Zipf, G. (1949). *Human behavior and the principle of least effort*. Reading, MA: Addison-Wesley.
Zuckerman, M. (1978). *Sensation seeking: beyond the optimal level of arousal*. Hillsdale, NJ: Lawrence Erlbaum Associates.
Zuckerman, M. (1983). A biological theory of sensation seeking. In M. Zuckerman (Ed.), *Biological bases of sensation seeking, impulsivity, and anxiety* (pp. 37–76). Hillsdale, NJ: Lawrence Erlbaum Associates.

(1988). L. Donohew, H. E. Sypher, & E. T. Higgins (Eds). Hillsdale, NJ: L. Erlbaum.

11 Communication, Social Cognition, and Affect: A Psychophysiological Approach

John T. Cacioppo
University of Iowa

Richard E. Petty
Ohio State University

Louis G. Tassinary
University of Iowa

Despite early obstacles and misunderstandings regarding the psychophysiological enterprise, psychophysiological procedures have the potential of extending the traditional verbal and behavioral measures of communication, affect, and social cognition and thereby provide a continuous and noninvasive means of tracking the means by which the social world impinges on individual action and experience. The history of psychophysiological research on social processes is traced briefly, and research illustrating how one can make strong inferences about a person's cognition and affect from physiological response profiles within structured situations is reviewed.

BACKGROUND

Traditionally, social psychologists have been interested in the reportable and behavioral effects of human association, communication, and interaction. Social psychology, like the field of communication, is partitioned into conceptual areas of research such as persuasion, mass media effects, interpersonal attraction, group processes, and so forth. The standard dependent measure has been verbal report, and the emphasis in research has been on observations in naturalistic settings or on highly controlled experimental settings and manipulations (e.g.

see Mayo & LaFrance, 1977). These traditions, which have had a major impact on the field of communications as well, were bequeathed by the very founders of the field of social psychology. For example, Allport (1947), in his Divisional Presidential address before the first annual meeting of the Division of Personality and Social Psychology, equated psychophysiology with simplistic mechanistic thinking and criticized it (along with animal and infant research) as being reductionistic, inadequate, and a waste of time and energy for those interested in relevant social behavior. Allport's influential Presidential address and subsequent writings provided an important defense of the cognitive orientation of early social psychologists against the juggernaut of American behaviorism, but it also cast verbal reports in the starring role of social processes and cast psychophysiological concepts and measures as irrelevant to the study of social processes and behavior generally and communication in particular (e.g., Allport, 1947, 1969; Bem, 1972; Valins, 1966).

Psychophysiology, in contrast, evolved out of the efforts of electrical engineers, physiologists, experimental psychologists and clinical psychologists and psychiatrists (e.g., Porges & Coles 1976; Kaplan & Bloom, 1960). The diverse goals and interests of these individuals, coupled with the formidable technical obstacles confronting these early investigators, led predictably to a partitioning of the discipline not into conceptual areas of research, but rather into anatomical areas (e.g., electrodermal, cardiovascular, electrocortical). The one common thread among early psychophysiologists was their equipment and recording technique, and accordingly the early definitions of psychophysiology were in operational terms such as research in which the polygraph was used (e.g., Ax, 1964).

Our research has focused primarily on attitudes and persuasion (see Petty, Cacioppo, Kasmer, this volume), but psychophysiology was of interest not only because the physiological knowledge base and noninvasive quantitative measurements held the potential of providing a means of testing and extending existing theories, but also because it held the potential for a mutually stimulating interdisciplinary enterprise wherein one considers the inherent biological and social nature of behavior and for tracking cognitive, emotional, and behavioral processes as they unfolded (Cacioppo & Petty, 1981a, 1986; Cacioppo & Sandman, 1981; Petty & Cacioppo, 1983). This multifaceted perspective representing social, psychological, and physiological levels of events is far from new, however, dating at least as far back as the third century B.C., when the Greek physician Erastratos used psychophysiological observations such as the disruption of a regular heart beat in a young man when his stepmother visited to isolate the *social* cause of the individual's malady—"lovesickness" (Mesulam & Perry, 1972).

Moreover, psychophysiological studies of communicative behavior began appearing in the psychological literature over half a century ago when, for instance: (a) Riddle (1925) studied deception and small group behavior by monitoring the respiratory rhythms of people bluffing during a poker game to study deception and stress; (b) Smith (1936) studied social influence by monitoring the skin resistance responses (SRRs) of individuals as they were confronted by the information that their peers held attitudes that were discrepant from their own; and (3) Rankin and Campbell (1955) studied racial prejudice by monitoring the SRRs of individuals as they were exposed to white and black experimenters. Despite the interesting findings of each of these investigations, the emphasis in early research was either on the construct of general physiological arousal (see Cacioppo & Petty, in press) or on the application of psychophysiological procedures to validate theoretical constructs and measures. Regarding the former, Fowles (1980) noted in his review of the literature that:

> The effect of attempting to assimilate all of these traditions to a single arousal theory was to create a model in which the reticular activating system was assumed to serve as a generalized arousal mechanism which responded to sensory input of all kinds, energized behavior, and produced both EEG and sympathetic nervous system activation. . . . As is well-known, this model failed the empirical test rather badly. (p. 88)

The promise of psychophysiological procedures for purposes of construct validation, however, appeared more considerable:

> At the very simplest level, the attraction of social psychologists to physiological techniques is not hard to understand. The techniques provide nonverbal, objective, relatively bias-free indices of human reaction that have some of the same appeal as gestural, postural, and other indicators of covert response. (Shapiro & Schwartz, 1970, pp. 89–90)

The key phrase here is *relatively* bias-free indices, however. Although physiological measures may be less susceptible to direct cognitive control than verbal or overt behaviors, physiological responses are vulnerable to instructional sets, intentional distortion, and social biases (e.g., see Fridlund & Izard, 1983; Sternbach, 1966; Tognacci & Cook, 1975).

PSYCHOPHYSIOLOGICAL PERSPECTIVES

Moreover, the fact that physiological indices are not linked invariantly to psychological processes or states proved a disappointment to some and resulted in suggestions that psychophysiology had failed to fulfill its promise (e.g., Allport, 1947; Stewart, 1984). This is because the establishment of a dissociation between a physiological marker and a psychological process or state invalidates the psychophysiological enterprise when the original investigation is designed to demonstrate invariant correlates. However, this also represents an outdated, overly simplistic, and reductionistic conceptualization of the psychophysiological enterprise (Cacioppo & Petty, 1986). As Donchin (1982) has noted:

> it is more sensible to view the psychophysiological measures as manifestations of processes evoked, or invoked, in the organism. Such processes may, or may not, be part of some information processing activity. When they are, their attributes may, or may not, be monotonic functions of some, arbitrarily selected, performance measure. When such functions are found they are of use to the extent that it is possible to address issues of theoretical import by employing psychophysiological measures as a source of data about the organism. (pp. 457–458)

This alternative, albeit less spectacular, view of the psychophysiological enterprise makes no pretense of promising someday to describe human behavior as a list of invariant physiological correlates of psychological events. Nevertheless, it is quite feasible to make strong inferences about a person's cognition and affect from physiological response profiles, but these inferences can only be made within the framework of a very structured situation. Expertise in forming the psychophysiological questions as well as an understanding of the physiological and bioelectrical basis of the phenomena are, therefore, critical to the success of any application of psychophysiology to the study of social or communication processes.

