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Psychophysiological Functioning, Cognitive Responding, and Attitudes

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INTRODUCTION

How are psychological phenomena such as attitudes and cognitive responses related to physiological processes? The question is thousands of years old and has frustrated generations of philosophers and scientists (cf. Ural, 1975). Indeed, Schopenhauer (1788-1860) was moved by the magnitude and complexity of this question to call it *the world knot*. This puzzle continues to mystify philosophers and scientists. Recently, scientists, particularly psychologists, have broken this overall question down into smaller subquestions. Some of these subquestions have been deemed inappropriate for scientific study, whereas empirical evidence has been collected that bears on some of the remaining subquestions. In this chapter, we consider the present state of evidence and theory pertaining to physiological processes as they relate to attitudes and cognitive response.

In the first part of this chapter, we discuss and evaluate some popular physiological techniques for measuring attitudes. These techniques can be added to the rating scale methods discussed in Chapter 2. In the second part, we show how cognitive responses may be reflected physiologically. In addition, a psychophysiological model of cognitive responses and attitudes is presented that illustrates that internal physiological factors may affect information processing and cognitive responding much like the external factor of distraction discussed in Chapter 3.

MEASURING ATTITUDES PHYSIOLOGICALLY

The earliest definitions of attitudes were stated in terms of bodily processes. Contemporary definitions of attitudes, however, no longer contain physiological references (see Chapters 1 and 2). Bodily processes are now of interest to investigators of attitude change because of the belief that these processes may reflect the attitude (McGuire, 1966a). Westie and DeFleur (1959) designated two assumptions that were necessary when using self-report measures of attitudes: (1) People can accurately (i.e., are able to) determine their attitude toward an attitude object; and (2) people are willing to disclose this information truthfully to another person (e.g., an experimenter). How much simpler the study of attitudes would be if investigators had a window to a person's thoughts and feelings. Although there are no transparent (physiological) windows of this kind, an understanding of the relationships between cognitive and physiological processes may offer unique data from which investigators can obtain a more complete picture of attitudinal and cognitive responses. Physiological processes most often have been tapped by monitoring bioelectrical activity by placing small discs (electrodes) on various parts of the body and head. This technique, termed *electrophysiological measurement*, provides information about the activity of the nervous system.

Two approaches to the bodily (physiological) assessment of attitudes are discussed in this section. In one approach, an attempt is made to tap the naturally occurring physiological indicators of affective states. The second approach involves an attempt to tap an evaluative reaction by monitoring a classically conditioned physiological response.

Emotional Response Approach

Early researchers hypothesized that the affective (emotional) aspect of the attitudinal reaction to an object was reflected in subsequent physiological activity. This bodily response presumably indicated both the direction and the intensity of the affect associated with the attitude object (cf. Summers, 1970). Hence, attitudinal direction was assessed by monitoring the direction (or pattern) of the physiological response(s), and the strength of the attitude was assessed by measuring the intensity of the response(s). This approach shares a perspective similar to that found in the classical theoretical work of James (1890) and Lange (1888): They argued that each emotional reaction is the result of a unique physiological syndrome or pattern of responses, with the intensity of the emotional state proportional to the intensity of the physiological reaction. (The theory of emotions proposed by James and Lange differs from the emotional response approach in a simple way. The classical Jamesian approach states that the emotional reaction to an attitude object is preceded and determined by the physiological responses; the emotional response approach seeks to monitor physiological responses that could

be a *consequence* of the evaluation of, or emotional reaction to, an attitude object.)

Cannon (1927) criticized the Jamesian concept that each emotional reaction was distinguishable physiologically. The critique was based primarily on anatomical grounds; he proposed instead that *all* emotional reactions were accompanied by the same pattern of general peripheral nervous system activation. He argued that emotional states were the result of a subcortical signal to the cortex that identified the emotion and simultaneously activated all the peripheral bodily responses for "fight or flight." Consequently, an emotional response model based partially on Cannon's (1927) theory of emotions might use the activation of any single physiological response to an attitude object as indicative of the strength of the attitudinal response. The direction of the attitude could not be assessed, however, and the attitudinal response would have to be extreme enough to be accompanied by an emotional reaction when elicited for assessment of attitudinal strength.

The models have in common the assumption that an attitude object elicits an affective (evaluative) reaction that, if strong enough, is accompanied by physiological activity. Most investigations employing the emotional response approach have monitored either electrodermal (skin) activity or pupillary responses. A summary of this research follows.

Electrodermal Activity and Attitudes: Novel Findings. Neurophysiologically, electrodermal activity is mediated by the sympathetic nervous system and is controlled by several *different* cortical and subcortical areas in the brain (Wang & Lu, 1930). In the past, electrodermal activity was thought to indicate the level of "arousal" of an organism. However, electrodermal responding may result from changes in one of various specific neural systems, often without corresponding changes in other responses. Consequently, "the common utilization of electrodermal activity as a relatively monolithic arousal indicator [sic] is a gross and erroneous over-simplification" (Edelberg, 1972, p. 394; see Martin & Venables, 1966; Prokasy & Raskin, 1973, for technical reviews).

