

2 Stalking Rudimentary Processes of Social Influence: A Psychophysiological Approach

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Social psychologists have been studying attitudes and persuasion ever since the discipline began (Allport, 1935), and over the past 70 years thousands of experiments have been conducted and scores of theories have promulgated. Unfortunately, for almost any variable studied—even a seemingly simple one like source credibility—the accumulated literature invariably shows that the variable can increase persuasion, decrease persuasion, or have no effect (see McGuire, 1985). Also, an embarrassment of riches holds when it comes to the number of theories that exists concerning the underlying *processes* of attitude formation and change (Insko, 1967; Petty & Cacioppo, 1981).

As a result of the many conflicting findings and different theories that had arisen by the late 1960s, interest in attitude change research began to decline. Reviewers of the attitudes literature in the 1970s were generally quite critical of either the attitude construct (e.g., Wicker, 1971) or the “reigning confusion” (Sherif, 1976) characterizing the accumulated literature (see also Fishbein & Ajzen, 1972). One of the major problems was that, as suggested above, persuasion variables seemed to have so many different effects and there were numerous theories that explained subsets of these effects. In a review of the attitudes literature (Petty & Cacioppo, 1981), we have suggested that the many existing theories of persuasion could be thought of as emphasizing one of two relatively distinct *routes* to persuasion. In some instances, persuasion occurred when change was based on a careful and thoughtful consideration of the issue-relevant arguments supporting an issue position. We called this the “central route” to persuasion. In other circumstances, however, persuasion occurred when attitude

change was based on some simple cue in the persuasion context that induced change without necessitating scrutiny of the true merits of the arguments presented. When simple cues induced agreement with little issue-relevant thinking, we called this the "peripheral route" to persuasion. Attitude changes induced via the central route are postulated to be more enduring, resistant to counterpersuasion, and predictive of behavior (see Fig. 2.1).

The central and peripheral routes to persuasion are two key processes in a general theory of persuasion called the Elaboration Likelihood Model (ELM) (Petty & Cacioppo, 1980, 1981, 1985, in press). More specifically, we view the

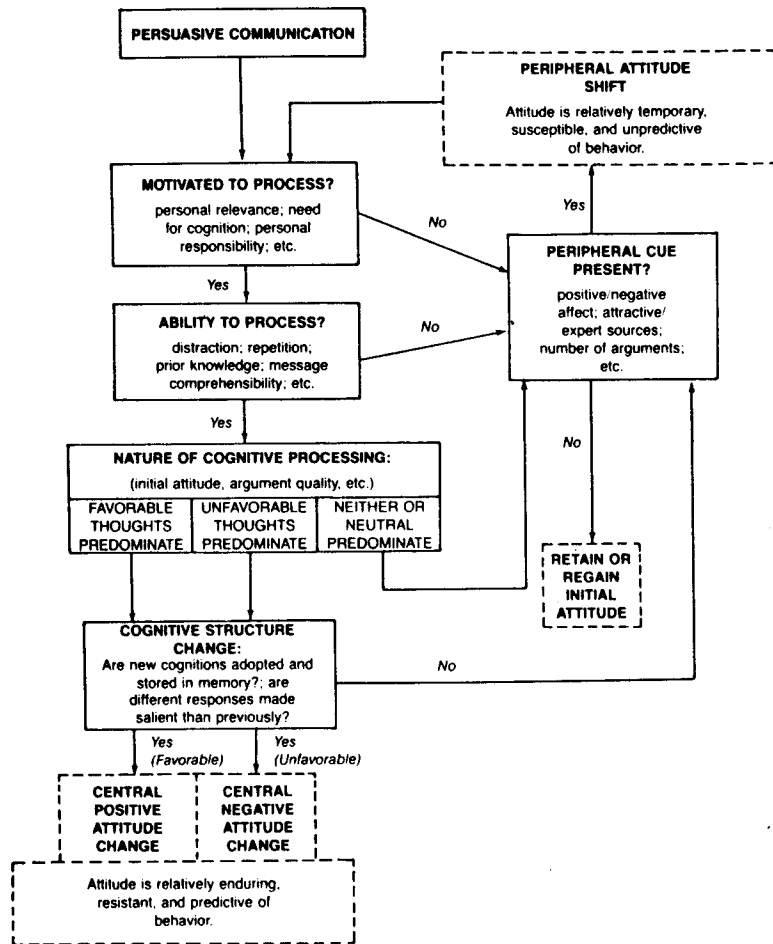


FIG. 2.1. The Elaboration Likelihood Model of persuasion. From Petty and Cacioppo (1985).

two routes to persuasion as anchoring a continuum of elaboration likelihood. By elaboration in a persuasion setting, we mean the extent to which a person carefully scrutinizes the issue-relevant information in a message by relating it to information stored previously in memory. In some persuasion situations, the likelihood of message elaboration and issue-relevant thinking is high. In these situations people are: (a) highly *motivated* to devote the cognitive work necessary to evaluate the message, perhaps because the message has direct personal relevance, personal responsibility is high, or they are the kind of people who typically enjoy thinking (Cacioppo, Petty, & Morris, 1983; Petty & Cacioppo, 1979; Petty, Cacioppo, & Harkins, 1983); and (b) highly *able* to evaluate the message, perhaps because the message is repeated several times, distractions are few, or they have considerable issue-relevant knowledge (Cacioppo & Petty, 1979c, 1980b; Petty, Wells, & Brock, 1976). In other situations, however, motivation and/or ability to process issue-relevant information is quite low. In these situations simple cues may induce agreement without argument scrutiny.

This continuum, which goes from persuasion situations in which the likelihood of message elaboration is very low to persuasion situations in which the likelihood of message elaboration is very high, is important because of the different consequences of elaboration (see Fig. 2.1), and because it appears that variables operate differently depending upon where along the continuum the variable is tested. For example, Fig. 2.2 depicts the effects that we have obtained for the variable "source credibility" when it is examined along the elaboration likelihood continuum. When people are generally unmotivated or unable to think about an issue, such as when personal relevance is very low, credibility serves as a simple acceptance or rejection cue affecting agreement with little or no argument processing (top panel). When elaboration likelihood is very high, such as when a message has certain relevance, credibility is unimportant as a simple cue. Instead, attitude change is determined mostly by the cogency of the issue-relevant arguments presented (bottom panel). When the elaboration likelihood is more moderate, such as when people are uncertain as to the personal relevance of a message, source credibility affects the extent of information processing (middle panel). That is, when elaboration likelihood is intermediate, source factors can help a person decide if a message merits or needs scrutiny (see recent review by Petty & Cacioppo, in press). The ELM, then, provides a framework for organizing the conflicting pattern of data characterizing variables such as source credibility.

