Ann. Rev. Psychol. 1979. 30:527–54

FACIAL EXPRESSIONS OF EMOTION[1]

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CONTENTS

[1]Because literature references are counted as part of the total number of pages allotted for this chapter, *no* attempt was made to cite most of the studies relevant to each topic discussed. Instead the space allotment was used primarily to discuss issues.

0066-4308/79/0201-0527$01.00

INTRODUCTION

Research on facial expressions of emotion has been episodic. The topic flourished from 1920 to 1940, drawing the attention of well-known psychologists: e.g. Allport, Boring, Goodenough, Guilford, Hunt, Klineberg, Landis, Munn, Titchener, Woodworth. Yet the cumulative knowledge was unimpressive. In the opinion of influential reviewers (15, 76, 127), there were no consistent answers to the most fundamental questions about the accuracy of information provided by facial expressions, their universality and possible innateness, etc. During the next 20 years there were comparatively few studies of facial expression, with the exception of Schlosberg's (112–114) reports that categorical judgments of emotion can be ordered in terms of underlying dimensions. A number of recent trends have contributed to the resurgence of interest in facial expression.

Tomkins (128, 129) provided a theoretical rationale for studying the face as a means of learning about personality and emotion. He (130) also showed that observers can obtain very high agreement in judging emotion if the facial expressions are carefully selected to show what he believes are the innate facial affects. Tomkins greatly influenced both Ekman and Izard, helping each of them to plan their initial cross-cultural studies of facial expression. The resulting evidence that there is universality in facial expression rekindled interest in this topic in psychology and anthropology.

The evidence of universals in facial expression not only fits with Tomkins' theory but also with the newly emerging interest in applying ethological methods and concepts to human behavior. Interested in the biological bases of behavior, human ethologists welcomed evidence of commonalities in social behavior across cultures. Human ethologists provided the first detailed "catalogs" describing naturally occurring facial behavior (10, 13, 66, 93). In recent years developmental psychologists investigating attachment, mother-infant interaction, and the development of emotion have also begun to study facial expression.

Interest in facial expression also reflects the current popularity of nonverbal communication. While most of the research done under this rubric has focused on hand and body movement, gaze direction, or posture, some studies have included a few facial measures or have used a judgment approach to assess the face.

A number of recent reviews have covered the literature on facial expression up to 1970. Ekman, Friesen & Ellsworth (52) reanalyzed many of the experiments conducted from 1914 to 1970. They found, contrary to Bruner & Tagiuri's (15) assessment, that the data yielded consistent, positive answers to fundamental questions about the language used to describe facial expression, the influence of context on judgments of facial expression, the

accuracy of judgments, and similarities across cultures. For other reviews of facial expression see: (30) on infants and children; (31, 104) on nonhuman primates; (44) on cross-cultural comparisons; (77) on theories of emotion.

We will focus primarily on studies since these reviews. We will discuss four topics we deem of major importance, either because of their long-standing theoretical significance (cross-cultural, developmental, and accuracy studies) or because of recent methodological advances (facial measurement). We will then more briefly consider research on the influence of facial feedback and on the neural correlates of facial expression. Rather than providing exhaustive coverage of each area, we summarize exemplary findings, point out gaps in empirical knowledge, and delineate questions for future study.

CROSS-CULTURAL STUDIES AND THE ISSUE OF UNIVERSALITY

What Has Been Found

1. *Observers label certain facial expressions of emotion in the same way regardless of culture.* A number of studies (reviewed in 44) attempted to show differences across cultures in the way observers judge isolated facial expressions. In fact, their findings were either ambiguous or showed similarity across cultures. More consistent results have been obtained by investigators who used explicit descriptive criteria (based on theory or empirical results) to select photographs of expressions representative of each emotion. These photographs were shown to observers who selected from a list of emotion terms the one that best described each expression. The majority of observers in each culture interpreted the facial expressions as conveying the same emotions [five literate cultures (43, 55); nine literate cultures (77)]. Similar experiments have obtained comparable results in Malaysia (11) and in two states of the Soviet Union (unpublished report by T. Niit and J. Valsiner).

Two studies investigated judgments of the intensity of emotional expression. Both found high agreement among members of literate cultures (44, 108).

In spite of this evidence, it could still be argued that facial expressions of emotion are culturally variable social signals, and that the commonality in judgments is attributable solely to common learning experience. By this interpretation, exposure to the same mass media representations of emotional expression might have taught people in each culture how to label facial expressions. This explanation was disproved by studies of isolated, preliterate cultures not exposed to the mass media: the South Fore in Papua/New Guinea (47) and the Dani in West Iran [Heider & Heider,

reported in (44)]. These people chose the same facial expressions for particular emotions as members of literate cultures.

A limitation of these cross-cultural experiments is that the facial expressions presented were not genuine but posed by subjects instructed to show a particular emotion or to move particular facial muscles. One interpreter of this literature (94) suggested that universality in judgments of facial expression might be limited to just such stereotyped, posed expressions. Two experiments argue against this interpretation. Winkelmayer et al (138) chose motion picture samples from interviews with normal and schizophrenic people to see if emotion judgments by members of different cultures would differ when spontaneous rather than posed expressions were shown. There was no overall difference among American, British, and Mexican observers. However, the Mexican observers were less accurate than the others in judging the facial expressions of normal but not schizophrenic subjects. This difference had not been predicted, may have been due to language and/or culture, and has not been replicated. More clear-cut results were obtained in a study by Ekman (43) in which Japanese and American observers judged whether the facial expressions of Japanese and American subjects were elicited by watching a stressful or neutral film. Observers of both cultures were equally accurate whether they judged members of their own or the other culture. Moreover, persons of either culture who were judged correctly by Americans were also judged correctly by Japanese (correlations above .75). This experiment was replicated with different subjects and observers.

2. *Members of different cultures show the same facial expressions when experiencing the same emotion unless culture-specific display rules interfere.* While many studies have compared judgments of facial expression by observers from different cultures, few studies have compared the facial expressions actually produced by members of different cultures in comparable situations. Without studies measuring actual facial activity, it is not possible to determine which specific aspects of facial expressions are universal, in what social contexts these configurations are shown, nor how cultural norms for managing emotional expression (display rules) operate. Such questions apply both to intended (posed) and spontaneous facial expressions. There has been but one study of each.

Ekman & Friesen (47) found that members of a preliterate New Guinea group showed the same facial movements when posing particular emotions as do members of literate cultures. Ekman (43) and Friesen (61) also found that when Japanese and American subjects sat alone watching either a stress-inducing or neutral film, they showed the same facial actions. However, as predicted by knowledge of display rules in the two cultures, when a person in authority was present, the Japanese subjects smiled more and showed more control of facial expression than did the Americans.

Unanswered or Unasked Questions

1. *How many emotions have a universal facial expression?* Research in literate cultures has found distinctive facial expressions for anger, disgust, happiness, sadness (or distress), fear, and surprise (11, 43, 44, 55, 77, 108). Izard (77) also reported evidence for interest and shame, but inspection of his photographs suggests that head position, not facial expression, may have provided the clues for recognizing these emotions. There have been no other cross-cultural studies of these two emotions. In the preliterate cultures studied, fear and surprise expressions were differentiated from anger, sadness, happiness, and disgust but were confused with each other both in labeling and posing expressions (44). In sum, there is unambiguous evidence of universality only for the expressions of happiness, anger, disgust, sadness, and combined fear/surprise. Further study might reveal universal facial expressions for other emotions.

2. *How many universal expressions are distinguishable for any emotion?* Tomkins (128, 129) hypothesized that each emotion would have both universal and culture-specific expressions, but he did not describe the appearance of the latter in any detail. The cross-cultural studies used only a few examples of each emotional expression and did not analyze observers' judgments to see whether different versions of each expression were judged differently.

3. *How great are the cultural differences in facial expression?* Most accounts of extreme cultural variability in the expression of emotion come from qualitative observations made by single observers who did not control for observer or sampling bias or take display rules into account [Birdwhistell, LaBarre, Leach, Mead, and Montague reviewed in (44, 45)]. One quantitative study of cultural differences is the previously cited finding by Ekman and Friesen (43, 61) that facial expressions in Japanese and American subjects differed in a social situation but not when the same subjects were alone. This fit the authors' hypothesis that socially learned *display rules* for managing facial expression in various contexts are a major source of cultural variation in facial expression. In another study of display rules, Heider (73) confirmed his prediction that one West Irian culture but not another would substitute disgust expressions for anger when asked to portray angry themes. There has been no further cross-cultural study of display rules. A study of yearbook photographs and conversations (116) found evidence for a facial expression "dialect" in patterns of smiling among Southeastern Americans. The origin and interpretation of this dialect remain uncertain.

