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CHAPTER 13

Facial Expressions of Emotion

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Within the field of emotion, the study of facial expressions has been notable both for empirical advances and for theoretical controversy. In this chapter, we draw upon an "evolutionist" approach to emotion, inspired by Charles Darwin, to draw together recent studies of facial expression. This literature indicates that facial expressions of emotion, as described by Darwin over 135 years ago, (1) include universal, reliable markers of discrete emotions when emotions are aroused and there is no reason to modify or manage the expression; (2) covary with distinct subjective experience; (3) are part of a coherent package of emotion responses that includes appraisals, physiological reactions, other nonverbal behaviors, and subsequent actions, as well as individual differences and mental and physical health; (4) are judged as discrete categories; and (5) as such, serve many interpersonal and social regulatory functions.

PERSPECTIVE AND ASSUMPTIONS

An evolutionist approach to facial expression has its roots in the work of Darwin (1872/1998) and of those who have refined and elaborated upon his evolutionist claims (Ekman, 1992b; Izard, 1971). Darwin claimed, in his principle of serviceable habits, that facial expressions are the residual actions of more complete behavioral responses, and occur in combination with other bodily responses—vocalizations, postures, gestures, skeletal muscle movements, and physiological responses. For example, we express anger by furrowing the brow and tightening the lips with teeth displayed, because these actions are part of an attack response; we express disgust with an open mouth, nose wrinkle, and tongue protrusion as part of a vomiting response. Facial expressions, then, are elements of a coordinated response involving multiple response systems.

As part of our evolutionary heritage, according to Darwin, all people, regardless of race or culture, should express emotions in the face and body in similar fashion. Darwin wrote *The Expression of the Emotions in Man and Animals* to refute the claims of Sir Charles Bell, the leading facial anatomist of his time and a teacher of Darwin's, about how God designed humans with unique facial muscles to express uniquely human emotions.[1] Relying on advances in photography and anatomy (Duchenne de Boulogne, 1862/1990), Darwin engaged in a detailed study of the muscle actions involved in emotion (see Table 13.1); he concluded that the muscle actions are universal, and their precursors can be seen in the expressive behaviors of nonhuman primates and other mammals.

Within the evolutionist framework that guides our analysis, facial expressions should covary with emotional experience, in large part because the signals that accompany involuntary experience give additional credibility to the display (Ekman, 1989; Ekman & O'Sullivan, 1991; although see Fridlund, 1994; Hauser, 1993; Krebs & Dawkins, 1984, for alternative perspectives). Those facial expressions that covary with emotion, it has been found, have certain properties, including brief duration, symmetry of muscle actions, and the presence of involuntary muscle actions (Ekman & Friesen, 1982; Ekman & Rosenberg, 2005). Facial expressions that accompany actual emotional experience are more reliable signals; they act as commitment devices to likely courses of action that are momentarily beyond the individual's volitional control (R. H. Frank, 1988; Gonzaga, Keltner, & Londahl, 2001).

The evolutionist perspective also suggests that facial expressions are more than simple readouts of internal states; they coordinate social interactions through their informative, evocative, and incentive functions (Keltner & Kring, 1998). They provide information to perceivers about the individual's emotional state (Ekman, 1993; Scherer, 1986), behavioral intentions (Fridlund, 1994), relational status vis-à-vis the target of the expression (Keltner, 1995; Tiedens, Ellsworth, & Mesquita, 2000), and objects and events in the social environment (Mineka & Cook, 1993). This view of facial expressions emerged from developmental studies of emotional exchanges between parents and children (Hertenstein & Campos, 2004; Klinnert, Campos, & Sorce, 1983; Klinnert, Emde, Butterfield, & Campos, 1986), as well as from ethological studies of such social behaviors as flirting, reconciliation, aggression, and play. It is consistent with claims regarding the coevolution of signal and perceiver response to displays (Eibl-Ebesfeldt, 1989; Hauser, 1993). Thus an individual's emotional expression serves as a "social affordance" that evokes "prepared" responses in others (Esteves, Dimberg, & Öhman, 1994). Anger, for example, may have evolved to elicit fear-related responses and the inhibition of inappropriate action (Dimberg & Öhman, 1996); note that the Japanese often label another person's angry expression as "scary" (Matsumoto, 2006). Distress calls may have evolved to elicit sympathetic responses in observers (Eisenberg et al., 1989). Through these processes, emotional communication helps individuals in relationships—parents and children, mates, bosses and subordinates—respond to the demands and opportunities of their social environment. They are basic elements of social interaction, from flirtatious exchanges to greeting rituals. This perspective provides a compelling rationale for the prediction that people should be reliable judges of emotional displays, and sets the stage for the claim that deficits in expression are associated with psychological disorders.

The evolutionist perspective that we have described thus far leads to the following five claims, for which we review the most recent findings. Specially, an evolutionist approach to facial expression holds that discrete facial expressions of emotion (1) occur universally in emotionally arousing situations; (2) are linked with subjective experience; (3) are part of a coherent package of emotional responses; (4) are judged universally and discretely; and (5) have important social functions. In the discussion that follows, we bring together recent evidence that bears upon these claims.

THE CLAIMS OF THE EVOLUTIONIST PERSPECTIVE: AN EMPIRICAL REVIEW

Universality of Facial Emotional Expressions in Emotionally Arousing Situations

Claims concerning the universality of facial expressions of emotion are rooted in the notion that the facial anatomy is brought into service in expressions to solve similar problems across

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Emotion	Darw (nonf paren
Anger	Nostr comp eyes (chest by sic body forwa
Contempt	Lip p partia turnir raised expira
Disgust	Lowe lip rai open, protru clearir tongu
Fear	Eyes c retract (crouc perspi end, n yawni
Happiness	Eyes s eyes w back a
Joy	Zygon muscle raised, (muscl purpos laughte jumpir stampi
Sadness	Corner inner c (low sp
Surprise	Eyebro eyes op (expira open h palms t straight backwa

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TABLE 13.1. Descriptions of Facial Muscles and Other Nonverbal Behaviors Involved in the Emotions Darwin Considered Universal

Emotion	Darwin's description (nonfacial elements in parentheses)	Action units (AUs) associated with Darwin's description	AUs found to be associated with this emotion in research with humans (optional AUs in parentheses)	Homologous or analogous AUs found in chimpanzees
Anger	Nostrils raised, mouth compressed, furrowed brow, eyes wide open, head erect, (chest expanded, arms rigid by sides, stamping ground, body swaying backward/forward, trembling]	4; 5; 24; 38	4; 5 or 7; 22; 23; 24	4; 22; 23; 24
Contempt	Lip protrusion, nose wrinkle, partial closure of eyelids, turning away eyes, upper lip raised, (snort, body expiration, expiration)	9; 10; 22; 41; 61 or 62	Unilateral 12; unilateral 14	9; 10
Disgust	Lower lip turned down, upper lip raised, expiration, mouth open, spitting, blowing out, protruding lips, throat-clearing sound, lower lip and tongue protruding	10; 16; 22; 25 or 26	9 or 10; (25 or 26)	9; 10
Fear	Eyes open, mouth open, lips retracted, eyebrows raised, (crouching, paleness, perspiration, hair standing on end, muscles shivering, yawning, trembling)	1; 2; 5; 20	1; 2; 4; 5; 20; (25 or 26)	1; 2; 4
Happiness	Eyes sparkling, skin under eyes wrinkled, mouth drawn back at corners	6; 12	6; 12	6; 12
Joy	Zygomatic and orbicularis muscles contracted, upper lip raised, nasolabial fold formed, (muscles trembling, purposeless movements, laughter, clapping hands, jumping, dancing about, stamping, chuckling/giggling)	6; 7; 12	6; 12	6; 12
Sadness	Corners of mouth depressed, inner corner eyebrows raised, (low spirits)	1; 15	1; (4); 15; (17)	1; 4; 15; 17
Surprise	Eyebrows raised, mouth open, eyes open, lips protruding, (expiration, blowing/hissing, open hands high above head, palms toward person with straightened fingers, arms backwards)	1; 2; 5; 25 or 26	1; 2; 5; 25 or 26	1; 2

