

Attitudes and Cognitive Response: An Electrophysiological Approach

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Two experiments employed electrophysiological procedures for assessing the covert information-processing activity of message recipients. In Experiment 1, 24 subjects expected to hear discrepant communications and were requested to "collect their thoughts" following each forewarning. As discrepancy increased, anticipatory counterargumentation increased, whereas production of favorable thoughts and agreement decreased. In addition, following forewarnings oral muscle, cardiac, and respiratory activity increased, whereas nonoral muscle activity remained constant and quiescent. In Experiment 2, 60 subjects anticipated and heard a proattitudinal, a counterattitudinal, or a neutral communication. They evaluated more positively and generated more favorable thoughts and fewer counterarguments to the proattitudinal than to the counterattitudinal advocacy, but rated similarly the neutral and proattitudinal advocacies. As in Experiment 1, incipient oral muscle activity increased following the forewarning of an involving *counterattitudinal* advocacy; it also increased for all conditions during the message. Patterns of subtle facial muscle changes reflected the affective nature of the cognitive responding before and during the message. These results provide evidence that electrophysiological assessments offer objective, concurrent, and independent measures of cognitive response in persuasion, and support the notion of recipients as active information processors when topic involvement is high.

Recent work in attitude change has emphasized the manner in which persons process the information contained in persuasive messages. Investigators have studied how such variables as source credibility (Cook, 1969; Gillig & Greenwald, 1974), distraction (Petty, Wells, & Brock, 1976), message repetition (Cacioppo & Petty, 1979), message comprehensibility (Eagly, 1974), forewarning of per-

suasive intent (Petty & Cacioppo, 1979a) and of topic and position (Petty & Cacioppo, 1977), number of arguments employed (Caldler, Insko, & Yandell, 1974), issue involvement (Petty & Cacioppo, 1979b), heart rate (Cacioppo, 1979), group discussion (Burnstein & Vinokur, 1977), and so forth affect the profile of cognitions (e.g., counterarguments, favorable thoughts, neutral thoughts), and attitude change. Theoretical interest in the influence on persuasion of a person's idiosyncratic cognitive responses to an advocacy is certainly not new (cf. Hovland, Lumsdaine, & Sheffield, 1949), but the present level of research activity in the area marks a shift in emphasis toward this approach (cf. Petty, Ostrom, & Brock, in press). The reinvigorated interest in these covert thought processes stems in part from the apparent inability of classical learning theories to provide parsimonious accounts of observed attitude changes (Greenwald, 1968; Petty, 1977),

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Sandman, & Walker, 1978; Edwards & Alsip, 1969); and (f) observing the cognitive and attitudinal effects of exogenously manipulated heart rate (Cacioppo, 1979). The cardiac response generally covaries with the cognitive requirements or difficulty of the task, particularly when the task requirements are substantial. Although considerable controversy still exists in psychophysiology regarding the neurophysiological and/or biological processes controlling the heart rate responses observed in the aforementioned studies, the empirical link between the cardiac response and cognitive activity seems well established. Whether the cardiac acceleration observed during the performance of cognitive tasks is initiated by a metabolic control center (cf. Obrist et al., 1970) or by a modulating negative feedback system (cf. Lacey, 1967) is unimportant here. Central to the present study is the finding that the cardiac response reflects considerable changes in cognitive activity, even when these changes are spontaneous and self-induced (Schwartz, 1971; Schwartz & Higgins, 1971).

Methodological Considerations

Several methodological safeguards were instituted here to assure that the electrophysiological measures we observed reflected covert information processing. First, a measure of general (nonlinguistic) somatic activity was obtained in addition to the measures of oral EMG and cardiac activity. To the extent that the activation is specific to the speech muscle fibers and heart rate when processing an external event, we are more confident that we have tapped covert processing rather than irrelevant (i.e., unreliable) movements, postural shifts, and so forth. Second, the level of heart rate and EMG activity observed while anticipating and processing the stimulus was compared with prestimulus measures to assess whether or not electrophysiological "response" actually occurred (McGuigan, 1970). And third, Miller and Baron (1973) have suggested that observations of oral EMG (and cardiac) activity may not differentiate the cognitive elaboration of the advocacy from the covert rehearsal of the arguments constituting the persuasive message. One of our aims was to

determine the *existence* of cognitive-response processes in persuasion; hence, we obtained recordings of the electrophysiological measures while subjects were *anticipating* highly involving and counterattitudinal advocacies as well as while subjects were processing them. A good deal of evidence documenting that anticipating a discrepant and involving message evokes issue-relevant cognitive responding has accrued using the thought-listing procedure (Cacioppo, Petty, & Snyder, 1979; Petty & Cacioppo, 1977; Cialdini & Petty, in press).

Experiment 1

The aim of Experiment 1 was primarily methodological. We sought to test the utility of an electrophysiological assessment of cognitive response. To do so, we forewarned individuals that they would hear a (counterattitudinal) message and we asked them to "collect their thoughts" about the issue. Immediately preceding our forewarning, we collected basal measures of physiological response, and we continued to record these measures while the individuals were anticipating the discrepant message (i.e., when they presumably were following instructions and were generating cognitive responses concerning the advocacy). We expected oral EMG and cardiac activity, but not general somatic activity, to be heightened during the "collect thoughts" interval, compared to basal levels.

Confirmation of these expectations would illustrate the applicability and utility of electrophysiological techniques for studying cognitive response in persuasion. Obtaining these results would *not*, of course, provide evidence that cognitive responses in persuasion are generated naturally, since we asked the individuals to collect their thoughts following the forewarning. A second experiment addressed this latter issue.

A second aim of Experiment 1 was to explore the effects of affect- and nonaffect-laden cognitive responding on electrophysiological response patterns. Neither oral EMG (cf. Garrity, 1977; McGuigan, 1978) nor cardiac activity (Cacioppo & Sandman, 1978; Harris, Katkin, Lick, & Habberfield, 1976) appear to

distinguish the types of affective response evoked, though differentiation between affect- and non-affect-laden thought sequences using heart rate has been observed (Schwartz, 1971). The discrepancy of the impending advocacy was manipulated in Experiment 1 to obtain gradations of affect-laden processing to assess its physiological effects. Additionally, the thought-listing procedure was used to explore the relationships among the cognitive (e.g., favorable thoughts, counterarguments, neutral/irrelevant thoughts) and electrophysiological (e.g., oral EMG, heart rate) responses.

