyance of intimate information fundamental to our lives: whether we are angry, surprised, disgusted, afraid, distressed, happy, interested; nuances in the intensity of these emotions; and blends of these emotions. Facial actions are also relevant to the flow of conversation, to animation in conversation, to the supplementation of the meaning of speech, and to the provision of punctuation signs.

REFERENCES

1. Darwin, C. R. (1872, 1955): *The Expression of Emotions in Man and Animals.* Philosophical Library, New York.
2. Devriese, P. P. (1977): Experimental compression of the facial nerve. In: *Facial Nerve Surgery*; Proceedings: Third International Symposium on Facial Nerve Surgery, 1976, Zurich; edited by U. Fisch, pp. 344–349. Kugler Medical Publications, Amstelveen, Netherlands; Aesculapius Publishing Co., Birmingham, Alabama.
3. Duchenne, G. B. A. (1876): *Mécanisme de la Physionomie Humaine ou Analyse Électrophysiologique de l'Expression des Passions.* 2nd edition. Baillière, Paris.
4. Ekman, P. (1979): About brows: Emotional and conversational signals. In: *Human Ethology*, edited by M. von Cranach, K. Foppa, W. Lepenies, et al. Cambridge University Press, London.
5. Ekman, P., and Friesen, W. V (1975): *Unmasking the Face.* Prentice-Hall, Englewood Cliffs, New Jersey.
6. Ekman, P., and Friesen, W. V. (1976): Measuring facial movement. *Environ. Psychol. Nonverbal Behav.*, 1:56–75.

7. Ekman, P., and Friesen, W. V. (1978): *Facial Action Coding System: A Manual for the Measurement of Facial Movement.* Consulting Psychologists Press, Palo Alto, California.
8. Ekman, P., Hager, J. C., and Friesen, W. V. (1981): Symmetry and the nature of facial action. *Psychophysiology,* 18(2):101–106.
9. Ekman, P., Roper, G., and Hager, J. C. (1981): Deliberate facial movement. *Child Dev.,* 51:886–891.
10. Ermiane, R., and Gergerian, E. (1978): *Atlas of Facial Expressions. Album des Expressions du Visage.* La Pensee Universelle, Paris.
11. Hjortsjö, C. H. (1970): *Man's Face and Mimic Language.* Studentilitteratur, Lund, Sweden.
12. Izard, C. E. (1979): *The Maximally Discriminative Facial Movement Coding System.* Instructional Resources Center, University of Delaware, Newark.
13. Krause, R. (1980): A social psychological approach to stuttering. In: *Social Psychology of Language,* edited by Fraser and C. E. Scherer, University Press, Cambridge (*in press*).
14. Lightoller, G. H. S. (1925): Facial muscles: The modiolus and muscles surrounding the rima oris with some remarks about the panniculus adiposus. *J. Anat. (Lond.),* 60:1–85.
15. Oster, H. (1978): Facial expression and affect development. In: *Affect Development,* edited by M. Lewis and L. A. Rosenblum, pp. 43–76. Plenum Publishing Corp., New York.