Facial Response System. The research we have been conducting on the messages carried in covert facial signals is a case in point. The somatic nervous system is the final pathway through which people interact with and modify their physical and social environments. That the pattern of efference is not always as intended (e.g., as when one performs clumsily), not always a veridical reflection of goals (e.g., as when one deceives), and not always obvious (e.g., as when one hides feelings) is important to recognize when specifying under what conditions a given pattern of efference will mark a particular psychological process. But without efference, individuals do not communicate, do not affiliate, do not proliferate, do not interact—in short, are not social. Even efferent discharges that are too subtle or fleeting to be observeable under normal conditions of social interaction may be of interest, therefore, because these are less likely to undergo the same distortions as overt expressions and actions and therefore may reflect incipient but socially relevant events.

Theoretical analyses of efferent activity during problem solving, imagery, and emotion have shared assumptions regarding the specificity and adaptive utility of somatic responses. In reviewing this research several years ago, Cacioppo and Petty (1981a) found evidence for the following five principles:

1. There are foci of somatic activity in which changes mark particular psychological processes (e.g., linguistic vs. nonlinguistic 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 the focal point increases; and
5. foci can be identified a priori by (a) analyzing the overt reactions that initially characterized the particular psychological process of interest but which appeared to drop out with practice, and (b) observing the somatic sites that are involved during the "acting out" of the particular psychological process of interest.

Moreover, from a communications perspective the muscles of facial expression may be especially noteworthy in that these somatic effectors are linked to connective tissue and fasciae rather than to skeletal structures; their influence on the social environment, therefore, is often mediated by the construction of facial configurations rather than by direct action through the movement of the skeletal structure (Rinn, 1984). Tomkins (1962), Izard (1971), and Ekman and Friesen (1975) have pioneered work on the face as a multisignal/multimessage response system.

Ekman and Friesen (1975), for instance, have conceptualized the face as the source of: (a) static, (b) slow, (c) artificial, and (d) rapid signals.

Carried by the rapid signals alone are a variety of messages, most over which individuals have a good deal of control. The perioral musculature, for instance, is heavily and contralaterally innervated by the facial (seventh cranial) nerve and is capable of extraordinary specificity and flexibility (e.g., as in the case of verbal articulation). Nonverbal facial messages include emblems (symbolic communication—e.g., wink), manipulators (self-manipulative associated movements—e.g. lip bite), illustrators (actions accompanying/highlighting speech—brows), regulators (nonverbal modulators—e.g., nods), and distinctive emotions (Ekman & Friesen, 1975).

Regarding the latter, the states of happiness, sadness, fear, anger, disgust, and surprise have been linked to distinctive facial displays across cultures and infants, whereas variability in facial efference and emotion has been linked to several sources, including differences in the emotion(s) evoked by a stimulus, differences in the timing of the emotional reaction, and to display rules (e.g., Ekman, 1972, 1982; Izard, 1977; Scherer & Ekman, 1982; Steiner, 1979).

Facial Efference. Of course, not all intra- or interpersonal processes are accompanied by visually or socially perceptible expressive facial actions, and this fact has limited the utility of research linking facial actions to underlying psychological processes (e.g., Graham, 1980; Love, 1972; Rajecki, 1983). It is therefore noteworthy 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)

Electromyography (EMG) is a psychophysiological technique that allows the measurement of both covert and overt facial efference. Briefly, each muscle consists of millions of fibers housed in connective tissue and is activated by a specific motor nerve. The motor nerve, in turn, consists of many tiny motoneurons, which terminate on muscle fibers at a region called the *motor end-plate*. These motoneurons have differential critical firing thresholds, such that progressively larger units are added to, or progressively smaller units are subtracted from, the total output of a motoneuron pool (size principle; Henneman, 1980). When a particular motoneuron is depolarized, a neural impulse travels to the end-plate region, and the chemical transmitter acetylcholine initiates a self-propogating muscle action potential (MAP), which activates the physiochemical mechanism causing the fiber to contract. Whenever a MAP passes along a muscle fiber, an electrical potential is created that can be measured at the skin. The acetylcholine is quickly eradicated by the enzyme cholinesterase, and MAP activity and muscle fiber contraction ceases without additional neural activity. Contraction of muscle fibers also activates skin receptors, which provide afferent feedback about facial muscle activity. Although the details of the individual MAPs are lost in 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) or motoneuron pools. (For further information about EMG recording, see Fridlund & Cacioppo, 1986.)

Consistent with the model of skeletomuscular patterning just outlined, research using facial EMG recordings has revealed several interesting somatic consequences of communication, social cognition, and affect:

1. *Cognitive dimension*—somatic activity over the perioral region is greater during cognitive deliberations (e.g., symbolic processing involving semantic material) than during automatic or visual processing;
2. *Affective dimension*—somatic activity is heightened over the zygomatic region and lessened over the corrugator region during positive emotions, whereas the opposite is the case during negative emotions; and
3. *Intensity dimension*—the amount of somatic activity over the perioral region varies as a function of the extent of cognitive deliberation; and the amount of activity over the corrugator (and possibly the zygomatic) muscle region varies as a function of the intensity of an emotional reaction.

Skeletomuscular Patterning During Action and Imagery. In an illustrativ study (Cacioppo, Petty, & Marshall-Goodell, 1984), subjects were led to believ they were participating in a study on involuntary neural responses during "actio and imagery." Subjects on any given trial either: (a) lifted a "light" (16 gran or "heavy" (35 gram) weight (action); (b) imagined lifting a "light" (16 gram or "heavy" (35 gram) weight (imagery); (c) silently read a neutral communica tion as if they agreed or disagreed with its thesis (action); or (d) imagined readin an editorial with which they agreed or disagreed (imagery). Based on the mode of skeletomuscular patterning, we expected the following: (a) orbicularis or (perioral) EMG activity would be greater during the communicative attitudin tasks than during the physical tasks, and (b) the affective processes invoked b the positive and negative attitudinal tasks would lead to distinguishable pattern of EMG activity over the corrugator supercilii, zygomatic major, and possibl the levator labii superioris (which is involved in expressions of disgust) region (see Fig. 11.1), whereas the simple physical tasks would lead to distinguishabl EMG activity over the superficial forearm flexors (whose actions control flexio about the wrist).

Imagining performing rather than actually performing the tasks was, o course, associated with lower mean levels of EMG activity. More importantl and consistent with the model of skeletomuscular patterning, multivariate analy ses revealed that the site and overall form of the task-evoked EMG response were generally similar across the levels of this factor. Analyses further reveale support for both predictions. First, perioral EMG activity was higher during th attitudinal than physical tasks even though the tasks required no overt verbaliza tion (see Fig. 11.2).

Second, EMG activity over the corrugator supercilii, zygomatic major, an levator labii superioris muscle regions in the face varied as a function of whethe subjects thought about the topic in an agreeable or disagreeable manner (see Fig 11.3), EMG activity over the superficial forearm flexors was higher during th physical than attitudinal tasks, and EMG activity over the forearm (but not ove the facial muscles) varied across the simple physical tasks (see Fig. 11.4).