Method

Subjects and Design

Three replications of eight male undergraduates were conducted. Subjects were tested individually, with assignment to replication determined randomly. A $3 \times 3 \times 2 \times 2$ mixed design was employed in which the three replications served as a between-subjects factor, and levels of communication discrepancy (low, moderate, and high), two different topics within each level of discrepancy, and interval during which electrophysiological measures were recorded (prewarning baseline and postwarning "collect thoughts" interval) served as within-subjects factors. (The interval factor was relevant only to the analyses of the electrophysiological measures.)

Materials

A separate audiotape was prepared for each of the three replications. Each tape contained the experimental instructions and six announcements regarding the source of, topic of, and position to be advanced in an upcoming message. (In fact, however, the messages were never presented.) Each level of discrepancy for each topic appeared in one replica-

tion. The tapes (i.e., replications) differed in the order of the topics, which was determined randomly for each replication. The experimental stimuli are displayed in Table 1.

Procedure

When subjects arrived at the laboratory, they were placed in a sound-attenuated room and were seated in a comfortable chair. Electrodes were attached for measuring oral (orbicularis oris—lips; digastricus—chin; platysma—throat) EMG activity, nonspeech (trapezius—back) EMG activity, heart rate, breathing rate, and cephalic pulse amplitude. A 5-minute adaptation period preceded the experimental trials.

Subjects were told that in about 40 minutes they would hear several different messages having direct consequences for undergraduates, and that before the presentation of the messages we should like to obtain their comments on and evaluations of the position (i.e., advocacy) to be advanced in each message. The subjects were asked to sit quietly and collect their thoughts for the minute following each announcement; then, at the experimenter's signal, subjects were asked to list everything about which they had been thinking (subjects were given 3 minutes to do so), to rate their agreement with the upcoming advocacy, and to complete several ancillary measures (i.e., felt effort, involvement, distraction, and responsibility). The nature of these forms is described in detail in Petty and Cacioppo (1977). The forewarning, collect thoughts, and thought-listing intervals were repeated six times to cover six different topics, each separated by a variable intertrial interval (ITI) ranging from 90 to 120 seconds. Each ITI was initiated when the experimenter requested the subjects to "please sit quietly for the next minute or so." The final 60 seconds of each ITI served as the baseline measure for the subsequent 60-second "collect thoughts" interval.

Chin muscle activity. Two Grass E55 cup electrodes filled with Grass EKG Sol were placed on the midline of the chin; the first was placed 1.8 cm above the point of the chin and the second was

Table 1
Experimental Stimuli

Source	Topic	Discrepant position		
		Low	Moderate	High
University board of regents	Increasing student tuition by . . .	\$5.00	\$40.50	\$90.00
State medical association	Increasing drinking age to . . .	19 years	21 years	25 years
Member of state legislature	Increasing gasoline sales tax by . . .	2¢	5¢	10¢
University faculty committee	Graduate students teaching all . . .	freshmen	freshmen & sophomores	freshmen & juniors
President of the university	Extending finals by . . .	2 days	5 days	9 days
County municipal courts	Increasing traffic fines by . . .	25%	100%	300%

placed 1.8 cm below the point of the chin. Following Cacioppo et al. (1978), chin muscle activity was calculated for the 60-sec intervals of interest using the following formula:

$$\text{Activity index} = \sum_{i=1}^n \frac{(l_i \times s_i)}{l_i}$$

where s_i is the scale value of a particular amplitude of EMG activity (larger amplitude EMG activity was assigned larger scale values; scale values ranged from 0, for deflections 2 mm or less, to 5, for deflections exceeding 2 cm); l_i is the total horizontal length (i.e., time) of a particular scale value of EMG activity measured in millimeters; and n is the number of distinct instances of a particular amplitude of EMG activity. The data were quantified in this manner for the 60-sec baseline and collect thoughts intervals.

Lip muscle activity. Two Grass E5S cup electrodes filled with Grass EKG Sol were placed 1 mm below the bottom lip; each was placed .5 cm in from the ends of the mouth. Lip muscle activity was calculated using the activity index described above.

Throat muscle activity. Two Grass E5S cup electrodes filled with Grass EKG Sol were placed off midline of throat; the first was placed approximately 1.0 cm to the right of and level with the midpoint of the throat, and the second was placed approximately 1.0 cm to the left and 1.0 cm above the midpoint. Throat muscle activity was calculated using the activity index described above.

Back muscle activity. Subjects were asked to place their fingertips on their collarbone while the electrodes were secured. Two Grass E5S cup electrodes filled with Grass EKG Sol were placed over the trapezius muscle group. The first was placed 4.0 cm outward from the midline of the line passing between the first thoracic and seventh cervical vertebrae, and the second was placed halfway between the spine and the head of humerus (near the point of the shoulder). Back muscle activity was calculated using the activity index described above.

Heart rate. Grass E5S cup electrodes filled with EKG Sol were placed over the lower left rib cage and the right collar bone. The signal was amplified by a Grass wide-band AC preamplifier. Heart rate was calculated by counting the number of beats that occurred in the 1-minute intervals of interest.

Breathing rate. The respirometer was a sliding piston (consisting of a photocell and a small light) mounted on an elastic band and placed around the subject's chest (Shmavonian, Miller, & Cohen, 1968). Breathing rate was calculated by counting the number of cycles (to the nearest half cycle) occurring in the intervals of interest.

Cephalic pulse amplitude.³ A photoplethysmograph was placed over the supraorbital notch (above the eyebrow), providing a relative measure of blood volume in the supraorbital artery. The photoplethysmograph was comprised of three light-emitting diodes (LED), radiating 100 μ W of light output at

660 nanometers. The LEDs were spaced at 120° on a radius of 6.3 mm around a high-speed photoconductor, and resistance changes were recorded with a Grass oscillograph. Cephalic pulse amplitude was calculated for the intervals of interest using the following formula:

Amplitude index =

$$\frac{\text{pulse amplitude in mm} \times \text{total mV/cm calibration}}{\text{standard sensitivity in mV/cm}}$$

where total mV/cm was the sensitivity of the preamp settings for a given subject, and the standard sensitivity was 1 mV/cm.