Note. The action unit (AU) numbers are those of Ekman and Friesen's (1978) Facial Action Coding System (FACS).

cultures related to social living, such as restoring justice, attending to others in need, signaling danger, expressing sexual or affiliative interest, and so on. By implication, the facial muscles themselves should be universal, and indeed they are. All humans around the world, regardless of race or culture, have the same facial anatomy (Gray & Goss, 1966). This universal facial musculature, furthermore, appears to be activated in emotion-specific ways across cultures.

Evidence from Adult Humans across Cultures

The strongest evidence for the universality of facial expressions of emotion comes from studies that directly measure facial behaviors when emotions are elicited. The first was Ekman's (1972) well-known study involving American and Japanese participants who viewed neutral and stressful films, and whose facial behaviors were recorded throughout the experiment (unbeknownst to them). Ekman coded the last 3 minutes of facial behavior during the neutral films, and the entire 3 minutes of the last stress film clip, using a modified version of the Facial Affect Scoring Technique (FAST), a precursor to the Facial Action Coding System (FACS; Ekman & Friesen, 1978). The FAST identified facial configurations of six emotions—anger, disgust, fear, happiness, sadness, and surprise—in different regions of the face. Two sets of analyses were performed on the facial codes: one involving separate facial areas, and one involving the whole face. The rank-order correlations on the facial behavior codes from the separate areas between the American and Japanese participants ranged from .72 for the eyes–lids area to .92 for the brows–forehead area. When the codes were combined into emotion-related configurations, the correlations ranged from .86 in the brows–forehead region to .96 in the lower face. Disgust, sadness, anger, and surprise were the most frequently displayed emotions, but fear and happiness were also evident. When facial codes were combined for whole-face emotions, according to the theoretical rationales of Darwin and of Tomkins (1962, 1963), the correlation between the Americans and the Japanese on the frequencies of whole-face emotions expressed spontaneously was .88.

Subsequent research has yielded further evidence supportive of the notion that theoretically relevant, universal facial expressions are elicited by specific emotionally evocative stimuli. There are at least 25 published studies in which the facial behaviors of individuals who participated in emotionally arousing conditions were coded reliably with the FACS and matched to the universal facial configurations of emotion (see Table 13.2). These studies demonstrate that the facial configurations of at least seven emotions, as postulated by Darwin and Tomkins, are produced when emotion is aroused and there is no reason to modify the expression because of social circumstances. (See also Eibl-Ebesfeldt, 1989, for an ethological perspective.)

The range of cultures in the 26 studies (25 in Table 13.2 and Ekman, 1972) is extensive. Matsumoto and Willingham's (2006) study, for instance, involved 84 athletes from 35 countries. Participants in other studies were Americans, Japanese, Germans, Canadians, and French. Collectively, these studies demonstrate that the facial expressions reported originally by Ekman actually do occur when emotion is aroused in people of different cultures. Table 13.1 contrasts the specific facial muscles originally proposed by Darwin (1872/1998) with the facial action units (AUs) that have been shown to be related to various emotions according to Ekman and Friesen's (1978) FACS.

Evidence from Nonhuman Primates

For years, ethologists (Chevalier-Skolnikoff, 1973; Geen, 1992; Hauser, 1993; Snowdon, 2003; Van Hoof, 1972) have noted the morphological similarities between human expressions of emotion and nonhuman primate expressions displayed in similar contexts. Van Hoof (1972) described the evolution of the smile and laugh along two different evolutionary tracks across early mammals, monkeys, apes, chimpanzees, and humans. Redican (1982) suggested that among nonhuman primates, facial displays described as grimaces and open-mouth grimaces are akin to the human emotions of fear and surprise; that the tense-mouth display is similar to anger; and that grimaces and a tense mouth combined form the often identified threat display. Redican also noted that nonhuman primates show a play face similar to the happy face of humans, and he suggested that the nonhuman pout serves a similar function to the human sad face. Ueno, Ueno, and Tomonaga (2004) demonstrated that both infant rhesus macaques

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Citation	Pa
Bonanno & Keltner (1997, 2004); Keltner & Bonanno (1997)	Ge scl psy pa hea
Bonanno et al. (2002)	Co ber ind
Camras et al. (1992)	Ind exp chil abu
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Ekman et al. (1990)	Stud
Ekman et al. (1997)	Ame stud
Ellgring (1986)	Depr inpat
Frank et al. (1993)	Germ patie
Gosselin et al. (1995)	Amer Unive
Harris & Alvarado (2005)	Actor Conse Dram Québ

TABLE 13.2. Studies Examining Spontaneous Facial Expressions of Emotion

Citation	Participants	Eliciting stimuli or situation	Measurement system	Emotions corresponding to the facial muscle configurations in universal expressions
Bonanno & Keltner (1997, 2004); Keltner & Bonanno (1997)	German schizophrenic and psychosomatic patients, and healthy controls	Engaging in a political conversation with a partner they had never met before	EMFACS	Contempt, disgust, anger, sadness, fear, surprise, happiness
Bonanno et al. (2002)	Conjugally bereaved individuals	Interviews about their deceased spouses or ongoing important relationships	EMFACS	Anger, contempt, disgust, fear, sadness, Duchenne smiles
Camras et al. (1992)	Individuals with experience of childhood sexual abuse	Narrative interviews about the most distressing event or series of events in their lives	EMFACS	Anger, disgust, sadness, fear, Duchenne smiles
Chesney et al. (1990)	American and Japanese infants	Arm restraint, which produces distress	FACS	Anger, sadness, fear, and happiness
Ekman et al. (1980)	American salaried employees in managerial positions at an aerospace firm	Structured interview designed to assess Type A behavior	FACS	Disgust, fear, sadness, happiness, anger, contempt, surprise
Ekman et al. (1988)	American college students	Films designed to elicit positive and negative emotion	FACS	Happiness, unspecified negative emotions
Ekman et al. (1990)	Student nurses	Films designed to elicit strong negative emotions	FACS	Happiness
Ekman et al. (1997)	American college students	Two film clips designed to elicit positive emotions, and two designed to elicit negative emotions	FACS	Happiness
Ellgring (1986)	Depressed inpatients	Intake and discharge interviews	FACS and EMFACS	Happiness, contempt, anger, disgust, fear, sadness
Frank et al. (1993)	German depressed patients	Interviews	FACS	Happiness
Gosselin et al. (1995)	American University students	Films designed to elicit various emotions	FACS	Happiness
Harris & Alvarado (2005)	Actors from the Conservatory of Dramatic Arts in Québec	Interpreting 2 of 24 scenarios designed to elicit happiness, fear, anger, surprise, sadness, and disgust	FACS	Happiness, fear, anger, surprise, sadness, and disgust

