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Properties of Affect and Affect-laden Information Processing As Viewed through the Facial Response System

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> The great German philosopher, Immanuel Kant, likened the human mind to a glass that imprinted its shape on whatever liquid was poured into the glass . . . [unfortunately] he neglected a major filtering mechanism, the innate affects, which necessarily color our every experience by producing a unique set of categorical imperatives, which amplify not only what precedes and activates each affect but also the further responses that are prompted by affect (Tomkins 1984, pp. 193–194).

> [T]here are many circumstances in which the affective reaction *precedes* the very cognitive appraisal on which the affective reaction is presumed to be based (Zajonc and Markus 1982, p. 125).

Theory and research on consumer behavior for nearly four decades have been influenced strongly by motivational notions of needs, drives, and rewards (Dichter 1964). With the growth of the cognitive perspective, the processes of encoding, storage, and retrieval became increasingly important topics of research, and the image of the consumer was upgraded to depict an information-integrating, decision-making organism whose primary purpose was to maximize life's comforts given limited processing and economic resources. Ill-considered actions on the part of consumers were no longer attributed to archaic urgings trapped in a civilized world but

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rather to errors in information processing and decision making resulting from the failure of a generally adaptive cognitive rule or heuristic.

Illustrative of the cognitive approach to consumer behavior is the wealth of research on multiattribute models, information integration, and cognitive responses to persuasion (for example, Zaltman and Wallendorf 1979). The premise underlying each of these theoretical approaches is that people's beliefs and cognitions about a product or recommendation determine their susceptibility or resistance to the appeal. In addition, individuals' retrospective verbal reports about their reactions to stimuli (for example, advertisements, products) or thought listings have been viewed as harboring information about the psychological foundations of attitudes and behavioral dispositions (Fishbein and Ajzen 1975; Petty, Ostrom, and Brock 1981).

The importance of the cognitive perspective for understanding consumer adaptability, versatility, and cultural variability should not be underemphasized. The thesis of this chapter, however, is that by focusing solely on a *cognitive* consumer we overlook the rudimentary and perhaps predominant forces underlying consumer behavior (compare Holbrook and Hirschman 1982).

Consider a case frequently encountered in research on attitudes using the thought-listing technique. Although the retrospective self-report data obtained using the thought-listing technique have been termed *cognitive responses* since Greenwald's influential chapter (1968), one can reasonably question whether this label captures the psychological foundations of responses such as "bull" written in bold, dark strokes across the thought-listing form (Miller and Baron 1973). One could view responses of this sort as a short-hand notation indicating that the individual had completed a detailed analysis of the appeal, possessed innumerable counterarguments, and decided not to list and elaborate on them for the experimenter, undoubtedly for good reason. On the other hand, the comment "bull" might *not* be the conclusion reached by individuals after thinking about the issue or the arguments for a particular recommendation; rather it might reflect the essentially emotional foundation underlying the person's reaction to the appeal (Cacioppo and Petty 1982; Petty and Cacioppo 1981). The articulation of retrospective verbal reports clearly relies on cognitive processes, and we and others therefore have viewed cognitive response data as the consequence of information processing (Cacioppo, Harkins, and Petty 1981). This is not to suggest that cognitive processes are the most rudimentary psychological act on which people's sentiments and actions can arise, but only to acknowledge that cognitive response data are at best an indirect index of both rudimentary affective and basic cognitive processes. It is noteworthy, for instance, that the only dimension along which thought-listing data have been related reliably to attitudes and behavioral inclinations is the polarity dimension (see reviews by Cacioppo and Petty 1981c; Wright 1980).

The effective antecedents of consumer behavior have been highlighted by recent research on attitude conditioning. This research indicates that affective features of advertisements having no intrinsic link to the merits of personally inconsequential products can nevertheless have subtle effects on consumer behavior. For example, Gorn (1982, Experiment 1) asked students to rate advertisements for new pens. Students were exposed to a light blue pen accompanied by background music from a popular album and a beige pen accompanied by a less well-liked excerpt of classical music; or the light blue pen accompanied by the disliked music and the beige pen accompanied by the popular musical excerpt. Results revealed that when subjects were later given the opportunity to choose between the two pens, they were more likely to select the pen that had been accompanied by the liked music even though they could not articulate this contingency. Of course, the inability of subjects to articulate the contingency does not mean that cognitive processes were absent; instead, it illustrates that affective manipulations can have subtle effects on consumer attitudes and behavior.

Petty and Cacioppo (1981, 1984, in press) have outlined an elaboration-likelihood model of attitude change in which simple affective cues are viewed as being more powerful determinants of attitudes when motivation and/or ability to process issue-relevant information is low than high. Consistent with this general framework, Gorn (1982, Experiment 2) exposed subjects to two different ads for a pen. One ad was attribute oriented, providing relevant information about the pen, whereas the other ad featured pleasant music rather than information. Before viewing the ads, half of the subjects were motivated to think by being told that their task was to advise an advertising agency as to whether or not it should purchase advertising time on television. Subjects in this condition were also told that they would later get to choose a three-pen pack of one of the advertised brands as a gift. Thus, the personal consequences of the subjects' evaluations were reasonably high. A second group of subjects was provided little reason to scrutinize the ads carefully. They did not expect to advise the ad agency and were not told about the free pen gift prior to ad exposure. About one hour after ad exposure, subjects were given a choice between the two brands of advertised pens. Seventy-one percent of subjects in the high-consequences condition chose the pen advertised with information, as compared with 37 percent in the low-consequences condition.

Finally, in an important study in which higher-order cognitive processes were even less obviously involved, Kunst-Wilson and Zajonc (1980) exposed subjects to a series of ten irregular polygons. The stimuli were presented tachistoscopically at a duration sufficiently brief that subjects could not discriminate the shapes to which they had been exposed from a comparable set of distractor shapes. Subjects, however, were significantly more likely to prefer the shapes to which they had been exposed than those not seen previously. These data have been interpreted as evidence that people "can like something or be afraid of it before we know precisely what it is and perhaps even *without* knowing what it is" (Zajonc 1980, p. 154).

The recent interest in the role of affect, therefore, may stem in part from research extending to or beyond the limits of the cognitive perspective (compare Zajonc 1980). Several other sources of impetus should be noted, however. Work in evolutionary biology and the neurosciences on adaptive but phylogenetically primitive systems for energizing and guiding behavior suggests that a system of evaluation and response exists that is tied less closely to the stimulus than is the reflex system but that is less flexible, adaptive, and reliant on neocortical nuclei than is the cognitive system as generally conceived (compare Izard, Kagan, and Zajonc 1984; Scherer and Ekman 1984). Conceptions of an affect system, such as Tomkins' characterization (1962, 1963, 1981, 1982) of it as a primary innate biological motivating mechanism that can interact with the reflex and cognitive systems in guiding behavior, fit well with these observations.

In addition, the very nature of the cognitive system—such as the variability in consumer attitudes and responses it potentiates across situations and individuals through learning and discrimination and the resistance to change it poses within situations and individuals through the establishment of dynamic cognitive structures—can place severe limits on the impact of any given cognitive appeal. These limitations contrast with the more universal, even if more transient, impact on consumer attitudes and behaviors one can expect from invoking the cruder (that is, less discriminating) affective system of evaluation (Petty and Cacioppo 1984; Zajonc 1980). It is interesting to note in this regard that advertisers, who are concerned with making a powerful impression on consumers rather than accounting for a small but statistically significant and predictable portion of variance in consumer response, appear to be returning to emotional appeals (Holbrook and O'Shaughnessy 1984).

The reexamination of the role of affect, therefore, portends advances in understanding consumer behavior. The reliance on cognitive analogies, paradigms, and measures to study affect may prove inadequate, however. Models that reduce affect to but one more attribute of a concept within a semantic network may match neatly with data obtained in cognitive paradigms (see review by Clark and Fiske 1982), and these formulations account well for the refined emotions that Tomkins (1981) termed *affect complexes* (for example, pride). But these conceptualizations fail to fully comprehend some of the distinguishing properties of affect, such as the similarities between its manifestation in neonates and adults, its automatic activation and pervasive influence, and its apparent dominance over thoughts and actions.

> One speaks of "being in the grip" of a strong emotion and that seems a particularly apt figure of speech. . . . One experiences a loss of control, a sense of functioning on a more primitive and less reflective level (Winton, Putnam, and Krauss 1984, p. 195).

To be sure, one can incorporate these properties into cognitive models (Lazarus 1984). However, the issue is not whether cognitive terminology can be developed to describe these behavioral phenomena, but rather whether theoretical clarity is gained by adopting a framework in which the affect and cognitive systems are jointly responsible for the evaluation of the environment, intraorganismic regulation, preparation of action, and communication of intention.

In this chapter, we adopt the position that consumer behavior can be more fully understood by accepting the premise that the cognitive system is not the only one with behavioral significance. Justification for this premise is elaborated on elsewhere; our purpose here is to examine advances in the objective assessment of ephemeral affective states.

Affect is not viewed here as being reducible to verbal report (Valins 1966) or physiological reaction (Meyer 1933) but rather as a system with motivational, perceptual, cognitive, physiological, motor expressive, and subjective manifestations. As Campos and Barrett (1984) note, individual differences, inhibitory testing conditions, and developmental changes make it unlikely for a given episode of an emotion to result in changes across all these modes of expression. Hence, until more is known about the parameters governing the operation of the affect system, experimental analyses should be employed that accommodate affect being elicited by multiple situational and imaginable events and manifesting in multiple and somewhat independent ways.