Data reduction. Physiological processes were monitored during the 1 minute preceding and following each of the six forewarnings. Persons scoring the electrophysiological data were unaware of the experimental hypotheses and of the treatments with which the data were associated.

The Grass Model 7 polygraph used in the experiment was equipped with three preamplifiers capable of measuring electromyographic activity. Since four EMG measures were of interest in the experiment, a random procedure was used to determine which three of the four EMG measures would be recorded for each subject within a replication. However, all electrode placements were prepared on each subject, and the subject was unaware of the dummy electrode placements. Difference scores relative to the prewarning levels were computed for each electrophysiological measure.

The subjects classified their cognitive response in a manner described by Petty and Cacioppo (1977): After listing their thoughts, subjects were instructed to place a plus (+) next to those thoughts that were in favor of the advocacy, a minus (-) next to those thoughts opposed to the advocacy, and a zero (0) next to those thoughts that were either neutral toward or irrelevant to the advocacy. Frequency counts served as measures of cognitive response.

³ A photoplethysmograph was placed over the supraorbital artery just above the eye. The amount of light reflected back onto the photoplethysmograph is inversely proportional to the amount of blood between the photoplethysmograph and the supraorbital notch (over which it was placed). Brain blood perfusion was assumed to be indirectly related to the relative volume changes of the pulse wave that traveled to the brain via the supraorbital artery. Pulse rate was not considered to be important because of the venous return mechanism, which drains the blood from a given body area at approximately the same rate as the blood is delivered to that area (Wallace & Wallace, 1968). The validity of this measure, however, has not yet been firmly established. The plethysmograph used in these studies was developed by Robert Isenhardt. More information about the plethysmograph is provided in Sandman, McCanne, Kaiser, and Diamond (1977).

Results and Discussion

Measurements of the seven electrophysiological dependent measures (chin, lip, throat, and back EMG activity, heart rate, breathing rate, and cephalic pulse amplitude) were obtained the minute preceding and following each forewarning. Parametric analyses of the questionnaire data were conducted while non-parametric analyses of the electrophysiological data were conducted, since the latter data were not distributed normally (cf. Schwartz, Fair, Salt, Mandel, & Klerman, 1976a, 1976b).

Cognitive Response, Agreement, and Ancillary Measures

We expected topic-relevant cognitive responding and agreement to be affected in a particular manner by discrepancy, but we had no particular expectations regarding neutral thought production and the ancillary measures. Hence, we set the experimentwise error rate at .10 and distributed this protection unequally across the tests (i.e., .05 for counterargumentation, favorable thought production, and agreement; .05 for the remaining five measures). We used Bonferroni-adjusted critical values for all tests, conducted two-tailed tests throughout, allocated 99% of the alpha associated with the contrasts for the first set of variables into the tail corresponding to the predicted direction of the effect (saving 1% as acknowledgment that opposite rather than predicted results sometimes obtain), and allocated 50% of the alpha associated with the tests for the second set of variables into each tail.⁴ Further, the Huynh and Feldt (1970) test for the homogeneity of treatment-difference variance (η^2_{TDV}) was conducted for each dependent measure (cf. Harris, 1975, pp. 125-127).⁵ These tests revealed a violation of the η^2_{TDV} assumption only for the measure of neutral thoughts, $\chi^2(2) = 8.11$. Neutral thought production was unaffected by discrepancy even with a positively biased F ratio.

The means for all cognitive response, agreement, and ancillary measures are summarized in Table 2. The analyses indicated that increasing the discrepancy between the subjects'

Table 2

Mean Responses to Thought Listing and Questionnaire Measures for Low, Moderate, and High Levels of Communication Discrepancy: Experiment 1

Measure	Mean		
	Low	Moderate	High
Primary			
Agreement	4.08	3.96	2.67
Counterarguments	2.04	2.73	3.40
Favorable thoughts	1.33	1.00	.63
Neutral thoughts	1.04	.77	.58
Ancillary			
Effort	7.35	8.42	8.42
Involvement	7.50	8.60	8.56
Distraction	3.98	3.40	2.90
Responsibility	6.81	7.96	7.42

Note. Entries for cognitive response measures indicate the mean frequency obtained in thought listings. Entries for questionnaire items are mean response to 11-point scale items in which higher numbers indicated more agreement, effort, involvement, distraction, and responsibility. Twenty-four subjects received two forewarnings at each level of discrepancy.

initial positions and the advocated position led to more anticipatory counterargumentation, $F(2, 42) = 8.80$, $p < .01$; production of fewer anticipatory favorable thoughts, $F(2, 42) = 3.70$, $p < .017$; and greater felt effort in preparing cognitively for the message, $F(2, 42) = 5.33$, $p < .01$. One additional test approached significance: Agreement tended to decrease as discrepancy increased, $F(2, 42) = 3.57$, $p < .019$. No other effect or interaction was statistically significant. This pattern of results is similar to that obtained in prior research on cognitive response and agreement as a function of communication discrepancy (Brock, 1967; Cacioppo, 1977).

Electrophysiological Measures

We hypothesized that the activity of the oral muscles and heart rate would increase

⁴ Required for statistical significance by these adjustments were $ps < .017$ for counterarguing, favorable thoughts, and agreement, and $ps < .01$ for the remaining measures.

⁵ We are indebted to Richard Harris for providing a computer program with which to test the η^2_{TDV} assumption.