Nevertheless, electrodermal activity has been one of the most frequently used physiological measures of arousal in the attitudinal response. Authors have argued that the size and/or frequency of the electrodermal response is related directly to the strength of the affective reaction to an attitude object (cf. Mueller 1970). The most commonly employed electrodermal measure has been the *galvanic skin response* (GSR), which refers to the varying electrical resistance of the skin to a small electrical current passing between two electrodes. Because GSR is thought to reflect the strength but not the direction of an attitude, it is a *unidirectional* measure.

One of the first studies to be conducted in this area was by Smith (1922). He monitored GSR while presenting words to persons and found that GSR deflections accompanied words with emotional meaning more often than words with

neutral meaning. Almost three decades hence, McCurdy (1950) reviewed the literature concerning mental states and electrodermal activity. He found substantial correlations reported (median value was +.75) to exist between the size of an electrodermal response and the vividness of various subjective and emotional experiences. For instance, Dyingier (1931; reported by McCurdy, 1950) presented to subjects a list of words, each of which was rated immediately after its presentation on a 5-point scale ranging from "very pleasant" to "very unpleasant." The electrodermal response was highly correlated ($r = .85$) with the extremity of the rating but was not correlated with whether the stimuli were rated on the pleasant or unpleasant portion of the scale. In other words, the strength of the subjective reaction was reflected in the electrodermal response, whereas the affective direction was not.

Some researchers failed to find any relationship between attitudes and GSR. To account for these failures, Rankin and Campbell (1955) noted that the use of verbal representations rather than actual presentations of attitude objects may have elicited too weak an affective reaction from persons to be detected. To test their notion, Rankin and Campbell (1955) recruited subjects with either extremely favorable or unfavorable attitudes toward blacks for participation in an experiment in which a black graduate student and a white graduate student served as the experimenters (and as the attitude objects). Electrodermal responses were recorded when the black versus the white experimenter entered the room to adjust an electrode on the subject's arm. The results indicated that *all* subjects displayed greater electrodermal activity when the black rather than the white experimenter was in the room. But is this due to unreported prejudices on the part of the "unbiased" subjects or to the insensitivity of the electrodermal response to prejudice? Subsequent experimentation indicated that persons with unfavorable attitudes toward blacks displayed larger electrodermal responses to black experimenters (Porier & Lott, 1967) and photographs of blacks (Vidulich & Krevanick, 1966; Westie & DeFleur, 1959) than persons with favorable attitudes toward blacks.

This result was interpreted as meaning that a relationship between attitudes and electrodermal activity would exist only if the presentation of the attitude object elicited a strong emotional reaction. If the presentation of an attitude object elicited electrodermal responses, one might conclude that the attitude was either very favorable or very unfavorable. For instance, Cooper and Singer (1956) asked 126 subjects to rate and rank 20 ethnic and national groups. Twenty of these 126 subjects revealed extreme attitudes toward their most liked and disliked groups and served subsequently as subjects in a laboratory experiment. Each subject was tested individually, and electrodermal activity was monitored while the experimenter (1) derogated the most liked group, (2) complimented the most disliked group, (3) derogated a group toward which subjects felt neutral, and (4) complimented a group toward which subjects felt neutral. The largest electrodermal responses followed derogatory statements about the most liked

group and complimentary statements about the most disliked group (see fig. 4.1). Cooper and Singer (1956) concluded that the electrodermal activity was indicative of the emotional energy expended and that there was greater emotional energy expended in response to attitude objects with maximum strength (e.g., prejudices) than to attitude objects with minimum strength (e.g., neutral attitudes).

Cooper and Siegel (1956) and Cooper and Pollock (1959) conducted partial replications of this experiment using similar procedures to assess the relationship between electrodermal activity and negative or neutral attitudes. It was again found that increased electrodermal activity was associated with complimentary statements about the most disliked group. (There were no conditions in which the most liked group was derogated in these experiments.) Cooper (1959) stated "Physiological tests support the thesis that prejudicial attitudes are attended by relatively strong emotion [p. 314]."