What might be the properties of this multilevel affect system? Consider pain phenomena. The argument regarding whether or not perceptual–cognitive processes are fundamental to affect has been based in part on arguments regarding the temporal relationship between stimulus recognition and feeling. It is interesting to note, therefore, that (1) sensory afferentiation can influence pain afferentiation at the level of the spinal cord; (2) the perception and recognition of the stimulus may actually precede the experience of pain due to differences in the transmission speeds of the differential neural circuits (that is, the afferents) responsive to the sensory and the pain features of a stimulus; and (3) the experience of pain can nevertheless develop independently of the perception and recognition of the stimulus (compare Melzack and Wall 1965). Affect and cognition need not rely on different afferents (as is the case for pain and sensation) but simply different neural circuits to suggest a comparable case may exist with regard to affect. Hence, the argument regarding the temporal precedence of affect and cognition may be moot.

Despite the capability of pain to develop independently of one's cognitive registration and appraisal of the eliciting stimulus, it is equally clear that the interpretation of the stimulus *can* have dramatic effects on physiological and psychological reactions. Evidence for this notion can be found in studies on topics ranging from cognitive dissonance (Zimbardo et al. 1969) to the predictability of highly noxious stimuli (Abbott, Schoen, and Badia 1984). It may be that, in the cases of both pain and affect, extended attributional processes are especially likely to emerge and modulate behavior when the cause of the pain or the affect is unknown.

Several additional parallels between the properties of pain and affect are noteworthy. As is the case for affect, the mechanisms for the registration of and response to pain do not depend on the verbal system and, indeed, exist in neonates and in nonprimates. Moreover, in a subset of pain and affect phenomena, a stimulus with specific features (for example, a sharp instrument, a bitter gustatory stimulus) impinging on the organism can evoke a reaction with strong motivational properties. Among the likely consequences are autonomic changes, a redirection of information processing, and behavioral adaptations.

Pain is usually a transient experience, but it can become chronic and subtly influence the information people seek and the manner in which they think about and respond to this information. Affect, too is generally conceived as a state rather than a trait, but affective states can be extended in time to become moods and can influence cognitive processes (Bower 1981; Gilligan and Bower 1984). As in the case of affect, pain tends to evoke stereotyped behavioral reactions and those aspects of the reaction that are observable act as powerful social stimuli (for example, Lanzetta and Orr 1980, 1981; Orr and Lanzetta 1980; Vaughan and Lanzetta 1980). Finally, through learning, pain can be evoked by the mere presentation of a conditioned stimulus. For instance, Rook (1984) argues that pain that persists into chronicity (defined as six months' duration and not responding to medical treatment) is best viewed as having "come under the control of cues and consequences in the environment. It is no longer a sensory event, but has become part of one's habits and life-style" (Rook 1984, pp. 476–477). Similarly, numerous studies have illustrated the power of a conditioned stimulus to evoke affect (for example, Gorn 1982; Lanzetta and Orr 1980; Ohman and Dimberg 1984; Zanna, Kiesler, and Pilkonis 1970).

The heuristic value of this analogy derives from its suggestions regarding the response properties of affect and from its argument for the plausibility of a partial independence in origin and function between the cognitive and affective systems of evaluation. It also underscores the suggestion that although the cognitive system is largely responsive for the vast flexibility, variability, and adaptability of human behavior, affect—like pain—may be capable of exerting a pervasive, motivating, and directive influence on what people attend to, encode, think about, retrieve, and seek. Silvan Tomkins put it as follows:

> The affect system is . . . the primary motivational system because without its amplification, nothing else matters, and with its amplification, anything else *can* matter. It thus combines urgency and generality. It lends its power to memory, to perception, to thought, and to action no less than to the drives (1984, p. 164).

Underscored, too, is that one of the most important characteristics of affect is its involvement of the somatovisceral apparatus (compare Knapp 1983).

Whereas debates have raged in consumer behavior regarding the utility of electrodermal responses, pupillary responses, heart rate, and the electroencephalogram for studying affect (for example, see reviews by Petty and Cacioppo 1983; Stewart and Furse 1982), important advances for measuring hidden feelings have been the studies made in reading facial expressions. To illustrate, previous research has seldom found discriminable autonomic manifestations of distinctive emotional states (but see Ax 1953; Ekman, Levenson and Friesen 1983). However, there is now considerable evidence to support postulating a tight link between qualitatively different facial expressions and distinctive emotional states. This evidence has come from a variety of sources and includes support for: (1) Darwin's notions (1872) regarding their evolutionary history and adaptive utility (compare Ekman 1972, 1982a); (2) the capacity of facial expressions to serve as social stimuli (for example, Englis, Vaughan, and Lanzetta 1982; Lanzetta and Orr 1981; Orr and Lanzetta 1980; Sorce et al. 1981); and (3) the existence of the associated movements accompanying intrapersonal processes such as silent language processing and emotion (see recent reviews by Ekman and Oster 1979; McGuigan 1978; Zuckerman, DePaulo, and Rosenthal 1981). In the next section, we examine the rationale for investigating affect and its relationship to verbal processes by monitoring the facial response system.

Facial Response System

The face is the site for the major sensory inputs (vision, olfaction, audition, gustation) and for the major linguistic output (speech). It is a multisignal, multimessage response system capable of tremendous flexibility and specificity (Ekman 1982a; Ekman and Friesen 1975). This system imparts information in a variety of ways. "Static facial signals" in Ekman and Friesen's terminology represent relatively permanent features of the face, such as bone structure and skin pigmentation. "Slow signals" represent changes in the appearance of the face that occur gradually over time, such as the development of permanent wrinkles and changes in skin texture. "Artificial signals" represent exogenously determined features of the face, such as eyeglasses and cosmetics. Finally, "rapid signals" represent phasic changes in neuromuscular activity that may lead to visually detectable changes in facial appearance.

We are concerned here with rapid signals, for they are the most important in the expression of emotion and the production of speech. Ekman and Friesen (1975) suggested that among the types of messages transmitted by the rapid facial actions are (1) emotions—expressions paralleling reportable states such as happiness, sadness, anger, disgust, surprise, and fear; (2) emblems—symbolic communicators such as the wink and pseudo-emotional expressions; (3) manipulators—self-manipulative associated movements such as lip biting; (4) illustrators—actions accompanying and highlighting speech such as a raised brow; and (5) regulators—nonverbal conversational mediators such as nods or smiles (see review by Fridlund, Ekman, and Oster in press).

With regard to rapid facial actions, a further distinction can be drawn between motor activities under the control of afferent input (reflex activity) and those directed by a central program (involuntary and voluntary activity). In a reflex, the output to a unimodal stimulus is unimodal, and effector output does not alter receptor input (Gallistel 1980). In a reflex model of an action sequence (for example, walking), each response generates a new sensory state that in turn evokes the next response in the sequence. Although reflex activity is integrated into the majority of mammalian motor activities and is important for the accurate performance of complex patterned movements, it does not appear to dominate motor activity. Instead, studies indicate that a *central program* model better represents the control of most repetitive or patterned movements. By *central,* we simply mean that the response is influenced primarily by neural activity descending from the brain, and this term is used in contrast to *cognitive* because it is more general. We do not mean to suggest by this term that peripheral mechanisms and feedback are unimportant. Welford (1974), for instance, proposed a three-stage central mechanism: input is analyzed and briefly stored in the first stage; the signal is related to a response (or inhibition of a response) in the second; and the selected response is executed in the third. This formulation has since been revised to cast the first two stages as feedback dependent (Glencross 1977). Thus, in this model, the new sensory state set by each response can influence, but does not determine, the next response.[a]

Movements controlled by a central program can occur in a stereotyped fashion and may have a *reflexive* appearance, but, strictly speaking, they constitute behavioral units rather than reflexes. For instance, Weiss (1950) has demonstrated innate, centrally programmed response sequences in studies involving the surgical rearrangement of neuromuscular connections in nonmammalian vertebrates. In an illustrative study, transplanting the limbs of larval salamanders in a position opposite to their original resulted in the salamander walking backward in situations where salamanders normally walked forward. Interestingly, this inappropriate behavior proved resistant to change in the face of environmental reinforcers.