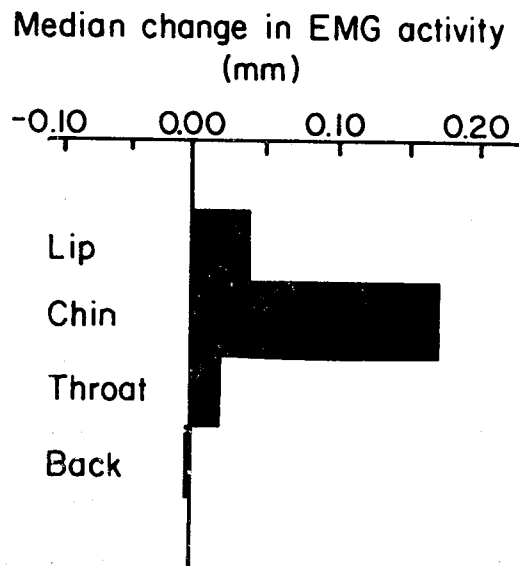


Figure 1. Median change from baseline for lip, chin, throat, and back electromyographic (EMG) activity following a forewarning about an impending counterattitudinal advocacy.

during the collect thoughts interval (relative to basal levels), since we expected cognitive response processes to be reflected electrophysiologically. Strong support for the hypothesis was obtained (see Figure 1). Oral EMG activity was elevated significantly after forewarnings of involving counterattitudinal communications (by the Wilcoxon Test: lip, $p < .001$; chin, $p < .001$; throat, $p < .10$). Also evident in Figure 1, general somatic activity, as measured by back EMG activity, was not altered by the anticipation of the counterattitudinal message ($p > .25$). The Wilcoxon Test for changes from baseline revealed that heart rate ($Mdn = 2.00$ bpm, $p < .02$) and breathing rate ($Mdn = 1.0$ cycle/min, $p < .01$) increased following the forewarning as well, whereas cephalic pulse amplitude was left unchanged ($Mdn = 0.00$). No other comparisons were significant statistically.⁶

Correlational Analyses

The affective intensity of the cognitive responses, which was varied by increasing communication discrepancy, did not affect the electrophysiological activity monitored in this

study. Canonical correlations between the cognitive responses (i.e., counterarguments, favorable thoughts, neutral/irrelevant thoughts) and the relevant electrophysiological measures (i.e., lip, chin, throat, and cardiac activity) were computed within each level of discrepancy to determine whether the predicted relationship between cognitive and electrophysiological activity existed and to explore whether any association existed between the affective nature of the covert processing and electrophysiological activity. The correlations were respectable ($r = .47$ for low discrepancy conditions; $r = .44$ for moderate discrepancy conditions; and $r = .64$ for high discrepancy conditions). When a canonical correlation was calculated, collapsing across the levels of discrepancy, a coefficient of .42 was obtained.

Furthermore, the electrophysiological *specificity* obtained in this research is in striking contrast to the massive and diffuse arousal associated with the fight-or-flight reaction of extreme emotional states (Cannon, 1927) and misattribution phenomena (Schachter, 1964; see also, Rhodewalt & Comer, 1979).

The calculation of within-cells correlations among cognitive responses and agreement revealed that anticipatory counterargumentation correlated negatively with agreement ($r = -.67$, $p < .01$), favorable thoughts ($r = -.67$, $p < .01$), and neutral thoughts ($r = -.45$, $p < .01$). Favorable thoughts correlated positively with agreement ($r = .72$, $p < .01$).⁷

⁶ Subjects were asked to count to five aloud and to move and tense slightly in their chair before the completion of the experiment to assess the validity of the EMG electrode placements. Trapezius EMG activity increased during body tensing and movements. Lip and chin EMG activity increased during overt oral behavior (counting aloud), whereas the throat EMG placement proved to be a relatively insensitive measure.

⁷ Analysis of covariance procedures were employed to explore some of the possible causal sequences of cognitive responding and attitude change. It should be noted, however, that these procedures do not *prove* that a particular causal model is operating. These analyses were conducted here to assess if the reduced agreement found with increasing discrepancy possibly resulted from counterargumentation. Pre-

Within-cell correlations further revealed that unfavorable thoughts were positively correlated with ratings of effort ($r = .42, p < .05$), involvement ($r = .43, p < .05$), and responsibility ($r = .29, p < .05$), and correlated negatively with ratings of distraction ($r = -.29, p < .05$). None of the electrophysiological measures was correlated significantly with any ancillary measure.

In sum, electrophysiological and thought-listing measures indicated that topic-relevant cognitive responding accompanied the anticipation of an involving counterattitudinal communication. Inspection of Figure 1 supports the notion that cognitive response processes in persuasion can be measured concurrently and without the subject's doing anything overt in particular (e.g., listing thoughts). Of course, no evidence was provided in Experiment 1 concerning the natural existence or elicitation of cognitive response in persuasion, since the subjects were aware that they were to list their thoughts; in fact, they had been instructed to collect their thoughts following each forewarning. We were also unable to distinguish electrophysiologically the affective natures of the recipients' covert preparations for the advocacy.

viously we have found that topic-relevant thinking appears to mediate the subsequent agreement with the advocacy (Cacioppo & Petty, 1979; Petty & Cacioppo, 1977), rather than vice versa. We expected the same results from the present study. (See Insko et al., 1974, for an extended rationale for the use of analyses of covariance [ANCOVA] with attitude and cognitive response measures.)

A series of analyses of covariance were performed in which agreement served as the criterion and each cognitive response (one per analysis) served as the covariate. A second series of covariance analyses was performed in which agreement served as the covariate and each cognitive response served as the criterion. The results of these analyses revealed only that the covariate, counterarguments, reduced the overall F ratio for the discrepancy factor for agreement: the F statistic for agreement was reduced from a significant 3.57 to a nonsignificant 1.70 ($df = 2, 41$). The analysis of covariance with counterarguments as the criterion and agreement as the covariate did not eliminate the significant F ratio for counterarguments, ANCOVA $F(2, 41) = 5.53$. These analyses are consistent with the notion that increasing discrepancy increased counterargumentation, which then reduced agreement.

We conducted a second experiment to address these issues.

Experiment 2

The first issue, that of providing electrophysiological evidence concerning the cognitive responses elicited naturally in persuasion, was addressed easily in the design of Experiment 2. Rather than asking the subjects to collect or list thoughts, we simply monitored the electrophysiological activity displayed during the anticipation and presentation of a single advocacy. Subjects had no notion that they would subsequently be asked to list their thoughts.