Ekman (43) postulated that learned triggers for each emotion were another major source of cultural variation, but he hypothesized that these elicitors may have some shared underlying characteristics. Boucher and

Cunningham (unpublished report) found evidence for similarities—but not for the hypothesized differences—in the specific elicitors of certain emotions in quite divergent cultures. In sum, there probably are important cultural differences in facial expression, attributable to learning, but precisely what these are and how they come to be are unknown.

4. *How often do people in natural situations actually show the distinctive, universal patterns of facial expression?* Are these expressions common or relatively rare? Does their occurrence vary with culture, sex, age, or the particular social context? Such questions call for detailed measurement of the facial expressions occurring in specified circumstances in different cultures, as well as knowledge of each culture's display rules. These facts are not available for even one culture.

5. *What are the evolutionary and/or ontogenetic origins of facial expressions?* Why are particular facial muscles activated in particular emotional expressions? For example, why are the lip corners raised in happiness and drawn down in sadness rather than vice versa? The finding of universal facial expressions has been taken as evidence that these expressions are *innate,* prewired, specialized signals (37, 42, 104, 128). Other writers (2, 103) have proposed instead that adult facial expressions derive ontogenetically from species-constant learning and from the biologically adaptive responses of the newborn: movements related to sensory reactions, defensive and orienting responses, crying, sucking, etc.

The crucial data for understanding the origin of facial expressions of emotion—longitudinal study involving detailed measurement of facial movements in infants in a variety of situations and in several unrelated cultures—exist in only piecemeal fashion. Detailed comparison of blind and sighted infants would reveal the importance of visual imitation and the adaptive use of facial movements involved in vision for the development of facial expressions. Studies of cogenitally blind infants (reviewed in 30) have provided the best evidence that direct imitation is unnecessary for the development of smiling, laughter, and crying. However, descriptions of the actual facial movements corresponding to these and other emotions (e.g. surprise, anger) in blind children have been vague and imprecise. Reports that blind infants and children are less facially expressive than sighted children (30, 59) have also lacked detailed description.

DEVELOPMENTAL STUDIES

Most research on facial expression in infants has been concerned with the timetable of emotional development. At what age and in what order do particular emotions emerge? Unfortunately, the behavioral criteria by which various emotional responses have been "recognized" and labeled are

often subjective and imprecise, with little attention paid to detailed description of the facial movements themselves. Most early studies also lacked independent, convergent measures for assessing the infant's presumed emotional state. Several recent studies have attempted to deal with these methodological problems (26, 74, 91, 136, 142). Nevertheless, it is still not known when the distinctive, universal facial expressions corresponding to certain emotions first appear, nor how they develop. Part of the problem is that the questions left unanswered by research on infants have not been pursued in studies of toddlers and young children.

What Has Been Found

1. *The facial musculature is fully formed and functional at birth.* Many observers have been struck by the newborn's considerable facial mobility (63, 72). Using a fine-grained measurement system (described below), Oster & Ekman (100) confirmed that all but one of the discrete facial muscle actions visible in the adult can be identified and finely discriminated in full-term and premature newborns. Evidence for organization and temporal patterning in expressive movements such as smiling, brow knitting, and pouting in young infants has also been found by fine-grained analysis (81, 99, 100).

2. *Distinctive facial expressions resembling certain adult expressions are present in early infancy.* Crying, the universal expression of *distress,* is of course present at birth, but there has been little careful description since Darwin of the facial signs of distress and no study of developmental changes, if any, in cry faces. It is not known whether different facial movements correspond to acoustically different cry types or different sources of distress. Newborn infants show expressions resembling adult *disgust* in response to unpleasant tastes (103, 124). These facial responses have been found in anencephalic and hydrocephalic infants, suggesting a brain stem origin (124). The processes by which these facial reactions become associated with a wide range of psychological elicitors are not known. The *startle* reaction can be triggered in the newborn by sudden, intense stimulation and often occurs as a spontaneous discharge in non-REM sleep. There is disagreement about whether startle should be considered an emotional response related to surprise or a physiological reflex (128, 135, 140). The facial response is quite different from surprise and is said not to change throughout life.

Contrary to previous belief, neonatal smiles are neither random nor produced by gas. They occur primarily during REM sleep and seem to reflect periodic, endogenous fluctuations in CNS activity (56, 122, 139). Social smiling, i.e. smiling in an alert, bright-eyed infant who is fixating the caregiver, first occurs around 3 to 4 weeks of age (139). The reliable,

full-blown social smile emerges in the third month (56, 139). Smiling in 2- to 3-month-olds has been observed in a variety of experimental situations suggesting that it reflects active cognitive engagement, "mastery," and a sense of efficacy (102, 118, 121, 122, 137). Beginning around the fourth month, smiling becomes increasingly reserved for the infant's primary caregivers (1, 12). With the exception of Wolff's classic study, little is known about developmental changes in the morphology of the smile or about differences—if any—in the appearance of "social," "playful," or "cognitive mastery" smiles (10, 133). Laughter first appears around 4 months. Most studies have focused on changes in the determinants of laughter (121, 122). Insights into the mechanisms underlying smiling and laughter have come from the study of Down's Syndrome infants (32).

3. *Three- to 4-month-olds show differential responses to facial expressions.* Early studies (30) indicated that infants do not begin to discriminate among facial expressions until 5 to 6 months. Several recent studies found differential visual fixation to slides of happy vs neutral or angry faces (84), and surprise vs happy faces (143) in 3- to 4-month-olds. It is not certain which aspect of the faces the infants were responding to, nor whether they perceived the stimuli (other than the smile, perhaps) as meaningful emotional expressions. Measurement of the infant's emotional responses and scan patterns to different facial expressions might help to resolve this question. Three-month-olds typically become "sober" or distressed when the caregiver presents an impassive face, suggesting a sensitivity to the animation and responsiveness of naturally occurring facial behavior (14, 123, 131). Detailed study of infants' responses to the dynamic, temporally patterned, often exaggerated facial expressions used by caregivers (cf 125) might reveal a greater sensitivity to differences in the expressive movements themselves.

4. *Imitation of some facial movements is possible at an early age.* Recent studies suggest that 2- to 3-week-old infants can differentially imitate actions such as mouth opening and tongue or lip protrusion (97), but there is disagreement about the possible mechanism underlying this feat (80, 97). It is not known whether neonates can imitate the principal actions used in emotional expression, nor what role imitation plays in the normal development or "fine-tuning" of facial expression. Such a role is suggested by Kaye & Marcus's recent finding (82) that 6-month-olds gradually accommodate their performance over a series of trials to match the movements modeled (bursts of mouth opening and closing). Many of the specific facial actions found in emotional expression can be imitated by 5 years (105).

5. *Preschool children know what the most common facial expressions look like, what they mean, and what kinds of situations typically elicit them.* The general finding from recognition, discrimination, affective role-taking, and empathy studies is that performance improves from age 3 to 10 (30, 67, 75). The abilities to imitate and voluntarily produce facial expressions to the

satisfaction of adult judges likewise increases with age (30, 70). On both recognition and production tasks the expression of happiness is easiest and fear among the most difficult. Most studies with children have involved cognitive tasks tapping knowledge of emotional expressions rather than measures of spontaneous emotional expression. However, a few empathy studies have shown that preschool children's spontaneous facial expressions reflect the emotions shown by others [(70), review by (75)]. The spontaneous nonverbal expressions of preschool children watching emotion-eliciting slides can be "decoded" by other preschool children, at least in terms of the pleasantness or unpleasantness of the "sender's" reaction (16). But no direct measures of the subject's facial expressions have been made in encoding/decoding studies. The only direct studies of facial behavior in children have come from an ethological perspective, as discussed below.

6. *Facial expression can play a role in the development of social communication.* The young infant is increasingly being viewed as an active individual, equipped with basic signaling capacities that serve to ensure certain kinds of attachment-promoting exchanges between infant and caregivers (1, 12, 14, 92, 131). Facial expression is recognized as a major component of this signaling system.

Ethological studies of natural social interaction in day care or nursery school settings have typically focused on the repertoire of facial and gestural actions associated with agonistic encounters, rough-and-tumble play, and social interaction with adults and peers (10). Ethologists discuss these actions in terms of their presumed motivation and signal function. However, there has been little quantitative documentation that particular expressive movements actually serve the presumed signaling function. Nor have ethologists systematically related the facial movements shown in such actions to emotional expressions. An exception on both scores is a recent ethologically oriented experimental study (28) showing that certain "aggressive" facial configurations used by children defending a desired object predicted both the child's own and his partner's subsequent behavior. The growing social control over emotional expression is suggested by observations that the presence of others can have a facilitative effect on emotional expressions such as crying (10) and humor (29).