Consistent with Weiss's observations regarding learning, Eibl-Eibesfeldt (1972) among others noted that each species has inborn predispositions to respond that can facilitate or impair learning. Specifically, Eibl-Eibesfeldt suggested that phylogenic adaptations are found on the receptor side, first in capacities of the sense organs, and second in the animal's ability to react with stereotyped behavior patterns to a subset of the perceived stimuli. These unconditioned stimuli are often configurative and highly specific. Moreover, because they unlock a behavior pattern, Eibl-Eibesfeldt has referred to them as *key stimuli.*

The preceding observations regarding motor programs are interesting given the evidence that emotional and articulatory facial actions are based on behavioral units that are operational at or shortly after birth (for example, see reviews by Fridlund, Ekman, and Oster in press; Steiner 1979). This

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[a] To note that human nature includes reflexes and innate, highly stereotyped predispositions to respond is not to argue that human behavior is genetically determined or driven by an ex-machina force. Willis and Grossman (1977), for instance, note that the cat is able to walk adequately immediately after the entire brain above the subthalamus is removed, whereas the primate cannot. This finding has been attributed to the greater encephalization of motor control in primates than in nonprimate species. It is worth emphasizing, therefore, that there is less than complete independence among behavioral systems, but then the tissues of the brain and the rest of the body obviously constitute an organic, interdependent unit. As Claude Bernard noted when discussing this thesis in the domain of physiology:

> We really must learn then that if we break up a living organism by isolating its different parts, it is only for the sake of ease in experimental analysis and by no means in order to conceive them separately. Indeed, when we wish to ascribe to a physiological quality, its value and true significance we must always refer to this whole and draw our final conclusions only in relation to its effects in the whole. Physiologists and physicians must, therefore, always consider organisms as a whole and in detail in one and the same time without ever losing sight of the peculiar conditions of all the special phenomena whose resultant is the individual (1927, p. 91).

evidence includes the following: (1) the vast majority of the discrete facial actions visible in adults can be detected in newborns (Oster and Ekman 1978); (2) imitation of specific facial actions (for example, mouth opening, tongue protrusion) may occur as early as two or three days following birth (Meltzoff and Moore 1977); (3) studies of the facial actions of anencephalic neonates, hydrocephalic neonates, full-term neonates, congenitally blind adolescents, mentally retarded adolescents, and normal adolescents have revealed discriminable facial expressions to pleasant (for example, sweet), neutral (for example, distilled water) and unpleasant (for example, sour) gustatory and olfactory stimuli (see Rosenstein and Oster 1981; Steiner 1979); (4) neonatal smiling occurs nonrandomly, primarily during REM sleep, and appears to reflect periodic, endogenous fluctuations in CNS activity (compare Fridlund, Ekman, and Oster in press); (5) reliable social smiling in an alert infant occurs as early as the third week (Wolff 1963); (6) congenitally deaf children born to deaf parents exhibit cooing at about three months, and they exhibit babbling—including well-articulated speech sounds such as *pakapakapaka,* laughter, and sounds of discontent similar to those of the hearing population—at about six months (Lenneberg 1967); (7) the phonemic repertoire with which children begin is similar across cultures, although the acquisition of a particular language subsequently reshapes this repertoire (Anisfeld 1984); and (8) large variations in environmental conditions leave the age of onset of certain speech and language capabilities relatively unaffected, suggesting that maturational changes are important (Lenneberg 1967).

The existence of rudimentary, possibly innate motor programs, of course, does not preclude the development through learning of complementary and/or more comprehensive motor programs for governing facial actions. As Glencross noted:

> During the early stages of skill acquisition, the executive system may monitor the response stage almost continuously, combining the unitary subroutines or units of action on the basis of incoming information. However, as competence is acquired, the executive system can combine predictable sequences of action and form larger units of action. These larger units are temporally integrated by the executive system, which at the same time is receiving and processing sensory feedback about the ongoing response. . . . The operation of such feedback mechanisms as those described above has a further significance in that the one motor program can be used to achieve a variety of related outcomes. (Glencross, 1977, pp. 26–27)

Moreover, voluntary movements appear to be characterized by the deliberate, reportable act of initiating movement (Willis and Grossman 1977). Once the movement is started, it is possible for it to be carried out by centrally programmed or reflex motor mechanisms. Hence, specific, innate motor programs serve as the building blocks for more complex and flexible expressions and behaviors, which themselves can become automated components of more complex patterns of volitional expression and action (Jackson 1958). Note too, however, that the development of comprehensive motor programs need not entirely mask the effects of primitive affective processes on rudimentary motor responses.

To summarize thus far, within rapid facial actions, one can distinguish (1) reflex actions under the control of afferent input; (2) rudimentary reflex-like or impulsive actions accompanying emotion and less differentiated information processing (for example, orienting reactions) that seem controlled by innate motor programs; (3) adaptable, versatile, and more culturally variable spontaneous actions that seem mediated by learned motor programs; and (4) malleable voluntary actions. Thus, certain movements, particularly of the facial muscles, are viewed as undemanding of a person's limited processing capacity, free of deliberate control for their evocation, and associated with (though not necessary for) rudimentary emotional and symbolic processing. Learning undoubtedly contributes to the development of these responses, but there are inborn predispositions on which the learned responses are based.[b]

Facial Actions and Affect Displays

The distinctions among the types and neural control of facial movements may hold some general interest to consumer researchers because they have implications for how affect is conceived (for example, Tomkins 1962, 1963) and suggest circumstances in which particular facial configurations can serve as objective and continuous markers for fundamental cognitive and affective processes. Based on the neural substrate of facial actions, for instance, one can postulate several psychophysiological connections.

First, as noted above, rudimentary expressions of emotion (for example, happiness, disgust) have been documented in anencephalic neonates, hydrocephalic neonates, full-term neonates, congenitally blind adolescents, mentally retarded adolescents, and normal adolescents. Ekman and Friesen (1975) have outlined the movements of facial landmarks that characterize surprise, fear, disgust, anger, happiness, and sadness, and blends of these emotional reactions (for example, happy surprise). In disgust, for instance, the brows

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[b] It is interesting to note that corresponding distinctions have been made in theories of emotion. Both Zillmann (1978) and Leventhal (1984), for instance, discriminate between innate affective reactions, conditioned emotional responses, and emotional states that are based on more differentiated associative processes (for example, inferences).

are drawn down, lowering the upper eyelid, the lower eyelid is raised but not tensed, the nose is wrinkled, the cheeks are raised, and the upper lip is raised. In a smile associated with happiness, the cheeks and lower eyelid are again raised and relaxed, but the corners of the mouth are drawn back and up, a wrinkle runs down from the corner of the nose to the edge beyond the mouth, and the brows are not drawn downward (Ekman and Friesen 1975). The drawing of the brows downward and together is achieved by the contraction of the *corrugator* and *depressor supercilii* muscles, whereas the drawing of the corners of the lips back and upward is achieved primarily by the contraction of the *zygomatic major* muscle (see figure 4–1), and the actions of those three muscles are among the most important discriminators of positive and negative emotional expressions (Fridlund and Izard 1983; Schwartz 1975). Indeed, over a century ago Darwin (1872, p. 222) observed that furrowing of the brow was frequently linked with "something difficult or displeasing encountered in a train of thought or action." Elementary affective processes, therefore, can be expected to have associated movements in selected facial muscles even in the absence of clearly noticeable and distinctive expressions of emotion.[c]

Second, crying, cooing, babbling and, subsequently, articulation involve the actions of the perioral musculature. For instance, bilabial consonants (for example, *b, p, m*) are articulated by bringing the lips together, and labiodental consonants (for example, *f, v*) are articulated by bringing the lower lip against the upper teeth (Anisfeld 1984; Lenneberg 1967). The *orbicularis oris* muscle controls the closing and pursing of the lips (see figure 4–1), and McGuigan (1970, 1978), Sokolov (1972) and others have suggested that silent language processing might therefore have associated movements in the perioral region. These movements, therefore, may be informative regarding the extent of verbal processing.

Third, it is noteworthy in light of the preceding review regarding the

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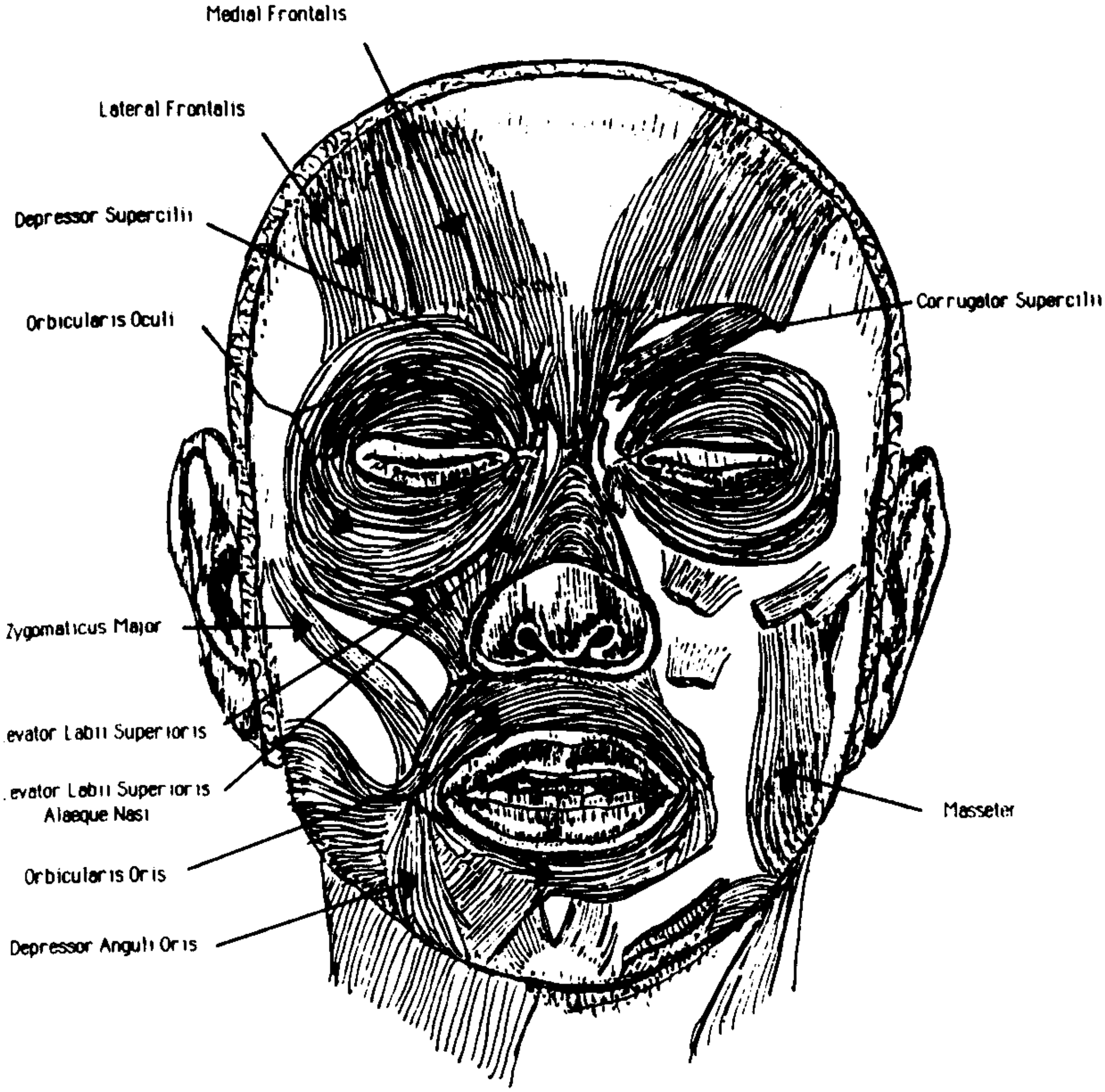
[c] The term *associated movements* is used here in its technical sense to refer to movements that normally occur as part of the total pattern of motor activity but are perhaps not necessary to performance of the basic activity. Our use of this term is not meant to imply that proprioception from somatic events has no emotional or behavioral significance, rather that a consideration of their role is not relevant to the present discussion. For instance, Cartwright-Smith (1979) measured forearm strength as people squeezed a dynamometer while relaxing their facial muscles, contracted their facial muscles (that is, grimaced), relaxed their foot, or contracted their foot. Results revealed that subjects showed the most strength when they grimaced and the least strength when they relaxed their facial muscles. To examine experimental demands in the setting, a second group of subjects were given the experimental instructions and were asked to specify the ordering of the cell means expected by the experimenter. Cartwright-Smith found that these subjects failed to specify the correct ordering of means. Although the theoretical mechanism underlying this phenomenon needs to be explored (for example, classical conditioning, excitation of the hypothalamus) and studies of this type do not bear directly on the principles discussed in this chapter, Cartwright-Smith's observations illustrate that the effects of proprioception from affect displays are an interesting area of inquiry in their own right (see also Petty and Cacioppo 1983; Zajonc and Markus 1982).