The second issue, developing an electrophysiological measure capable of differentiating the affective nature of cognitive responding (should it exist in persuasion), proved to be more difficult. Previous studies of attitudes and bodily reactions have employed three basic research strategies: Procedures have been employed (a) to tap the physiological processes indicating covert information processing (e.g., Experiment 1; Cacioppo, 1979); (b) to measure an evaluative reaction by monitoring a classically conditioned physiological response (e.g., Tognacci & Cook, 1975); and (c) to assess the naturally occurring physiological indicators of affective states (e.g., Cooper, 1959; Hess, 1965). Studies of attitudes applying the third research strategy have often used measures of pupillary response or electrodermal activity (galvanic skin responses). These studies have provided some evidence that attitudes, if extreme, may be measurable. Even in these instances, however, the polarity of the attitude (i.e., positive or negative) has not been distinguishable (Cacioppo & Sandman, in press; Mueller, 1970).

Recent work on the neuromuscular substrates of emotion and depression offered us a potential solution. Darwin (1872) first documented the specificity and reliability of facial muscle patterning in the expression of emotions (cf. Cacioppo & Petty, in press-a). More recently, Schwartz and his colleagues (Schwartz, 1975; Schwartz et al., 1976a, 1976b) have found that generating

imagery or attempting to experience through fantasy the emotional states of happiness, sadness, and anger leads to distinctive patterns of EMG activation of the face. Moreover, these patterns go unnoticed by subjects as well as observers (see also Izard, 1971). We reasoned that by monitoring these facial (i.e., corrugator, zygomatic, depressor angulioris, and mentalis) muscles during the anticipation and presentation of advocacies, we would be able to distinguish favorable from unfavorable (i.e., counterargument) cognitive responses emitted by a recipient. In Experiment 1 and in previous research, we have found oral EMG to distinguish the extent rather than the affectivity of covert processing (e.g., Cacioppo & Petty, in press-b, in press-c). Hence, we considered the measure of mentalis EMG activity, which taps the electrical activity of the muscle fibers between and including the lower lip and chin, as a measure of the extent rather than emotionality of processing (see also McGuigan, 1978). Again, heart rate was recorded.

Method

Subjects and Design

Sixty male undergraduates were led to believe they were evaluating the sound quality of taped radio editorials that had been produced by the students in a sound-engineering course. Electrodes were placed on each subject's body, and subjects were tested individually in a darkened, sound-attenuated room "to reduce external distractions from the task." Forty-eight subjects were forewarned about and heard either a proattitudinal or a counterattitudinal advocacy on one of two topics (alcoholic beverages or visitation hours). Twelve additional subjects were forewarned only that they would hear a taped communication, and they heard a message about an obscure news event. Subjects in this group served in an external control (neutral advocacy) condition. The assignment of subjects to condition again was determined randomly.⁸

Materials

The topics of alcoholic beverages and visitation hours were selected because initial pilot testing revealed existing university regulations regarding them to be highly involving and counterattitudinal. Forewarnings and messages were constructed that advocated the adoption of either stricter (counteratti-

tudinal) or more lenient (proattitudinal) regulations regarding these issues. The neutral message concerned a small archeological find and was obtained from a past issue of a national news magazine.

Procedure

When subjects arrived at the laboratory, they were told that their task was to evaluate the sound quality of a taped radio editorial, that electrodes would be attached, and that during the study we would be recording the involuntary bodily responses that accompany listening to a communication.⁹ Subjects were instructed to refrain from unnecessary movements, to breathe normally, and to keep their eyes closed throughout the study. After adapting to the laboratory, subjects again heard these instructions and were told that the study would begin shortly. At this point, a computer-controlled procedure—which involved (a) a 60-sec prewarning (baseline) interval, (b) a 15-sec forewarning, (c) a 60-sec postwarning-premessage interval, and (d) a 120-sec message—was initiated.

After listening to the tape, the subjects read the following:

Because your own opinion about the position advocated on the tape may influence the way you rate the quality of the tape, we would like to obtain a measure of how you feel about the views proposed by the speaker on each scale below.

The subjects responded to four 9-point semantic differentials; their responses were summed to obtain a measure of their attitude toward the advocacy. In the same manner as in Experiment 1, subjects were instructed to list everything about which they had thought during the message (subjects were given 3 minutes). Afterwards, subjects rated their listed thoughts as favorable (+), unfavorable (-), or neutral/irrelevant (0) toward the message. Subjects then rated on 11-point Likert-type scales their felt involvement, effort, and distraction, the personal relevance of the message, the sound quality of the tape, and the speaker's rate of delivery and enthusiasm.

Heart rate. Grass E5S cup electrodes filled with Grass EC3 paste were placed over the lower left rib and the right collar bone. The signal was amplified

⁸ An additional factor included in the design was whether subjects were informed that the communication had implications locally or not. Manipulation checks revealed that our manipulation of this factor failed here, so this factor is not discussed further.

⁹ Electroencephalographic measures were obtained also, the results of which are to be reported elsewhere, since they were collected to address a different issue. Suffice it to say that enough electrodes were attached to subjects to make the cover story concerning the measurement of involuntary processes seem entirely plausible to them.

by a Narco Biosystem Physiograph AC preamplifier. The output was displayed on a Narco Biosystem Physiograph 6 and was transmitted on-line to a PDP-8I laboratory computer for analysis.

Facial muscle activity. Grass E5S cup electrodes filled with Grass EC3 paste were placed adjacent to each other in pairs with interelectrode resistance reduced to less than 10,000 ohms. The four muscles over which the pairs of electrodes were placed were the corrugator (just above the eyebrow), zygomatic (upper cheek), depressor anguli oris (lower cheek), and mentalis (between lip and chin) on the left side of the face (cf. Schwartz et al., 1976a). Since surface electrodes were used, recordings of EMG activity were obtained from these and surrounding muscle groups.

Each EMG measure was amplified by a Narco Biosystem Physiograph AC preamplifier, individually rectified and summed by an EMG integrator with a time constant of .2 sec. The average integrated EMG was displayed on the physiograph with a full-scale pen deflection of 40 mm (1 mm = 7.5 μ V). The integrated EMG also was transmitted on-line to the PDP-8I laboratory computer, sampled 10 times per second, and recorded. The computer was programmed to eliminate from its recordings any obvious movement artifact or overt (e.g., visually detectable) facial expression.