Unanswered or Unasked Questions

1. *At what age can emotion be inferred from facial expressions seen in early infancy?* Most psychologists have believed that young infants lack the cognitive prerequisites for the experience of emotion This belief cuts across the nativist/empiricist spectrum (e.g. 2, 63, 103), though there have been widely differing views on the presumed cognitive prerequisites for experiencing "true emotion," on the age when these prerequisites are attained, and on the ontogenetic mechanisms presumed to be involved. Recent articles

(56, 90, 107, 121) have interpreted expressive movements such as crying and smiling in early infancy as purely passive, reflex-like precursors of later expressions of emotion. There is said to be no "genuine" emotion until the emergence of the first signs of active cognitive processing or "consciousness" around the third month (56, 121), or until the emergence of "self-conscious awareness" around 18 months (90). While not denying the importance of these cognitive achievements, several researchers maintain that emotion is present at birth (79, 128, 129), or suggest a more gradual transition from physiological to psychological causation of emotional expressions (99, 123, 140). This issue cannot be resolved on the basis of available empirical data.

2. *When do adult-like, differentiated facial expressions for the emotions of interest, surprise, sadness, fear, and anger first appear?* "Brightening" of the eyes and face has been noted in alert newborns attending to visual or auditory stimuli. But more detailed study is needed before we could conclude that the expression of interest, as distinct from orienting and attentional responses, is present in early infancy. The typical adult surprise face is infrequently observed in infants less than 1 year old (30, 135), even though infants in the second half year may respond to presumably surprising experimental situations in ways suggesting that they were surprised (38, 74, 135).

We cannot yet specify when discrete negative affect expressions (as distinct from crying) begin to appear on a regular basis, nor in what natural circumstances they are likely to occur. Sadness and distress faces differ in adults, but this distinction has not been made in studies of infants and children. "Wariness" and fear emerge in the second half year of life, as inferred from the onset of hesitant, avoidant, or overtly negative reactions to situations that were not previously distressing, such as heights or the approach of a stranger (27, 38, 56, 120, 121). Anger has been inferred from "tantrum" behaviors and from instrumental acts such as hitting, throwing, and biting (30, 121). But the facial expressions accompanying these emotional responses have not been described in detail. Investigators who coded infants' responses to emotion-arousing situations in terms of specific facial actions (26, 74, 91, 136, 142) have not found differentiated expressions of fear, sadness, or anger, but rather affectively neutral attention and components of pre-cry or distress faces of various intensities. In one of the few studies that tried to elicit several different negative affects (142), the infants' reactions could not be distinguished on the basis of facial expression alone. A finer grain coding system might reveal precursors of adult expressions of anger, sadness, or fear in the cry or pre-cry faces elicited by different events or associated with other behaviors indicative of these affects.

As noted above, 5-year-olds can satisfactorily pose expressions of anger, fear, and sadness. But there has been no systematic study of the actual

occurrence of discrete negative affect expressions in natural or laboratory settings. Crying apparently remains the prepotent expression of virtually all strong negative affect throughout early childhood. However, no studies have investigated Tomkins' proposal (129) that different cry vocalizations and cry faces accompany different negative affects. Nor is it clear whether young children cry because they do not yet "use" more discrete facial expressions (which they can, however, produce voluntarily), or because all negative affect is blended with or produces distress at this age.

3. *When—and how—do facial expressions of emotion come under voluntary control?* The development of voluntary control and of culturally defined "display rules" for managing emotional expression remains a virtual *terra incognita,* with only impressionistic observations suggesting a gradual transition from the automatic, uncontrolled expression of emotion in early infancy to the more modulated, subtle, and voluntary expression of emotion seen in older children and adults. The first step is probably the (not fully conscious) instrumental use of crying and smiling, somewhere in the first 2 to 3 months of life—as suggested by subjective impressions of "fake" crying (141); by evidence that both crying and smiling can be brought under the control of social reinforcement (64); and by reports suggesting that during the first half year of life infants begin to acquire a sense of the efficacy of their own signaling behaviors (6). By the end of the first year, one sees what seem to be smiles used as social greetings, deliberate "tantrum" behaviors, and visible efforts to hold back or suppress tears. The specific facial actions used in such behaviors have never been closely examined, however.

As noted above, one form of voluntary control—deliberately imitating or posing facial expressions when the corresponding emotion is (presumably) not felt—is present to some extent in preschool children. One recent study investigating children's verbal knowledge of social display rules (106) found increasing awareness of rules for managing emotional expression from 6 to 10 years. We know of no studies that directly studied children's efforts to control emotional expression or their use of display rules. Despite the general assumption that feedback from others (e.g. "big boys don't cry") plays a crucial role in shaping children's tendencies to manage emotional expression, we know of no objective data on the amount and kind of social feedback that children actually receive in response to their facial expressions, nor the extent to which parents, other adults, and peers serve as direct models.

FACIAL MEASUREMENT

As repeatedly indicated above, many of the central questions in cross-cultural and developmental research require measurement of facial activity

itself and cannot be answered solely by reliance upon observers' judgments of emotion. Methods have recently been developed to allow measurement of two different but related aspects of facial activity—muscle tonus changes and visible actions.

Muscle Tonus Measurement

Schwartz and his co-workers (115) have shown that surface electromyographic (EMG) measurements are sensitive to differences among recalled emotions and moods and can distinguish depressive from normal subjects. The EMG leads were placed over facial areas that, according to theory (49, 128, 129), were expected to be differentially active for the emotions studied. While a given placement of leads apparently can differentiate among two or three emotions, it is not certain whether surface EMG procedures could distinguish as many as five or six emotions. A study in progress by Ekman, Schwartz, and Friesen on the relationship between EMG and visible facial activity suggests that the EMG can record muscle tonus changes that are barely visible or totally invisible.

EMG measurement of facial activity may be most applicable when the investigator can specify in advance the emotions of interest, when unobtrusiveness is not crucial, and when the subject will not be likely to move his face. (The leads, paste, and tape tend to inhibit movement and may be torn by strong muscle actions.) EMG should be useful when emotion is aroused by fantasy, recall, listening, viewing a film, etc. EMG is also the only method for studying Birdwhistell's (8) proposal that there are stable individual differences in the pattern of muscular tension maintained when the face is at rest (see 119).

Measurement of Visible Action

The early attempts to measure visible facial action (reviewed in 52, Chap. 16) have been ignored by those who followed. These early methods for measuring facial action did not explain the rationale for their choice of facial measurement units. Yet as Altman commented, "... what stage in our research could be more crucial than this initial choosing of behavioral units. Upon it rests all of our subsequent records of communication interactions and any conclusions we may draw from them ..." (3, p. 501). Selection of behavioral units has been based on theory, inductive observation, or facial anatomy.

THEORY-BASED SELECTION Ekman, Friesen & Tomkins' (53) Facial Affect Scoring Technique (FAST) specified what they believed—on the basis of previous research—to be the distinctive components of six universal affect expressions. FAST proved useful in studies relating subjects' facial

expressions to autonomic responses, experimental conditions, and observers' judgments. FAST is not a general purpose tool, however. It could not be used to determine whether actions other than those specified are relevant to emotion nor to study developmental changes or individual differences in the expression of emotion. The first two criticisms of the inductively derived systems listed below also apply to FAST. Izard's (personal communication) newly developed Facial Expression Scoring Manual, which follows the same general approach as FAST, probably also suffers from the same limitations. Some investigators (e.g. 74; Izard, personal communication) have used theory based systems [e.g. materials developed by Ekman & Friesen (49) for training clinicians, or Izard's FESM] as the basis for scoring emotional expressions or components of those expressions in infants or young children. This approach suffers from the problems outlined above for FAST. There are additional methodological problems inherent in using a theory-based facial measurement system derived from data on adults for research on infants. More serious, such an approach cannot reveal how full-face, adult-like expressions develop and ignores possible early precursors of these expressions.

INDUCTIVELY BASED SELECTION Several overlapping listings of facial actions have been derived by observing spontaneous behavior in infants (98, 142), children (9, 13, 66, 93), and normal and psychiatric adult patients (66). These systems have been useful in generating "ethograms," or catalogs of the salient behaviors in the communicative repertoire. Blurton Jones' system has been adopted with some variations by a number of developmental psychologists. Yet all suffer from major methodological flaws if considered as general purpose facial measurement systems.

All are incomplete, without explanation of what has been left out or why. All include—without mention—both simple muscle actions and complex movements involving several independent actions. Behavioral units are sometimes given inference-laden names (e.g. "angry frown"), making objective study of the action's meaning difficult. Many units are only vaguely described, so that investigators cannot know if they are coding the same actions. Descriptions of some actions are anatomically incorrect. Finally, individual, racial, or age-related differences in physiognomy may make it difficult to identify certain actions described in terms of static configurations (e.g. "oblong mouth").

ANATOMICALLY BASED SELECTION Since every facial movement is the result of muscular action, a system for describing facial expression can be comprehensive if the measurement units are based on knowledge of how each muscle acts to change appearance. Any complex facial movement can

then be scored analytically in terms of the minimal muscle actions that collectively produce the movement. Three investigators have followed this logic.