To probe whether subjects had suspicions regarding facial efference being th focus of the study, subjects were interviewed at the end of each session and wer asked specifically what they believed to be the experimental hypothesis. Becaus subjects might reason that they should not disclose how much they "knew," w emphasized that it was important that they respond honestly and accurately. Th post-experimental interviews failed to reveal any evidence for the operation o experimental demands. All subjects appeared convinced of the cover story (e.g. that the sensors were used to detect involuntary physiological reactions), and n subject articulated anything resembling the experimental hypothesis. Instead, th post-experimental interviews of subjects indicated that they tended to organiz the experimental trials in terms of whether they imagined or performed some tas

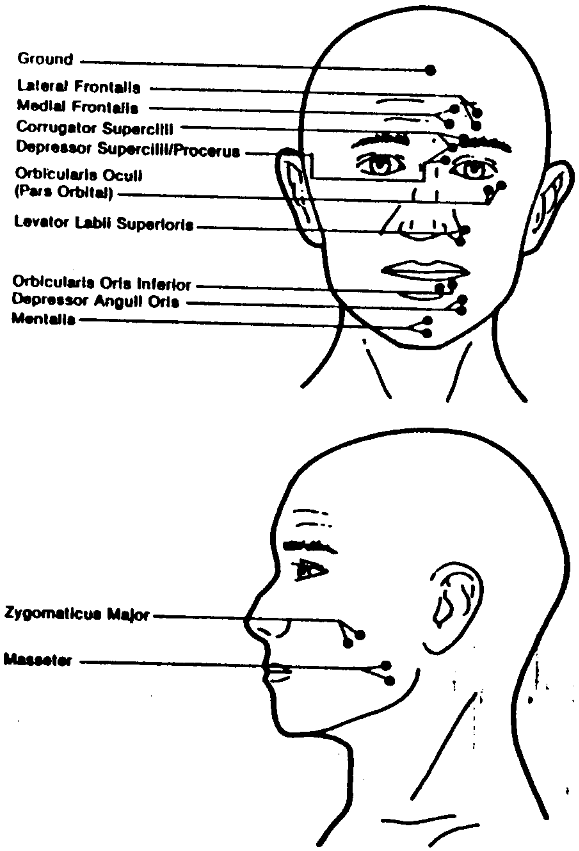

FIGURE 11.1. Recording sites for bipolar electromyographic recording over various facial muscle regions (adapted from Fridlund & Cacioppo, 1986).

(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 is unlikely 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

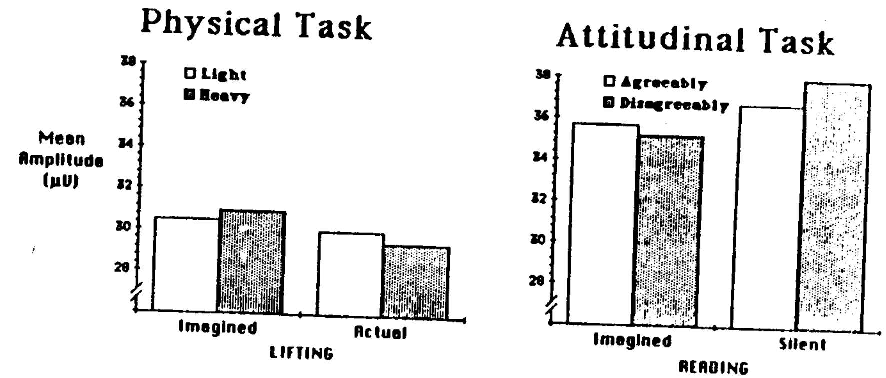

FIGURE 11.2. EMG activity over the perioral (orbicularis oris) muscle region during physical and attitudinal tasks (adapted from Cacioppo, Petty, & Marshall-Goodell, 1984).

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 social cognition and affect can have discriminable effects on facial EMG patterning.

Perioral EMG Activity as a Function of Self-Referent Processing. The data displayed in Fig. 11.2 are also 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 previous research, are not particularly informative regarding the specificity of the relationship between perioral EMG activity and information processing because 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. Because the literature on communication and persuasion is characterized both by theories based on the premise that people commonly engage in cognitive deliberations regarding the content of persuasive appeals (Fishbein & Ajzen, 1975; Greenwald, 1968) 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, in press; Cialdini, 1984) and possibly without awareness (Kunst-Wilson & Zajonc, 1980), we have proposed the elaboration likelihood model (ELM) as a general framework to organize the

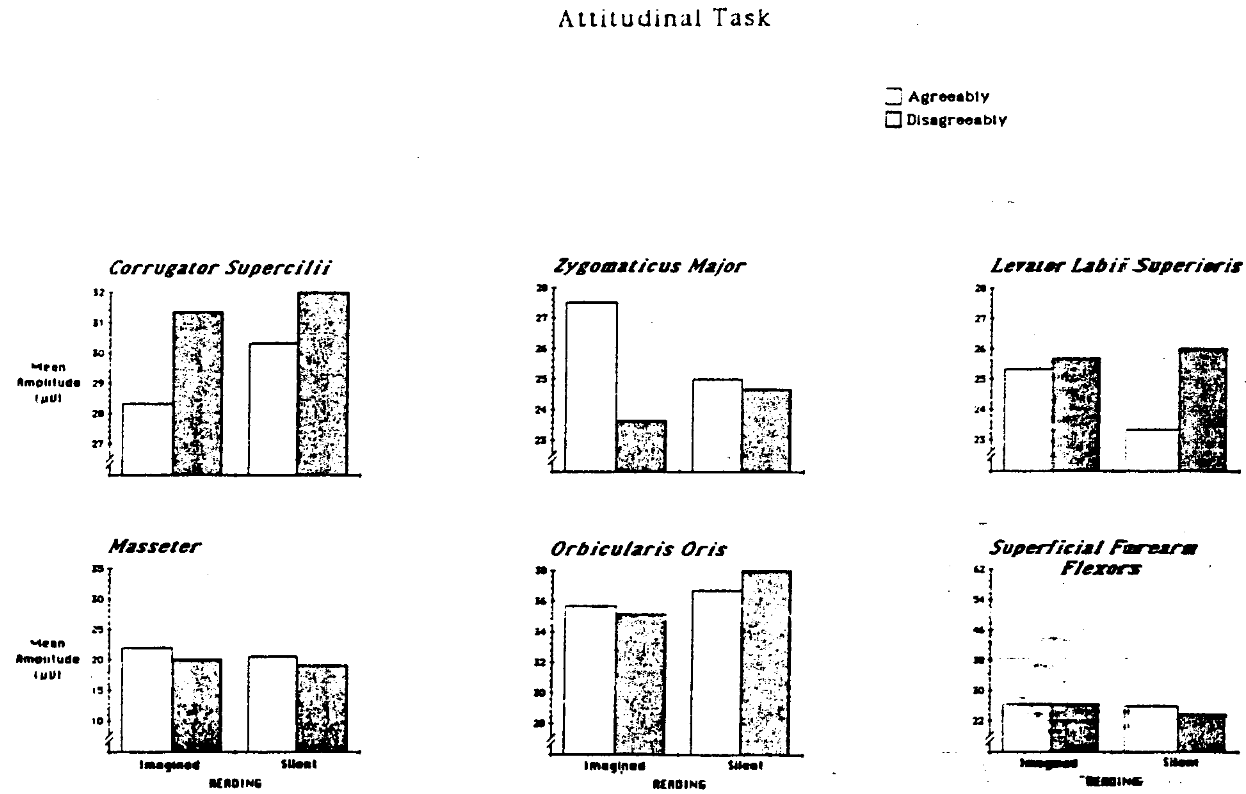

FIGURE 11.3. EMG activity over mimicry muscle regions (top row), and over masseter, perioral, and forearm (bottom row) muscle regions as a function of attitudinal tasks (adapted from Cacioppo, Petty, & Marshall-Goodell, 1984).