Source: Modified and redrawn from figure 351 in Sobotta, J., and H. J. Figge. 1968. *Atlas of Human Anatomy,* Vol. 1, *Atlas of Bones, Joints, and Muscles,* 8th ed. New York: Hafner.

Figure 4–1. Facial Musculature. Superficial Muscles are Depicted on the Left, and Deep Musculature is Exposed on the Right.

hierarchical control of facial actions that part of the *experience* of emotion is the reported feeling that one can lose, or actually loses, self-control (Izard 1977; Scherer and Ekman 1984). If in fact emotional experiences may range from being *reflexive*—characterized by the perception of a loss of control and the rapid recruitment of facial actions—to *reflective*—characterized by a sense of predictability and control—then it is reasonable to expect reflexive emotional facial expressions (for example, disgust in response to the smell of rotten eggs) to be more explosive and stereotyped in appearance and to be more difficult to disrupt than reflective emotions (although expression of the former are still subject to being masked or inhibited).

Finally, although the preceding suggests connections between facial actions and affect, it should be emphasized that these connections are variable. As Ekman and Friesen (1975; Ekman 1982a) have noted, rapid facial actions serve a variety of functions, including the expression of emotion, articulation, eating and drinking, the regulation of oral and nasal respiration, gustation and olfaction, and the protection and lubrication of the eyes. Moreover, the meaning of an action in any single facial region is likely to be ambiguous. Disgust, anger, annoyance, seriousness, intense concentration,[d] and punctuating a word or phrase nonverbally can each lead to a drawing of the brows downward or together with corresponding activation of the corrugator muscle. Thus, temporally and spatially patterned facial actions provide the rich repertoire for the facial messages.

With these connections outlined, we now turn to a discussion of methodological issues in research on affect and the facial response system.

Methodological Issues

Judgmental Procedures

Psychological research on rapid facial actions has been pursued using various methods (see review by Ekman 1982b). The simplest technique is to have subjects make *selective judgments* regarding the nature and strength of the psychological state underlying a given facial display (for example, Sackeim

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[d] Darwin (1872) posited that activity over the corrugator region was an indicant of generalized disturbance, cognitive or affective, in addition to negative affect. He noted, for example, that the brows could be observed to be drawn inward and downward during tasks requiring concentration, and he argued that this could not be taken as an indicant of negative affect because people sought and enjoyed tasks requiring intense concentration. Alternatively, these data can be interpreted as follows: (1) difficult tasks require that individuals identify and focus their attention on task-relevant information to the exclusion of tangential, more readily accessible information; (2) failure to exclude the irrelevant information constitutes a failure to perform the task in the manner to which the individuals aspire, and this evokes an unpleasant affective state; (3) the unpleasant affective state is displayed in increased activity over the corrugator region *and* provides a motivational booster to process the available information discriminantly (that is, to concentrate). In other words, the greater the concentration, the more evident the activity over the corrugator region, but it may be the negative affect evoked by the individual's endangered aspirations regarding task performance that pushes concentration and enhances activity over the corrugator region. Formulations such as opponent process (Solomon 1980) and cognitive dissonance (Festinger 1957) make it conceivable that intense concentration can be both predicated on an unpleasant affective reaction and yet ultimately become a rewarding activity.

and Gur 1978). This technique provides an indirect, subjective measure of facial actions and has demonstrated value. Ekman (1972), for instance, showed that people from various backgrounds and cultures could reliably identify the facial displays associated with the emotions of happiness, sadness, fear, anger, disgust, and surprise.

A second procedure involves measuring the *signal vehicles* (that is, specific changes in facial appearance) that convey the message. Ekman and Friesen's Facial Action Coding System (FACS) (1978) for scoring all "action units" that people are capable of seeing in the human face (for example, AU 4 = brows lowered and drawn together) is the most comprehensive measurement tool falling under this approach:

> Our interest in comprehensiveness was motivated not only by the diverse applications we had in mind, but by an awareness of the growing need for a common nomenclature for this field of research. . . . A constraint in the development of FAC was that it deals with what is clearly *visible* in the face, ignoring invisible changes (e.g., certain changes in muscle tonus), and discarding visible changes too subtle for reliable distinction. In part, this constraint on measuring the visible was willingly adopted, based on our interest in what could have social consequences (Ekman and Friesen 1976, p. 59).

The differences between these procedures do not reside only in what raters are asked to do. As Ekman (1982b) notes: (1) null findings with subjective judgment and positive findings with a sign vehicle measurement system such as FACs suggest that the raters were insensitive to actual differences in facial responses; (2) positive findings with subjective judgment and null findings with sign vehicle measurement suggest the latter is somehow faulty—perhaps due to being incomplete, unreliable, or insensitive; and (3) null findings with both measurement procedures may occur because the facial stimulus was ambiguous or unrepresentative, the actions too fleeting or subtle to be detected using either method, or "the face simply does not provide information about the topic being studied" (Ekman 1982b, p. 48).

Early research on facial expressions relied on drawings and still photographs of faces, and null or unreliable findings were common (for example, see review by Ekman 1973). Static representations such as photographs, however, provide a limited and potentially misleading portrayal of facial actions. It can be difficult to determine, for instance, whether a forehead wrinkle represents a static landmark (that is, a slow signal) or a contraction by the frontalis muscles (that is, a rapid signal). The use of videotapes and comprehensive assessments such as Ekman and Friesen's FAC system (1978), which emphasizes the timing and intensity as well as the location of facial actions, has unmasked previously controversial or poorly documented conversational and emotional facial messages. Ekman and Friesen (1975, 1978) have identified the facial actions that distinguish the expressions of happiness, sadness, fear, anger, disgust, and surprise, and Ekman and Friesen (1975) suggested that "blends" of these distinctive facial actions (for example, facial actions characteristic of surprise accompanied by the drawing of the corners of the mouth back and upward) correspond to blends of emotional appearances (for example, happily surprised).

Moreover, assessment of observable facial actions following the induction of these diverse emotional states has revealed that the facial expressions accompanying pleasant and unpleasant emotional reactions could be distinguished, as to some extent could the intensity of these positive or negative reactions (Ekman, Friesen, and Ancoli 1980; see Fridlund, Ekman, and Oster in press). Finally, they found that a large portion of variance in people's observable facial actions could be attributed to what they termed *display rules*—that is, socially learned prescriptions for regulating expressions of emotion (Ekman 1972; Friesen 1972).

Electromyographic Procedures

It should be emphasized, however, that:

> Facial expressions are principally the result of stereotyped movements of facial skin and fascia (connective tissue) due to contraction of the facial muscles in certain combinations. Such contractions create folds, lines, and wrinkles in the skin and cause movement of facial landmarks such as mouth corners and eyebrows (Rinn 1984, p. 52).

It is these folds, lines, and wrinkles in the skin and the movements of facial landmarks, not the neuromuscular impulses underlying these facial actions, that are measured when photographs and videotapes are analyzed. Measurement of the underlying neuromuscular impulses, therefore, may provide information not available using other procedures.