Importantly, it is also possible to place theories of attitude change along the elaboration continuum. At the low end of the continuum are theories that require very little, if any, issue-relevant elaboration to produce influence. Theories of attitude change such as classical conditioning and operant conditioning (e.g., Lott & Lott, 1968; Staats & Staats, 1958) which emphasize associating an object, issue, or person, with some simple affective cue typify this influence. For

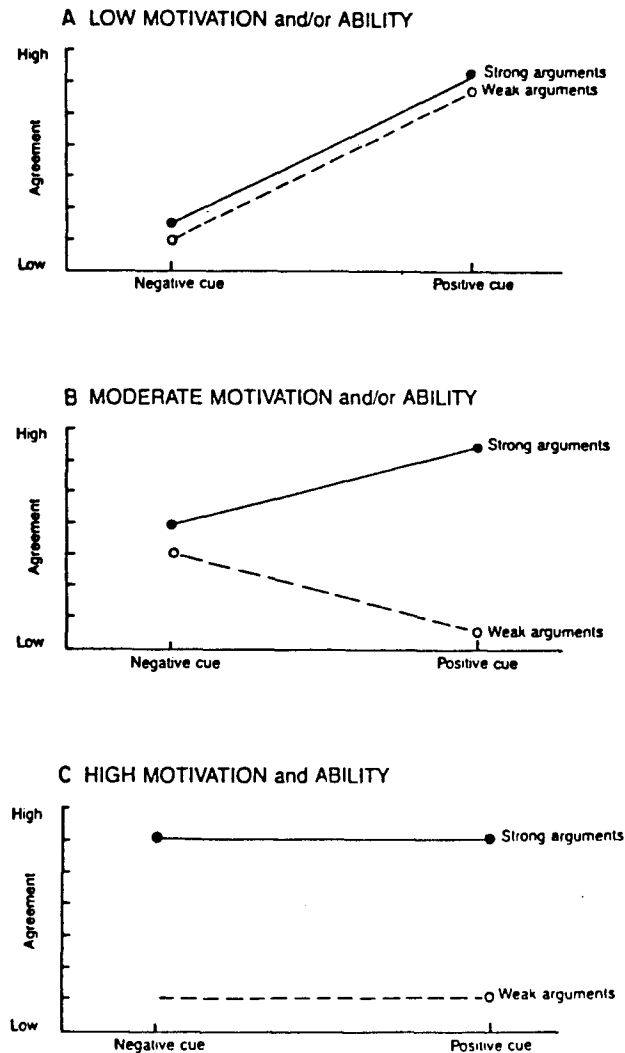


FIG. 2.2. The Elaboration Likelihood Model of Source Factors. From Petty and Cacioppo (1984).

instance, Gorn (1982) provided evidence that subjects developed a preference for an inexpensive product that was associated with liked rather than disliked background music.

Moving a little further up the continuum are theories in which again some simple cue provides the basis of the attitude change, but the cue may be used more deliberately. For example, it is possible for people to adopt the opinion of a

similar other without carefully scrutinizing issue-relevant arguments if the person "identifies" with the source (Kelman, 1961), employs the "balance" principle (Heider, 1946), or makes use of a learned similarity "heuristic" (Chaiken, see Chapter 1). As with the process of affective association, these theories can be characterized as peripheral in that the resulting attitude is based primarily on a simple cue rather than scrutiny of the information central to the merits of the advocacy.

Finally, at the high end of the continuum are theories that emphasize issue-relevant thinking, and the integration of issue-relevant beliefs into a coherent position. The cognitive response approach (Greenwald, 1968; Petty, Ostrom, & Brock, 1981), the theory of reasoned action (Ajzen & Fishbein, 1980), and inoculation theory (McGuire, 1964), for example, emphasize processes characterized by the high end of the elaboration continuum. The ELM, then, provides a general framework for organizing the existing theories of persuasion and indicating when the different underlying processes of persuasion are likely to be invoked. Consistent with this model, the logic of experimental designs and postcommunication attitude assessments have suggested that simple affective associations (e.g., Gorn, 1982) and cognitive inferences (e.g., Chaiken, 1980; Taylor, 1975) are more powerful determinants of persuasion when the personal relevance or consequences of a message are low rather than high, whereas the quality of issue-relevant arguments are more important when personal relevance is high rather than low (e.g., Petty & Cacioppo, 1979; Petty, Cacioppo, & Goldman, 1981; for an extended discussion of the ELM, see Petty & Cacioppo, in press).

ASSESSING ATTITUDINAL PROCESSES

Although many different processes ranging from simple affective associations to extended elaboration of issue-relevant arguments have been posited to operate in persuasion contexts, our knowledge of these processes has traditionally relied on people's postcommunication attitude ratings and self-reports. In a prototypical persuasion experiment, for instance, self-reports are used to assess the efficacy of the experimental manipulations, the effects of these manipulations on verbal or overt behavior, and the operation of the assumed intervening sequence of events (cf. Gerard, 1964; McGuire, 1985). This is a great deal to ask of any single measurement strategy.¹

A second feature of research on social influence is that multiple self-report measures and truly clever experimental designs have been employed to allow inferences to be drawn regarding the processes underlying these data (e.g.,

¹These points, of course, apply not only to the study of attitudes but to the study of social processes generally (see recent review by Cacioppo & Petty, 1985).

Moreland & Zajonc, 1977; Zanna & Cooper, 1974). However, these inferences are themselves not infrequently followed by equally clever counterarguments (e.g., Birnbaum & Mellers, 1979; Greenwald, 1975) and occasionally by theoretical impasses (e.g., See Kiesler & Munson, 1975) or disinterest (Wicker, 1969). The inclusion of chronometric or behavioral measures to augment self-report indices has strengthened the grounds for theorizing about social influence, but common to these methods is that the measured responses (e.g., reaction time, recall, compliance behavior) trail and reflect upon an entire sequence of events since they are obtained following the posited social process. Inferences regarding the timing, nature, and intensity of the underlying attitudinal processes based solely on the study of these measures can be called into question, since these measures may: (1) occur at various points after the events constituting the posited social process(es); (2) be unrepresentative of all but the material in short term memory and material in long-term memory which is easily accessible at the time of measurement; and/or (3) be colored by the cognitive strategy by which responses are requested (e.g., coherent verbal reports or ratings, reaction time—see discussions by Cacioppo & Petty, 1985; Ericsson & Simon, 1980; Nisbett & Wilson, 1977).²

Affect—which is widely viewed as a fundamental antecedent if not the major component or essence of attitudes—is a case in point. Philosophers and theorists have spoken of affect and emotion as being characterized by actions and feelings beyond a person's control, as when an individual is described as being *insanely* jealous, in a *blind* rage, or *dumbfounded* with astonishment.

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, & Krauss, 1984, p. 195).

Individuals may voice explanations for affective states, but these explanations can be influenced by rationalization, ego-defensive processes, and naive inference-making. Although the notion of an "affective reaction" assumes a precipitating circumstance or stimulus, the perception or registration of the eliciting stimulus need not be reportable or conscious (Kunst-Wilson & Zajonc, 1980), nor does the affect need have verbal or elaborate cognitive antecedents (Greenwald, 1982; cf. Lazarus, 1984; Zajonc, 1980, 1984). Tomkins (1981), for instance, has distinguished "primary affects" from more cognitively refined "affect complexes." Primary affects and emotions are generally viewed as limited

²A possible but infrequently found exception to this rule is experimental designs which accommodate the collection of either self-report measures or reaction-time measures to a secondary task at various points in time during the process of interest. This procedure has been criticized recently, however, for altering the nature of the normally occurring process.

in number; manifesting in some form at all evolutionary levels; having some relevance to basic adaptive processes; relying little upon learning, memory, and cognition; emerging early in infants; and possessing pancultural display characteristics. Affect complexes, on the other hand, account for the myriad of human emotions such as pride, shame, and embarrassment which involve cognitive if not conscious self-reflection.

Previous attempts to study the basic affective foundations of attitudes and the affective processes in attitude development and change have been characterized either by the use of *verbal* measures—a strategy which may misrepresent the role of affect by misgauging the nature, intensity, and timing of attitude-relevant affect; or *visceral* measures—a strategy which may misrepresent the role of affect by misgauging the valence of the reaction and the relative importance and timing of affect when the visceral measures are contrasted with verbal measures of cognition (e.g., see Breckler, 1984). The purpose of the present chapter is to survey our research on somatic markers of feeling and knowing, and to outline the inferential context in which these markers are viewed as valid. We then return to a brief discussion of the applicability of psychophysiological assessments in studies of the ELM.