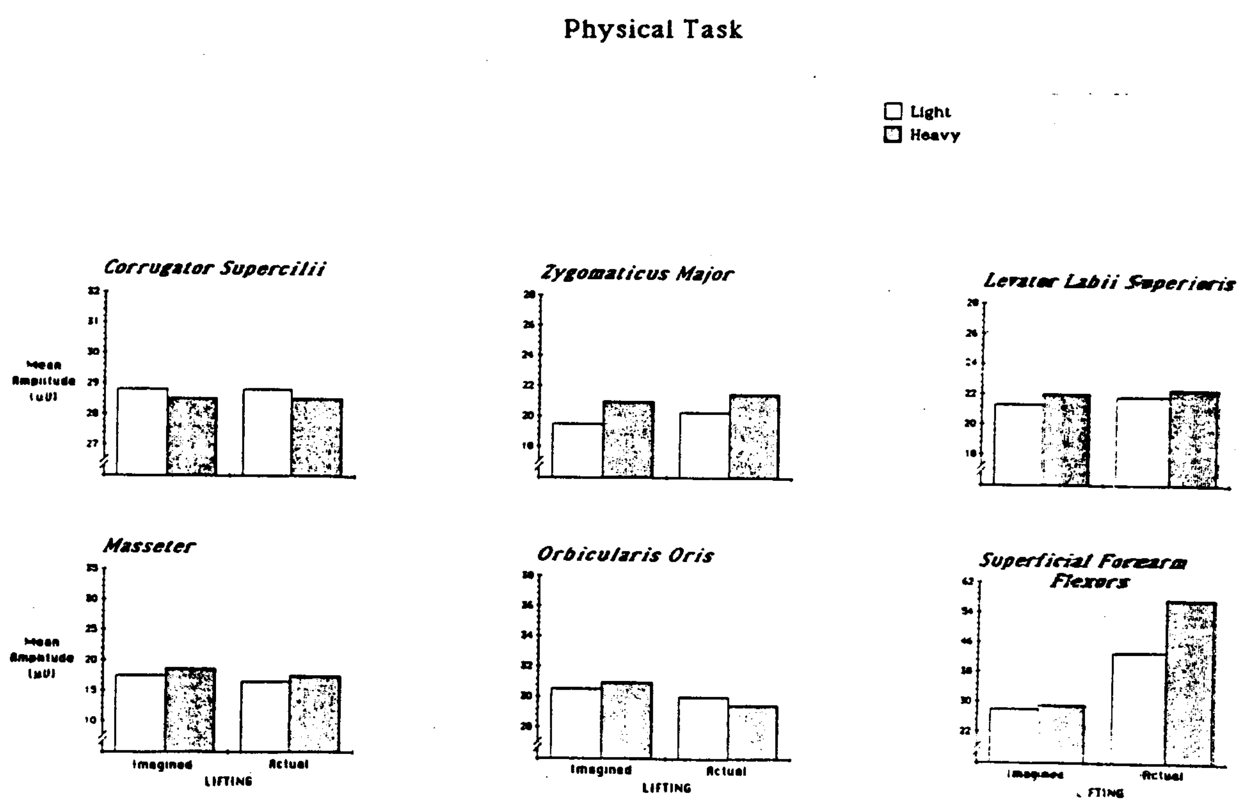

FIGURE 11.4. EMG activity over mimicry muscle regions (top row), and over masseter, perioral, and forearm (bottom row) muscle regions as a function of physical tasks (adapted from Cacioppo, Petty, & Marshall-Goodell, 1984).

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).

The purpose of our initial study was to determine whether perioral (orbicularis oris) EMG activity was higher when subjects performed tasks that 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 determine 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, whereas half were were not at all self-descriptive. Subjects responded yes or no by pressing one of two microswitches. Results revealed several interesting results (see Fig. 11.5). 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 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).

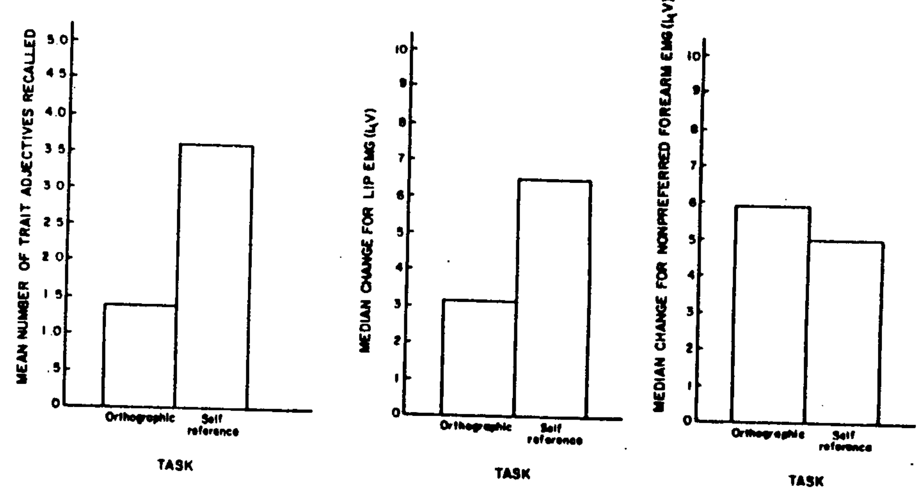

FIGURE 11.5. EMG activity over the perioral region as a function of orthographic and self-referent processing (from Cacioppo & Petty, 1981a).

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; see, also, Cacioppo, Petty, & Morris, 1985). 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 (see Fig. 11.6). 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

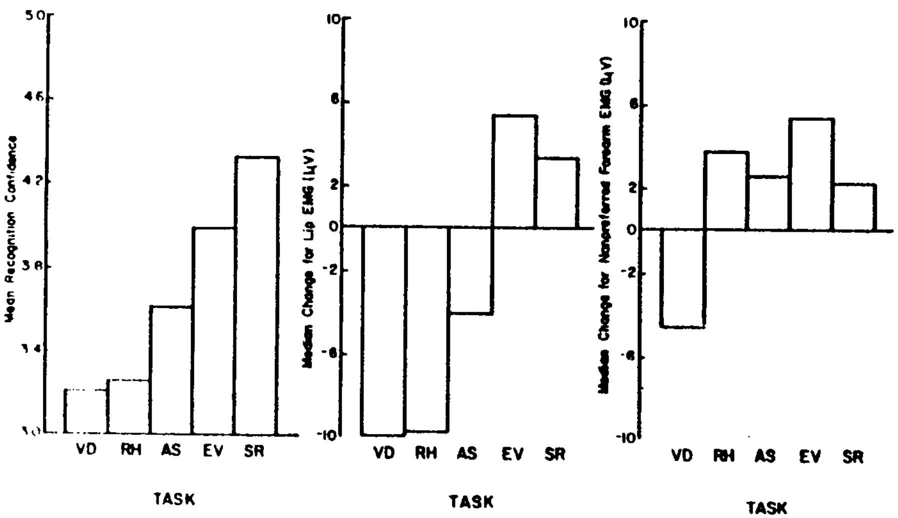

FIGURE 11.6 EMG activity over the perioral region as a function of volume discrimination (VD), rhyme (RH), association (AS), evaluation (EV) and self-reference (SR) tasks (from Cacioppo & Petty, 1981a).

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.

Facial EMG Activity as a Function of Persuasive Appeals. 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 post-experimental questioning rather than processes evoked by the persuasive communication.

An initial study supported the applicability of psychophysiological principles and procedures to the particular communications 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; see Fig. 11.7).