Data reduction. The cognitive data were scored in the same manner as in Experiment 1. Physiological responses were monitored during the minute preceding the forewarning through the completion of the 120-sec message. The data for each measure were averaged for each subject and each interval. Difference scores relative to the prewarning (basal) levels were calculated for each measure and interval, and nonparametric analyses were employed, since the data were not distributed normally. The presentation here of the results for facial EMG activity is similar in format to the presentation by Schwartz et al. (1976a, 1976b) to facilitate comparisons.

Results and Discussion

Our purposes in this study were to determine if cognitive responses were generated naturally in persuasion settings and, if so, whether or not the *affective nature* of these responses could be assessed electrophysiologically. A multivariate analysis of variance of the 11 questionnaire measures was conducted first to determine the general effects of the experimental factors. As expected, the effect of position was highly significant, based on Wilks' lambda, $F(11, 30) = 3.63$, $p < .01$, and the effect of topic was not significant, $F(11, 30) = 1.74$, $p > .11$. Hence, all analyses reported below are collapsed across the topic factor.

Table 3

Mean Cognitive and Attitudinal Responses as a Function of the Affectivity of the Advocacy: Experiment 2

Measure	Pro-attitudinal	Counter-attitudinal	Neutral
Evaluation of the taped advocacy	27.04	16.75 ^a	25.00
Counterarguments	2.00	3.54	2.17
Favorable thoughts	2.34 ^a	1.13	1.25
Neutral/irrelevant thoughts	2.04	1.54 ^a	3.33
Total thoughts	6.38	6.23	6.74

^a The mean differs from the corresponding neutral mean at the .05 level by Dunnett's test.

Cognitive Response, Attitude, and Ancillary Measures

Subjects anticipated and listened to a proattitudinal advocacy, a counterattitudinal advocacy, or a neutral communication, and rated their evaluation of and thoughts about the taped presentation. As is evident from an inspection of the means in Table 3 for these measures, the proattitudinal advocacy was evaluated more positively, $F(1, 40) = 30.37$, $p < .001$, and elicited more favorable thoughts, $F(1, 40) = 6.58$, $p < .02$, and fewer counterarguments, $F(1, 40) = 6.50$, $p < .02$, than did the counterattitudinal advocacy.

The Dunnett test for comparisons involving an external control mean (Kirk, 1968) was employed to determine the relative effects of the proattitudinal and counterattitudinal communications relative to the neutral communication on cognitive and attitudinal responding. These comparisons revealed that the neutral communication differed from the counterattitudinal communication in evaluation and in the number of neutral/irrelevant thoughts elicited ($ps < .05$); in addition, these communications differed marginally in the number of counterarguments elicited ($p < .10$). On the other hand, the neutral and proattitudinal communications were evaluated and were thought about similarly (see Table 3). Evidently the subjects enjoyed hearing our "neutral" message about an archeological dig.

Analyses of the ancillary measures and ratings of tape quality failed to produce any significant effects.

Electrophysiological Measures

All tests of the significance of changes from prewarning baselines for the electrophysiological measures were conducted using two-tailed Mann-Whitney tests.

Does cognitive responding occur naturally?

The analyses of covert oral (mentalis) EMG activity, which was the most sensitive measure of covert processing in Experiment 1, indicated that it was elevated during the postwarning-premessage interval for the *counterattitudinal* condition ($Mdn = .24 \mu V$, $p < .03$). This finding replicates that of Experiment 1, but here was obtained without explicit requests for subjects to collect their thoughts. Interestingly, oral EMG activity was *not* altered significantly during this interval in the *proattitudinal* or *neutral* conditions ($ps > .15$). Still, the *presentation* of a message, whether it was *proattitudinal*, *counterattitudinal*, or *neutral*, led to increased oral EMG activity ($Mdn = .43 \mu V$, $1.21 \mu V$, and $1.26 \mu V$, respectively, $ps < .03$). Also, as in Experiment 1, the affective nature of the covert processing was not distinguishable by oral EMG; the mentalis activity did not differ as a function of position. The analyses of heart rate indicated that this measure was less sensitive than oral EMG activity, as differences from basal levels were evident only during the presentation of the communications (*counterattitudinal* $Mdn = .73$ bpm; *proattitudinal* $Mdn = .36$ bpm; *neutral* $Mdn = 2.68$ bpm; $ps < .05$). Finally, changes in heart rate during the communication were greater for the *neutral* than for the *counterattitudinal* ($p < .03$) and the *proattitudinal* ($p < .04$) conditions. The cause of this difference is not immediately apparent, but the news story about the archeological find may have required more thought to comprehend or elaborate, producing greater accelerations of heart rate.

Is the emotional tone of this cognitive activity distinguishable? We next sought to determine if the affective nature of the cogni-

tive responses was distinguishable by the pattern of *facial* EMG activity. Schwartz and his associates have demonstrated that pleasant states (e.g., happiness) lead to less corrugator and more zygomatic and depressor EMG activity than do unpleasant states (e.g., sadness, anger), with corrugator EMG activity providing the most discriminating measure (Schwartz, Fair, Salt, Mandel, Mieske, & Klerman, 1978). Figure 2 displays the median change from baseline for these measures as a function of position and interval in the present study.

Several findings are evident immediately upon inspection of Figure 2. First, only corrugator activity was altered during the announcement of the *forewarning* (upper panel), with greater and equal activation relative to baseline appearing in all conditions ($ps < .01$). Less evident in the upper panel of Figure 2 is the marginally significant tendency for zygomatic activity to discriminate between the *counterattitudinal* and *neutral* forewarnings ($p < .06$).

During the *postwarning-premessage* interval (middle panel of Figure 2), corrugator activity remained elevated from basal levels ($ps < .02$), though a significant decrease from the *forewarning* level was displayed in the *proattitudinal* condition ($p < .01$). Between-group comparisons yielded a nonsignificant difference in corrugator activity between the *proattitudinal* and *counterattitudinal* conditions ($p < .11$), with the direction of the difference that which would be expected from Schwartz and his colleagues' research. That is, corrugator activity was higher when anticipating the *counter* than *proattitudinal* advocacy. Finally, the activity in the zygomatic muscle region in the *neutral* condition was enhanced relative to basal levels ($p < .03$) and distinguished this condition from the group anticipating a *counterattitudinal* advocacy ($p < .01$). This too is consistent with the previous studies of emotional fantasy and imagery (cf. Schwartz, 1975). No other differences were statistically significant.