(continued)

TABLE 13.2. *(continued)*

Citation	Participants	Eliciting stimuli or situation	Measurement system	Emotions corresponding to the facial muscle configurations in universal expressions
Heller & Haynal (1994)	American college students	Either being tickled, listening to an audiotape of jokes, or placing a hand in ice water	FACS	Duchenne smiles
Keltner et al. (1995)	French depressed patients	Interviews with the patients' psychiatrists	FACS and EMFACS	Contempt
Lerner et al. (2005)	American adolescents with behavior problems	Administration of the Wechsler Intelligence Scale for Children—Revised	EMFACS	Anger, fear, and sadness
Matsumoto & Willingham (2005)	American college students	Induction of three kinds of stress	EMFACS	Fear, anger, and disgust
Mauss et al. (2005)	Olympic medalists	Immediately after winning or losing a medal in competition, and on the podium	FACS	Six different types of smiles, contempt, disgust, fear, and sadness
Gross & Levenson (1993)	American college students	Films designed to elicit amusement and sadness	Emotion Expressive Behavior Coding (Messinger et al., 2001)	Amusement and sadness
Rosenberg & Ekman (1994)	Infants and their mothers	Play sessions between infants and mothers	FACS and Baby FACS	Duchenne smiles of happiness
Ruch (1995)	American university students	Videos selected for their ability to elicit primarily disgust and secondarily fear	FACS	Disgust, sadness, fear, happiness, contempt, and anger
Ruch (1993)	German university students	Slides of jokes and cartoons	FACS	Happiness
Soto et al. (2005)	German university students	Slides of jokes and cartoons	FACS	Happiness
Gross & Levenson (1993)	Chinese American and Mexican American college students	Aversive acoustic startle	Emotion Expressive Behavior Coding (Levenson, 2003b)	Anger, anxiety, disgust, confusion, contempt, interest, embarrassment, fear, happiness, sadness, surprise, crying, laughter

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and infant chimpanzees showed different facial expressions to sweet and bitter tastes, but that the chimps' facial expressions were more similar to human facial expressions than to those of the macaques. However, even some of the smaller apes, such as siamangs (*Symphalangus syndactylus*), noted for their limited facial expression repertoire, have distinguishable facial expressions accompanying sexuality, agonistic behavior, grooming, and play (Liebal, Pika, & Tomasello, 2004). De Waal (2002) suggests that for some states a species less closely related to humans than chimpanzees, the bononos, may have more emotions in common with humans.

The most recent research has gone beyond demonstrating equivalence in morphological descriptions of expressions to identifying the exact facial musculature involved in the display behavior.[2] Indeed, the strongest support for the biological bases of facial expression would be a demonstration of homology in facial expressions between humans and related species, such as chimpanzees (*Pan troglodytes*). This would suggest that as humans evolved during the 120 million years of primate evolution, similar facial muscles developed, presumably to serve similar social functions. The newest work in this area, by Waller and colleagues (2006), reported that the forehead musculature of chimps is less well developed than that of humans. (They speculate that the greater hairiness of chimps makes eyebrow movements less visible, and hence less communicative.) But many other facial muscles and expressions have homologues and analogues comparable to those defined in the human FACS (Ekman & Friesen, 1978). For example, Waller et al. (2006) report that many of the muscles coded on the human face have the same location and functional effect in humans and chimpanzees (see Table 13.1). Based on this work, there is now a ChimpFACS that allows for identification of the specific AUs chimpanzees use in producing facial expressions (see Vick, Waller, Parr, Pasqualini, & Bard, 2007).[3]

Linkages between Facial Emotional Expressions and Subjective Experience

The evolutionist perspective suggests a linkage between each universal signal of emotion and a subjective experience, in particular when there is no reason to manage or modify the expression because of social circumstances. Eleven studies reported in Table 13.2 report correlations between emotion-specific facial behaviors and self-reports of the experience of the discrete emotion (these findings are summarized in Table 13.3). It is noteworthy that linkages between discrete facial expressions of emotion and self-reports of the same emotional states are stronger in within-subject designs that involve precise, second-to-second measurement of both expression and experience, such as Rosenberg and Ekman's (1994) study and that by Mauss, Levenson, McCarter, Wilhelm, and Gross (2005). In the latter, cross-lag correlations indicated very high within-individual correlations between facial behavior and experience intensity for both amusing and sadness-eliciting films (r's = .73 and .74, respectively). When correlations were corrected for disattenuation, they were even higher (r's = .89 and .97).

Moreover, important *nonfindings* not reflected in Table 13.3 need to be considered. In Bonanno and Keltner's (1997) study, for instance, anger, contempt, and sadness were positively correlated with reports of grief, but fear and disgust were not. In Ekman, Friesen, and Ancoli's (1980) study, expressions of disgust were positively correlated with disgust but negatively correlated with anger and sadness. In Harris and Alvarado's (2005) study, Duchenne smiles were correlated with happiness and amusement, but not with reports of feeling anxious, angry, or embarrassed.

Complementing the studies listed in Table 13.3 are several lines of research that provide convergent evidence. Matsumoto and Kupperbusch (2001) reported significant correlations between judged expressions and self-reported experience. Duchenne smiles have been correlated with the experience of positive emotion in young and old adults (Frank, Ekman, & Friesen, 1993; Hess, Banse, & Kappas, 1995; Keltner & Bonanno, 1997; Smith, 1995). Duchenne and non-Duchenne smiles distinguished nonharassed and harassed job applicants (Woodzicka & LaFrance, 2001), as well as honest and deceptive interviewees (Ekman, Friesen, & O'Sullivan, 1988). Frank and Ekman (1997) reported predicted differences in fear between honest and deceptive men. The facial signals related to embarrassment and amusement (e.g., gaze aversion and smile controls vs. the open-mouthed smile) were correlated with self-reports of these emotions (Keltner, 1995). Spontaneous laughter and

TABLE 13.3. Studies Reporting Significant Correlations between Spontaneous Facial Expressions of Emotion and Self-Reports of Specific Emotions