BRIDGES BETWEEN SOCIAL INFLUENCE CONSTRUCTS AND SOMATIC DATA

Theoretical analyses of somatic activity during problem solving, imagery, and emotion have shared assumptions regarding the specificity and adaptive utility of somatic responses (Cacioppo & Petty, 1981a; Ekman & Friesen, 1975; Izard, 1971; McGuigan, 1978; Sokolov, 1972; Tomkins, 1962; Zajonc & Markus, 1982). Darwin (1872/1965), for instance, posited three general principles to account for the origin of distinctive facial expressions. In the first, termed the principle of serviceable associated habits, Darwin (1872/1965) posited that the distinctive facial expressions have an adaptive origin:

Certain complex actions are of direct or indirect service under certain states of mind, in order to relieve or gratify certain sensations, desires, etc; and whenever the same state of mind is induced, however feebly, there is a tendency through the force of habit and association for the same movements to be performed, though they may not then be of the least use. (p. 28)

Thus, for instance, disgust is characterized by facial actions which serve to expel noxious materials from the mouth and the feeling of disgust—even in the absence of a noxious gustatory stimulus, is associated with the same pattern of facial actions.

In the principle of antithesis, Darwin posited that diametrical psychological states produce a strong involuntary tendency to perform movements of a directly

opposite nature. Thus, the drawing of the corners of the mouth upwards and back in the form of a smile may have evolved to characterize positive feelings because these muscular actions contrast with the serviceable facial actions associated with negative emotions. Finally, Darwin posited the principle of direct action of the nervous system, which states that excitatory stimuli lead to discharges in the nervous system, causing effects such as trembling and tachycardia.

Tomkins (1962, 1963), whose theoretical work has contributed to our understanding of the antecedents and properties of emotion, has long resisted the belief in social psychology that physiological measures are incapable of distinguishing between positive and negative affective states and therefore are useful only in assessing general arousal:

The low visibility of the affects and the difficulties to be encountered in attempting to identify the primary affects have already been described. Yet our task is not as difficult as it might otherwise have been, for the primary affects, before the transformations due to learning, seem to be innately related in a one-to-one fashion with an organ system which is extraordinarily visible. (Tomkins, 1962, p. 204)

Tomkins was, of course, referring to the facial efference system—an organ system we know from common experience is capable of more complex and variable actions than captured by the notion of general arousal. Indeed, consistent with much of Darwin's and Tomkin's thinking, Ekman and Friesen (Ekman, 1972; Ekman & Friesen, 1969) have found that people from various cultures distinguished the facial expressions for the emotions of happiness, sadness, surprise, anger, disgust, and fear; that the facial expressions accompanying pleasant and unpleasant emotional states could be distinguished, as to some extent could the intensity of these positive and negative reactions; and that a large portion of variance in people's observable facial displays could be attributed to socially learned prescriptions, termed display rules, for regulating expressions of emotion (see recent review by Fridlund, Ekman, & Oster, in press).

Recently we proposed that several additional principles were supported by studies of somatic patterning using electromyography (EMG): (1) there are foci of somatic activity in which changes mark particular psychological processes (e.g., linguistic vs. nonlinguistic information processing, positive vs. negative affect); (2) inhibitory as well as excitatory changes in somatic activity can mark a psychological process; (3) changes in somatic activity are patterned temporally as well as spatially; (4) changes in somatic activity become less evident as the distance of measurement from a focal point increases; and (5) foci can be identified a priori by (i) analyzing the overt reactions that initially characterized the particular psychological process of interest but which appeared to drop out with practice, and (ii) observing the somatic sites that are involved during the "acting out" of the particular psychological process of interest. Together, these princi-

ples were termed the model of skeletomuscular patterning (Cacioppo & Petty, 1981a).

The first, second, and fifth principles are illustrated in research by Schwartz and his colleagues (Schwartz, Fair, Salt, Mandel, & Klerman, 1976a, 1976b). They found that, even in the absence of noticeable facial expressions, the level of EMG activity increased over the zygomatic major (whose action pulls the ends of the mouth upwards and back) and depressor anguli oris (whose action pulls the corner of the mouth downward) muscle regions and tended to decrease over the corrugator supercillii (whose action pulls the brows together and down) region following instructions to imagine a *happy* situation, whereas EMG activity increased primarily over the corrugator supercillii region following instructions to imagine a *sad* situation (see Fig. 2.3 for an atlas of selected facial muscles). In addition, Schwartz and his colleagues found that this patterning of facial muscle activity reliably distinguished positive and negative emotional imagery in nor-

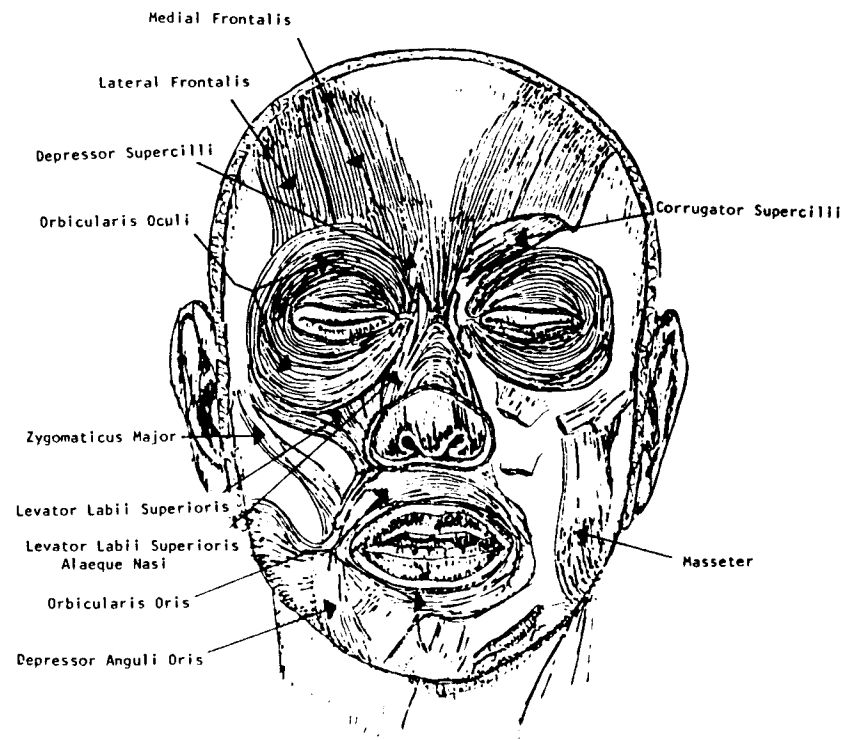


FIG. 2.3. The facial musculature. The superficial muscles are depicted on the left and the deep muscles are revealed on the right. From Cacioppo, Losch, Tassinary, and Petty (in press).

mals and clinically depressed patients; and that 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.

Patterns of Efference Accompanying Simple Physical and Attitudinal Tasks

The interesting results in the clinical domain obtained by Schwartz and their colleagues led us to conduct a study to test more explicitly the model of skeletomuscular patterning (Cacioppo, Petty, & Marshall-Goodell, 1984). Ekman and Friesen (1975, 1978) have emphasized that specific, overt emotional expressions are evident in the lower (e.g., mouth), middle (e.g., eyes, nose), and upper (e.g., brows) regions of the face. Hence, EMG activity was monitored over muscles which control the movement of facial landmarks in the lower (e.g., zygomatic major), middle (e.g., levator labii superioris, which raises the lip and dilates the nostril in the primitive expression of disgust), and upper (e.g., corrugator supercilii) regions of the face to determine whether invisibly small muscle actions were evoked and varied as a function of the affective tone of attitudinal processing. 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: (a) lifted a "light" (16 gram) or "heavy" (35 gram) weight (action); (b) imagined lifting a "light" (16 gram) or "heavy" (35 gram) weight (imagery); (c) silently read a neutral communication as if they agreed or disagreed with its thesis (action); or (d) imagined reading an editorial with which they agreed or disagreed (imagery). Based on the model of skeletomuscular patterning, we expected that the affective processes invoked by the positive and negative attitudinal tasks would lead to distinguishable patterns of EMG activity over the corrugator supercilii, zygomatic major, and possibly the levator labii superioris (which is involved in expressions of disgust) regions, whereas the simple physical tasks would lead to distinguishable EMG activity over the superficial forearm flexors (whose actions control flexion about the wrist).