The *presentation* of the messages (lower panel of Figure 2) resulted in elevated corrugator EMG activity relative to basal ($ps < .01$) and *postwarning-premessage* levels (ps

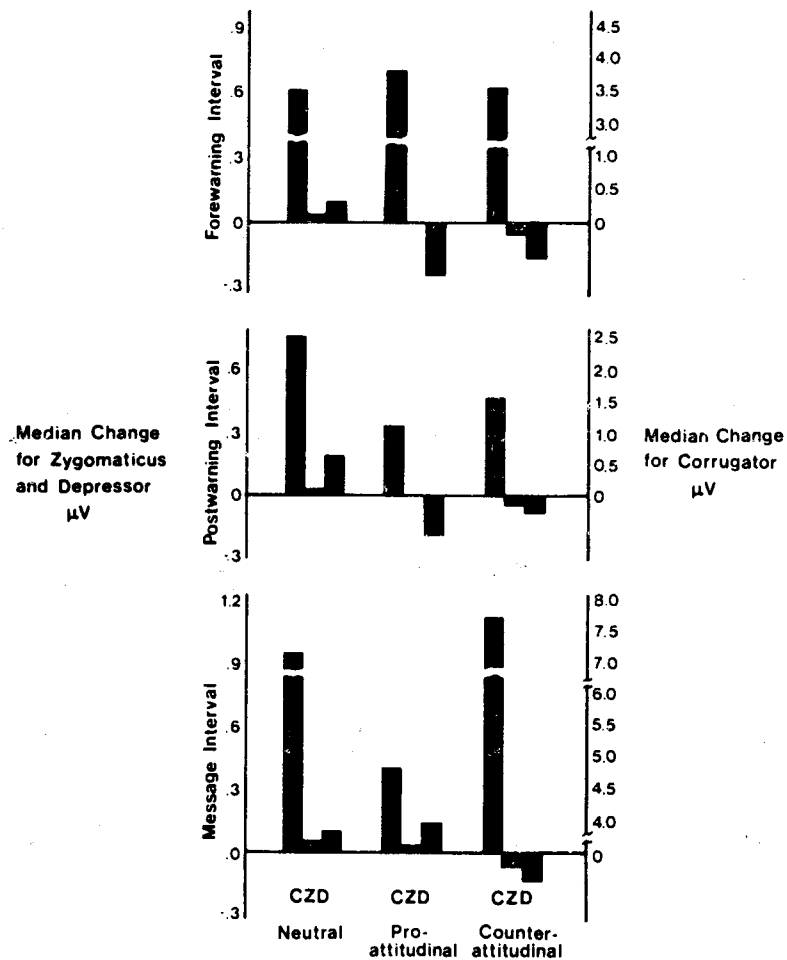


Figure 2. Median change from baseline for corrugatory (C), zygomaticus (Z), and depressor (D) electromyographic activity during the forewarning (top panel), postwarning-premessage (middle panel), and message (bottom panel) intervals. (The data are displayed separately for subjects who anticipated and heard the neutral [$n = 12$], proattitudinal [$n = 24$], and counterattitudinal [$n = 24$] advocacies.)

< .01); in addition, it was elevated marginally during this interval compared to forewarning levels ($p < .06$). The zygomatic activity continued to differentiate the affectivity of the covert processing: Zygomatic EMG activity during the counterattitudinal message was lower than that displayed during baseline ($p < .05$), the proattitudinal message ($p < .01$), and the neutral message ($p < .05$). Furthermore, the zygomatic activity during the proattitudinal message was significantly greater than its basal level and marginally greater than its forewarning ($p < .08$) and postwarning-premessage levels ($p <$

.08). Similarly, depressor EMG activity was enhanced marginally during the proattitudinal message compared to its postwarning-premessage level ($p < .06$) and compared to the counterattitudinal message ($p < .10$), effects also similar to those found by Schwartz et al. (1976a, 1976b). No other comparisons approached statistical significance.

In sum, oral EMG activity increased from baseline after the forewarning of an impending and involving *counterattitudinal* communication, even though we did not request subjects to collect their thoughts and subjects were unaware that they would be asked to list

their thoughts, heard only one forewarning and message, and had no reason to suspect the purpose of our measurements. Furthermore, anticipating and hearing proattitudinal, counterattitudinal, and neutral communications led to distinctive and predictable patterns of facial EMG activity during the stimulus sequence. Specifically, less corrugator and more zygomatic activity was observed in the proattitudinal and neutral conditions than in the counterattitudinal condition. The activity of the depressor muscle region, for the most part, was unaffected by the affectivity or interval of the communication sequence. The differences that *were* observed, however, were as predicted: Depressor activity tended to be greater during the proattitudinal and neutral communications than during the counterattitudinal communication. Finally, although the patterns of facial EMG activity were similar for the neutral and proattitudinal conditions, there was a high degree of similarity between these conditions in the cognitive and evaluative responses as well.

Correlational Analyses

Canonical correlations between the cognitive responses (i.e., counterarguments, favorable thoughts, neutral thoughts) and electrophysiological scores (i.e., heart rate, mentalis, corrugator, zygomatic, and depression EMG activity) were calculated, once using the physiological responses for the postwarning-premessage interval, and once using the responses for the message interval. Since thought listings were obtained immediately following the message interval, the canonical correlation between thoughts and the bodily responses from this interval should show the strongest association; but physiological responses from both intervals should correlate somewhat with the listed thoughts. Correlations were .30 for the postwarning-premessage interval and .46 for the message interval, $\chi^2(15) = 7.20$ and 16.20, respectively, *ns*. Hence, the covariation of cognitive and electrophysiological response was weak by these indices, but the latter index was stronger than the former, as expected.