Each muscle consists of millions of individual muscle fibers housed in connective tissue and is innervated by a specific motor nerve. The motor nerve, in turn, consists of millions of nerve fibers that arise from discrete populations of motor neurons in the spinal cord and brainstem. (The area where a neural fiber actually terminates on a muscle fiber is called the motor end plate.) These motoneurons have differential critical firing thresholds, such that progressively larger motoneurons are added to, or progressively smaller units are subtracted from, the total output of a motoneuron pool as the neural input to the neurons is increased or decreased, respectively (Henneman 1980).

When a particular motoneuron is depolarized, a neural impulse travels to the end-plate region, and the chemical transmitter acetylcholine is released. The acetylcholine initiates a self-propagating electrical impulse, or muscle action potential (MAP), that traverses the muscle fiber and activates the physiochemical mechanism, which causes the fiber to contract. The acetylcholine is quickly eradicated by the enzyme acetylecholineserase, and MAP activity and muscle fiber contraction cease without additional neural activity.

Whenever a MAP passes along a muscle fiber, an electrical potential is created that can be measured at the skin. The greater the MAP activity, the greater the total voltage measurable at the skin. Needle electrodes inserted into the muscle or surface electrodes placed on the skin over muscle regions allow detection, amplification, and recording of these voltages; the resultant is called the electromyogram (EMG). (Interested readers should consult Fridlund and Izard 1983, for further discussion of these points.)

Small surface electrodes held into place by adhesive collars rather than needle electrodes are used in most psychophysiological research (for example, see Goldstein 1972; McGuigan 1979). EMG signals obtained from surface, in contrast to needle, electrodes do not allow precise determination of the source of the MAP activity since they reflect the MAPs from a cluster of heterogeneous motor units, perhaps from several proximal muscles, rather than the MAPs from a single unit or muscle. Although the details of the individual MAPs are lost in the surface EMG recordings, the discrete microvolt discharges from individual MAPs summate spatially and temporally during motor unit recruitment to yield an aggregate that, with proper placement and amplification, can indicate the action (or inaction) of motoneuron pools in facial muscle (for example, perioral) regions. Frequency analyses of the raw EMG signals obtained from surface recordings have thus far proven no more sensitive to psychological factors than the relatively inexpensive process of recording and analyzing the integrated EMG response (McGuigan et al. 1982; Sokolov 1972), although it has been useful in more traditional physiological investigations (for example, van Boxtel et al. 1983). Hence, the integrated EMG is the most common contemporary psychophysiological measure of the skeletal muscular system. The physiological observations of the lawful behavior of motoneuron pools supports the assumption that changes in the amplitude and form of the integrated EMG provides a reliable and valid index of changes in MAP activity (Lippold 1967; Cacioppo, Marshall-Goodell, and Dorfman 1983; Gans and Gorniak 1980).

The surface electrodes in EMG recording are placed in pairs over specific superficial muscle regions, as is shown in figure 4–1. Each person's facial size and musculature is slightly different, but the exact placement of electrodes can be determined unobtrusively while interacting with that individual. For instance, asking students how they feel about their sports teams almost invariably evokes a smile, which then can be used to identify fairly precisely where the *zygomatic major* muscle strip or smile muscle lies. Recordings from a variety of muscle regions can be obtained using this procedure.

The more fibers within a muscle that contract simultaneously, the greater the likelihood that overt muscle contractions will be exhibited. EMG recordings, however, can reveal MAP activity too small to evoke noticeable movements and/or whose corresponding muscle contraction is counteracted by contraction of an antagonist. In an interesting illustration of this principle, Ekman, Schwartz, and Friesen (reported in Ekman 1982b) simultaneously secured videorecordings and surface EMG recordings of individuals as they deliberately intensified the contraction of specific facial muscles *(corrugator supercilii* and *medial frontalis)*. Results revealed that (1) FACS and EMG recordings were highly correlated (*r* = +.85), but (2) reliable EMG signals emerged at levels of muscle activity substantially lower than could be reliably detected visually.

Ekman (1982b) also reported evidence suggesting that patterns of facial actions too subtle or fleeting to be reliably detected using visual scoring procedures may nevertheless leave an impression on observers carefully scrutinizing the person's facial expression:

> This study also showed that there are visible clues to muscle tension, measureable by EMG, when there is no movement. The person measuring the faces with FACS guessed which muscle had been tensed when they could not see any movement. . . . Analyses showed that when these guesses were correct—when the scorer predicted which muscle the performer was tensing, even though no movement was visible—there was a greater increase in EMG than when the guesses were incorrect (Ekman 1982b, p. 82).

Distinctive facial actions and expressions are not limited to interpersonal interactions, but can also reflect intrapersonal processes. People engage in covert oral behavior (for example, subvocalization, lip pressing) when silently reading (see reviews by McGuigan 1970, 1978; Sokolov 1972). Moreover:

> Whereas sounds and the body movements that illustrate speech are intermittent, the face even in repose may provide information about some emotion or mood state. Many nonverbal behaviors simply do not occur when a person is alone, or at least do so very rarely. For example, it would be unusual for someone to shrug or gesture hello when totally alone. Yet facial expressions of emotion may be quite intense even when a person is alone. They are not occasioned only by the presence of others. In fact, social situations can dampen facial expression of emotion (Ekman 1982b, p. 45).

To summarize thus far, facial EMG recordings seem to be capable of uncovering MAP activity in the human face even in the absence of visually quantifiable facial actions. More importantly, both cognitive (for example, semantic–messages vs visual–image information processing) and affective (for example, positive–negative) processes presumed to be fundamental to consumer behavior may be associated with discriminable (though not necessarily invariant) patterns of MAPs in the human face (Cacioppo and Petty 1981a). It may be possible, therefore, to study the role of cognitive and affective processes using a common methodology that does not require the individual to verbalize. In the remaining sections of this chapter, we review our research in this area. We conclude by noting the implications of our observations for conceptions of cognitions, affect, and attitudes.

Effects of Affect-laden Information Processing on Perioral EMG Activity

Most of the early psychophysiological research on facial EMG concerned the relationship between the activation of the muscles of articulation (perioral EMG) and information processing. Only recently has research focused on facial EMG and affect. Therefore, we begin by reviewing the earlier work on perioral EMG and information processing to examine the effects on facial EMG activity of information processing and to examine what effects mild variations of emotion have on perioral EMG activity. The empirical evidence to date is consistent with the notion that perioral EMG activity is related to information processing (see reviews by Garrity 1977; McGuigan 1970, 1978; Sokolov 1972) but the data are less clear regarding the validity and specificity of this relationship. Previous research has shown that silently processing linguistic materials (for example, reading) leads to greater EMG activity over the perioral region than silently processing nonlinguistic material (for example, music) and both tasks usually result in elevated perioral EMG activity relative to baseline measures (for example, Edfeldt 1960; McGuigan and Bailey 1969). The activation of the perioral muscles is also specific: (1) concomitant increases in EMG activity are not typically found indiscriminately or generally in nonoral muscle groups or in electrodermal responding when silently processing language material (for example, McGuigan and Tanner 1971; Sokolov 1972); and (2) the relative activation of muscles within the perioral (for example, tongue vs. lip) region has been shown to vary as a function of the phonetic characteristics (for example, *ta* vs. *ba*) of the material being processed (McGuigan and Winstead 1974). Finally, poor readers have been found to display greater perioral EMG activity when reading than good readers, though both display increased perioral EMG activity when silently reading difficult rather than simple text (for example, Edfeldt 1960; Faaborg-Anderson and Edfeldt 1958). Note, however, that the type of stimulus presented and/or the type of subject employed has been varied along with the extent of covert linguistic processing presumably manipulated. For instance, although poor readers show greater perioral EMG activity while reading than good readers, it is unclear whether this effect is caused by differences in the cognitive work involved in comprehending or in encoding the material, the manner in which the material is being processed, attentional differences in the readers, differences in self-monitoring between the readers, and/or differences in apprehension.

The instructional manipulations commonly used in cognitive psychology to study encoding operations provide an alternative procedure to study the associated movements of information processing.The paradigm involves presenting target words (for example, trait adjectives) to subjects while randomly varying the question pertaining to each trait word (Craik and Tulving 1975). In this paradigm, somatic responses attributable to features of subjects and stimuli are assigned to the error term and what generally remains is variance due to the instructional factor (the *cue question*), which serves operationally to pinpoint the predominant type of informational analysis operating during the target word presentation (compare Baddeley 1978; Cermak and Craik 1979).

Results of research in this paradigm have generally shown that the more semantic (that is, meaning-oriented) the cued analysis, the more likely subjects are to remember the stimulus word (see review by Craik 1979), although these effects are especially evident when semantic processes are cued both at the time of encoding and at the time of retrieval (Morris, Bransford, and Franks 1977; Tulving 1978). These data have been interpreted as indicating the existence of qualitatively different processes by which incoming information is related to one or more existing domains of knowledge (Cermak and Craik 1979; Craik 1979). The purpose of our initial study, therefore, was to determine whether perioral *(orbicularis oris)* EMG activity was higher when subjects performed tasks requiring that they think about the meaning and self-descriptiveness of a word rather than about the structural appearance of the word (Cacioppo and Petty 1979c). Furthermore, EMG activity over a nonoral muscle region (*superficial forearm flexors* of the nonpreferred arm) was recorded to determine whether task-evoked changes in EMG activity were general or specific.