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 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, a newsstory about an archeologi-

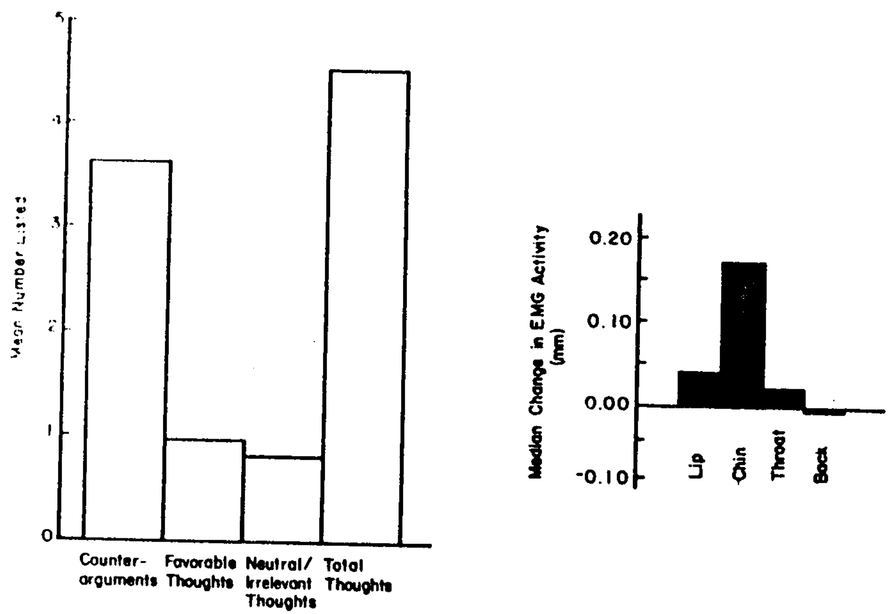

FIGURE 11.7. Thought-listings and EMG activity over the perioral region as a function of a forewarning of an impending, personally involving counterattitudinal appeal (from Cacioppo & Petty, 1981a).

cal 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, as illustrated in Fig. 11.8 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.

Facial EMG as a Function of the Direction and Intensity of Affective Reactions. Finally, physiological measures have traditionally been viewed in communications and social psychology as useful only in assessing general arousal and therefore incapable of distinguishing between positive and negative affective states. The studies reviewed thus far, however, suggest facial EMG patterning is influenced differentially by positive and negative affective states. In addition, most of the studies have involved such mild affective states that autonomic activation was not observed. Recent research has also suggested that these subtle, transient, and distinctive patterns of facial EMG activity vary in magnitude with the intensity of the affective states (Cacioppo, Petty, Losch, & Kim, 1986). Subjects were exposed to slides of moderately unpleasant, mildly unpleasant, mildly pleasant, and moderately pleasant scenes. 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

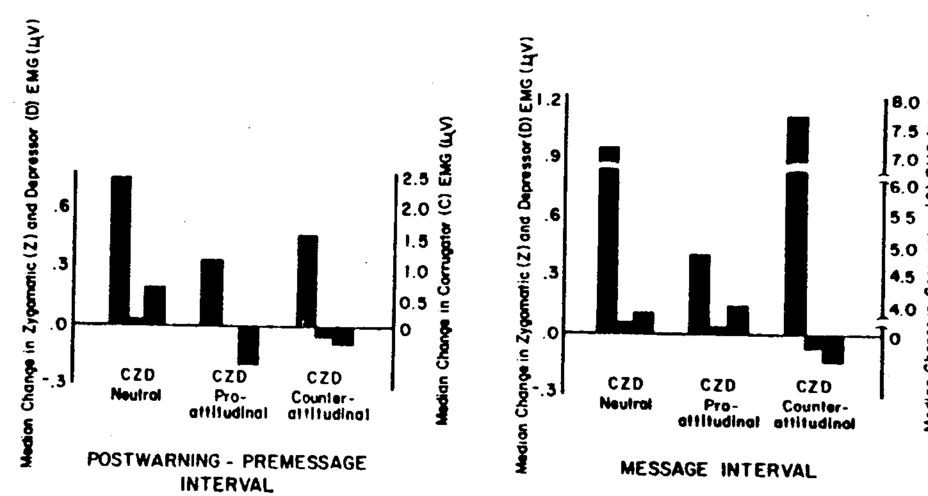

FIGURE 11.8. Facial EMG activity as a function of a forewarning and presentation of a proattitudinal, neutral, and counterattitudinal communication (from Cacioppo & Petty, 1981a).

TABLE 11.1
Mean Verbal Descriptions and Electromyographic Responses as a Function of Affective Valence and Intensity

Measure	Negative: Moderately	Negative: Mildly	Positive: Mildly	Positive: Moderately
Verbal descriptions				
Liking	2.09_a	5.23_b	5.78_c	8.42_d
Arousal	6.64_a	5.27_b	4.94_b	5.08_b
Familiarity	3.16_a	4.82_b	5.50_c	5.74_c
Electromyographic responses*				
Corrugator supercilia	47.37_a	46.21_b	45.27_b	42.22_c
Zygomatic major	23.12_a	23.50_{ab}	24.04_b	24.16_b
Orbicularis oculi	28.39_a	28.56_a	28.83_a	30.32_b
Orbicularis oris	33.02_a	33.73_a	32.82_a	33.58_a
Medial frontalis	29.07_{ab}	29.35_b	28.65_a	28.82_{ab}
Superficial forearm flexor	23.50_a	23.56_a	23.25_a	23.57_a

Note. Means in a row with a similar subscript do not differ significantly by the Duncan multiple-range test ($p < .05$).

*Entries represent the mean amplitude of transformed scores for 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 (see Table 11.1). 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, Losch, Tassinary, & Petty, 1986; Cacioppo & Petty, 1981a).

INFERENTIAL CONTEXT: AFFIRMING THE CONSEQUENT ERRORS AND REVERSE ENGINEERING DESIGNS

It should be emphasized that the psychological processes in these studies (such as the extent and affectivity of covert information processing) are viewed as being *an* antecedent rather than *the* antecedent of the observed physiological reaction. What is known about the physiological system underlying the physiological

endpoint and the context in which the measures are obtained, therefore, a[re] considered in order to derive specific hypotheses with limited ranges of constru[ct] validity and application. For instance, Ekman (1972) and Friesen (1972) hav[e] demonstrated, facial actions are clearly controllable and serve deceptive as we[ll] as communicative and emotionally expressive functions. The EMG patternin[g] observed in this research is subtle and is easily distorted, requiring optima[l] experimental conditions to obtain (cf. Cacioppo, Petty, & Marshall-Goodell, 1984; Fridlund & Cacioppo, 1986).

Moreover, psychophysiological assessments often are useful to social psy[-] chologists and communication researchers only to the extent that they can inf[er] the presence or absence of a particular antecedent or process (e.g., negativ[e] affect) when a particular target physiological response (e.g., corrugator EMG activity) is observed. Yet, a point often not fully appreciated when one ceases t[o] think of psychophysiology as a reductionistic search for invariants, is that *know[-] ing that a given factor (e.g., silent language processing; general arousal) lead[s] to a particular physiological response (e.g., perioral EMG activation; increase[d] electrodermal activity) is a necessary but not sufficient reason for such a[n] inference*. This is because research that establishes the cause-outcome rela[-] tionship A leads to B does *not* imply that given B, A was the antecedent or tha[t] given not-B, A was absent. For example, increased electrodermal (EDA) is evoked by a variety of factors, ranging from stress to novelty to arousal t[o] significant events. To infer that a person was physiologically aroused based simply on increased EDA, therefore, is to commit a logical error (i.e., affirming the consequent).

How can one avoid this logical error while also using physiological responses as markers of communication processes? One way is to also consider: (a) what is known about the likelihood of observing the target physiological response in the experimental context in the *absence* of the psychological antecedent of interest; and (b) the likelihood that the psychological antecedent leads to something other than the target physiological response in the experimental context when interpret[-] ing the physiological data. There are, in fact, two studies of this type that address the psychophysiological links we have suggested using what might be termed *reverse engineering* designs.