Seaford (116) provided an excellent, detailed critique of the hazards involved in theoretically or inductively derived systems. His description of a regional variation in facial expression showed the utility of an anatomical approach. Ermiane & Gregerian (57) have developed a general-purpose, anatomically based facial measurement system. But they do not report reliability data nor mention whether the system can be learned without personal instruction.

Ekman & Friesen's (50, 51) Facial Action Coding System (FACS), also a general-purpose system, was designed to measure all visible facial behavior in any context, not just actions related to emotion. The list of minimal units overlaps considerably with that of Ermiane and Gregarian. However, FACS specifies minimal units not only in terms of anatomically possible actions but also in terms of which actions can be reliably distinguished. Persons who learn the system without personal instruction from the developers have achieved high reliability.

FACS is slow to learn and use, requiring repeated, slow-motion viewing of facial actions. It is thus unsuitable for real-time coding. By its nature, FACS includes more distinctions than may be needed for any particular study, which increases the expense and tedium of measurement. However, once meaningful units of behavior are defined empirically, it is possible in a given study to collapse some of the elementary measurement units or to disregard subtle distinctions. As yet there is no empirical evidence to substantiate which facial actions and combinations, as scored by FACS, correspond to particular emotions.

Other Facial Measures

Perhaps the most popular measure of facial activity has been direction of gaze, yet surprisingly this rarely has been studied in relation to emotion or facial expressions [recent exceptions are (65, 86, 123, 125, 136)]. While pupil dilation has been studied in relation to emotion, we know of no study of associated changes in facial expression. Blood flow, skin temperature, and coloration changes in the face are other measures that so far remain unexplored.

ACCURACY

How are we to determine if the information provided by a person's facial expression is accurate? We must have some criterion—independent of the face itself—for establishing which emotion, if any, was experienced at the

moment of facial expression. The problem of independent validation has been the greatest obstacle to research on accuracy. A common approach has been to ask subjects to report their feelings (usually retrospectively) and to see whether their facial expressions differ when reporting emotion A as compared to emotion B. Such self-reports are error-prone, since subjects may fail to remember or to distinguish among the emotions experienced—particularly if several minutes elapse before the report is made. A subject who successively felt anger, disgust, and contempt while watching a film might not recall all three reactions, their exact sequence, or their time of occurrence. This problem can be avoided by limiting self-report to the grosser distinction between pleasant vs unpleasant feelings; but we then cannot determine whether facial expressions convey accurate information about particular unpleasant or pleasant feelings.

A second common approach has been to find out if subjects' facial expressions vary according to the eliciting conditions: e.g. affectively positive vs negative films or slides; anticipation of an electric shock vs a no-shock trial; or hostile vs friendly remarks made by another person. Since it is unlikely that all subjects experience the same, discrete emotion during a particular condition, this approach can usually show only that different facial expressions are used in presumably pleasant and unpleasant situations.

Attempts to pre- or postdict other information about a subject (e.g. whether he has many friends) have also been used to assess accuracy; but this approach implies that facial expressions can provide information about enduring traits in addition to transient states. If particular changes in voice pitch or quality, body movement, or speech were infallible indicators of particular emotions, these could serve as accuracy criteria. Unfortunately, there is no evidence that these channels provide any more accurate information than facial expressions. Similarly, change in autonomic or central nervous system activity could provide a useful criterion if there were evidence that different patterns of neural activity reliably accompany different emotions. The few studies that have explored the neural correlates of facial expression are reviewed in a later section. Since there is no single, infallible way to determine a person's "true" emotional state, it is unfortunate that so few investigators have followed the approach of using multiple convergent measures to gain a more reliable indication of the emotion experienced.

Regardless of the accuracy criterion used, the information provided by facial expression can be studied either indirectly, by observers' judgments (of the emotion experienced, the eliciting conditions, etc), or by direct measurement of facial activity (using any of the techniques described in the previous section). Facial measurement and observer judgments need not yield the same results, even when applied to the same facial expressions. Direct measurement could reveal expressive movements that observers

missed in real-time or that they failed to interpret correctly. Conversely, observers could pick up cues that were not among the units measured. Observer judgment studies have far exceeded facial measurement studies, probably because the latter are more expensive and time-consuming than the former.

What Has Been Found

1. *Facial expressions of emotion can provide accurate information about the occurrence of pleasant as compared to unpleasant emotional states.* A reanalysis of studies from 1914 to 1970 (52) concluded that both facial measurement and observers' judgment methods accurately distinguished pleasant from unpleasant states. Since then a number of experiments (cited below) have replicated these findings but have not extended them to possible distinctions among particular positive or negative emotions. There is little information pinpointing the specific facial actions that differentiate between pleasant and unpleasant states. Most investigators have used observers' judgments of facial expression without trying to determine which configurations observers were responding to. Those who directly measured facial expression failed to report the frequency of specific actions or full-face configurations used in the expressions that provided accurate information.

2. *Facial expressions can be disguised to mislead an observer about the emotions experienced.* Among the dozens of recent experiments on interpersonal deceit, only five (48, 71, 88, 95, 145) explicitly instructed subjects to conceal their emotions and also obtained evidence independent of the face that they actually experienced emotion. The results were contradictory, most likely due to variations in the strength or number of emotions aroused, the subjects' motivation to deceive, and their prior practice in perpetrating such deception. However, the experiments also differed in other ways: e.g. whether subjects knew they were being videotaped; whether observers knew that deception might be involved; whether they were trained; whether they heard the deceivers' speech in addition to seeing their faces. Despite the lack of consistency, this seems an important area for further study.

3. *Individuals differ in facial "expressiveness" (encoding ability) and in their ability to judge facial expressions (decoding ability).* In encoding/decoding studies, encoders are videotaped in emotion-arousing situations (while watching slides or undergoing shock); decoders (often the same subjects) then try to infer, from each encoder's facial expressions, the eliciting condition (category of slides or level of shock) or the encoder's rating of his/her own emotional experience. There are marked individual differences in how accurately an individual's facial expressions are judged and in how accurately an individual judges the faces of others (17, 36, 71, 89,

145). This finding is consistent with observations from other experiments that were not specifically looking for individual differences. Attempts to study the relationship between encoding and decoding abilities have produced negative, positive, and insignificant correlations. [See (62) for a careful discussion.] Inconsistent findings have also been obtained in the search for personality correlates of individual differences in encoding and decoding abilities. An exception is the small but consistent superiority of women in both encoding and decoding (68, 69).

These studies are fraught with methodological problems, which may explain some of the inconsistencies. In some studies the subjects must periodically rate their own emotional experience, a task that might affect their facial expressions or the experience itself. Many experiments do not verify which, if any, emotion was experienced by encoders. Exceptions are studies that obtained independent ratings of the emotions aroused by their elicitor (36, 71) or that used psychophysiological measures to indicate arousal, though not which emotion was aroused (88). Most often, the only measure of emotional arousal is the observers' success in inferring the relative pleasantness of the eliciting condition or the subject's subsequent rating of his own feelings (19, 20, 146). Such judgments could be made on the basis of cues having nothing to do with facial expression—e.g. posture, gross body movements—or facial signs of cognitive activity.

Although the search for personality correlates of individual differences in encoding and decoding abilities implies that these differences are stable, there has been no study of test-retest reliability in individual encoding ability or in encoding and decoding abilities in the same subjects. Another problem is that in many decoding tasks observers must judge facial expressions that occurred during speech but with the speech omitted. Only the deaf might have sufficient experience with this condition to develop stable individual differences in decoding such stimuli. Quite a different approach to individual differences is illustrated by Schiffenbauer's (111) finding that the emotional state of the observer influenced the emotion he attributed to a facial expression.

Unanswered or Unasked Questions

1. *Can facial expressions provide accurate information about the distinctions among several negative and positive emotions?* The only evidence that they can is for posed facial expressions.

2. *When can we expect facial expression to provide accurate information about emotion?* Studies showing that the facial expressions of some people are difficult to judge did not determine whether detailed measurement of their facial activity would reveal reliable cues missed by observers, nor

whether those individuals might be more expressive in other social circumstances. Studies showing that people can successfully disguise their facial expressions of emotion did not explore whether this ability is a stable characteristic of the person nor whether measurement of their facial activity would reveal reliable signs (i.e. "leakage") of their actual feelings.

Quite apart from the issues of individual differences and deception—which might limit the accuracy of information provided by facial expression—there is little information about the number and kinds of situations in which facial movement expresses emotion. It has been suggested (45, 46) that most facial activity in social interaction has little to do with emotion, but no empirical studies have compared different types of facial activity in different settings.