Subjects were shown cue questions asking whether or not the succeeding trait adjective was printed in upper-case letters or whether or not the word was self-descriptive. Half the trait adjectives were printed in upper-case letters and half were printed in lower case; and half the trait adjectives were highly self-descriptive, whereas half were not at all self-descriptive. Subjects responded "yes" or "no" by pressing one of two buttons on a key pad. Cacioppo and Petty (1979b) found that (1) the self-referent task led to better recall than the structural task, replicating previous studies in social psychology (for example, Rogers, Kuiper, and Kirker 1977); (2) the self-referent task led to greater increases in perioral EMG activity than the structural task; and (3) EMG activity over a nonoral muscle group did not vary as a function of the orienting task. This latter effect renders it unlikely that subjects were generally more aroused or tense when performing the self-referent than structural task.

This orienting-task paradigm has also been used to investigate possible differences in the organization of domains of product and social knowledge. Studies have shown that product information and trait words are better recalled when rated for their descriptiveness of oneself or one's best friend than of people about whom one has little or no direct knowledge (for example, Bower and Gilligan 1979; Keenan and Baillet 1980). These data have been interpreted as indicating structural differences in domains of social and consumer knowledge in memory. As Ferguson, Rule, and Carlson (1983) note, the domains of knowledge (for example, one's self) accessed by tasks (for example, self-referent task) that produce relatively better recall of the incoming stimuli are thought to be characterized by greater elaboration (that is, more associates), integration (that is, stronger interassociative bonding), and/or differentiation (that is, more chunking of associates into distinct but related subsets). Ferguson, Rule, and Carlson (1983) further reported data from this paradigm using a between-subjects design showing that self-referent and evaluative orienting tasks yielded similar response latencies and levels of recall. They argued that (1) evaluation constitutes a central dimension along which incoming information is categorized and stored; and (2) both evaluative and self-referent tasks facilitated the use of the evaluative dimension and minimized the use of other irrelevant dimensions in processing incoming information. They concluded that, given the centrality of the evaluative dimension in the organization of memory, "no unique memorial status need be attributed to the self or familiar others." (Ferguson, Rule, and Carlson 1983, p. 260)

We have completed two studies on perioral EMG activity and information processing that bear both on the effects of information processing on perioral EMG activity and on Ferguson, Rule, and Carlson's analysis. In one study, subjects were exposed to sixty positive, neutral, and negative trait adjectives (Cacioppo and Petty 1981b). Each trait adjective was preceded by one of five cue questions that defined the processing task: (1) Does the following word rhyme with———(rhyme); (2) Is the following word spoken louder than this question? (volume discrimination); (3) Is the following word similar in meaning to———? (association), (4) Is the following word good (bad)? (evaluation); and (5) Is the following word self-descriptive? (self-reference). Finally, as in all of our facial EMG research, subjects in this study knew bioelectrical activity was being recorded, but they were not told that activity over which they had voluntary control was being monitored.

Results revealed that mean recognition confidence ratings were ordered as follows: self-reference, evaluation, association, rhyme, and volume discrimination. Importantly, all means except the last two differed significantly from one another. In addition, (1) the mean amplitude of perioral *(orbicularis oris)* EMG activity was lowest for the nonsemantic tasks of rhyme and volume discrimination, intermediate for the task of association, and equally high for the tasks of evaluation and self-reference; (2) cardiac activity and the mean amplitude of EMG activity over a nonoral muscle region (that is, nonpreferred *superficial forearm flexors* region) did not vary as a function of the type of task performed; and (3) the association between task and perioral EMG activity was temporally specific, with task-discriminating EMG activity observed only while subjects analyzed the aurally presented trait adjectives and formulated their response.

In a follow-up study, we found that evaluative and self-referent tasks have different effects on perioral EMG activity, but that the effect is on the *form* rather than mean amplitude of the task-evoked response (Cacioppo, Petty, and Morris 1985). Subjects performed structural, grammatical, evaluative, and self-referent orienting tasks. EMG activity and response latency were assessed during each trial, either task difficulty (replication 1) or reported cognitive effort (replication 2) was assessed following each trial, and recall was assessed at the conclusion of the study. Analyses of the cognitive measures revealed that recall was poorest when trait words were judged in terms of their structural appearance, moderately poor and moderately good when words were judged in terms of their grammatical and evaluative features, respectively, and best when words were judged in terms of their self-descriptiveness—all this despite the finding that subjects took longest to perform the grammatical task and rated this task the most difficult and most cognitively effortful to perform.

More interestingly here, analyses revealed that the form rather than the mean amplitude of perioral EMG activity differentiated these simple cognitive tasks, with significant differences emerging during semantic and nonsemantic processing and between evaluative and self-referent processing. Perioral EMG activity, for instance, was characterized by more frequent bursts of EMG activity during the self-referent than evaluative tasks. Further analyses revealed that perioral EMG activity covaried more closely with indices of cognitive deliberation (for example, rated cognitive effort) than long-term memory processes (that is, recall). Although EMG activity over the forearm rose more sharply, later in the processing epoch, when subjects performed simple structural instead of semantic tasks, the form of EMG activity over the preferred forearm was similar for evaluative and self-referent processing. Moreover, little evidence was found to support the hypothesis that simply accessing or evaluating the meaning of positive or negative trait words was sufficient to evoke traces of emotional facial displays.

These results, obtained using a within-subjects rather than between-subjects design (compare McCaul and Maki 1984), support Osgood, Suci, and Tannenbaum's notion (1957) that a central dimension along which incoming information is effectively categorized, stored, and retrieved is the evaluative dimension. Contrary to Ferguson, Rule, and Carlson's suggestion (1983), however, these results also suggest that self-referent and evaluative processing are distinguishable quantitatively if not qualitatively. Finally, these data support the notion that long-term memory for incoming information is affected both by short-term memory processes and by the accessibility and structure of existing knowledge domains, but that short-term working memory processes have the more direct effect on perioral EMG activity. To illustrate, consider an individual who has difficulty retrieving information from long-term memory either because there is so little in a particular memorial domain or because there is so much in that domain. The results of our research on perioral EMG activity suggests that in both instances the individual should show an elevation of perioral EMG activity over levels observed during relaxation since it is the short-term cognitive work, not the amount of information in long-term memory, that has the immediate effect on perioral EMG activity.

Effects of Affective Experience on Facial EMG

Although the muscles of the lower face are clearly involved in overt expressions of emotions (Ekman 1982a; Ekman and Friesen 1975, 1978), perioral EMG activity does not appear to be related to the affective tone of an individual's information processing, given the low levels of affect and the visual and auditory stimuli with which we are dealing in these studies. For instance, some of the trait words employed in the Cacioppo and Petty (1981b) study were positive, others were neutral, and still others were negative in meaning. Although we have observed differential hemispheric EEG activity to these stimuli (Cacioppo and Petty 1980), we found no differences in perioral EMG activity as a function of word valence.

In a corroborating experiment, subjects were forewarned of an impending recommendation that differed slightly, moderately, or considerably from their own attitude on an issue (Cacioppo and Petty 1979a). Following each forewarning, subjects were instructed to collect their thoughts on the issue for the next minute, and, at the end of the minute, they were asked to list everything about which they had thought. Analyses of subjects' retrospective verbal reports revealed that the profile of listed thoughts, rather than the total number of thoughts listed, changed as communication discrepancy increased: agreement and the frequency of counterarguments increased whereas the frequency of proarguments decreased. More interestingly here were the findings that (1) localized increases in perioral EMG activity were observed during the collect-thoughts interval; but (2) communication discrepancy had *no* effect on perioral EMG activity. Although the level of perioral EMG activity was related to the total number of listed thoughts, there simply was no evidence that perioral EMG activity changed as the affective tone of issue-relevant thinking changed.

Whereas the extent of cognitive deliberation rather than people's affective reactions has been apparent in perioral EMG activity, EMG activity over muscles that control the movement of facial landmarks in the lower, middle, and upper face *has* been found to vary as a function of the affective tone of attitudinal processing. In the initial studies on facial EMG and emotional imagery, Schwartz and his colleagues (Schwartz et al. 1976a, 1976b) demonstrated that (1) when subjects followed instructions to imagine a *happy* situation, the level of EMG activity increased over the cheek *(zygomatic major)* and lower lateral chin *(depressor anguli oris)* regions and tended to decrease over the brow *(corrugator)* region; (2) when subjects followed instructions to imagine a *sad* situation, EMG activity increased primarily over the brow region; (3) this patterning of facial muscle activity reliably distinguished positive and negative emotional imagery in normals and clinically depressed patients; and (4) the depressed patients showed an attenuated pattern of facial EMG activity during happy imagery and an exaggerated pattern of facial EMG activity to sad imagery. Fridlund and Izard (1983), however, have argued that demand characteristics may have contributed to, or accounted for, the results of facial EMG studies of affective imagery. The crux of their criticism was that the placement of multiple electrodes on a subject's face sensitizes the subject to the importance of his or her face as a response system. They further reasoned that the imagery instructions may artifactually induce subjects to use their face to express the psychological state believed to be the focus of study.

This led us to conduct a study with three specific aims (Cacioppo, Petty, and Marshall-Goodell 1984). First, we sought to conceptually replicate our research showing that perioral EMG activity was greater while people thought about an attitude issue than when they were engaged in a nonlanguage task and that the perioral EMG activity was unrelated to the valence of the attitude processing.