Imagining performing rather than actually performing the tasks was, of course, associated with lower mean levels of EMG activity. More importantly, and consistent with the model of skeletomuscular patterning, multivariate analyses revealed that the site and overall form of the task-evoked EMG responses were generally similar across the levels of this factor. Analyses further revealed that EMG activity over the corrugator supercilii, zygomatic major, and levator labii superioris muscle regions in the face varied as a function of whether subjects thought about the topic in an agreeable or disagreeable manner, EMG activity over the superficial forearm flexors was higher during the physical than attitudinal tasks, and EMG activity over the forearm (but not over the facial muscles) varied across the simple physical tasks.

To probe whether subjects had suspicions regarding facial efference being the focus of the study, subjects were interviewed at the end of each session 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. The postexperimental interviews failed to reveal any evidence for the operation of experimental demands. All subjects appeared convinced of the cover story (e.g., that the sensors were used to detect involuntary physiological reactions), and no subject articulated anything resembling the experimental hypothesis. Instead, the postexperimental interviews of subjects indicated that they tended to organize the experimental trials in terms of whether they imagined or performed some task (e.g., lifting a weight or silently reading a text) rather than in terms of whether the task was physical or attitudinal.

Finally, following the study two judges viewed videotapes of subjects during trials on which the subjects performed positive and negative attitudinal tasks. The judges' task was to guess the valence of the task performed each trial based on their observations of the subjects' facial displays during the trial. Judges performed at chance level. It seems to us to strain plausibility to argue that subjects chose to support the experimental hypothesis by making socially imperceptible facial responses to the attitudinal tasks. Indeed, Hefferline, Keenan, and Harford (1959) found they could operantly condition an invisibly small thumb-twitch even though subjects remained ignorant of their behavior and its effect; and they reported that subjects could not produce this covert behavior in the absence of EMG feedback when deliberately trying to do so. Together these data suggest both that experimental demands are not necessary for the selective facial EMG activation observed during affective processing and imagery and, more interestingly, that attitudinal processing can have discriminable effects on facial EMG patterning.

Patterns of Efference During Silent Language Processing

One final set of observations of interest from this study is that EMG activity over the region of the muscles of speech (i.e., perioral EMG activity) was higher during the attitudinal than physical tasks even though the tasks required no overt verbalization and perioral EMG activity did not vary as a function of the affective tone of people's attitudinal processing. These data are consistent with the notion that problem solving and silent language processing influence perioral EMG activity (see reviews by Garrity, 1977; McGuigan, 1970). However, these data, like the previous research, are not particularly informative regarding the specificity of the relationship between perioral EMG activity and information processing since the type of stimulus presented and/or the type of subject employed has been

varied along with the extent of linguistic processing presumably manipulated. For instance, although poor readers show greater perioral EMG activity while reading than good readers (e.g., Edfeldt, 1960; Faaborg-Anderson & Edfeldt, 1958), 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. Since the literature on social influence is characterized both by theories based on the premise that people commonly engage in cognitive deliberations regarding the content of persuasive appeals (Fishbein & Ajzen, 1972; Greenwald, 1968; see, also, Sherman, Chapter 3, Wolfe, Chapter 9) and by theories based on the contrasting premise that social influence can be achieved much of the time mindlessly (Langer, Blank, & Chanowitz, 1978), automatically (Chaiken, 1983; Cialdini, 1984) and possibly without awareness (Kunst-Wilson & Zajonc, 1980), we have proposed the ELM as a general framework to organize the processes postulated by these various theories, and we have attempted in our psychophysiological research to extend the model of skeletomuscular patterning to determine precisely how facial efference generally and perioral EMG activity in particular serves as a marker for cognitive and affective processing.

In most of our initial investigations of perioral EMG activity, we employed the instructional manipulations used commonly to study encoding operations. The paradigm involves presenting target words (e.g., trait adjectives) to subjects while randomly varying the question pertaining to each trait word (Craik & 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 as the operationalization of the predominant type of informational analysis operating during the presentation of the target word (cf. Baddeley, 1978; Cermak & Craik, 1979). Results of research in this paradigm have generally shown that the more semantic (i.e., 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, & 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 & Craik, 1979; Craik, 1979).

Semantic and Nonsemantic Processing. The purpose of our initial study was to determine whether perioral (orbicularis oris) EMG activity was higher when subjects performed tasks which required that they think about the meaning and self-descriptiveness of a word rather than about the orthographic appearance of the word (Cacioppo & Petty, 1979b). EMG activity over a nonoral muscle region (superficial forearm flexors of the nonpreferred arm) was also recorded to deter-

mine whether task-evoked changes in EMG activity were specific or general (e.g., part of an arousal response). Subjects were shown cue-questions asking them whether or not the succeeding trait-adjective was printed in upper-case letters, or whether or not the word was self-descriptive. Half of the trait adjectives were printed in upper-case letters and half were printed in lower-case; and half of the trait adjectives were highly self-descriptive, while half were not at all self-descriptive. Subjects responded yes or no by pressing one of two micro-switches. Results revealed several interesting results. First, the self-referent task led to better recall than the orthographic task, replicating previous studies in social psychology (e.g., Rogers, Kuiper, & Kirker, 1977). Second, the self-referent task led to greater increases in perioral EMG activity than the orthographic task. Third, EMG activity over a nonoral muscle group did not vary as a function of the orienting task, making it unlikely that the association between self-referent processing and perioral EMG activity was due to subjects being generally more aroused or tense when performing the self-referent than orthographic task.

This orienting-task paradigm has also been used in social psychology to investigate possible differences in the existence of different processes by which incoming information is related to one or more existing domains of social knowledge. Studies have shown that 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 (e.g., Bower & Gilligan, 1979; Keenan & Baillet, 1980). These data have been interpreted as indicating structural differences in domains of social knowledge in memory. As Ferguson, Rule, and Carlson (1983) note, the domains of knowledge (e.g., one's self) accessed by tasks (e.g., self-referent task) that produce relatively better recall of the incoming stimuli are thought to be characterized by greater elaboration (i.e., more associates), integration (i.e., stronger interassociative bonding), and/or differentiation (i.e., more chunking of associates into distinct, but related subsets). Ferguson et al. 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: (a) evaluation constitutes a central dimension along which incoming information such as trait words is categorized and stored, and (b) both evaluative and self-referent tasks facilitated the use of the evaluative dimension and minimized the use of other irrelevant dimensions in rating traits. This led them to conclude 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 et al., 1983, p. 260).

Evaluative and Self-Referent Processing. In an experiment bearing upon both the effects of information processing on perioral EMG activity and on Ferguson et al.'s analysis, subjects were exposed to 60 trait adjectives spanning a

range of likeability (Cacioppo & Petty, 1981b). Each trait adjective was preceded by one of five cue-questions, which defined the processing task. The cue questions were: (a) Does the following word rhyme with ---" (Rhyme), (b) "Is the following word spoken louder than this question?" (Volume discrimination), (c) "Is the following word similar in meaning to ---?" (Association), (d) "Is the following word good (bad)?" (Evaluation), and (e) "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 did not realize 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. These data, which were obtained using a within-subjects rather than a between-subjects design, have been conceptually replicated by McCaul and Maki (1984) and argue against Ferguson et al.'s contention that evaluative and self-referent processing are fundamentally the same. In addition we found that: (a) 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 (in a subsequent section of this chapter, we show that these tasks, too, can be differentiated using psychophysiological measures); (b) cardiac activity and the mean amplitude of EMG activity over a nonoral muscle region (i.e., nonpreferred superficial forearm flexors region) did not vary as a function of the type of task performed; and (c) 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.