3. *How much information does the face, as compared to voice, speech, and body movement, provide about emotion?* A number of studies have compared observers' judgments about an event perceived via different "channels": audiovisual, audio alone, or visual alone. Most experiments found that the face is more accurately judged, produces higher agreement, or correlates better with judgments based on full audiovisual input than do voice or speech (5, 24, 39, 96, 144). A few experiments found that the face was less important than another channel (7, 117) or that channel cue varied with the observer (132). The findings of most "channel" experiments are suspect because the behavior judged was quite contrived. The most extensive series of studies (33) on naturally occurring behavior found that what was said mattered more than the visual input and that knowledge of demographic information produced as much accurate behavioral postdiction as exposure to an audiovisual film.

Another problem in this research is that observers judging the "face" channel are usually shown—without sound—facial expressions that occurred embedded in speech. This could cause misinterpretation of speech-related facial expressions. Moreover, observers who are limited to just the face may get more information than they would ordinarily get from the face when it is viewed in context.

A study in progress by Ekman, Friesen, O'Sullivan, and Scherer found that the relative weight given to facial expression, speech, and body cues depended both upon the judgment task (e.g. rating the stimulus subject's dominance, sociability, or relaxation) and upon the conditions in which the behavior occurred (while subjects frankly described positive reactions to a pleasant film or tried to conceal negative feelings aroused by a stressful film). The correlation between judgments made by observers who saw the face without speech and judgments made by observers who saw the face with speech were quite low on some scales (e.g. calm-agitated) and quite high on other scales (outgoing-withdrawn).

Studies by Bugental et al suggest that the influence of facial expression as compared to other sources depends upon the expressor, the perceiver, the message contained in each channel, and previous experience. Children were less influenced than were adults by a smile shown by an adult female when it was accompanied by negative words and voice tone (21). Some experiential grounds for distrusting mothers' smiles was found in a study showing that smiling in mothers (but not fathers) was not related to the positive vs negative content of the simultaneous speech (22). Also, mothers (but not fathers) of disturbed children produced more discrepant messages (among face, voice, and words) than did parents of nondisturbed children (23).

Although Scherer et al (110) studied judgments of personality rather than emotion, his findings also contradict the simple notion that one channel is better than another. Personality inferences were usually channel specific, some best made from one source, some from another. No one combination of channels (face plus speech, face plus voice, etc) yielded the most accurate judgments. It varied with the trait judged.

The whole question of how much information is conveyed by "separate" channels may inevitably be misleading. There is no evidence that individuals in actual social interaction selectively attend to another person's face, body, voice, or speech or that the information conveyed by these channels is simply additive. The central mechanisms directing behavior cut across channels, so that, for example, certain aspects of face, body, voice, and speech are more spontaneous, while others are more closely monitored and controlled. It might well be that observers selectively attend not to a particular channel but to a particular type of information (e.g. cues to emotion, deception, or cognitive activity), which might be available within several channels. No investigator has explored this possibility or the possibility that different individuals may typically attend to different types of information.

FACIAL FEEDBACK

The next group of studies addresses the long-debated issue of how we know what we feel. Since the demise of the James-Lange theory of emotion—postulating visceral and other somatic feedback as the source of our subjective experience of emotion—cognitive theories have prevailed. These theorists (e.g. Schacter) view emotional arousal as undifferentiated; our experience of a particular emotion, they argue, comes from interpretation of situational cues. By contrast, Tomkins (128, 129) holds that we experience discrete, differentiated emotions via feedback from innately patterned facial expressions.

A variant of the facial feedback hypothesis, set within the framework of self-attribution theory, postulates that we can use information from our own

facial (and other) behavior to *infer* how we feel. Laird's (85) study provided a model for later feedback experiments: subjects were instructed to contract particular facial muscles, producing—presumably without their awareness —a "happy" or a "frowning" expression which they held while viewing slides or cartoons. The face manipulation had a significant though small effect (compared with the effect of the slides) on their reported feelings. A subsequent series of experiments found that individual differences on the face manipulation task were related to other indices of an individual's tendency to use "self"- vs "situation"-produced cues (e.g. 41).

A recent experiment (Tourangeau & Ellsworth, unpublished manuscript) failed to confirm the strong version of the facial feedback hypothesis, i.e. that overt facial expression is both necessary and sufficient for the experience of emotion. Facial manipulations had no significant effect on self-reported emotion and only ambiguous effects on physiological responses.

These contradictory findings are difficult to evaluate due to methodological problems inherent in the expression manipulation paradigm: the demand characteristics of the task; the implausibility of the cover stories; and the artificiality of the situation and facial "expressions," which must be held unnaturally long. As Laird (85) cautioned, feedback that is too unnatural could be discounted by the subject (or the CNS), thus working against the hypothesis.

The strongest evidence for a positive link between voluntary facial expression and emotional experience comes from a series of experiments by Lanzetta, Kleck, and colleagues (34, 83, 88) investigating the effect of overt facial expression on the intensity of emotional arousal produced by shock. Attempts to conceal the facial signs of pain consistently led to decreases in both skin conductance and subjective ratings of pain, while posing the expression of intense shock significantly increased both measures of arousal. When subjects were told that they were being observed by another person, they showed less intense facial expressions and correspondingly decreased autonomic responses and subjective ratings of pain—even though they received no instructions to inhibit their responses (83). These findings can be interpreted in various ways (see 88). Before concluding that facial feedback was directly and causally related to the observed changes in arousal, it would be necessary to rule out the possibility that some other strategy used by subjects might have affected both their facial expressions and emotional experience. It is also not clear that the effect is specific to facial vs bodily signs of emotion. Nevertheless, these findings suggest that overt facial expression can affect the intensity of emotional arousal. Evidence that facial feedback can determine *which* emotion we experience is far more ambiguous. It is worth noting that little is known about the nature and quality of feedback from the muscles of facial expression.

NEURAL CONTROL AND ANS CORRELATES OF FACIAL EXPRESSION

Psychophysiological Correlates

Two different approaches have examined the relationship between facial expression and autonomic nervous system responses. In one type of study gross changes in autonomic measures (usually GSR) averaged over some period of time are compared to changes in facial expression (as inferred by observers' judgments of emotion). The other approach has looked for patterning in the moment-to-moment changes in autonomic and facial measures. This approach has produced more consistent results.

Correlational studies of individual differences in ANS responsivity and facial expressiveness (in encoding/decoding studies discussed above) have typically found negative relationships: i.e. subjects whose faces can be accurately judged as anticipating shock (89) or as viewing slides arousing positive vs negative affect show lower GSR responses and vice versa (reviewed in 17). In experimental, within-subject studies, however (e.g. facial feedback and deception studies discussed above), increases in facial expressiveness have been shown to be accompanied by increases in ANS responsivity (88; see other recent studies cited above).

Malmstrom, Ekman & Friesen (147), in a pilot study, found that different patterns of heart rate acceleration and deceleration coincided with facial activity showing elements of disgust vs surprise when subjects viewed a stressful film. Ancoli (4) found that facial expressions of disgust in subjects viewing a stressful film were related to respiration changes (thoracic as compared to abdominal).

In developmental studies of infants' reactions to an approaching stranger, several investigators (e.g. 26; 136, reviewed in 120) have found greater heart rate acceleration in 6- to 10-month-old infants who showed facial signs of "wariness" or distress than in infants who showed neutral or positive expressions. An "open" or affectively neutral, attentive face was typically accompanied by heart rate deceleration. Lewis, Brooks & Haviland (91), while finding a relationship between heart rate deceleration and attentive faces, did not find a significant relationship between heart rate acceleration and negative affect expressions.

Face and Brain

Most knowledge about the neural control of facial expression has come from clinical studies of neurological disorders. The dual control of facial movement is shown by the finding that individuals suffering from complete paralysis of voluntary facial movements (as in pseudobulbar palsy, which affects the corticobulbar tracts) may show spontaneous facial expressions

—often grossly exaggerated—when emotion is aroused (58). Conversely, spontaneous emotional expression but not voluntary movement may be affected by subcortical lesions, postencephalitic Parkinsonism, or "congenital weakness of the facial muscles" (58). The limbic system is known to be important in emotional expression (reviewed in 87), and successive states in the ontogenetic development of spontaneous and volitional facial and vocal expression are probably related to the maturation of specific brain structures and subsystems, though the evidence at present is indirect and often sketchy.

Several converging lines of evidence (brain lesion studies, research on commisurotomized patients, recognition and reaction time experiments with normal subjects) point to a right hemisphere advantage in recognizing faces. This advantage is especially pronounced when the task requires processing in terms of the higher-order, configurational properties of faces, rather than isolated features (25, 40). It is also greater (126) when the faces to be recognized by subjects show emotional expressions than when they are affectively neutral. The ability to use configurational information for recognizing unfamiliar faces does not develop until around 10 years of age. Younger children—like patients with right hemisphere lesions—use piecemeal processing and can be fooled easily by salient paraphernalia such as items of clothing (40). Facial expression was not found to be a source of confusion in children of any age, suggesting that—unlike clothing—it is not normally seen as an isolated cue to identify but rather as linked to the higher-order, configurational properties of faces. This view was confirmed by Campbell's finding (unpublished report) that adults are often misled by facial expression when facial stimuli are projected to the right but not to the left hemisphere (see also 35).