Facial EMG as a Marker of Affect. The research reviewed previously, for instance, has linked EMG activity over the corrugator supercilii muscle region to negative emotional imagery and to negative affective reactions to auditory, visu[-] al, and social stimuli. The question addressed in a recent study (Cacioppo, Petty, & Martzke, 1987) is whether distinctive bursts of activity over the corrugator supercilii muscle region during a social interaction was associated with more negative thoughts and images than periods in which EMG activity over this region was quiescent. Pilot research suggested that the form of the EMG burst might provide additional information about the nature of emotional thoughts and images. To examine these issues, undergraduate women were recruited to participate in a study on self-disclosure. Following a recruitment meeting, during which time the procedures were described and a plausible cover story was presented, subjects were interviewed individually while unobtrusive videorecordings and recordings of facial EMG activity (integrated using a time-constant of .20 seconds) and verbalizations were obtained. Subjects were seated in a dimly illuminated room and were asked to close their eyes and relax throughout the interview. Following adaptation to the lab, subjects were asked to talk about themselves with the goal of disclosing their underlying nature. The interviewer, who was located in a separate room and was blind to experimental condition, sought descriptions ranging from the superficial (e.g., physical attributes, demographics) to the intimate (e.g., perceived strengths and inadequacies, traumatic experiences). Throughout the interview, two other experimenters blind to the experimental hypothesis identified exemplars of each of four types of EMG responses over the corrugator supercilii muscle region: (a) *control*—quiescent period at least 10 seconds in duration; (b) *mound*—smooth response no longer than 5 seconds characterized by a gradual onset and offset; (c) *cluster*—multimodal response from 1 to 5 seconds characterized by an abrupt onset and offset; and (d) *spike*—unimodal response with sharp onset and offset. To assure these periods were otherwise comparable, exemplars were selected only if the individual was speaking, and EMG activity over the corrugator region did not reflect a blink or generalized activation of the facial muscles.

Immediately following the interview, the interviewer conducted a videotape reconstruction with the subject. Subjects were shown the entire videorecording, which was paused at 20 separate segments (five randomly selected exemplars from each of the four response types just identified). At each pause, subjects were asked to report what thoughts and images "flashed through their minds" at that moment during the interview, and the entire videotape reconstruction was audiotaped. Subjects returned within a few days for a final session, at which time they rated each of the 20 reported recollections along the differential emotions scale and in terms of how self-disclosive and personally insightful was the recollection. The results are summarized in Fig. 11.9. Analyses revealed the ratings of the associations recalled during control and spike intervals were equivalently positive and nondisclosive; those recalled during EMG clusters and mounds were rated as being relatively negative and self-disclosive. It is possible that the EMG spikes over the corrugator region marked more transient negative affect that were so transient that subjects failed to recall or repressed the experience during videotape reconstruction. For instance, subjects were subsequently classified as sensitizer or repressor based on a median split of their scores on the Byrne repression/sensitization scale, and subjects' ratings of the thoughts and images that covaried with EMG spikes and control intervals were contrasted. Results revealed that repressors tended to rate the thoughts and images covarying with EMG spikes over the corrugator muscle region as less "insightful" than those that occurred during control intervals, whereas sensitizers revealed the opposite pattern.

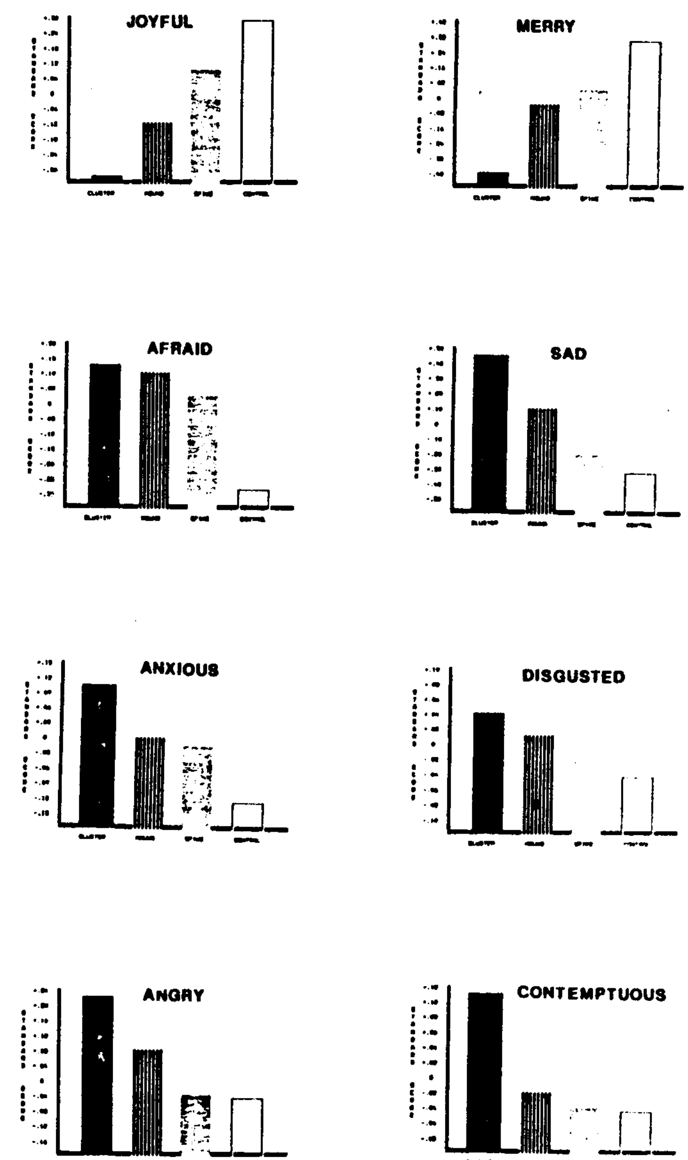

FIGURE 11.9. Mean ratings of their thoughts and associations as a function of the form of EMG discharge observed (from Cacioppo, Petty, & Martzke, 1986).

Perioral EMG as a Marker of Silent Language Processing. Shimizu and Inoue (1986) reported a conceptually similar study regarding perioral EMG activity as a marker of silent language processing. Electroencephalographic (EEG), electrooculargraphic (EOG), perioral EMG, and nonoral EMG activity were recorded as subjects slept. Subjects were awakened during either rapid eye movement (REM) or State 2 sleep—as determined by inspection of the EEG and EOG recordings. When subjects reported dreaming, subjects were asked whether or not they had been speaking in their dreams. Dream recall during REM sleep occurred in approximately 80% of the awakenings, and it occured during State 2 sleep in approximately 28% of the awakenings. Awakenings without dream recall were excluded from further analyses, as were awakenings preceded by phasic discharges in the perioral musculature that were accompanied by any vocalization. Results revealed the following: (a) When phasic discharges over the perioral musculature were observed within the 30 seconds preceding the awakening, subjects reported having been speaking in their dreams in 88% of the awakenings from REM sleep and 71% of the awakenings during State 2 sleep; (b) when phasic discharges over the perioral musculature were not observed within the 30 seconds preceding the awakening, subjects reported having been speaking in their dreams in only 19% of the awakenings from REM sleep and in 0% of the awakening's during State 2 sleep; (c) when phasic discharges over the nonoral rather than perioral musculature were observed within the 30 seconds preceding the awakening, subjects reported having been speaking in their dreams in only 28% of the awakenings from REM sleep and in 0% of the awakenings during State 2 sleep; and (d) when phasic discharges were not observed over any region within the 30 seconds preceding the awakening, subjects reported having been speaking in their dreams in 62% of the awakenings from REM sleep and in 43% of the awakenings during State 2 sleep.