Second, Ekman and Friesen (1975, 1978) have emphasized that emotional expressions are evident in the upper (for example, brows), middle (for example, eyes, nose), and lower (for example, mouth) regions of the face. The unequivocal expression of anger, for instance, requires rapid signals emanating from all three regions (Ekman and Friesen 1975). Another aim of our study, therefore, was to determine whether EMG activity over muscles that control the movement of facial landmarks in the lower (for example, *zygomatic major,* which pulls the corners of the mouth upward and back when forming a smile), middle (for example, *levator labii superioris* and *levator labii superioris alaequa nasi,* which raises the lip and dilates the nostril in the primitive expression of disgust), and upper (for example, *corrugator* and *depressor supercilii,* which draw the brows down and/or together in negative emotions such as anger and sadness) regions of the face varied as a function of the affective tone of attitudinal processing.

Our third aim was to examine whether demand characteristics were necessary for the facial patterning during emotional imagery observed by Schwartz and his colleagues. Subjects were led to believe they were participating in a study on involuntary neural responses during action and imagery. Subjects on any given trial either lifted (action) or imagined lifting (imagery) a *light* or *heavy* weight or either silently read (action) a neutral communication as if they agreed or disagreed with its thesis or imagined reading (imagery) an editorial with which they agreed or disagreed. Based on previous research (for example, see reviews by Ekman and Friesen 1975; Fridlund and Izard 1983) and our own pilot research on overt facial actions during physical exertion, EMG activity was recorded over the brow *(corrugator supercilii),* cheek *(zygomatic major),* nose *(levator labii superioris),* jaw (*masseter,* whose action raises and protracts the mandible), periocular *(orbicularis oris),* and forearm *(superficial forearm flexors)* muscle regions. It was expected that (1) EMG activity over the perioral *(orbicularis oris)* region would be greater for the attitudinal than physical tasks; (2) perioral EMG activity would not vary as a function of the valence of the attitudinal tasks, but instead EMG activity over the regions of the brow, cheek, and nose would differentiate the positive and negative attitudinal tasks; and, of course, (3) EMG activity over the forearm flexors would be greater during the physical than attitudinal tasks and would differentiate the physical tasks.

In addition, we found in preliminary research that expressions of physical exertion (such as when a person lifts a heavy weight) were characterized by a tensing of a variety of facial muscles including the brow, periocular, and jaw. If the simple placement of multiple electrodes on a subject's face cued the subject to the importance of his or her facial actions in this paradigm, then not only might EMG responses over the regions of the brow, cheek, and nose differ as subjects adopted an agreeable vs. disagreeable attitudinal set, but EMG responses over at least selected facial muscles (for example, brow, jaw, periocular) might vary when subjects were instructed to lift or imagine lifting what was described to them as being a heavy in contrast to a light weight. In fact, subjects worked with 16 gram and 35 gram weights in the physical tasks, both of which are fairly light, and subjects were exposed to identical neutral text in the attitudinal tasks when they were asked to silently read the text in an agreeable vs. disagreeable manner. Hence, nothing about the stimuli per se should have evoked facial actions of any kind. Finally, at the end of each session, subjects were interviewed and were asked specifically what they believed to be the experimental hypothesis. Since subjects might reason that they should not disclose how much they knew, we emphasized that it was important that they respond honestly and accurately.

Results provided support for the hypotheses. Perioral EMG activity was higher during the attitudinal than physical tasks, but perioral EMG activity was again essentially unchanged by the affective tone of attitudinal processing. Yet, whether subjects thought about the topic in an agreeable versus disagreeable manner affected EMG activity over the facial regions of the brow, cheek, and nose. These results replicate and extend the research on emotional imagery conducted by Schwartz and his colleagues (compare Brown and Schwartz 1980).

Moreover, a strikingly different pattern of somatic activity was evoked by the physical tasks. As expected, EMG activity over the forearm flexors was higher during the physical than attitudinal tasks, and the EMG activity over the forearm varied across the physical tasks. Facial EMG activity, in contrast, was unaffected by the type of physical task performed. There was simply no hint that subjects were modifying their facial displays when lifting, or imagining lifting, what were described to subjects as heavy and light weights. Furthermore, the postexperimental interviews failed to reveal any evidence for the operation of experimental demands. All subjects appeared convinced of the cover story (that is, the sensors were used to detect involuntary physiological reactions), and no subject articulated anything resembling the experimental hypothesis. Indeed, the postexperimental interviews of subjects indicated that they tended implicitly to organize the experimental trials in terms of whether they imagined or performed some task (for example, lifting a weight or silently reading a text) rather than in terms of whether the task was physical or attitudinal. Finally, what we found to be the most compelling evidence against the operation of experimental demands was that rarely were visible facial actions observed during the tasks and data from those few trials on which actions could be seen were deleted prior to analysis. It seems implausible that subjects chose to support the hypothesis by making only covert facial responses.

In sum, these data support the view that experimental demands are not necessary for the somatic patterning observed during affective processing and imagery, that perioral EMG activity is greater during silent language processing (for example, reading) than during nonlanguage processing (for example, lifting a weight), and that EMG activity over selected facial muscle regions including the brow *(corrugator supercilii)* and the cheek *(zygomatic major)* differentiates positive from negative affects.

There is also evidence for the utility of facial EMG recordings as a continuous and objective probe of the low-level cognitive and affective responses evoked when subjects anticipate and are exposed to a persuasive communication (Cacioppo and Petty 1979a). Students in our study were recruited for what they believed was an experiment on *biosensory processes.* As in the previous research, subjects were told that we were studying the involuntary neural responses evoked by communicative stimuli and were monitored unobtrusively to avoid invoking display rules. After subjects adapted to the laboratory, we obtained recordings of basal EMG activity, forewarned subjects that in 60 seconds they would be hearing an editorial with which they agreed, an editorial with which they disagreed, or an unspecified message, obtained another 60 seconds of physiological recording while subjects sat quietly, and obtained yet another 120 seconds of data while subjects listened to a proattitudinal appeal, counterattitudinal appeal, or what turned out to be a pleasant news story about an archeological expedition.

Consistent with the observations of facial activity during emotion and emotional imagery, results indicated that EMG activity over the cheek *(zygomatic major)* region was higher and the activity over the brow *(corrugator supercilii)* region was slightly lower when subjects anticipated and listened to a proattitudinal instead of a counterattitudinal appeal. Although this patterning was evident during the postwarning–premessage period, it was magnified when subjects were actually confronted by the proattitudinal or counterattitudinal message. We also found perioral increased EMG activity over the basal level when subjects anticipated a counterattitudinal message, and it increased to an equally high level across conditions when an actual message was presented regardless of the valence of the appeal. Together, these data suggest that the presentation of a communication about which subjects think increases perioral EMG activity. The affective attributes of the persuasive appeal was again unrelated to the level of perioral EMG activity; instead, it was reflected in the pattern of facial EMG activity over the brow and cheek regions. Finally, the selective activation of perioral EMG activity during the postwarning–premessage period provided convergent evidence for the view that people engage in anticipatory cognitive activity to buttress their beliefs when they anticipate hearing a personally involving, counterattitudinal appeal (compare Hass and Grady 1975; Petty and Cacioppo 1977).

Although these results are encouraging, Ekman (1982b) has expressed a concern that electromyographic studies of visually imperceptible facial actions may not prove useful in distinguishing among specific emotional states. Brown and Schwartz (1980), for instance, used standardized affective imagery instructions and observed that happy emotional imagery increased the mean amplitude of EMG activity over the cheek *(zygomatic major)* muscle region, whereas sad, anger, and fear imagery all increased the EMG activity over the brow *(corrugator supercilii)* region. Changes in EMG activity over the jaw *(masseter)* and forehead (*lateral frontalis,* whose action raises the outer eyebrows and wrinkles the forehead) muscle regions failed to distinguish these imagery conditions even though these muscles can be involved when forming overt facial expressions of emotions (compare Fridlund, Schwartz, and Fowler 1984).

Although further research is necessary, it is useful to think about the expression of affect in terms of a hierarchy of neuromuscular action. Rudimentary or low-level affective reactions to auditory and visual stimuli may tend to be discriminated in only a few facial muscle actions (for example, *corrugator supercilii, zygomatic major*) that reflect the general valence of the stimuli, whereas more intense emotional reactions may be differentiated within these muscle regions and/or across a greater number of facial muscles (compare Cacioppo, Petty, and Marshall-Goodell 1984). Moreover, both research on the communication of emotion through facial expressions (Osgood 1966) and studies of the conceptual organization of emotion suggest distinguishing between positive and negative affects and between mild and intense affects captures much of people's emotional experience. Russell (1983), for instance, conducted a multidimensional scaling study of the similarity judgments of emotionally descriptive words (for example, happy, annoyed, sad, angry). To study the pancultural aspects of people's conceptualization of emotions, subjects from five distinct cultures were tested. Russell found that within each culture the organization of emotions was described adequately by two dimensions: valence (pleasant–unpleasant) and intensity (calm–excited; see also, McHugo, Smith, and Lanzetta 1982). Similarly, Osgood (1966) investigated what dimensions of emotional experience could reliably be communicated to others using facial expressions. He found pleasantness, intensity, and control to be the most important dimensions. Hence, the difficulty in discriminating among the negative affects using low-level facial EMG responses would be less of a limitation in the study of affect if facial EMG activity—at least when recorded in controlled laboratory settings—could be used to gauge the intensity as well as the valence of affective processing.