Campbell (25 and unpublished report) used chimeric face stimuli (composites of two half-faces showing different individuals or facial expressions or mirror-reversed expressions) to study lateralization effects in the production and perception of facial expression. Her findings reveal that—in right-handed adults—the perception of facial expression is dominated by the left visual field (i.e by the viewer's right hemisphere), corresponding to the right side of the face stimuli. At the same time, emotion actually may be expressed more strongly by the left side of the face, controlled by the producer's right hemisphere. Lesion studies (e.g. 18) provide further evidence of a right-hemisphere superiority for emotional expression.

FUTURE DIRECTIONS

The study of facial expression promises to provide new insights into a wide variety of psychological problems. We have already reviewed studies in-

dicating the relevance of facial expression to research in developmental psychology, person perception, theories of emotion, and the neurophysiology of emotion. The relevance of facial expression—and of hypothesized styles of controlling emotional expression (49, 78, 128)—to personality disorders and psychosomatic disease remains unexplored. Unstudied also is the relationship—real or perceived—between facial expression and intelligence, an important issue for the assessment of IQ (72).

In closing we note a number of recent findings that show how the study of facial expressions may help to understand some of the practical aspects of social interaction. An instructor in a learning task delivered less punishment to victims who looked angry rather than joyful (109). Pupils learned more from a teacher who showed positive rather than negative emotional expressions while giving a lesson (60). Children who looked happy rather than sad while watching televised violence subsequently showed more aggressive as compared to altruistic behavior (54). Subjects scoring high on "humanism" smiled more often during conversation than "non-humanist" subjects (134). The type of facial movement used to emphasize speech (46) or to indicate a question (Camras, personal communication) is related to the hypothesized role of those movements in emotional expression: and the differential use of particular facial actions to emphasize speech affects the impressions conveyed to others (101).

Literature Cited

1. Ainsworth, M. 1973. The development of infant-mother attachment. In *Review of Child Development Research,* Vol. 3, pp. 1–94, ed. B. Caldwell, H. Ricciuti. Chicago: Chicago Univ. Press
2. Allport, F. M. 1924. *Social Psychology.* Boston: Houghton Mifflin
3. Altmann, S. 1968. Primates. In *Animal Communication: Techniques and Results of Research,* ed. T. Sebeok, p. 466–522. Bloomington: Indiana Univ. Press
4. Ancoli, S. 1978. *Psychophysiological response patterns to emotions.* PhD thesis. Univ. California, San Francisco, Calif.
5. Argyle, M., Alkema, F., Gilmour, R. 1971. The communication of friendly and hostile attitudes by verbal and nonverbal signals. *Eur. J. Soc. Psychol.* 1(3):385–402
6. Bell, S. M., Ainsworth, M. D. S. 1972. Infant crying and maternal responsiveness. *Child Dev.* 43:1171–90
7. Berman, H. J., Shulman, A. D., Marwit, S. J. 1976. Comparison of multidimensional decoding of affect from audio, video and audiovideo recordings. *Sociometry* 39(1):83–89
8. Birdwhistell, R. L. 1970. *Kinesics and Context.* Philadelphia: Univ Pennsylvania Press
9. Blurton Jones, N. G. 1971. Criteria for use in describing facial expressions in children. *Hum. Biol.* 41:365–413
10. Blurton Jones, N. G. 1972. Non-verbal communication in children. In *Nonverbal Communication,* ed. R. A. Hinde, pp. 271–96. Cambridge, England: Cambridge Univ. Press
11. Boucher, J. D. 1973. *Facial behavior and the perception of emotion: Studies of Malays and Temuan Orang Asli.* Presented at Conf. Psychol. Related Disciplines, Kuala Lumpur
12. Bowlby, J. 1969. *Attachment and Loss.* Vol. 1. *Attachment.* New York: Basic Books
13. Brannigan, C R., Humphries, D. A. 1972. Human nonverbal behavior, a means of communication. In *Ethological Studies of Child Behavior,* ed. N. G. Blurton Jones. Cambridge: Cambridge Univ. Press
14. Brazelton, T., Tronick, E., Adamson, L., Als, H., Wise, S. 1975. Early mother-infant reciprocity. *Parent-Infant In-*

teraction. Amsterdam: Elsevier Exp. Med.
15. Bruner, J. S., Tagiuri, R. 1954. The perception of people. In *Handbook of Social Psychology,* Vol. 2, ed. G. Lindzey. Reading, Mass: Addison-Wesley
16. Buck, R. 1975. Nonverbal communication of affect in children. *J. Pers. Soc. Psychol.* 31:644–53
17. Buck, R. 1977. *Measuring individual differences in the nonverbal communication of affect: The slide viewing paradigm.* Presented at Am. Psychol. Assoc. meet., San Francisco
18. Buck, R., Duffy, R. 1977. *Nonverbal communication of affect in brain-damaged patients.* Presented at Am. Psychol. Assoc. meet., San Francisco
19. Buck, R., Miller, R. E., Caul, W. F. 1974. Sex, personality, and physiological variables in the communication of affect via facial expression. *J. Pers. Soc. Psychol.* 30(4):587–96
20. Buck, R., Savin, V. J., Miller, R. E., Caul, W. F. 1972 Communication of affect through facial expressions in humans. *J. Pers. Soc. Psychol.* 23: 362–71
21. Bugental, D., Kaswan, J., Love, L., Fox, M. 1970. Child versus adult perception of evaluative messages in verbal, vocal and visual channels. *Dev. Psychol.* 2(3):367–75
22. Bugental, D., Love, L., Gianetto, R. 1971. Perfidious feminine faces. *J. Pers. Soc. Psychol.* 17(3):314–18
23. Bugental, D., Love, L., Kaswan, J., April, C. 1971 Verbal-nonverbal conflict in parental messages to normal and disturbed children *J. Abnorm. Psychol.* 77(1):6–10
24. Burns, K. L., Beier, E. G. 1973. Significance of vocal and visual channels in the decoding of emotional meaning. *J. Commun.* 23:118–30
25. Campbell, R. 1978. Asymmetries in interpreting and expressing a posed facial expression. *Cortex.* In press
26. Campos, J. J., Emde, R. N., Gaensbauer, T., Henderson, C. 1975. Cardiac and behavioral interrelationships in the reactions of infants to strangers. *Dev. Psychol.* 11(4):589–601
27. Campos, J. J., Hiatt, S., Ramsay, D., Henderson, C., Svejda, M. 1978. The emergence of fear on the visual cliff. In *The Development of Affect,* ed. M. Lewis, L. Rosenblum, pp. 149–82. New York: Plenum
28. Camras, L. 1977. Facial expressions used by children in a conflict situation. *Child Dev.* 48:1431–35
29. Chapman, A. J., Wright, D. S. 1976. Social enhancement of laughter: An experimental analysis of some companion variables. *J. Exp. Child Psychol.* 21: 201–18
30. Charlesworth, W. R., Kreutzer, M. A. 1973. Facial expression of infants and children. In *Darwin and Facial Expression,* ed. P. Ekman, pp. 91–168. New York: Academic
31. Chevalier-Skolnikoff, S. 1973. Facial expression of emotion in non-human primates. See Ref. 30, pp. 11–89
32. Cicchetti, D., Sroufe, L. A. 1978. An organizational view of affect: Illustration from the study of Down's Syndrome infants. See Ref. 27, pp. 309–50
33. Cline, V. B., Atzet, J., Holmes, E. 1972. Assessing the validity of verbal and nonverbal cues in accurately judging others. *Comp. Group Stud.* 3:383–94
34. Colby, C. Z., Lanzetta, J. T., Kleck R. E. 1977 Effects of the expression of pain on autonomic and pain tolerance responses to subject-controlled pain. *Psychophysiology* 14(6):537–40
35. Crouch, W. W. 1976. Dominant direction of conjugate lateral eye movements and responsiveness to facial and verbal cues. *Percept. Mot. Skills* 42:167–74
36. Cunningham, M. R. 1977. Personality and the structure of the nonverbal communication of emotion. *J. Pers.* 45: 564–84
37. Darwin, C. 1955. *The Expression of Emotion in Man and Animals.* New York: Philosophical Library (Originally published 1872)
38. Decarie, T. 1978. Affect development and cognition in a Piagetian context. See Ref. 27, pp. 183–204
39. DePaulo, B., Rosenthal, R., Eisenstat, R., Finkelstein, S., Rogers, P. 1978. Decoding discrepant nonverbal cues. *J. Pers. Soc. Psychol.* In press
40. Diamond, R., Carey, S. 1977. Developmental changes in the representation of faces. *J. Exp. Child Psychol.* 23: 1–22
41. Duncan, J., Laird, J. D. 1977. Cross-modality consistencies in individual differences in self-attribution. *J. Pers.* 45(2):191–206
42. Eibl-Eibesfeldt, I. 1971. Similarities and differences between cultures in expressive movements. See Ref. 10, pp. 297–312
43. Ekman, P. 1972 Universals and cultural differences in facial expressions of emotion. *Nebr. Symp. Motiv.* 1971, pp. 207–83
44. Ekman, P. 1973. Cross cultural studies