Citation[a]	Facial expressions measured	Self-reports obtained	Correlation
Bonanno & Keltner (1997)	Duchenne laughing	Grief (concurrent)	–.39*
	Anger		.36*
	Contempt		.31*
	Sadness		.34*
Keltner & Bonanno (1997)	Duchenne smiles	Distress	–.49**
		Fear	–.31*
		Enjoyment	.35*
	Duchenne laughing	Distress	–.36*
		Enjoyment	.34*
Bonanno & Keltner (2004)	Duchenne smiles	Distress	–.44*
	Duchenne laughing	Anger	–.51**
Ekman et al. (1980)	Smiling (frequency)	Happiness	.60**
	Smiling (duration)	Happiness	.35*
	Smiling (intensity)	Happiness	.34*
	Disgust (frequency)	Disgust	.37*
		Anger	–.35*
		Sadness	–.46**
	Disgust (duration)	Disgust	.55**
		Fear	.46*
		Pain	.41*
Ekman et al. (1990)	Duchenne smiles	Amusement	.70*
		Happiness	.59*
		Excitement	.39***
		Interest	.40***
		Anger	–.38***
		Sadness	–.44***
Harris & Alvarado (2005)	Duchenne smiles	Happiness	.19† (humor condition)
		Amusement	.28**
Mauss et al. (2005)	Duchenne smiles	Amusement	.73***
	Sadness	Sadness	.74***
Rosenberg & Ekman (1994)[b]	Disgust and fear	Disgust and fear	.71 (rat film)
			.90 (amputation film)
			.83 (amputation film)
Ruch (1993)	Duchenne smiles	Positive affectivity	.33* (experimental group)
			.52* (control group)
			.78* (rank order of cell means)
		Verbal enjoyment	.28*
Ruch (1995)	Duchenne smiles	Funniness	.55 (between-subjects design, aggregate data)
			.96 (within-subjects design, aggregate data)
			.61 (between-subjects design, raw data)
			.71 (within-subjects design, raw data)
			.63 (across all stimuli and designs)

[a]Gosselin et al. (1995) obtained self-reports but did not report correlations between the ratings and facial expressions.
[b]The statistics reported for this study are the probabilities of co-occurrence between the ratings of specific emotion categories and the corresponding facial expressions.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$; $^{\dagger}p < .10$

smiling were found to have some distinct experiential correlates (Keltner & Bonanno, 1997). The intensity of laughter or smiling correlated with self-reports of the funniness of the humorous stimuli (McGhee, 1977; Ruch, 1995).

Facial Expressions as Part of a Coherent Package of Emotional Responses

Darwin (1872/1998) suggested, in his principle of serviceable habits, that facial expressions are the residual actions of more complete behavioral responses. By implication, facial expressions not only should be related to emotional experience; they should also be coordinated with other components, such as autonomic or neuroendocrine changes, that enable the organism to respond adaptively. Researchers refer to this possibility in terms of "emotion packages," "emotion response system coherence," or "response covariation" (Bonanno & Keltner, 2004; Ekman, 1992a; Lazarus, 1991; Levenson, 1994). Distinct lines of evidence suggest that brief facial expressions of emotion covary in systematic fashion with appraisal processes, physiological responses, specific actions (e.g., aggressive behavior or cooperation), broad individual differences in emotionality, and measures of physical and mental health.

Co-occurrence with Distinct Appraisals

If facial expressions are part of a coherent response profile, they should covary with emotion-specific appraisal processes. Evidence suggests that this is the case. For example, bereaved adults' facial expressions of anger and sadness while discussing their deceased spouses co-occurred with distinct appraisal themes (justice and loss) coded from participants' spontaneous narratives that were contemporaneous with the facial expressions (Bonanno & Keltner, 1997). Another study found that posing facial expressions of anger was related to the appraisal that others were responsible for social events, whereas posing facial sadness was associated with the appraisal that the same events were due to situational causes (Keltner, Ellsworth, & Edwards, 1993). Moreover, spontaneous facial expressions reliably differentiate whether Olympic athletes have won or lost a medal, and differences in their smiling behavior differentiate what kind of medal they won (Matsumoto & Willingham, 2006). As a final example, expressions of anger, contempt, and disgust are reliably associated with appraisals related to moral violations of autonomy, community, and divinity, respectively (Rozin, Lowery, Imada, & Haidt, 1999). Taken together, these studies suggest that facial expressions of distinct emotions covary with specific appraisals.

Covariance with Distinct Physiological Responses

Facial expressions are also coordinated with physiology. When emotions are aroused and facial expressions are used as markers of those emotions, discrete physiological signatures occur in both the autonomic nervous system and the brain (Davidson, 2003; Ekman, Davidson, & Friesen, 1990; Ekman, Levenson, & Friesen, 1983; Levenson, Carstensen, Friesen, & Ekman, 1991; Levenson & Ekman, 2002; Levenson, Ekman, & Friesen, 1990; Levenson, Ekman, Heider, & Friesen, 1992; Mauss et al., 2005; Tsai & Levenson, 1997). Table 13.4, adapted from Levenson (2003b), summarizes the major findings in this area and highlights how emotions signaled in facial expression are associated with activity in other physiological systems. These patterns have been found in people from cultures as widely divergent as the United States and the Minangkabau of West Sumatra, Indonesia.

Alongside these findings, it is important to note that the coherence of facial expression and physiology has not always been consistent. Some studies (Brown & Schwartz, 1980; Cacioppo, Martzke, Petty, & Tassinary, 1988) demonstrated only low correlations between expression and physiological response, and some found no relationship (Buck, 1977; Mauss, Wilhelm, & Gross, 2004). These negative findings are the likely results of several methodological factors: (1) the fact that the occurrence of an emotion is sometimes defined by the attempt to manipulate it, instead of the independent confirmation of its elicitation; (2) the type of emotion elicited; (3) the nature of the measures of emotional responding used; (4) the temporal resolution of the measurement (Mauss et al., 2005; Rosenberg & Ekman, 1994); (5) the fact that the laboratory may not be the optimal context in which to elicit adaptive physiological responses; and (6) the difference between between- and within-subjects designs. The Mauss et al. (2005) study described earlier highlights the importance of the last issue. They measured facial behaviors, emotional

TABLE 13.4. Changes in Appearance and Autonomic Nervous System (ANS) Activity Associated with the Discrete Emotional States Darwin Considered Universal

Emotion	AUs associated with the physiological changes reported	Type of change	Change	ANS mediation
Anger	1; 4; 5; 17; 23 or 24	Coloration	Reddening	Vasodilation, increased contractability
		Moisture and secretions	Foaming	Salivary glands
		Protrusions	Piloerection	Muscle fibers at base of hair follicles
			Blood vessels bulging	Vasodilation
		Eye appearance	Constriction	Pupils
			Bulging	Eyelid muscles
Disgust	9 or 10	Moisture and secretions	Salivating, drooling	Salivary glands
Fear	1; 2; 4; 5; 7; 20	Coloration	Blanching	Vasoconstriction
		Moisture and secretions	Sweating, clamminess	Sweat glands
		Protrusions	Piloerection	Muscle fibers at base of hair follicles
		Eye appearance	Dilation	Pupils
			Bulging	Eyelid muscles
Happiness	6; 12	Eye appearance	Twinkling	Lacrimal glands plus contraction of orbicularis oculi
Sadness	1 (or 1 + 4); 15	Moisture and secretions	Tearing, crying	Lacrimal glands
Embarrassment		Coloration	Blushing	Vasodilation

Note. Adapted with permission from Levenson (2003b). Changes from the original table include the reorganization of contents according to emotion, the addition of action units (AUs) associated with physiological changes, minor wording changes, and the removal of sexual arousal from the emotion category.

experience, and three types of physiological response (skin conductance, cardiovascular activation, and somatic activity) with second-by-second precision while participants watched films designed to elicit amusement and sadness. The results indicated clear, moderate-sized, within-individual correlations between facial behavior and the various physiological response components.