Affect-laden Information Processing in Persuasion Contexts. Given evidence that perioral EMG activity varies as a function of semantic processing and that EMG activity over selected facial muscle regions (e.g., corrugator supercilii, zygomatic major) can discriminate between positive and negative affective states, we reasoned that facial EMG measures might prove informative regarding elementary processes evoked by the anticipation and presentation of personally involving persuasive communications. Brock (1967) and Greenwald (1968), for instance, posited that recipients of persuasive communications "cognitively responded" to message arguments, generating new associations, links, and counterarguments in the process. Miller and Baron (1973), on the other hand, argued that recipients did *not* engage in extensive cognitive activity when confronted by a persuasive communication (see also, Langer et al., 1978; Miller, Maruyama, Beaber, & Valone, 1976). Experimental results based on subjects' reported attitudes and the thoughts and ideas they listed in retrospective verbal protocols

("thought listings") provided support for the former position (Petty & Cacioppo, 1977; cf. Cialdini & Petty, 1981), but others have expressed concerns that these data reflect post hoc rationalizations produced in response to postexperimental questioning rather than processes evoked by the persuasive communication.

An initial study supported the applicability of psychophysiological principles and procedures to the particular social psychological paradigm of interest: Localized increases in perioral EMG activity were observed when individuals followed the experimental instruction to "collect their thoughts" about an impending counterattitudinal editorial (Cacioppo & Petty, 1979a, Experiment 1). More importantly, a follow-up study was conducted in which subjects anticipated and heard a proattitudinal, counterattitudinal, or neutral communication (Cacioppo & Petty, 1979a, Experiment 2). Students were recruited for what they believed was an experiment on "biosensory processes," and as in the previous research, they were unaware that somatic responses were being monitored. After subjects adapted to the laboratory, we obtained recordings of basal EMG activity, forewarned subjects that in 60 sec they would be hearing an editorial with which they agreed, an editorial with which they disagreed, or an unspecified message, obtained another 60 sec of physiological recording while subjects sat quietly, and obtained yet another 120 sec of data while subjects listened to a proattitudinal appeal, counterattitudinal appeal, a news story about an archeological expedition. Subjects were not told to collect their thoughts in this study, but rather somatovisceral activity was simply monitored while subjects awaited and listened to the message presentation. This allowed us to assess the extent to which spontaneous thinking accompanied the anticipation of a persuasive communication.

As expected, subjects evaluated more positively and reported having more favorable thoughts and fewer counterarguments to the proattitudinal than to the counterattitudinal advocacy. Although unexpected, we also found that subjects reported enjoying the "neutral" message (which concerned an obscure archeological expedition) as much as they did the proattitudinal editorial. Analyses of perioral EMG indicated that perioral activity increased following the forewarning of an impending and personally involving counterattitudinal advocacy, and it increased for all conditions during the presentation of the message. This 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. Moreover, the pattern of subtle facial EMG activity was found to reflect the positive/negative nature of the persuasive appeal before and during the message. Presentation of the proattitudinal and *neutral* messages was accompanied by a pattern of facial EMG activity similar to that found to accompany pleasant emotional imagery, whereas both the anticipation and presentation of the counterattitudinal message was associated with a

pattern of EMG activity similar to that found to accompany unpleasant emotional imagery.

Patterns of Facial Efference and Affect

Although this study indicates that facial EMG activity can find applications in studies of social influence, one can question whether electromyographic studies of visually imperceptible emotional expressions are useful only in distinguishing positive from negative 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 zygomatic major region, whereas sad, anger, and fear imagery increased the EMG activity over the corrugator supercilii muscle region. Changes in EMG activity over the masseter and 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.

The Valence and Intensity of Affective Reactions. The inability of low-level facial EMG activity to discriminate among the negative affects would not seem to be a major limitation in studies of attitudes, however, 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 reactions which were sufficiently mild to be unaccompanied by noticeable emotional expressions. Physiological measures have traditionally been viewed in social psychology as useful only in assessing general arousal and therefore incapable of distinguishing between positive and negative affective states. Evidence from several laboratories now indicate, however, that facial EMG responses differentiate positive and negative affective states (e.g., see recent review by Fridlund & Izard, 1983). If these subtle, transient, and distinctive patterns of facial EMG activity vary in magnitude with the intensity of the affective states, then they would potentially constitute an objective, continuous, and sensitive probe of affective processes underlying attitude formation and change. In a study designed to examine this question, subjects were exposed to slides of moderately unpleasant, mildly unpleasant, mildly pleasant, and moderately pleasant scenes (Cacioppo, Petty, Losch, & Kim, 1986). Subjects viewed each slide for 5 seconds and rated how much they liked the scene that was depicted, how familiar the scene appeared, and how aroused it made them feel. Judgments of the videorecordings of subjects' facial actions during the 5-second stimulus presentations indicated that the scenes were sufficiently mild to avoid evoking socially perceptible facial expressions. Nevertheless, analyses revealed that EMG activity over the corrugator supercilii and orbicularis oculi muscle regions 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 corrugator supercilii region; moreover, EMG activity was higher over the orbicularis oculi region when moderately pleasant than mildly pleasant or unpleasant stimuli were presented. EMG activity over the zygomatic major region also tended to be greater for liked than disliked scenes, with EMG activity being significantly higher when liked than disliked scenes were presented.³ Importantly, neither EMG activity over the corrugator supercilii region nor EMG activity over the zygomatic major 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 likeability. These data, therefore, are more consistent with the view of response specificity in the facial actions accompanying cognition and affect than with the view that somatic activity increases generally as affective intensity increases (Cacioppo & Petty, 1981a; Winton et al., 1984).

The Topography of EMG Activity. A second potential limitation of facial EMG measures involves the manner in which EMG activity has been conceptualized. For instance, when trying to articulate the theoretical connections between neurophysiological principles regarding efferent activity (cf. Henneman, 1980a, 1980b; Rinn, 1984; Willis & Grossman, 1977) and the form and function of somatic (e.g., facial EMG) responses in studies of social processes (e.g., regarding the spontaneous/deliberate nature of an emotional expression), we realized that unambiguous links could not be derived as long as EMG activity was equated with the mean amplitude of the response. Yet most psychophysiological research using the electromyogram, including most of that reviewed above, has employed the measure of the average amplitude recorded in a given period—such as during a task (see reviews by Fridlund & Izard, 1983; McGuigan, 1978; Schwartz, 1975). This is noteworthy because the extraction of mean amplitude, which itself is a relatively recent advance in the analysis of the aperiodic electromyogram (Lippold, 1967; McGuigan, 1979), ignores the form

³The pattern of EMG activity obtained over the orbicularis oculi muscle region was not expected but based on data from a pilot study is reliable even when a visual focal point was employed. An interesting account for these data can be derived from Ekman and Friesen's (1982) important work on "felt" smiles. Ekman and Friesen suggest that people display a smile—whether happy or not—when they wish to present a happy image, but that people display both a smile and crow's feet at the outer edges of their eyes when they feel happy. Ekman and Friesen hypothesize that the common elements in the facial expression of the person who actually experiences a positive emotion are the action of two muscles: "the zygomatic major pulling the lip corners upwards toward the cheekbone; and the orbicularis oculi which raises the cheek and gathers skin inwards from around the eye socket" (p. 242). Since there was no reason in this setting for subjects to feign positive affective reactions to the experimental stimuli, it is possible that the heightened EMG activity over the orbicularis oculi region may be related to the variations in the subjects' feelings of positive regard for the depicted scenes.

of the response as it unfolds over time. Thus, neither the temporal nor frequency domain of EMG activity is represented, and the amplitude domain is represented in a limited fashion. One implication of interest here is that an implicit but unintended assumption in (facial) EMG research has been that cognitive and affective processes are graded but static "events." This is, of course, a gross oversimplification which suffers from many of the same problems as does using photographs rather than videotapes to study overt facial actions (cf. Ekman, 1982b).