Calculations of within-cell correlations

among the cognitive response data revealed that, as in Experiment 1, counterargumentation correlated negatively with the attitude toward the communication ($r = -.30$, $p < .05$) and favorable thoughts ($r = -.41$, $p < .05$), whereas favorable thoughts correlated positively with attitude ($r = .45$, $p < .05$).

General Discussion

Theory and research in persuasion have focused recently on the covert idiosyncratic responses of individuals. In this article, we have reported two experiments describing the theory for and development of electrophysiological procedures for assessing this covert cognitive activity. Moreover, the evidence obtained suggests strongly that cognitive response processes are evoked naturally, at least when the advocacy is involving and counterattitudinal.

In Experiment 1, we found that subjects who had been asked to collect their thoughts about an upcoming discrepant message exhibited increased oral muscle, cardiac, and respiratory activity, whereas nonoral somatic activity remained constant and quiescent. These results are in accord with research in cardiovascular psychophysiology (e.g., Lacey et al., 1963) and with the literature on the electromyographic concomitants of thought (Jacobsen, 1973; McGuigan, 1978; Sokolov, 1972). Further, these results demonstrate that cognitive responses in persuasion settings are measurable concurrently and reliably, without asking the subject to respond overtly during the measurement and without the subject's awareness of the purpose or focus of the (electrophysiological) measurement instruments.

A second experiment was conducted to provide answers to two important questions: (a) Do subjects engage normally in active, covert processing when anticipating and hearing persuasive appeals? (b) If so, can the emotional tone of this cognitive activity be assessed electrophysiologically? Using an electromyographic technique to measure subtle responses of the facial muscles, we found that the forewarning of a counterattitudinal, but not a proattitudinal or neutral, communication

led to elevated oral EMG activity. Furthermore, the anticipation and presentation of counterattitudinal, proattitudinal, and neutral communications led to active though covert processing activity, the affective nature of which was revealed in the concomitant patterning of facial EMG activity.¹⁰

Cognitive Encoding or Elaboration?

It might be argued that the increased oral muscle activity indexed silent rehearsals rather than cognitive elaborations of the message arguments (cf. Miller & Baron, 1973). Listening to prose does cause a slight increase in oral muscle activity (McGuigan & Bailey, 1969a). Hence, comprehending and rehearsing the message arguments probably contributed to the elevated oral muscle activity exhibited *during the message presentation*. However, the *anticipation* of a counterattitudinal advocacy led to elevated speech muscle activity when there were no message arguments to rehearse. One might argue that subjects were rehearsing the forewarning and potential message arguments, stopping to generate counterarguments only when asked by the experimenter at the end of the study to "list everything about which you thought." Besides the absence of parsimony, this explanation fails to account for the subtle facial expressions indicating affect-laden cognitive responding that was displayed while subjects awaited the message. More persuasively, this explanation cannot account for the failure of subjects who were expecting a proattitudinal message to display significant increases in oral muscle activity during the postwarning-premessage interval.

Cognitive, Attitudinal, and Electrophysiological Response

According to the cognitive response analysis, a forewarning of an upcoming and involving discrepant communication elicits preparatory cognitive activity (e.g., anticipatory counterargumentation) in an effort to rally one's cognitive defenses (Cialdini et al., 1976; McGuire & Papageorgis, 1962; Petty & Cacioppo, 1977). Interestingly, there are no

studies in the literature that report the effects of anticipating a proattitudinal message that collected thought listings. We believe that anticipating a counterattitudinal as compared to a proattitudinal message generally results in deeper processing (i.e., more extensive cognitive preparation—Cacioppo & Petty, 1979). This difference may be attributable to the relative importance in defending from attack one's attitudes and beliefs (e.g., avoiding cognitive inconsistency), or to the relative thought that was devoted previously to (or scripts developed for) proattitudinal rather than counterattitudinal positions. The present study does not consider which of these interpretations is most plausible.

It should be noted that the observation of greater oral EMG activity being obtained when anticipating a counterattitudinal rather than proattitudinal or neutral communication does *not* imply that oral EMG activity is a measure of "counterargumentation." Indeed, the results of both experiments suggest it is not. As mentioned above, we believe that the cognitive preparation for a counterattitudinal rather than a proattitudinal or neutral message elicits more extensive processing, which may result in the generation of counterarguments, favorable thoughts, *and/or* neutral thoughts. Accordingly, the activation of the oral muscles reflects this difference in the extent of cognitive elaboration rather than the affectivity of the processing. Evidence that oral EMG reflects this depth of processing has been found in a study in which subjects viewed a word and identified whether it was printed in uppercase letters (shallow processing) or was self-descriptive (deep processing—Cacioppo & Petty, in press-b, in press-c). We found that deeper processing resulted in elevated speech EMG activity.

Finally, a word might be said about the

¹⁰ Love (1972) attempted to detect subtle changes in facial expression by videotaping the shoulders and face of subjects as they listened to an advocacy. Raters then scored the nonverbal cues emitted by these subjects. This measure proved to be insensitive to the experimental manipulations. The electrophysiological approach illustrated here has the advantage of being sensitive to subtle changes in responding by recipients.

sensitivity and specificity of the electrophysiological measures employed. The procedures we employed for scoring these responses eliminated obvious movement artifacts and facial expressions (the number of the edits did not differ across the experimental conditions); hence, we intentionally confined ourselves to the study of covert electrophysiological responses. Nevertheless, in this research, oral EMG activity has been a more sensitive measure of covert information processing than heart rate (see also McGuigan, 1978). Heart rate and speech muscle activity increased following the forewarning of an upcoming discrepant message, but the change in heart rate in Experiment 2 was not significant statistically; heart rate *did* increase significantly during the presentation of the communications, although again, the electromyographic measures proved more sensitive. Similarly, the various measures of facial EMG activity were not equally sensitive to affect-laden processing. Schwartz and his colleagues (1976a, 1976b, 1978) have found, as we here have found, that corrugator EMG activity best distinguishes subtle affective states. These instances of differing sensitivity, or response discordance, illustrate a point made by the Lacey's (e.g., 1959, 1967) regarding the specificity of autonomic and somatic activation. Moreover, this remarkable specificity contrasts sharply with Cannon's (1927) theory of physiological arousal and emotion, and provides unique evidence for cognitive response processes in persuasion.

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