Most recently, Lerner, Gonzalez, Dahl, Haririr, and Taylor (2005) demonstrated that the discrete facial expressions of fear, anger, and disgust were reliably linked not only to cardiovascular responses, but to neuroendocrine activity as well. Participants were exposed to three different types of stressors during which they were videotaped, and their cardiovascular and hypothalamic–pituitary–adrenocortical (cortisol) responses were measured. Fear expressions were associated with elevated cardiovascular and cortisol levels; anger and disgust were linked with reduced responses. Matsumoto, Nezlek, and Koopmann (2007) reported moderate-sized correlations between self-reported expressive behavior and three types of physiological sensations (ergotropic, trophotropic, and felt temperature) in approximately 3,000 respondents from 27 countries. They also reported consistent correlations between verbal and nonverbal expressions, as well as between emotion intensity and physiological sensations, all of which suggest coherence in an underlying neurophysiological reality.

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ANS mediation

Vasodilation, increased contractability
Salivary glands

Muscle fibers at base of hair follicles
Vasodilation
Pupils
Eyelid muscles

Salivary glands

Vasoconstriction
Sweat glands

Muscle fibers at base of hair follicles
Pupils
Eyelid muscles

Lacrimal glands plus contraction of orbicularis oculi

Lacrimal glands

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Covariance with Subsequent Behaviors

Another source of evidence supporting the links between expressions and emotional responses comes from studies that demonstrate covariance between facial expressions of emotion and subsequent behaviors. Facial expressions of emotion can signal behavioral intent. In the first study to demonstrate this effect, Ekman, Liebert, et al. (1972) examined the relationship between facial expressions of emotion produced by children as they watched television and their subsequent hurtful behaviors and aggressive play. Children were videotaped as they watched either a violent scene from a movie or competitive sports. Afterwards, they were placed in a situation where they could either help or hurt another child, and then engaged in a free-play period. Boys who smiled during the violent scenes engaged in more hurtful behavior and aggressive play afterwards; boys who showed sadness during the violent scenes engaged in more helpful behavior and less aggressive play when the video was finished.

Matsumoto, Haan, Gary, Theodorou, and Cooke-Carney (1986) videotaped the facial behaviors of preschool dyads as they either cooperated or competed in a Prisoner's Dilemma game, and used the Emotion Facial Action Coding System (EMFACS) to code facial behaviors. The children displayed varied emotional responses, and these were reliably linked to the actions of the game. Cooperative behaviors elicited decreased negative emotion, whereas children who were defected against expressed more non-Duchenne smiles and positive–negative blends. Most importantly, facial expressions that occurred after an action—cooperation or competition—predicted subsequent behavior. Children who expressed Duchenne smiles after their partners cooperated were more likely to cooperate also; those who expressed anything else after cooperation were more likely to defect. Defections that were followed by non-Duchenne smiling were more likely to lead to subsequent, repeated defections; when defections were followed by Duchenne smiling, however, the subsequent act was likely to be cooperative.

More recently, Keltner, Moffitt, and Stouthamer-Loeber (1995), in their study of adolescent boys, examined relations between facial expressions of emotion observed in a 2-minute interaction and teacher reports of social behavior. Facial displays of anger observed in an interactive IQ testing context correlated significantly with teacher ratings of delinquent and aggressive behavior at school; facial displays of fear correlated negatively with these behaviors, and positively with withdrawal-related behaviors.

Covariance with Broad Individual Differences

Further evidence consistent with the claim that facial expressions covary with multisystem responses comes from studies linking facial expressions to measures of individual differences in emotionality. For example, as noted earlier, Bonanno and Keltner (1997) used the FACS to code bereaved adults' facial expressions as they talked about their recently deceased spouses. Facial expressions of anger predicted increased grief severity 14 and 25 months after loss; laughing and smiling, however, predicted reduced grief over time. Importantly, facial expressions predicted long-term adjustment, independently of initial levels of grief and individual differences in the tendency to report high levels of distress. These findings suggest that brief measures of facial expressions (in this study, 6 minutes of behavior were coded) predict broad patterns of adaptation to important life events.

Harker and Keltner (2001) coded women's college yearbook photos with the FACS, and showed that Duchenne smiling was positively correlated with multiple measures of personality (i.e., affiliation, warmth, competence), personal well-being, and marital satisfaction at various times over the next 30 years. And Abe and Izard (1999) measured discrete facial expressions of emotion in 18-month-old infants during episodes of the Strange Situation procedure, and correlated these with maternal ratings of the five-factor model of personality when the children were 3.5 years old. Negative expressions were strongly correlated with Neuroticism and inversely related to Agreeableness and Conscientiousness; full-face positive expressions were positively correlated with Extraversion and Openness to Experience. These findings suggest that facial expressions of discrete emotions systematically covary with coherent patterns of thought, feeling, and action as captured in personality measures.

Covariance with Measures of Mental and Physical Health

If facial expressions are part of more coherent responses to the environment, they should likewise be related to measures of mental and physical health, which capture maladaptive patterns of thought, action, and feeling. Several studies indicate that fleeting facial expressions of emotion are telling clues about personal adjustment. Anger displays are related to the incidence of ischemia in patients with coronary artery disease (Rosenberg et al., 2001). The oblique eyebrows and pressed lips of sympathy correlate with reduced heart rate, whereas winces of pain are related to elevated heart rate (Eisenberg et al., 1989). Facial expressions differentiate among genuine pain, masked pain, and faked pain (Craig, Hyde, & Patrick, 1991; Prkachin, 1992), as well as between healthy individuals and psychiatric patients (Ellgring, 1986; Steimer-Krause, Krause, & Wagner, 1990), schizophrenic and psychosomatic patients (Steimer-Krause et al., 1990), schizophrenic and depressed patients (Berenbaum & Oltmanns, 1992; Ekman, Matsumoto, & Friesen, 1997; Ellgring, 1986), suicidal and nonsuicidal depressed patients (Heller & Haynal, 1994), and patients with major versus minor depression (Ekman et al., 1997). In Ekman et al.'s (1997) study, for instance, patients with major depression showed more sadness and disgust and fewer non-Duchenne smiles than those with minor depression. Manic patients showed more Duchenne and non-Duchenne smiles, and less anger, disgust, or sadness than either group with depression. Schizophrenic patients showed more fear and fewer displays of all other emotions. Moreover, expressions of contempt and unfelt happiness measured during intake interviews of the depressed patients predicted improvement at discharge. In another study, facial expressions of disgust (and glaring) differentiated between individuals with Type A and Type B personalities, and facial expressions of contempt, anger, and disgust were all correlated with various speech indices of hostility, anger, competitiveness, and despondency (Chesney et al., 1990). Moreover, Duchenne smiles differentiated whether depressed patients were improving as a result of treatment (Ekman et al., 1997), and patients with right-hemisphere damage were impaired in the production of facial expressions of emotions, particularly positive emotion (Borod, Koff, Lorch, & Nicholas, 1986).