of facial expression. See Ref. 30, pp. 169–229
45. Ekman, P. 1977. Biological and cultural contributions to body and facial movement. In *The Anthropology of the Body*, ed. J. Blacking. London: Academic
46. Ekman, P. 1978. About brows: Emotional and conversational signals. In *Human Ethology*, ed. J. Aschoff, M. von Cranach, K. Foppa, W. Lepenies, D. Ploog. Cambridge: Cambridge Univ. Press. In press
47. Ekman, P., Friesen, W. V. 1971. Constants across cultures in the face and emotion. *J. Pers. Soc. Psychol.* 17: 124–29
48. Ekman, P., Friesen, W. V. 1974. Detecting deception from the body or face. *J. Pers. Soc. Psychol.* 29(3):288–98
49. Ekman, P., Friesen, W. V. 1975. *Unmasking the Face.* Englewood Cliffs, NJ: Prentice-Hall
50. Ekman, P., Friesen, W. V. 1976. Measuring facial movement. *J. Environ. Psychol. Nonverb. Behav.* 1(1):56–75
51. Ekman, P., Friesen, W. V. 1978. *The Facial Action Coding System.* Palo Alto, Calif: Consult. Psychol. Press
52. Ekman, P., Friesen, W. V., Ellsworth, P. 1972. *Emotion in the Human Face.* Elmsford, NY: Pergamon
53. Ekman, P., Friesen, W. V., Tomkins, S. S. 1971. Facial Affect Scoring Technique (FAST): A first validity study. *Semiotica* 3(1):37–38
54. Ekman, P., Liebert, R. M., Friesen, W. V., Harrison, R. A., Zlatchin, C., Malmstrom, E. J., Baron, R. A. 1972. Facial expressions of emotion while watching televised violence as predictors of subsequent aggression. In *Television and Social Behavior Vol. V., Television's Effects: Further explorations*, ed. G. A. Comstock, E. A. Rubinstein, J. P. Murray. A technical report to the Surgeon General's Scientific Advisory Committee on Television and Social Behavior. Washington, DC: GPO
55. Ekman, P., Sorenson, E. R., Friesen, W. V. 1969. Pan-cultural elements in facial displays of emotion. *Science* 164(3875): 86–88
56. Emde, R. N., Gaensbauer, T. J., Harmon, R. J. 1976. Emotional expression in infancy: A biobehavioral study. *Psychol. Issues Monogr. Ser.* 10, Monogr. 37
57. Ermaine, R., Gregerian, E. 1978. *Atlas of Facial Expressions. Album des expressions du visage.* Paris: La Pensée Universelle
58. Ford, F. R. 1966. *Diseases of the Nervous System in Infancy, Childhood, and Adolescence.* Springfield, Ill: Thomas. 5th ed.
59. Fraiberg, S. 1974. Blind infants and their mothers: An examination of the sign system. See Ref. 92, pp. 215–32
60. Fried, E. 1976. *The impact of nonverbal communication of facial affect on children's learning.* PhD thesis, Rutgers Univ., New Brunswick, NJ
61. Friesen, W. V. 1972. *Cultural differences in facial expressions in a social situation: An experimental test of the concept of display rules.* PhD thesis. Univ. California, San Francisco
62. Fujita, B. 1977. *Encoding and decoding of spontaneous and enacted facial expressions of emotion.* PhD thesis. Univ. Oregon, Portland
63. Gesell, A. 1945. *The Embryology of Behavior.* New York: Harper
64. Gewirtz, J. L., Boyd, E. F. 1976. Mother-infant interaction and its study. *Adv. Child Dev. Behav.* 11: 141–63
65. Graham, J. A., Argyle, M. 1975. The effects of different patterns of gaze combined with different facial expressions, on impression information. *J. Hum. Movement Stud.* 1:178–82
66. Grant, N. G. 1969. Human facial expression. *Man* 4:525–36
67. Greenspan, S., Barenboim, C., Chandler, M. J. 1976. Empathy and pseudoempathy: The affective judgments of first- and third-graders. *J. Genet. Psychol.* 129:77–88
68. Hall, J. 1978. Gender effects in decoding nonverbal cues. *Psychol. Bull.* In press
69. Hall, J. 1978. Gender effects in encoding nonverbal cues. *Psychol. Bull.* In press
70. Hamilton, M. L. 1973. Imitative behavior and expressive ability in facial expression of emotion. *Dev. Psychol.* 8(1): 138
71. Harper, R. G., Wiens, A. N., Fujita, B. 1977. Individual differences in encoding-decoding of emotional expression and emotional dissimulation. Presented at Am. Psychol. Assoc. meet., San Francisco
72. Haviland, J. 1975. Looking smart: The relationship between affect and intelligence in infancy. In *Origins of Infant Intelligence*, ed. M. Lewis. New York: Plenum
73. Heider, K. 1974. *Affect display rules in the Dani.* Presented at Am. Anthropol. Assoc. meet., New Orleans
74. Hiatt, S., Campos, J., Emde, R. 1977. *Fear, surprise, and happiness: The patterning of facial expression in infants.*

Presented at Soc. Res. Child Dev., New Orleans
75. Hoffman, M. L. 1977 Empathy, its development and prosocial implications. *Nebr. Symp. Motiv.* 25: In press
76. Hunt, W. A. 1941. Recent developments in the field of emotion. *Psychol. Bull.* 38(5):249–76
77. Izard, C. 1971. *The Face of Emotion.* New York: Appleton-Century-Crofts
78. Izard, C 1977. *Human Emotions.* New York, London: Plenum
79. Izard, C. 1978. On the ontogenesis of emotions and emotion-cognition relationships in infancy. See Ref. 27, pp. 389–413
80. Jacobson, S., Kagan, J. 1978. *Released responses in early infancy: Evidence contradicting selective imitation.* Presented at Int Conf. Infant Stud., Providence, R.I.
81. Josse, D., Leonard, M., Lezine, I., Robinot, F , Rouchouse, J. 1973. Evolution de la communication entre l'enfant de 4 a 9 mois et un adulte. *Enfance* 3(4):175–206
82. Kaye, K., Marcus, J 1978. Imitation over a series of trials without feedback: Age six months. *Infant Behav. Dev.* 1:141–55
83. Kleck, R. E., Vaughan, R. C., Cartwright-Smith, J., Vaughan, K. B., Colby, C Z., Lanzetta, J T. 1976. Effects of being observed on expressive, subjective, and physiological responses to painful stimuli. *J. Pers. Soc. Psychol.* 34:1211–18
84. LaBarbera, J. D., Izard, (Vietze, P., Parisi, S. A 1976. Four- and six-month-old infants' visual responses to joy, anger, and neutral expressions. *Child Dev.* 47:535–38
85. Laird, J D. 1974. Self-attribution of emotion: The effects of expressive behavior on the quality of emotional experience. *J. Pers. Soc Psychol.* 29(4): 475–86
86. Lalljee, M. 1978. The role of gaze in the expression of emotion *Aust. J. Psychol.* In press
87. Lamendella, J. T. 1977. The limbic system in human communication. In *Studies in Neurolinguistics,* Vol. 3, ed. H. Whitaker, H A. Whitaker. New York: Academic
88. Lanzetta, J T , Cartwright-Smith, J., Kleck, R. E 1976. Effects of nonverbal dissimulation on emotional experience and autonomic arousal. *J. Pers. Soc. Psychol.* 33(3):354–70
89. Lanzetta, J T., Kleck, R. E. 1970. Encoding and decoding of nonverbal affects in humans. *J. Pers. Soc. Psychol.* 16:12–19
90. Lewis, M., Brooks, J. 1978. Self-knowledge and emotional development. See Ref. 27, pp. 205–26
91. Lewis, M., Brooks, J., Haviland, J. 1978. Hearts and faces: A study in the measurement of emotion. See Ref. 27, pp. 77–124
92. Lewis, M., Rosenblum, L. A., eds. 1974. *The Effect of the Infant on its Caregiver.* New York: Wiley
93. McGrew, W. C. 1972. *An Ethological Study of Children's Behavior.* New York: Academic
94. Mead, M. 1975. Review of *Darwin and Facial Expression,* ed. P. Ekman. *J. Commun.* 25(1):209–13
95. Mehrabian, A. 1971. Nonverbal betrayal of feeling. *J. Exp. Res. Pers.* 5(1): 64–73
96. Mehrabian, A., Ferris, S. 1967. Inference of attitudes from nonverbal communication in two channels. *J. Consult. Psychol.* 31(3):248–52
97 Meltzoff, A. N., Moore, M. K. 1977. Imitation of facial and manual gestures by human neonates. *Science* 198:75–78
98. Nystrom, M. 1974. Neonatal facial-postural patterning during sleep: I. Description and reliability of observation. *Psychol. Res. Bull.* 14:7
99. Oster, H. 1978. Facial expression and affect development. See Ref. 27, pp. 43–76
100. Oster, H., Ekman, P. 1978. Facial behavior in child development. *Minn. Symp. Child Psychol.* 11:231–76
101. O'Sullivan, M., Eyman, J. 1978. Signal value of eyebrow movements in conversation. Presented at West. Psychol. Assoc. meet., San Francisco
102. Papousek, H., Papousek, M. 1977. Mothering and the cognitive head-start: psychobiological considerations. In *Studies in Mother-Infant Interaction,* ed. H. R. Schaffer, pp. 63–85. New York: Academic
103. Pieper, A. 1963. *Cerebral Function in Infancy and Childhood.* New York: Consultants Bureau
104. Redican, W. K. 1975. Facial expression in nonhuman primates. In *Primate Behavior Vol. 4,* ed. L. A. Rosenblum. New York: Academic
105. Roper, G. 1977. *The development of voluntary facial imitation in children.* MA thesis. San Francisco State Univ., San Francisco, Calif.
106. Saarni, C. 1978. *Acquisition of display rules for expressive behavior.* Presented