We found that a variety of statistical and mathematical procedures had been employed in studies using the electromyogram (e.g., gradients of mean amplitude within epochs, fast Fourier transform, cross correlations, coherency analysis, ratio of evoked amplitude to basal level), but perhaps surprisingly none has proven generally applicable or satisfactory (e.g., Grabiner & Robertson, in press; O'Donnell, Rapp, Berkhout, & Adey, 1973; Person, Gundarov, Kudina, Vojtenko, & Konjuxova, 1967; Lippold, 1967; Malmo, 1975; McGuigan, Dollins, Pierce, Lusebrink, & Corus, 1982; Robertson & Grabiner, in press; Sokolov, 1972). Consequently, an analytical procedure to quantify the time and amplitude dimensions of the EMG response was developed (Cacioppo, Marshall-Goodell, & Dorfman, 1983; Cacioppo & Dorfman, 1985).⁴

Perioral EMG Activity and the Utilization of Cognitive Resources. The empirical and theoretical power gained by considering the form rather than simply the mean amplitude of EMG activity is illustrated in a recent study on the effects of simple cognitive tasks on perioral EMG activity. Recall that we had found perioral EMG activity, as indexed by mean amplitude, to be greater during semantic than nonsemantic processing, but that perioral EMG activity was equivalent across the semantic (e.g., evaluative and self-referent) tasks even though subjects expressed greater recognition confidence in having seen trait words used in the self-reference than evaluation tasks (Cacioppo & Petty, 1981b). In a follow-up study, subjects performed orthographic, grammatical, evaluative, and self-referent orienting tasks (Cacioppo, Petty, & Morris, 1985). 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 orthographic appearance, moderately poor

⁴Although discussion of this analysis is beyond the scope of the present chapter, interested readers may wish to consult Cacioppo et al. (1983) for the theoretical rationale for using moment-based parameters to characterize the time and amplitude dimensions of the (integrated) EMG response, and for evidence that the topographical analysis is capable of differentiating unique waveforms, provides a reliable and valid index of EMG activity obtained under conditions of submaximal isometric muscle contraction, and represents a significant improvement over mean amplitude.

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 as the most difficult and most cognitively effortful to perform. Clear evidence was again obtained, therefore, that the orienting tasks invoked distinctive analyses of the trait words. More interestingly here, multivariate analyses of the topography of facial EMG activity in general, and perioral (orbicularis oris) EMG activity in particular, revealed that the form rather than the mean amplitude of the task-evoked EMG responses differentiated these simple cognitive tasks, with significant differences emerging during semantic and nonsemantic processing and between evaluative and self-referent tasks. Subsequent regression analyses revealed that perioral EMG activity covaried more closely with reported cognitive effort than with recall. These results suggest 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 memory processes have the more direct effect on perioral EMG activity. For example, one can invoke extensive short-term processing, and exhibit heightened perioral EMG activity, when there is so little in long-term memory that there are few cues to assist retrieval and when there is so much in long-term memory that there are conflicting retrieval cues. Consider two students in an introductory college chemistry class, one of whom had high school chemistry, the other of whom did not. Although the latter student may have to utilize more cognitive resources (and show greater elevations in perioral EMG activity) to simply comprehend the class lectures as they are presented, the former student nevertheless could well transfer more of the class material to long-term memory because of a more highly developed schema for chemistry.

Spontaneous and Deliberately Modified Expressions of Emotion. It should be noted that the EMG patterning observed in our research has been subtle and is easily distorted, requiring optimal experimental conditions to obtain. As Ekman (1972) and Friesen (1972) have demonstrated, facial actions are clearly controllable and serve communicative and deceptive as well as emotionally expressive functions. In a recent study, we examined the patterns of facial EMG activity that characterized spontaneous facial expressions to mildly pleasant or unpleasant visual stimuli and those that characterized expressions that were deliberately modified in response to these stimuli (Cacioppo & Bush, 1985). Based on the work by Ekman and his colleagues, it was hypothesized that 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 (cf. Ekman, 1982a).

Facial EMG activity was recorded as subjects viewed slides of mildly pleasant or mildly unpleasant faces and scenes. Each slide was presented for 5 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 of whom was a close friend and another of whom was 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 (deliberately posed unexpressive facial displays) or through subtle facial displays, try to communicate to the friend, but not the stranger, whether the stimulus was pleasant or unpleasant (deliberately posed expressive facial displays). Subjects were given an opportunity to practice prior to the experimental trials, the order of these last two instructions was counterbalanced across replications of the study, and data from the few trials on which emotional facial expressions were noticeable were deleted prior to analysis.

Results revealed that the facial EMG activity associated with spontaneous affect versus the interpersonal communication of affect were distinguished in the predicted manner. EMG activity over the corrugator supercilii was again greater in response to unpleasant than pleasant visual stimuli; deliberately masked facial displays were characterized generally 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 which developed more intensely and were maintained over a longer period of time than spontaneous emotional expressions. Since the focus of this study was on socially imperceptible patterns of facial activity, one cannot be completely confident that these results would generalize to cases where subjects are simply told to exaggerate their emotional expression. Nevertheless, this preliminary study has broad implications for the study of attitude formation and change if, as these data suggest, the temporal parameters of facial efference can be used to distinguish between spontaneous and deliberately managed expressions of emotion.

INFERENCEAL CONTEXT AND IMPLICATIONS

Previous research on affect and emotion has identified two or three stable dimensions of experience: valence (pleasantness/unpleasantness), intensity (calm/excited), and control (spontaneous/voluntary) (e.g., Osgood, 1966). Our research thus far indicates that at least the first two of these dimensions of affect have reliable effects on facial EMG activity, and the preceding study suggests the third dimension may also have discriminable somatic effects. Studies of emotion have further revealed that emotions can be highly transient, occur in combinations ("blends"), and at times go undetected using verbal reports, visual observa-

tions, or response latencies (e.g., Ekman, 1982b; Haggard & Issacs, 1966; Kunst-Wilson & Zajonc, 1980; Schwartz, 1975; Tomkins, 1962). While the analyses of the dynamic aspects of overt expressive behaviors using videotapes (in contrast to drawings or photographs) to augment verbal reports has revealed a wealth of information regarding communication and emotion (Ekman & Friesen, 1978; Izard, 1971, 1977), there is room for yet other convergent, concomitant measures because not all social processes are accompanied by visually (Ekman, Schwartz, & Friesen—cited in Ekman, 1982b) or socially perceptible (Love, 1972; Rajecki, 1983) 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 (e.g., 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 & Petty, 1979a). The social psychological research on overt facial actions illustrates the utility of convergent operations which allow measurement of social processes as they unfold over time (e.g., Ekman & Friesen, 1974, 1975; Ekman, Friesen, & Ancoli, 1980; Izard, 1977; Zuckerman, DePaulo, & Rosenthal, 1981), while the research on facial EMG suggests that psychological events (e.g., positive/negative affect) too subtle or fleeting to evoke an overt expression may nevertheless be tracked (Cacioppo et al., 1986).