Pathologies also affect the ability to pose and recognize emotional expressions. Abused children, for instance, have difficulties both posing and recognizing facial expressions (Camras et al., 1988; Pollak, Cicchetti, Hornung, & Reed, 2000; Pollak & Sinha, 2002). Severely autistic children have broad and pervasive deficits in recognizing emotions (Hobson, 1986; Ozonoff, Pennington, & Rogers, 1990). Children with high-functioning autism or Asperger's syndrome have emotion-specific deficits: They are generally able to recognize happiness, sadness, fear, and anger (Capps, Yirmiya, & Sigman, 1992), but not facial signals of embarrassment or shame (Heerey, Keltner, & Capps, 2003). Individuals with high trait anxiety recognize fearful faces better than those without such anxiety (Surcinelli, Codispoti, Montebarocci, Rossi, & Baldaro, 2004), and individuals who are depressed are generally worse at recognizing all facial emotions (Persad & Polivy, 1993). Individuals with current substance dependence and a history of alcohol dependence are also generally worse at recognizing facial emotions (Foisy et al., 2005). And patients with myotonic dystrophy Type 1 have difficulty recognizing angry, disgusted, and fearful faces (Winblad, Hellstrom, Lindberg, & Hansen, 2006).

More than 135 years ago, Charles Darwin claimed that brief facial expressions are really tokens of more complex, multisystem responses to specific environmental demands or opportunities. The literature we have reviewed in this section elaborates upon this early evolutionist claim, indicating that facial expressions of distinct emotions covary systematically with distinct appraisals, physiological response, social behavior, stable individual differences, and markers of physical and mental health.

Recognition of Facial Emotional Expressions: Universality and Brain Involvement

Universal Recognition

Early studies supporting the universal recognition of facial expressions of emotion were judgment studies, in which observers of different cultures viewed facial stimuli and judged the emotions portrayed in them. The earliest studies by Ekman and Izard demonstrated the existence of six universal expressions—anger, disgust, fear, happiness, sadness, and surprise—in literate and preliterate cultures (Ekman, 1972, 1973; Ekman & Friesen, 1971; Ekman, Sorenson, & Friesen, 1969; Izard, 1971). Even when low-intensity expressions were used (Ekman et al., 1987; Matsumoto et al., 2002), there was strong agreement across cultures about the emotion in the expression.

Since the original studies by Ekman and Izard, 27 studies examining judgments of facial expressions have replicated the finding of universal recognition of facial expressions of emotion (Matsumoto, 2001). In addition, a meta-analysis of 168 datasets examining judgments of emotion in the face and other nonverbal stimuli indicated universal emotion recognition at well above chance levels (Elfenbein & Ambady, 2002b). Even after correction for chance guessing, this statistic was associated with a very large effect size, consistently supporting the findings that expressions are universally recognized.

More recent research continues to complement this conclusion. Horstmann (2003), for instance, asked approximately 2,000 online participants whether the universal facial expressions signaled feeling states, behavioral intentions, or action requests. The majority of the observers chose feeling states as the primary message of the expressions of disgust, fear, sadness, surprise, and happiness. (Participants did choose behavioral intentions or action requests as the message of angry expressions.) Lawrence et al. (2005) asked 484 children between 6 and 16 years of age to judge the universal faces. All of these children were able to judge the emotions accurately beyond chance levels, and the accuracy rates increased linearly across age for happiness, surprise, fear, and disgust; for sad and angry expressions, accuracy rates remained constant across age. And Parr (2003) has demonstrated that chimpanzees are able to discriminate five emotional expressions with similarities to human expressions (relaxed-lip face, pant-hoot, play face/relaxed open-mouth face, scream face, and bared-teeth face) and a neutral face. Moreover, chimpanzees are able to match different emotional faces with specific behaviors—a finding suggesting that they understand specific meanings associated with facial expressions, much as humans do in matching faces with emotional stories (Matsumoto & Ekman, 2004; Rosenberg & Ekman, 1995). These findings suggest strongly that chimpanzees, like humans, respond to different faces as categories.

There have been various methodological critiques of the studies of face recognition (e.g., Russell, 1991a, 1994; Russell, Bachorowski, & Fernandez-Dols, 2003). This body of criticism has been addressed in a number of studies (e.g., Ekman et al., 1987; Matsumoto, 2005; Matsumoto & Ekman, 1989, 2004; Yrizarry, Matsumoto, & Wilson-Cohn, 1998; Frank & Stennett, 2001; Rosenberg & Ekman, 1995). These studies demonstrate that the original findings of universality in judgments of discrete emotion categories were not artifacts of the forced-choice judgment task and are, in fact, quite robust across different judgment tasks and cultures. The literature we review below indicates that the recognition of distinct facial expressions activates specific regions of the brain.

Brain Activation Produced by Perceiving Facial Expressions

Electroencephalographic and brain imaging studies demonstrate brain specificity in judgments of discrete emotions. The perception of fearful faces activates regions in the left amygdala (Breiter et al., 1996; Phillips et al., 1997; Whalen et al., 2004), even when the presentation of a fearful face is masked by the presentation of an immediately ensuing neutral expression (Whalen et al., 1998), or by other, consciously perceived expressions in the face or voice (de Gelder, Morris, & Dolan, 2005). This neural network is modulated by the right prefrontal cortex (Hariri, Mattay, Tessitore, Fera, & Weinberger, 2003) and by the peptide oxytocin (Kirsch et al., 2005). The perception of sad faces activates the left amygdala and right temporal lobe (Blair, Morris, Frith, Perrett, & Dolan, 1998). The perception of angry faces activates the right orbito-frontal cortex and cingulate cortex (Blair et al., 1998; Sprengelmeyer et al., 1996). The perception of disgusted faces activates the basal ganglia, anterior insula, and frontal lobes (Phillips et al., 1997; Sprengelmeyer et al., 1996). Duchenne smiles activate the left side of the lateral frontal, midfrontal, anterior temporal, and central anterior scalp regions (Davidson et al., 1990;

Ekman & Davidson, 1993). Some evidence suggests that the brain areas involved when emotion is elicited are the same areas involved in judging emotions in others (Calder, 2003; Calder, Keane, Manes, Antoun, & Young, 2000).

Disease and lesion studies indicate that the perception of different emotions is associated with different brain regions. Bilateral lesions to the amygdala impair the ability to recognize fearful faces and vocalizations, but not the ability to recognize facial expressions of sadness, disgust, or happiness (Adolphs, Tranel, Damasio, & Damasio, 1994, 1995; Adolphs et al., 1999; Broks et al., 1998; Calder, Young, & Perrett, 1996; Sprengelmeyer et al., 1996; Young, Hellawell, Van de Wal, & Johnson, 1996). Individuals suffering from Huntington's disease, which affects the basal ganglia, are unable to recognize disgusted expressions accurately but are accurate in judging facial expressions of other negative emotions (Sprengelmeyer et al., 1996). Even carriers of Huntington's disease are unable to recognize facial expressions of disgust (Gray, Young, Barker, Curtis, & Gibson, 1997).