to East. Psychol. Assoc. meet., Washington DC
107. Saarni, C. 1978. Cognitive and communicative features of emotional experience, or do you show what you think you feel? See Ref. 27, pp. 361–76
108. Saha, G. B. 1973. Judgment of facial expression of emotion—a cross-cultural study. *J. Psychol. Res.* 17(2):59–63
109. Savitsky, J. C., Izard, C. E., Kotsch, W. E., Christy, L. 1974. Aggressor's response to the victim's facial expression of emotion. *J. Res. Pers.* 7:346–57
110. Scherer, K. R., Scherer, U., Hall, J. A., Rosenthal, R. 1977. Differential attribution of personality based on multichannel presentation of verbal and nonverbal cues. *Psychol. Res.* 39:221–47
111. Schiffenbauer, A. 1974. Effect of observer's emotional state on judgments of the emotional state of others. *J. Pers. Soc. Psychol.* 30(1):31–35
112. Schlosberg, H. 1941. A scale for the judgment of facial expression. *J. Exp. Psychol.* 29:497–510
113. Schlosberg, H. 1952. The description of facial expressions in terms of two dimensions. *J. Exp. Psychol.* 44:229–37
114. Schlosberg, H. 1954. Three dimensions of emotion. *Psychol. Rev.* 61:81–88
115. Schwartz, G. E., Fair, P. L., Salt, P., Mandel, M. K., Klerman, G. L. 1976. Facial muscle patterning to affective imagery in depressed and non-depressed subjects. *Science* 192(4238):489–91
116. Seaford, H. W. 1976. *Maximizing replicability in describing facial behavior.* Presented at Am. Anthropol. Assoc. meet., Washington DC
117. Shapiro, J. G. 1972. Variability and usefulness of facial and body cues. *Comp. Group Stud.* 3(4):437–42
118. Shultz, T. R., Zigler, E. 1970. Emotional concomitants of visual mastery in infants: The effect of stimulus movement on smiling and vocalizing. *J. Exp. Child Psychol.* 10:390–402
119. Smith, R. P. 1973. Frontalis muscle tension and personality. *Psychophysiology* 10(3):311–12
120. Sroufe, L. A. 1977. Wariness of strangers and the study of infant development. *Child Dev.* 48:731–46
121. Sroufe, L. A. 1978. The ontogenesis of emotion. In *Handbook of Infancy,* ed. J. Osofosky. New York: Wiley. In press
122. Sroufe, L. A., Waters, E. 1976. The ontogenesis of smiling and laughter: A perspective on the organization of development in infancy. *Psychol. Rev.* 83:173–189
123. Stechler, G., Carpenter, G. 1967. A viewpoint on early affect development. In *Exceptional Infant* Vol I.; *The Normal Infant,* ed. J. Hellmuth. New York: Brunner/Mazel
124. Steiner, J. E. 1973. The gustofacial response: Observation on normal and anencephalic newborn infants. In *Fourth Symposium on Oral Sensation and Perception,* ed. J. F. Bosma. Bethesda, Md: US Dep. HEW
125. Stern, D. N., Beebe, B., Jaffe, J., Bennett, S. L. 1978. The infant's stimulus world during social interaction: A study of caregiver behaviours with particular reference to repetition and timing. See Ref. 103, pp. 177–202
126. Suberi, M., McKeever, W. F. 1977. Differential right hemispheric memory storage of emotional and non-emotional faces. *Neuropsychologia* 15:757–68
127. Tagiuri, R. 1968. Person perception. In *The Handbook of Social Psychology,* ed. G. Lindzey, E. Aronson. Reading, Mass: Addison-Wesley
128. Tomkins, S. S. 1962. *Affect, Imagery, Consciousness,* Vol. 1, *The Positive Affects.* New York: Springer
129 Tomkins, S. S. 1963. *Affect, Imagery, Consciousness,* Vol. 2, *The Negative Affects.* New York: Springer
130. Tomkins, S. S., McCarter, R. 1964. What and where are the primary affects? Some evidence for a theory *Percept. Mot. Skills* 18:119–58
131 Trevarthen, C 1977. Descriptive analyses of infant communicative behavior. See Ref. 103, pp. 227–70
132. Vande Creek, L., Watkins, J. T 1972. Responses to incongruent verbal and nonverbal emotional cues. *J. Commun.* 22:311–16
133. van Hooff, J. A. R. A. M. 1972. A comparative approach to the phylogeny of laughter and smiling. See Ref 10, pp. 209–38
134. Vasquez, J. 1975. *The face and ideology.* PhD thesis. Rutgers Univ., New Brunswick, NJ
135 Vaughn, B. E., Sroufe, L A. 1976. *The face of surprise in infants.* Presented at Animal Behav. Soc. meet., Boulder, Colo.
136. Waters, E., Matas, L., Sroufe, L. 1975. Infants' reaction to an approaching stranger: Description, validation, and functional significance of wariness. *Child Dev.* 46:348–56
137. Watson, J S. 1978. Perception of contingency as a determinent of social responsiveness. In *The Origin of the Infant's Social Responsiveness,* ed. E. P.

Thoman. Hillsdale, NJ: Erlbaum. In press
138. Winkelmayer, R., Exline, R. V., Gottheil, E., Paredes, A. 1978. The relative accuracy of U.S., British, and Mexican raters in judging the emotional displays of schizophrenic and normal U.S. women. *J. Clin. Psychol.* In press
139. Wolff, P. H. 1963. Observations on the early development of smiling. In *Determinants of Infant Behavior II.* ed. B. M. Foss. New York: Wiley
140. Wolff, P. H. 1966. The causes, controls, and organization of behavior in the neonate. *Psychol. Issues* 5: Monogr. 17
141. Wolff, P. H. 1969. The natural history of crying and other vocalizations in early infancy. In *Determinants of Infant Behavior IV.* ed. B. M. Foss. London: Methuen
142. Young, G., Decarie, T. G. 1977. An ethology-based catalogue of facial/vocal behaviors in infancy. *Anim. Behav.* 25(1):95–107
143. Young-Browne, G., Rosenfeld, H. M., Horowitz, F. D. 1977. Infant discrimination of facial expressions. *Child Dev.* 48:555–62
144. Zaidel, S., Mehrabian, A. 1969. The ability to communicate and infer positive and negative attitudes facially and vocally. *J. Exp. Res. Pers.* 3:233–41
145. Zuckerman, M., DeFrank, R. S., Hall, J. A., Rosenthal, R. 1978. Nonverbal encoding and decoding of pleasant and unpleasant affects and of honest and deceptive messages. *J. Pers. Soc. Psychol.* In press
146. Zuckerman, M., Hall, J., DeFrank, R. S., Rosenthal, R. 1976. Encoding and decoding of spontaneous and posed facial expressions. *J. Pers. Soc. Psychol.* 34(5):966–77

Added in proof:

147. Malmstrom, E., Ekman, P., Friesen, W V. 1972. *Autonomic changes with facial displays of surprise and disgust.* Presented at West. Psychol. Assoc. Meet., Portland, Ore.