In a study bearing on this issue, subjects were exposed to slides of moderately unpleasant, mildly unpleasant, mildly pleasant, and moderately pleasant scenes (Cacioppo et al. in preparation). Subjects viewed each slide for five seconds and rated how much they liked the depicted scene, how familiar the scene appeared, and how aroused it made them feel. Examination of the videorecordings of subjects' facial expressions during the five-second stimulus presentations indicated that the scenes were sufficiently mild to avoid evoking perceptible facial actions. Nevertheless, both analyses of variance and correlational analyses revealed that EMG activity over the brow *(corrugator supercilii)* muscle region differentiated the direction *and* intensity of people's affective reaction to the scenes: the more subjects liked the scene, the lower the level of EMG activity over the brow region. Also, EMG activity over the cheek *(zygomatic major)* region was also greater for liked than disliked scenes. Importantly, neither EMG activity over the brow region nor over the cheek region covaried with reported arousal, nor did EMG activity over the perioral *(orbicularis oris)* region or a peripheral muscle region *(superficial forearm flexors)* vary as a function of stimulus valence. A second study replicated these results and also demonstrated than an independent set of judges could not accurately guess the emotional nature of the stimulus to which subjects were exposed when they viewed the subjects' overt facial actions. These data are clearly more compatible with the view of response specificity in the facial actions accompanying cognition and affect than with the view that somatic activity varies as a function of affective intensity (compare Cacioppo and Petty 1981a; Winton, Putman, and Krauss 1984).

With these bridges between psychological constructs and psychophysiological data specified, we should emphasize the sometimes circuitous route to these bridges. Specifically, this psychophysiological research does not indicate that distinctive and naturally occurring incipient facial actions can be invariantly linked to low-level cognitive or affective states (Cacioppo and Petty 1985). The EMG patterning observed in our research has been subtle and is easily distorted, requiring optimal experimental conditions to obtain. Facial actions are clearly controllable, and facial expressions serve communicative, deceptive, and emotionally expressive functions with admirable facility. It should be borne in mind, therefore, that special conditions have been established in this research to maximize the likelihood of observing task-related somatic responses and to minimize the likelihood that these responses would be masked or altered by display rules. For instance, subjects are given an introductory lecture on bioelectrical recording principles and a tour of the testing rooms prior to volunteering to participate, and they undergo progressive relaxation and practice tasks prior to being exposed to experimental stimuli. These procedures are employed to minimize their overall level of somatic activity and apprehension about participating in the research so that they are responsive to the experimental tasks per se. Subjects have numerous dummy electrodes attached to them, are given a cover story so that they are unaware that somatic (much less facial EMG) activity is being recorded, are placed alone in a testing room, and are observed unobtrusively. As a result, throughout most of this research subjects appear to be sitting quietly and void of emotion. Although this research illustrates the existence of unique relationships between facial EMG and the nature, intensity, and timing of certain classes of cognitive and affective processes, the ecological validity for these relationships is limited (Cacioppo and Petty 1985).

For example, Lauren Bush recently completed a study in our laboratory that examined the features of EMG activity that differentiate spontaneous facial expressions to mildly pleasant or unpleasant visual stimuli from actions designed to mask affective reactions to these stimuli and expressions that were deliberately constructed by subjects to subtly communicate their feelings about these stimuli. Based on the work by Ekman and his colleagues, it was hypothesized that under certain circumstances the timing of the spontaneously produced and deliberately constructed EMG responses would differ, with the latter developing more slowly and over a longer period of time. Facial EMG activity was recorded as subjects viewed slides of mildly pleasant or mildly unpleasant faces and scenes. Each slide was presented for five seconds, and during the first set of slides subjects were simply instructed to examine each when it was presented and to rate how much they liked it following its presentation. Following this initial series of slides, subjects were told to imagine two individuals were seated in front of them—one a close friend, the other a stranger. Subjects were instructed that, as they examined the photographs projected onto the screen, they should either try not to reveal through their facial displays whether the stimulus was pleasant or unpleasant (posed unexpressive facial displays) or through subtle facial displays, they should try to communicate to the friend, but not the stranger, whether the stimulus was pleasant or unpleasant (subtly posed expressive facial displays). Subjects practiced each task before the experimental trials, and the order of these last two instructions was counterbalanced across replications of the study. Data from the few trials on which emotional facial expressions were noticeable were deleted prior to analysis.

Results revealed that facial EMG activity associated with spontaneous affect versus interpersonal masking and communication of affect *were* distinguishable. EMG activity over the brow *(corrugator supercilii)* region was again greater in response to unpleasant than pleasant visual stimuli; deliberately masked facial displays were characterized by a maintenance of EMG activity at prestimulus levels across the facial muscles; and deliberately posed expressive facial displays were characterized by affect-discriminating EMG responses that developed more intensely and were maintained over a longer period of time than were spontaneous emotional expressions. These data illustrate that the connections between facial EMG activity and affect are not invariant. On the other hand, and although it is not known whether the observed differences between spontaneous and deliberately constructed expressions of emotion generalize to conditions in which subjects are told simply to exaggerate or misrepresent displays of their feelings about a stimulus, this study also demonstrates that spontaneous and deliberately constructed expressions of affect can be distinguished quantitatively if not qualitatively within at least some contexts (compare Hager and Ekman 1985).

Conclusion

Difficulties in extracting information regarding affect from ongoing organismic processes are to be expected given the nonpsychological (for example, homeostatic) functions served by the human organism, the paucity of current knowledge about the neurophysiological mechanisms serving affective processes, and the methodological limitations inherent in studying human subjects using noninvasive somatovisceral recording procedures (compare Coles, Donchin, and Porges 1985). Indeed, although somatovisceral measures have been used with some success to index psychological states such as the use of deception (Lykken 1981; Podlesny and Raskin 1977; Waid and Orne 1981) and the intensity or direction of reported attitudes (Cacioppo and Sandman 1981; Petty and Cacioppo 1983; Tursky and Jamner 1983), physiological measures of enduring and accessible psychological states have often proved to be expensive, cumbersome, and less sensitive than traditional methods such as verbal reports (for example, Rogers 1983; Crider 1983; Shapiro and Schwartz 1970) or simple variations on these assessments, such as the bogus pipeline (Jones and Sigall 1971; see review by Petty and Cacioppo 1983).

It is noteworthy, therefore, that a major advantage of somatovisceral measures and manipulations—augmenting our means for studying the role of affective processes and their relationship to language processing—has remained largely unexplored. As noted above, the somatic nervous system is the ultimate mechanism through which humans interact with and modify their environments, and the muscles of facial expression have the further distinction of being linked to connective tissue and fascia rather than to skeletal structures. This endows the facial response system with an interesting (although not unique) functional property: the effects on the environment of the neural activation of the facial muscles of expression are in part indirect—mediated by the construction of facial configurations that communicate information (for example, ideas, inferences), misinformation (for example, deception), and emotion (for example, threat, approval). It is perhaps less than surprising, therefore, that the understanding of people's preferences and actions can be enriched by analyses of the facial response system.

On the other hand, one cannot expect facial EMG responses alone to provide a definitive basis for unequivocally inferring consumer's reactions in applied settings. As indicated in our introduction, affect is viewed as having motivational, perceptual, cognitive, motor expressive, physiological, and subjective manifestations, and no given episode of emotion is likely to result in changes across all these modes of expression. Moreover, the range of construct validity of the facial EMG measures is limited and is unlikely to extend to a broad range of applications without the introduction of additional experimental controls. For instance, facial reactions to gustatory stimuli—for instance, in a market food test—can potentially unmask a consumer's gut reaction to a product, but consumer researchers would first need to be concerned with the facial actions involved in mastication and with the social context in which the assessment was conducted (for example, to avoid experimenter bias, self-presentation). Hence, additional research on the facial response system in applied settings using naturalistic stimuli is clearly needed before procedures such as the facial EMG can be used confidently to address and resolve specific theoretical questions having practical significance to the manager or decision maker in an applied area.

In sum, the present research suggests that specific dimensions of affect have reliable effects on the location, intensity, and timing of EMG activity recorded over facial muscle regions. Studies using verbal reports or visual observations have further revealed that emotions can be highly transient, occur in combinations (blends), and at times go undetected (for example, Haggard and Issacs 1966; Schwartz et al. 1976a; Kunst-Wilson and Zajonc 1980). Although the analyses of the dynamic aspects of overt expressive behaviors using videotapes (in contrast to drawings or photographs) to augment verbal reports have revealed a wealth of information regarding communication and emotion (Ekman and Friesen 1978; Izard 1971, 1977), there is room for yet other convergent, concomitant measures because not all affective processes are accompanied by visually (Ekman 1982b) or socially perceptible (Love 1972; Rajecki 1984) expressive behaviors. Love (1972), for instance, videotaped people's facial expressions while they were exposed to a proattitudinal or counterattitudinal appeal and reported detecting no differences in overt expressions. As noted above, we replicated this result while also demonstrating that the mean amplitude of the EMG activity recorded over facial muscle regions (for example, corrugator, zygomatic) during the communication differentiated between subjects who were exposed to a proattitudinal appeal from those who were exposed to a counterattitudinal appeal (Cacioppo and Petty 1979a). Thus, the research on overt facial action illustrates the utility of convergent operations that allow measurement of affective processes as they unfold over time (for example, Ekman and Friesen 1974, 1975; Ekman, Friesen, and Ancoli 1980; Izard 1977; Zuckerman, DePaulo, and Rosenthal 1981), whereas the research on facial EMG suggests psychological events (for example, positive–negative affect) too fleeting or subtle to evoke an overt expression may nevertheless be examined objectively.