Several caveats are in order, however. First, although the effects on which we have focused have been obtained repeatedly in our laboratory and by others (e.g., McGuigan, 1978; McHugo, Lanzetta, Sullivan, Masters, & Englis, 1985; Ohman & Dimberg, 1984), these effects are subtle, transient, and easily masked by noise (e.g., electrostatic interference from power lines, individual variability, muscular tension or muscular fatigue). Second, difficulties in extracting psychologically and behaviorally relevant information from ongoing somatovisceral processes are to be expected given the nonpsychological (e.g., homeostatic, reflexive) functions served by the human organism, the paucity of current knowledge about the neurophysiological mechanisms serving psychological processes, and the methodological limitations inherent in studying human subjects using noninvasive somatovisceral recording procedures (cf. Coles, Donchin, & Porges, 1985). Indeed, although somatovisceral measures have been used with some success to index psychological states such as the use of deception (cf. Fridlund, Ekman, & Oster, in press; Lykken, 1981; Podlesny & Raskin, 1977; Waid & Orne, 1981) and the intensity or direction of reported attitudes (cf. Cacioppo & Sandman, 1981; Tursky & Jamner, 1983; Petty & Cacioppo, 1983), physiological measures of enduring and accessible psychological states have oftentimes proven to be expensive, cumbersome, and less sensitive than traditional methods in social psychology such as verbal reports (e.g., Rogers, 1983; cf. Crider, 1983;

Shapiro & Schwartz, 1970) or simple variations on these assessments such as the bogus pipeline (Jones & Sigall, 1971; see review by Petty & Cacioppo, 1983).

Consider, for instance, the limits to the utility of facial EMG as a physiological measure of attitudes. Electrodermal activity (e.g., Rankin & Campbell, 1955), pupil size (e.g., Hess, 1965), and heart rate (e.g., Katz, Cadoret, Hughes, & Abbey, 1965) have all been used to study attitudes, but these physiological measures have at best proven sensitive to variations in the extent of strong emotion underlying an attitude (cf. Cacioppo & Sandman, 1981; Petty & Cacioppo, 1983; Zanna, Detweiler, & Olson, 1984). Although measures of facial efference may overcome this particular problem (Cacioppo et al., 1986), we do not envision facial EMG to be an effective physiological measure of attitudes in many contexts. At the simplest level, people are capable of suppressing, falsifying, and distorting their facial expressions, making it difficult to determine their true feelings toward a stimulus using measures of facial actions, at least in some contexts (Zuckerman, Larrance, Spiegel, & Klorman, 1981; cf. Cacioppo & Petty, 1985).

Second, attitudes are generally conceived as being global and enduring evaluations of a stimulus (e.g., Petty & Cacioppo, 1981; Zanna & Rempel, 1984). People's positive attitudes toward their children endure despite moments of displeasure and occasional thoughts of abandonment. Facial efference, on the other hand, can be extremely transient and specific, marking perhaps a positive thought and feeling one moment and the realization of an undesirable consequence the next. This is not to say that attitudes and facial EMG will never covary; when people are left to simply think about an unequivocally counterattitudinal vs proattitudinal issue, for instance, the predominant thought and feeling can be expected to vary so dramatically and consistently that facial EMG should differentiate the individuals in these conditions (Cacioppo & Petty, 1979a). But the same general factors mitigating attitude-behavior correspondence when comparing a general measure of attitude with a specific measure of behavior can also be expected to vitiate the correspondence between a person's general and enduring attitude toward a stimulus and the facial efference associated with transient, specific, and possibly issue-irrelevant (e.g., a speaker's facial expression—cf. McHugo et al., 1985) affective reactions.

Third, conditions can be anticipated in which even general expressions of attitudes and of affect diverge. Avid smokers, for instance, may generally hold that the consumption of cigarettes is foolish, harmful, and negative, but nevertheless have consistent and positive affective reactions toward the act of smoking cigarettes (Fishbein, 1980).

Finally, and relatedly, the accessing of one's attitude toward a stimulus can but need not be accompanied by an unequivocal affective reaction. For instance, mild affective reactions habituate with repeated presentations of a stimulus, yet people's evaluation of the stimulus need not become neutral (e.g., Hare, 1973). Similarly, individuals appear able to categorize a familiar stimulus as being good

or bad with minimal if any affective involvement (e.g., Cacioppo & Petty, 1980a; Cacioppo et al., 1985; Gordon & Holyoak, 1983). This is not to suggest that affect cannot precede inferences, but simply to suggest that individuals, like well-programmed computers, can access a previously formulated attitude and can perhaps even apply a set of criteria to categorize a stimulus as being *good or bad, wise or foolish, or harmful or beneficial* without invoking emotion. To the extent that this analysis is accurate, at least in relative if not absolute terms, then interesting questions arise regarding the differences in the consequences of social judgments (e.g., attitudes, attributions, inferences) grounded primarily in cognition versus those based primarily in affect (cf. Zanna & Rempel, 1984).

Yet a major advantage of somatovisceral measures and manipulations—providing means for studying the *process* by which the social world impinges on individual action and experience, has remained largely unexploited; and it is in this respect that we have applied most of our psychophysiological research to the ELM. For instance, the somatic nervous system is the ultimate mechanism through which humans interact with and modify their environments. Moreover, the muscles of facial expression differ from most other skeletal muscles in that they are linked to connective tissue and fascia rather than to skeletal structures (cf. Rinn, 1984). Thus, neural activation of the facial muscles of expression is somewhat unique in function in that it generally does not operate directly on the physical environment, but rather its effect is often mediated by the construction of facial configurations which communicate information (e.g., ideas, inferences), misinformation (e.g., deception), and emotion (e.g., threat, approval). It is not unreasonable, therefore, to suggest that an understanding of people's actions and experiences, and perhaps particularly those pertaining to communication and social interaction, may be enriched if the operation of central events is analyzed in terms of its output. Specifically, the location, intensity, and timing of EMG activity recorded over facial muscle regions, although the consequence of a number of central and peripheral factors (Fridlund & Izard, 1983; Henneman, 1980b; Rinn, 1984; Willis & Grossman, 1977), can be particularly informative regarding social processes.

To study the processes outlined in the ELM, our psychophysiological research has departed from earlier traditions in a couple of respects. First, verbal, behavioral, and/or chronometric measures of processes presumably involved in attitude development and change ranging from affective arousal to cognitive processing have been supplemented using continuous, noninvasive video and psychophysiological recordings for the purpose of tracking the means by which the social world impinges on individual action and experience. Potentially important in this regard is the development of a mathematical procedure that allows representation of the temporal features of nonnegative bounded waveforms, since the topographical analysis of EMG responses provides a means for studying the changes across time in imperceptible as well as perceptible facial actions (e.g., Cacioppo et al., 1984).

Second, monitoring facial efference to track affect-laden information processing places particular importance on the interpretive context in which the measures are collected—just as is the case when reaction time is used to study cognitive processes (cf. Cacioppo & Petty, 1985). For instance, although more extensive cognitive analyses of a linguistic stimulus tend to result in longer reaction times and greater perioral EMG activity, knowing either of the latter does not indicate the presence of the former. Following work in cognitive psychophysiology (cf. Donchin, 1982), we have used psychophysiological measures as markers rather than as universal correlates of cognitive and affective processes (Cacioppo & Petty, 1985, in press-a). Physiological measures of psychological states and processes have possessed a particular attraction to attitude researchers, apparently because these measures have some of the attributes one would want in a “valid” index. A continuous record of physiological activity can be collected while individuals do nothing more than act naturally as they are exposed to various attitude stimuli (e.g., see Cooper, 1959; Hess, 1965; Rankin, 1955). Moreover, several physiological indices, such as cardiovascular, electrodermal, and electrocortical, are difficult for novices to control—though they are not difficult for novices to affect (cf. White & Tursky, 1982). And although there are individual differences in physiological responding, variations in environmental and social stimuli can also be shown to have clear and powerful effects across individuals (Cacioppo & Petty, 1983; Lacey & Lacey, 1958; Schwartz & Shapiro, 1973; Waid, 1984). Finally, high expectations regarding the validity of psychophysiological measures are raised by anecdotes regarding what can be learned about an individual’s feelings and inclinations if only one scrutinizes another’s bodily responses sufficiently closely (e.g., Darwin, 1872/1965; Galton, 1884). It is worth emphasizing, therefore, that verbal, nonverbal, and physiological measures have different attributes, distinctive utilities and disutilities, and only partially overlapping ranges of construct validity. All are potentially useful in limited contexts—for instance, as markers (i.e., temporally stable indicators of the presence of a particular psychological process or state)—and none is “purer” than any other (see recent review by Cacioppo & Petty, 1985).