In summary, previous research had indicated that negative affective reactions influenced the EMG activity over the corrugator supercilii muscle region and that silent language and numeric processing influenced the EMG activity over the perioral muscle region. The research just reviewed further suggests that phasic EMG discharges over the corrugator supercilii and over the perioral muscle region can be used to mark episodes of negative affect and silent language processing, respectively. In addition, the results of both studies raise interesting questions about the sensitivity of these somatic markers, at least within these measurement contexts, too difficult to report affective and cognitive events.

CONCLUSION

The conceptualization of the psychophysiological enterprise as involving the identification of episodic markers of behaviorally relevant cognitive and affective processes is a fairly recent development in psychophysiology and is still

sometimes misunderstood (cf. Cacioppo & Petty, 1985, 1986). At least part of this misunderstanding has a factual basis and a long history. For instance, Allport (1947) cited the following as being said by Carlston during a then-recent presidential address to the American Psychological Association:

> I believe that robotic thinking helps precision of psychological thought, and will continue to help it until psychophysiology is so far advanced that an image is nothing other than a neural event, and object constancy is obviously just something that happens in the brain. (p. 185)

Allport's criticisms of reductionism and of the search for psychophysiological invariants to explain social behavior, as well as his early defense of social cognition were cogent and influential. But rather than questioning the charge that the promise of psychophysiology was to generate a list of physiological invariants, Allport rejected the entire approach to the study of communication and behavior:

> In taking stock of the situation I observe how many of us seem so stupefied by admiration of physical science that we believe psychology in order to succeed need only imitate the models, postulates, methods and language of physical science. If someone points out the present inutility of mechanical models in predicting anything but the most peripheral forms of human behavior, we are inclined to reply: "Wait a thousand years." (p. 182)

Given recent developments in psychophysiology, perhaps it is time that we reconsider Allport's protests against the psychophysiological enterprise.

ACKNOWLEDGMENT

Preparation of this chapter was supported by National Science Foundation Grant Nos. BNS-8414853 and BNS-8444909 to JTC.

REFERENCES

Allport, G. W. (1947). Scientific models and human morals. *Psychological Review, 54*, 182–192.

Allport, G. W. (1969). The historical background of modern social psychology. In G. Lindzey & E. Aronson (Eds.), *The handbook of social psychology* (2nd ed., pp. 1–80). Reading, MA: Addison-Wesley.

Ax, A. F. (1964). Goals and methods of psychophysiology. *Psychophysiology, 1*, 8–25.

Bem, D. J. (1972). Self-perception theory. *Advances in Experimental Social Psychology, 6*, 1–61.

Bower, G. H., & Gilligan, S. G. (1979). Remembering information related to one's self. *Journal of Research in Personality, 13*, 420–432.

Baddeley, A. D. (1978). The trouble with levels: A reexamination of Craik and Lockhart's framework for memory research. *Psychological Review, 85*, 139–152.

Brock, T. C. (1967). Communication discrepancy and intent to persuade as determinants of counterargument production. *Journal of Experimental Social Psychology, 3*, 269–309.

Cacioppo, J. T., Losch, M. E., Tassinary, L. G., & Petty, R. E. (1986). Properties of affect and affect-laden information processing as viewed through the facial response system. In R. A. Peterson, W. D. Hoyer, & W. R. Wilson (Eds.), *The role of affect in consumer behavior: Emerging theories and applications* (pp. 87–118). Lexington, MA: D. C. Heath.

Cacioppo, J. T., & Petty, R. E. (1979a). Attitudes and cognitive response: An electrophysiological approach. *Journal of Personality and Social Psychology, 37*, 2181–2199.

Cacioppo, J. T., & Petty, R. E. (1979b). Lip and nonpreferred forearm EMG activity as a function of orienting task. *Biological Psychology, 9*, 103–113.

Cacioppo, J. T., & Petty, R. E. (1981a). Electromyograms as measures of extent and affectivity of information processing. *American Psychologist, 36*, 441–456.

Cacioppo, J. T., & Petty, R. E. (1981b). Electromyographic specificity during covert information processing. *Psychophysiology, 18*, 518–523.

Cacioppo, J. T., & Petty, R. E. (1985). Physiological responses and advertising effects: Is the cup half full or half empty? *Psychology and Marketing, 2*(2), 115–126.

Cacioppo, J. T., & Petty, R. E. (1986). Social processes. In M. G. H. Coles, E. Donchin, & S. Porges (Eds.), *Psychophysiology: Systems, processes, and applications* (pp. 646–679). New York: Guilford Press.

Cacioppo, J. T., & Petty, R. E. (in press). Stalking rudimentary processes of social influence: A psychophysiological approach. In M. P. Zanna, J. M. Olson, & C. P. Herman (Eds.), *Social influence: The Ontario symposium* (Vol. 5) Hillsdale, NJ: Lawrence Erlbaum Associates.

Cacioppo, J. T., Petty, R. E., Losch, M. E., & Kim, H. S. (1986). Attributions of responsibility for helping and harmdoing: Evidence for confusion of responsibility. *Journal of Personality and Social Psychology, 50*, 100–105.

Cacioppo, J. T., Petty, R. E., & Marshall-Goodell, B. (1984). Electromyographic specificity during simple physical and attitudinal tasks: Location and topographical features of integrated EMG responses. *Biological Psychology, 18*, 85–121.

Cacioppo, J. T., Petty, R. E., & Martzke, J. S. (1987). *Facial electromyographic responses index emotions during self-disclosures.* Manuscript submitted.

Cacioppo, J. T., Petty, R. E., & Morris, K. J. (1985). Semantic, evaluative, and self-referent processing: Memory, cognitive effort, and somatovisceral activity. *Psychophysiology, 22*, 371–384.

Cacioppo, J. T., & Sandman, C. A. (1981). Psychophysiological functioning, cognitive responding, and attitudes. In R. E. Petty, T. M. Ostrom, & T. C. Brook (Eds.), *Cognitive responses in persuasion* (pp. 81–104). Hillsdale, NJ: Lawrence Erlbaum Associates.

Cermak, L. S., & Craik, F. I. M. (Eds.). (1979). *Levels of processing in human memory*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Chaiken, S. (in press). The heuristic model of persuasion. In M. P. Zanna, J. M. Olson, & C. P. Herman (Eds.), *Social influence: The Ontario Symposium (Vol. 5)*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Cialdini, R. B. (1984). Principles of automatic influence. In J. Jacoby & C. S. Craig (Eds.), *Personal selling: Theory, research, and practice* (pp. 1–28) Lexington, MA: D. C. Heath.

Cialdini, R. B., & Petty, R. E. (1981). Anticipatory opinion effects. In R. E. Petty, T. M. Ostrom, & T. C. Brock (Eds.), *Cognitive responses in persuasion*. (pp. 217–236). Hillsdale, NJ: Lawrence Erlbaum Associates.

Craik, F. I. M. (1979). Human memory. *Annual Review of Psychology, 30*, 63–102.

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General, 104*, 268–294.

Donchin, E. (1982). The relevance of dissociations and the irrelevance of dissociationism: A reply to Schwartz and Pritchard. *Psychophysiology, 19*, 457–463.

Edfeldt, A. W. (1960). *Silent speech and silent reading*. Chicago: University of Chicago Press.

Ekman, P. (1972). Universal and cultural differences in facial expressions of emotion. In J. Cole (Ed.), *Nebraska symposium on motivation, 1971* (Vol. 19). Cambridge: Cambridge University Press.