The last 10 years, then, have seen the emergence of two robust literatures converging upon the conclusion that evolution has shaped the capacity, universal to humans, to reliably recognize distinct facial expressions of emotion. The first is the new wave of studies of emotion recognition, which have dealt with confounds and problems in interpretation of the influential Ekman and Izard studies, and found consistently that the recognition of facial emotion expressions is universal. A second literature has shown that different patterns of regional activation in the brain occur when individuals perceive distinct facial expressions, raising the possibility that we humans have evolved distinct emotion perception systems or circuits.

Important Social Functions of Facial Emotional Expressions

Central to an evolutionist analysis of emotion is the premise that the emotions evolved to help solve social problems (e.g., Ekman, 1992; Keltner, Haidt, & Shiota, in press; Tooby & Cosmides, 1992). Expressions are central to these processes in three ways (Keltner, 2003). First, they provide information about the expressor's emotions, intentions, relationship with the target, and relationship with the environment. Second, they evoke responses, particularly emotions, from others. Third, they provide incentives for desired social behavior. The research reviewed above supports the first contention. Research reviewed in this section supports the second two.

Facilitating Specific Behaviors in Perceivers

Because facial expressions of emotion are universal social signals, they contain meaning not only about the expressor's intent and subsequent behavior, but also about what the perceiver is likely to do. Marsh, Ambady, and Kleck (2005) showed observers fearful and angry faces, and asked them either to push or to pull a lever when they saw them. Anger facilitated avoidance-related behaviors, whereas fear facilitated approach-related behaviors. Winkielman, Berridge, and Wilbarger (2005) found that subliminal presentation of smiles produced increases in how much of a beverage people poured and consumed, and how much they were willing to pay for it; presentation of angry faces decreased these behaviors. Also, emotional displays evoke specific, complementary emotional responses from observers. For example, anger has been found to evoke fear (Dimberg & Öhman, 1996; Esteves et al., 1994), whereas distress evokes sympathy and aid (Eisenberg et al., 1989).

Signaling the Nature of Interpersonal Relationships

Some of the more important and provocative set of findings in the area of facial emotional expressions and interpersonal relationships come from Gottman and Levenson's (Gottman & Levenson, 1992; Gottman, Levenson, & Woodin, 2001) studies involving married couples. In their research, married couples visited their laboratory after the spouses had not seen each other for 24 hours, and then the spouses engaged in intimate conversations about daily events, issues of conflict, and so forth. Discrete expressions of contempt, especially by the men, and disgust, especially by the women, predicted later marital dissatisfaction and even divorce.

Regulating Social Interaction

Facial expressions of emotion, and other facial behaviors, are important regulators of social interaction. In the developmental literature,

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this concept has been investigated under the rubric of "social referencing" (Klinnert et al., 1983)—that is, the process whereby infants seek out emotional information from others to interpret ambiguous objects and events, and then use that information to act (see also Hertenstein & Campos, 2004).

The Importance of Judging Emotions Accurately

Because facial expressions are reliable markers of emotion, and because they serve important social functions, the ability to judge them accurately may be linked to important intra- and interpersonal processes. In exploring this thesis, Matsumoto and his colleagues addressed this problem in the creation of the Japanese and Caucasian Brief Affect Recognition Test (JACBART), which was based on Ekman and Friesen's (1969) observation of microexpressions (described earlier). In the JACBART, seven universal facial expressions are presented very briefly (for 0.20 second), embedded within a 1-second presentation of the same expressor's neutral face.[4] Matsumoto et al. (2000) demonstrated the internal and temporal reliability of the emotion recognition scores produced; sufficient item discrimination and range; convergent validity among emotions; and reliability across response alternatives. Construct validity was established by correlations between emotion recognition accuracy scores and the personality constructs Openness and Conscientiousness in multiple measures of personality. Moreover, emotion recognition accuracy scores were independent of visual acuity in judging general facial stimuli presented at high speeds. The findings on Openness have been replicated by others (Terracciano, Merritt, Zonderman, & Evans, 2003).

Emotion recognition ability has been theoretically linked to the concept of emotional intelligence (Mayer, Salovey, Caruso, & Sitarenios, 2001; Salovey & Mayer, 1990). In fact, in a study using behavioral measures to test the predictive validity of the JACBART, emotion recognition accuracy was correlated with Problem Solving, Goal Setting, and total Effectiveness as measured by an In-Basket task (Matsumoto, LeRoux, Bernhard, & Gray, 2004). And Yoo, Matsumoto, and LeRoux (2006) used the JACBART to demonstrate that emotion recognition abilities of international students measured at the beginning of the school year were correlated with various adjustment indices at the beginning of the year (anxiety, homesickness, culture shock), as well as at the end of the year (anxiety, contentment). Recognition ability was also correlated with students' end-of-year grade point averages and with ratings of their participation in the behavioral task obtained in the laboratory session.

The hypothesis that microexpressions are related to deception, outlined above, suggests that the ability to recognize emotions from microexpressions should be related to the ability to detect lies. In fact, using an early microexpression test (the Brief Affect Recognition Test), Ekman and Friesen (1974) did indeed find that the ability to recognize microexpressions was significantly correlated with lie detection accuracy. Ekman and O'Sullivan (1991) replicated this finding. Most recently, Ekman (2003) has developed the Micro Expression Training Tool (METT), which allows individuals to test themselves on their ability to identify correctly basic expressions of anger, fear, sadness, disgust, happiness, contempt, and surprise. Training with this technique significantly increases the accurate recognition of deceptive items in which microexpressions occur (Ekman & Frank, 2005), and these results have been replicated across cultures (Frank, 2007). Recent research has indicated that schizophrenic individuals trained with the METT improved to a level that was not significantly different from the performance of pretrained controls (Russell, Chu, & Phillips, 2006).

In concluding our empirical review, we suggest that the studies brought together here, for the first time, strongly support the five claims made from an evolutionist approach to facial expression. The data suggest that facial expressions of emotion, as originally described by Darwin, are universally aroused in specific situations (Claim 1); linked to subjective experience (Claim 2); part of a coherent, multisystem response package (Claim 3); judged across different cultures in similar fashion (Claim 4); and associated with social functions (Claim 5).

A RESEARCH AGENDA FOR THE FUTURE

Evolutionist approaches to facial expression, and the methods and findings inspired by this perspective, have been integral to the development of the field of emotion. This perspective has inspired coherent lines of empirical inquiry on the universality, coherence, recognition, and social functions of facial expression. All remain fruitful areas of exploration. We close this chapter by referring briefly to questions where the need for empirical research is great, and where opportunities for discovery are clear.

When Do Discrete Facial Expressions of Emotion Appear in Development?

There is continuing controversy about whether newborns signal discrete emotions in the face. The biologically based programs that lead to the regular occurrence of facial expressions may unfold later according to maturational or developmental milestones, especially milestones in cognitive abilities. Few longitudinal data in early infancy, however, shed light on the developmental timetable for discrete facial expressions, and future research is needed in this area.

What Other Emotions May Be Expressed in the Face?