As we noted above, the limits in self-report data correspond to potential strengths in psychophysiological assessments. For a physiological reaction (or syndrome) to serve as a marker for a psychological process, it should be shown that, *within a given experimental context*, the physiological reaction: (a) can be measured reliably and is stable across time; (b) occurs infrequently in the absence of the psychological process of interest; and (c) generally emerges at the onset and returns to basal levels at the offset of the psychological process of interest—although reliable time-lags between the two levels can be accommodated (Iacono, 1983). Thus, when the regions of construct validity between specific verbal and physiological measures diverge, each can potentially provide information about social influence and behavior not easily attainable from the other.

The fact that the ranges of validity for these measures are not identical makes each worthwhile.

The overlapping regions of construct validity for psychophysiological and self-report data are also informative, for they define the contexts and provide the means for assessing the construct validity of simple, inexpensive self-report measures. Given the results from a variety of measurement strategies identify a specific context in which people are willing and able to report accurately what are the processes underlying their attitudes, one could reasonably rely on simple verbal indices to draw inferences within measurement context. The initial research often must be conducted within a context in which verbal and physiological indices lead to the same theoretical inference. Once bridges between social psychological constructs and psychophysiological data have been established, the latter can fruitfully be extended to regions in which the validity of self-report measures is more suspect.

As a case in point, the research reviewed in this chapter suggests that facial EMG activity may be used to assess the extent and affectivity of information processing. Since the central, in contrast to peripheral, route to persuasion involves the expenditure of cognitive resources on processing issue-relevant information, facial EMG holds promise as an objective and continuous probe of the extent to which persuasion processes are central; but this relationship would be expected to hold only when peripheral processes involved only minimal (silent) language processing. Although such persuasion contexts theoretically exist (e.g., see Harkins & Petty, 1981), peripheral processes can also involve the effortful processing of information that has little or no relevance to the actual merits of the recommended position (see Petty & Cacioppo, in press, Ch. 2). Hence, facial EMG should be a useful measure of message elaboration only when the persuasion context is such that the focus of most of the silent language processing is message and issue-relevant information.

Interestingly, it may also be possible to index the extent to which information processing activity is relatively objective rather than biased by assessing the extent of differential hemispheric activation during message processing. For example, in two studies we found that individuals who produced a relatively polarized profile of thoughts (unfavorable–favorable thoughts) in response to a persuasive message also demonstrated relative right hemispheric EEG activation as assessed over the parietal lobes (Cacioppo, Petty, Quintanar, 1982). Although this relationship appears quite reliable, the boundary conditions for this effect (e.g., aural vs. visual presentations) have not yet been established.

Note that the ongoing somatovisceral reactions which serve as markers of psychological events (e.g., muscle action potentials across the face marking a positive or negative affective reaction) need not represent an instrumental component of the psychological event. Noninstrumental physiological reactions (e.g., associated movements) as well as instrumental physiological events can favor the involvement of a particular psychological process (e.g., semantic ver-

sus emotional reactions to an appeal) or of a given physiological mechanism (e.g., unitary arousal vs. a highly specific, behaviorally adaptive response system). Whether or not a given physiological reaction is necessary for a particular process, while interesting in its own right, is not critical for a measure to serve as an episodic marker.

Finally, although our research has not been designed to answer questions about the role of facial efference in affective experience, the observed correspondence between subtle patterns of facial efference and subject's transient and idiosyncratic affective reactions is certainly consistent with the view that facial efference is a significant determinant of emotion as well as with the view emphasized above that facial efference can serve as emotional readout. It is possible, for instance, that subjects in the present study rated their affective reactions as more intense *because* greater discriminably patterned feedback had been evoked. Research on the temporal specificity of striated muscular activity (e.g., Henneman, 1980b), facial actions (e.g., Ekman & Friesen, 1978), and facial EMG activity (e.g., Cacioppo et al., 1984) is clearly consistent with recent arguments that the temporal parameters of the efference resulting from spontaneous versus deliberate facial actions are distinguishable just as are the spatial parameters that differentiate the feedback resulting from expressions of, say, happiness and sadness (Tomkins, 1981).

As is well known, evidence has also been reported questioning the contributions of facial efference to affective experience (cf. Tourangeau & Ellsworth, 1979). However, several mechanisms of action linking spontaneous facial efference to affective experience can be suggested that do not cast the relationship between facial efference and affective experience as an invariant. In addition to innate afferent mechanisms (e.g., Izard, 1977; Tomkins, 1962, 1963), one might point to the processes of classical conditioning (wherein facial feedback from spontaneous expressions of emotion have been paired so frequently with particular emotional experiences that this feedback has come to serve as a conditioned stimulus), self-perception (e.g., why would one smile spontaneously at another unless liking was involved), and behavioral confirmations (e.g., facial expressions, like overt actions toward another, should influence the social feedback individuals receive). While deliberate facial expressions of emotion may invoke some of these mechanisms in a weakened form (e.g., even the effects attributable to social feedback should be weakened by leakage from other channels—cf. Zuckerman et al., 1981), the construction and maintenance of a deliberate expression of emotion and the monitoring of the communicative effectiveness of the expression can also subsume processing capacity. When an individual's processing resources are sufficiently limited in an emotionally evocative context that the capacity allocated to the construction, maintenance, and monitoring of an expressive display diminishes what can be allocated to the evocative stimulus, then one might expect deliberate expressions of emotion to actually attenuate the affective experience or to introduce feelings of

negative affect such as anxiety or distress. For instance, expressing and maintaining an unfelt smile in the face of danger may prove to be an effective means of attenuating fear because of the disruption of the normal (i.e., spontaneous) pattern of efference and feedback found in this situation *and* because of the reduction in the processing capacity that can be allocated to the fear-evoking situation. Of course, the latter process would not hold for deliberately constructed facial expressions when the expression is so well practiced as to have achieved automaticity, the emotionally evocative stimulus requires little to no processing capacity, or the emotionally evocative stimulus persists sufficiently long that any diminution of processing resources which can be allocated to the stimulus becomes trivial.

In sum, previous research has demonstrated that overt facial expressions vary as a function of people's emotional reactions; that overt perioral activity is associated with language processing; and that the electromyogram is an effective technology for examining neuromuscular actions in the absence of overt muscle contractions. The results of our psychophysiological research point to a procedure for tracking various aspects of cognitive and affective information processing. For instance, results have indicated that facial EMG can mark the valence and intensity of transient and specific affective reactions even in the absence of emotional expressions that are noticeable, at least under normal viewing conditions. Although the pattern of facial efference is unlikely to yield a satisfactory physiological marker of attitudes *per se*, the present results do suggest that facial EMG may provide a useful technology for tracking silent language processing as well as the rudimentary positive or negative feelings a person has toward a stimulus and the more elementary processes underlying a variety of social judgments and behaviors such as attitude development and change. It is also possible that questions regarding whether episodes of "instrumental" and "hostile" aggression studied in social psychological laboratories differ in terms of their emotional underpinnings (cf. Rajcecki, 1983), questions regarding whether cognitive dissonance is characterized phenomenologically by the perception of arousal or by an unpleasant affective reaction (see recent reviews by Cacioppo & Petty, 1985; Fazio & Cooper, 1983) and a number of other elusive questions of interest to social psychologists may be amenable to psychophysiological probes.

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