Ekman, P. (1982). Methods of measuring facial action. In K. R. Scherer & P. Ekman (Eds.), *Handbook of methods in nonverbal behavior research* (pp. 45–90). Cambridge: Cambridge University Press.

Ekman, P., & Friesen, W. V. (1975). *Unmasking the face*. Englewood Cliffs, NJ: Prentice Hall.

Faaborg-Anderson, K., & Edfeldt, A. W. (1958). Electromyography of intrinsic and extrinsic laryngeal muscles during silent speech: Correlation with reading activity. *Acta Otolaryngologica, 49*, 478–482.

Ferguson, T. J., Rule, B. G., & Carlson, D. (1983). Memory for personally relevant information. *Journal of Personality and Social Psychology, 44*, 251–261.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fowles, D. C. (1980). The three arousal model: Implications of Gray's two-factor learning theory for heart rate, electrodermal activity, and psychopathy. *Psychophysiology, 17*, 87–104.

Fridlund, A. J., & Cacioppo, J. T. (1986). Guidelines for human electromyographic research. *Psychophysiology, 23*, 567–589.

Fridlund, A. J., & Izard, C. E. (1983). Electromyographic studies of facial expressions of emotions and patterns of emotion. In J. T. Cacioppo & R. E. Petty (Eds.), *Social psychophysiology: A sourcebook* (pp. 243–286). New York: Guilford Press.

Friesen, W. V. (1972). *Cultural differences in facial expression in a social situation: An experimental test of the concept of display rules*. Unpublished doctoral dissertation, University of California, San Francisco.

Garrity, L. I. (1977). Electromyography: A review of the current status of subvocal speech research. *Memory and Cognition, 5*, 615–622.

Graham, J. L. (1980). A new system for measuring nonverbal responses to marketing appeals. *1980 AMA Educator's Conference Proceedings, 46*, 340–343.

Greenwald, A. G. (1968). Cognitive learning, cognitive response to persuasion, and attitude change. In A. Greenwald, T. Brock, & T. Ostrom (Eds.), *Psychological foundations of attitudes* (pp. 147–170). New York: Academic Press.

Hefferline, R. F., Keenan, B., & Harford, R. A. (1959). Escape and avoidance conditioning in human subjects without their observation of the response. *Science, 1*, 1338–1339.

Henneman, E. (1980). Organization of the motoneuron pool: The size principle. In V. B. Mountcastle (Ed.), *Medical physiology* (14th ed., Vol. 1, pp. 718–741). St. Louis: Mosby.

Izard, C. E. (1971). *The face of emotion*. New York: Appleton-Century-Crofts.

Izard, C. E. (1977). *Human emotions*. New York: Plenum.

Kaplan, H. B., & Bloom, S. W. (1960). The use of sociological and social-psychological concepts in physiological research: A review of selected experimental studies. *Journal of Nervous and Mental Disorders, 131*, 128–134.

Keenan, J. M., & Baillet, S. D. (1980). Memory for personally and socially significant events. In R. S. Nickerson (Ed.), *Attention and performance VIII*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Kunst-Wilson, W. R., & Zajonc, R. B. (1980). Affective discrimination of stimuli that cannot be recognized. *Science, 207*, 557–558.

Langer, E., Blank, A., & Chanowitz, B. (1978). The mindlessness of ostensibly thoughtful action: The role of "placebic" information in interpersonal interaction. *Journal of Personality and Social Psychology, 36*, 635–642.

Love, R. E. (1972). *Unobtrusive measurement of cognitive reactions to persuasive communications.* Unpublished doctoral dissertation, Ohio State University.

Mayo, C., & LaFrance, M. (1977). *Evaluating research in social psychology.* Monterey, CA: Brooks/Cole.

McCaul, K. D., & Maki, R. H. (1984). Self-reference effects on memory: A reply to Ferguson, Rule, and Carlson. *Journal of Personality and Social Psychology, 47,* 953–955.

McGuigan, F. J. (1970). Covert oral behavior during silent performance of language tasks. *Psychological Bulletin, 74,* 309–326.

Mesulam, M., & Perry, J. (1972). The diagnosis of lovesickness: Experimental psychophysiology without the polygraph. *Psychophysiology, 9,* 546–551.

Miller, N., & Baron, R. S. (1973). On measuring counterarguing. *Journal for the Theory of Social Behavior, 3,* 101–118.

Miller, N., Maruyama, G., Baeber, R., & Valone, K. (1976). Speed of speech and persuasion. *Journal of Personality and Social Psychology, 34,* 615–625.

Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior, 16,* 519–533.

Petty, R. E., & Cacioppo, J. T. (1977). Forewarning, cognitive responding and resistance to persuasion. *Journal of Personality and Social Psychology, 35,* 645–655.

Petty, R. E., & Cacioppo, J. T. (1983). The role of bodily responses in attitude measurement and change. In J. T. Cacioppo & R. E. Petty (Eds.), *Social psychophysiology: A sourcebook* (pp. 51–101). New York: Guilford Press.

Porges, S. W., & Coles, M. G. H. (1976). *Psychophysiology: Benchmark papers in animal behavior* (Vol. 6). Stroudsburg, PA: Dowden, Hutchinson & Ross.

Rajecki, D. W. (1983). Animal aggression: Implications for human aggression. In R. G. Green & E. I. Donnerstein (Eds.), *Aggression: Theoretical and empirical reviews* (Vol. 1, pp. 189–211). New York: Academic Press.

Rankin, R. E., & Campbell, D. T. (1955). Galvanic skin response to Negro and white experimenters. *Journal of Abnormal and Social Psychology, 51,* 30–33.

Riddle, E. M. (1925). Aggressive behavior in a small social group. *Archives of Psychology,* No. 78.

Rinn, W. E. (1984). The neuropsychology of facial expression: A review of the neurological and psychological mechanisms for producing facial expression. *Psychological Bulletin, 95,* 52–77.

Rogers, T. B., Kuiper, N. A., & Kirker, W. S. (1977). Self-reference and the encoding of personal information. *Journal of Personality and Social Psychology, 35,* 677–688.

Scherer, K. R., & Ekman, P. (1982). *Handbook of methods in nonverbal behavior research.* Cambridge: Cambridge University Press.

Shapiro, D., & Schwartz, G. E. (1970). Psychophysiological contributions to social psychology. *Annual Review of Psychology, 21,* 87–112.

Shimizu, A., & Inoue, T. (1986). Dreamed speech and speech muscle activity. *Psychophysiology, 23,* pp. 210–214.

Smith, C. E. (1936). The autonomic excitation resulting from the interaction of individual opinion and group opinion. *Journal of Abnormal and Social Psychology, 30,* 138–164.

Steiner, J. E. (1979). Human facial expression in response to taste and smell stimulation. *Advances in Child Development and Behavior, 13,* 257–295.

Sternbach, R. A. (1966). *Principles of psychophysiology: An introductory text and readings.* New York: Academic Press.

Stewart, D. W. (1984). Physiological measurement of advertising effects. *Psychology and Marketing, 1,* 43–48.

Tognacci, L. N., & Cook, S. (1975). Conditioned autonomic responses as bidirectional indicators of racial attitude. *Journal of Personality and Social Psychology, 31,* 137–144.

Tomkins, S. S. (1962). *Affect, imagery, consciousness: Vol. 1. The positive affects.* New York: Springer.

Tulving, E. (1978). Relation between encoding specificity and levels of processing. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory* (pp. 19–92). New York: Guilford Press.

Valins, S. (1966). Cognitive effects of false heart rate feedback. *Journal of Personality and Social Psychology, 4,* 400–408.