Anger, disgust, fear, happiness, sadness, and surprise are the only emotions for which evidence has been found to date demonstrating their universal signal characteristics, unique physiological signatures, universal appraisal mechanisms, and presence in other primates. But they may not be the only emotions with such qualities. Unfortunately, evidence for others is suggestive but incomplete. For instance, preliminary data suggest that candidates include displays of contempt (Ekman & Friesen, 1986; Ekman & Heider, 1988); embarrassment (Keltner & Buswell, 1997) and pride (Tracy & Robins, 2004) and positive emotions such as awe, desire, and love (Gonzaga, Keltner, & Londahl, 2001; Gonzaga et al., 2006; Shiota, Campos, & Keltner, 2003). Future studies will need to address the possibility that other emotions are also displayed in the face, as well as variants of the same emotion.

In What Other Channels Can Emotions Be Expressed?

It is certain that emotions are expressed in channels other than the face and voice, the two most studied to date. Both the well-studied emotions, such as anger and disgust, and the less investigated emotions, such as embarrassment and love, are certain to involve expressive behavior in other channels, such as gaze, head position, posture, touch, or proximity. Recent research suggests such possibilities. New research in this area includes studies on embarrassment (Keltner, 1995), shame (Halisch & Halisch, 1980; Lewis, Alessandri, & Sullivan, 1992; Stipek & Gralinski, 1991), pride (Tracy & Matsumoto, 2005; Tracy & Robins, 2004), romantic love (Gonzaga et al., 2001), and sympathy (Eisenberg et al., 1989).

These new findings suggest that more emotions than previously thought can be communicated in brief expressive behaviors. These findings raise important questions to pursue. To what extent do the different channels—facial expression, gaze, posture, touch—covary in coherent fashion? To what extent to these channels of emotion communication convey distinct emotion-relevant information (e.g., about felt experience or behavioral intention), and to what extent is the information they convey redundant?

What Factors Moderate Facial Expressions and Their Linkages with Other Emotion Responses?

Regulation of facial expressions in humans is a complex neuropsychological phenomenon that can occur outside of conscious awareness (Matsumoto & Lee, 1993). Expression regulation via display rules provides an opportunity to understand how the linkage between expression and experience can be systematically decoupled. The coherence between emotion and expression is moderated by context, and contexts that require the modification of expression may result in decoupling of the linkage between experience and display. Research on this topic, however, is still in its infancy.

What Factors Moderate the Production of Facial Prototypes of the Universal Emotions?

The full-face, high-intensity facial prototypes of the basic emotions do not always occur when emotion is aroused. Facial expression prototypes, we suggest, are more likely to be seen when strong emotions are aroused and the context allows for their expression, such as when married couples fight (Gottman & Levenson, 1992), or athletes win or lose a medal at the Olympic Games (Matsumoto &

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Willingham, 2006). When the full-face prototypes are not expressed, partial facial expressions may occur. In addition to the influence of context and emotion intensity, partial expressions occur in part because of the different neural wiring of the facial muscles (Matsumoto & Lee, 1993). Lower-face muscles are represented more fully in the motor cortex than those of the upper face, allowing for more control of the lower face. Moreover, the number of bilateral versus contralateral fibers to the facial muscles differs depending on region, with the lower face being primarily contralateral and bilateral fibers increasing in the upper face. And voluntary and involuntary expressions are under the control of different neural tracts. These factors strongly suggest that the lower-face components of facial expressions are more likely to be moderated by various factors, including culture and individual differences.

How Many Variants of Each Facial Emotional Expression Exist?

The original studies documenting universality of facial expressions, as well as subsequent research, indicate that many of the emotions have variants in expressions. With some exceptions (Matsumoto, 1989; Rozin, Lowery, & Ebert, 1994), research has not examined the nature of these variants. Different variants may be associated with different intentions; for instance, anger may lead to a joke, walking away, or physical aggression, and it is possible that these different behavioral consequences are signaled by different variants of anger expressions. Similar differences may exist for the other emotions as well, and future studies will need to explore these possibilities.

The only emotion that appears to have a single facial muscle action is that of enjoyment, which is signaled by the Duchenne smile. There are, however, many kinds of enjoyment (Ekman, 2003), and it is likely that these different kinds of enjoyment are signaled through different expressive channels, such as postural behavior and gaze activity. This research is just getting underway.

CONCLUSION

An evolutionist approach to facial expression has generated vibrant empirical literatures, which allow for the following conclusions:

1. Some facial expressions are universal, reliable markers of discrete emotions when emotions are aroused and there is no reason to modify or manage the expressions.
2. Discrete facial expressions generally correspond to discrete underlying subjective experiences.
3. Discrete facial expressions are part of a coherent package of emotion responses that includes appraisals, physiological reactions, other nonverbal behaviors, and subsequent actions; they are also reliable signs of individual differences and of mental and physical health.
4. Discrete facial expressions are judged reliably in different cultures.
5. Discrete facial expressions serve many interpersonal and social regulatory functions.

Numerous questions of theoretical significance remain, and await a next wave of empirical studies.

NOTES

1. To wit, Darwin penciled in the margin of Bell's book, "He never looked at a monkey" (Darwin, 1872/1998).
2. The importance of specifying the exact muscles underlying facial expressions can be understood by recognizing the difference in ethologists' verbal descriptions of fear, play, and threat faces of apes. A nonfearful threat involves a tense mouth (AU 23) with no teeth showing. When fear is involved, as is common when subordinate animals are threatening those superior to them in the social hierarchy, the lips are stretched back (AU 20), thereby showing teeth. This seeming smile is not a smile at all, but a fear grimace. By contrast, in the commonly reported "play face" of apes, the corners of the lips go up (AU 12) as they do in human smiles. The difference between AU 20 (a tense lateral stretch) and AU 12 (a relaxed upward pull) is crucial.
3. In analyzing the facial musculature of human infants, Oster (2004) found that adjustments had to be made to the human adult FACS to account for the greater degree of subcutaneous fat in infants. Similarly, the Waller et al. (2006) chimpanzee FACS has just been completed, and several adjustments had to be made to this as well. With this tool, future researchers will be able to ascertain for sure which muscles are innervated in which types of expressions in chimpanzees.
4. Many other tests have been developed over the years to assess related concepts, such as the Profile of Nonverbal Sensitivity (Rosenthal, Hall, DeMatteo, Rogers, & Archer, 1979), the Social Skills Inventory

(Riggio, 1986), the Social Interpretations Test (Archer & Akert, 1977), and the Diagnostic Analysis of Nonverbal Accuracy Scale (Nowicki & Duke, 1994). These, however, do not focus on the recognition of discrete emotional states. Other tests are more emotion-focused, such as the Communication and Reception of Affect Test (Buck, 1976), the Test of Emotional Styles (Allen & Hamsher, 1974), the Understanding our Feelings Test (Elmore, 1985), the Feldstein Affect Judgment Test (Wolitzky, 1973), the Affect Communication Test (Friedman, Prince, Riggio, & DiMatteo, 1980), the Contextual and Affective Sensitivity Test (Trimboli & Walker, 1993), and the Perception of Affect Task (Lane, Sechrest, & Reidel, 1996). These, however, suffer from questionable validity of the expressions used to portray emotion, the inability to produce scores on discrete emotions, and the lack of balance in encoder characteristics.

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