Although these studies demonstrated electrodermal activation in response to the presentation of certain attitude objects, it may not be the case that the electrodermal activity reflects emotion per se. Indeed, Lacey (1959) has argued that increased electrodermal activity does not necessarily indicate evaluative reactions, even though, as he stated, "the differential magnitude of galvanometric deflections to words is one of the most reliable phenomena in psychology today [p. 163]." For instance, the presentation of strange, novel, or unexpected stimuli

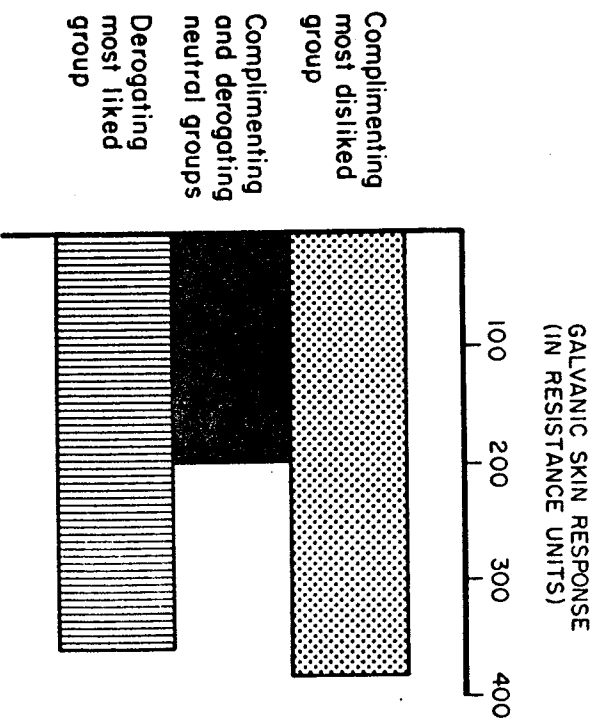


FIG. 4.1. Mean galvanic skin response to verbal stimuli (calculated from data presented in Cooper, 1959).

has been shown to elicit an increase in electrodermal activity (Sokolov, 1963) and to be a component of the orienting or "what is it?" response (Pavlov, 1927). It is possible that the subjects in research such as that just described found an experimenter complimenting their most disliked group to be more novel or surprising than an experimenter complimenting a group toward which they felt neutral. And conversely, when subjects heard the experimenter derogate their most liked group, they possibly were more surprised by the novelty of this behavior than when he derogated a group toward which they felt neutral. Consequently, the increased electrodermal activity found in these experiments (see Fig. 4.1) could be indicative of the unexpected nature of the stimuli rather than of the "emotional energy" expended in the *attitudinal reaction* to the stimuli. Whereas in either case, the physiological measure might be used to assess an attitude, the novelty interpretation offered here ties the validity of this assessment to the peculiar attributes of these experimental settings.

Cooper and Singer (1956) and Cooper (1959) provide some evidence that supports the notion that the electrodermal responses were caused by the novelty of the stimuli. Cooper (1959) reported that there was some general agreement in the subject population concerning who were the most liked and disliked groups. If the subjects were aware that their preferences were similar to, or at least not opposite from, those of other persons with whom they interacted, they may have expected the experimenter also to have similar preferences concerning the groups. Second, and more compelling, Cooper and Singer (1956) reported that questioning subjects about their prejudices did not cause increased electrodermal activity. "It was only when a subject's positive prejudice object was cast in a derogatory light or his negative prejudice object was cast in a complimentary light that significant amounts of emotionality [increased electrodermal activity] appeared" (Cooper & Singer, 1956, p. 245). That is, electrodermal activity increased only when the attitude object appeared in a novel or unexpected context.

The novel or unexpected context in which the attitude object was presented may account also for the differences in electrodermal activity found between persons with pro- and antiblack attitudes when race-related stimuli were presented. For instance, a black experimenter may have been more novel to a prejudiced person than to a person not prejudiced; similarly, 10 to 20 years ago, photographs of blacks may have been more novel or unexpected for prejudiced than for unprejudiced persons. Thus, electrodermal activity may have indicated the attentional response of orienting rather than an evaluative response.

In further support of this proposition, it is interesting to note that Flanagan (1967) found attention to be a better intervening-variable interpretation of electrodermal activity than was emotion. A major reason for Flanagan's conclusion (in addition to his own experimental evidence) was Darrow's (1936) report that in some cases of strong emotion, electrodermal activity *decreased* rather than *increased*.

In summary, although several investigations have found that strong positive and negative attitudes are accompanied by increased electrodermal activity, it is possible that the electrodermal activity resulted from the novelty of the stimuli rather than as a simple evaluative reaction. To distinguish between these interpretations, experimentation must be conducted in which novelty is neither confounded with the initial attitude position nor with the presentation of neutral and extreme attitude objects. In any event, it seems, at best, that an attitude is reflected in increased physiological activity only if the attitude is strong enough to elicit an emotional reaction when the attitude object is presented.

The Pupillary Response and Attitudes: Interesting Phenomena. The pupil of the eye is capable of a *bidirectional* response: It dilates when lighting is dim, and it constricts when lighting is bright. The size of the pupil is under the control of two smooth muscles in the iris. The muscle responsible for pupillary constriction is mediated by the parasympathetic nervous system (which primarily functions to maintain systems), whereas the muscle that controls pupillary dilation is under the control of the sympathetic nervous system (which primarily functions to activate systems). The pupil can range in size from 1.5 to 9.0 millimeters and can react to stimulation in as little as .2 seconds (Lowenstein & Loewenfeld, 1962). Loewenfeld (1958) provides a comprehensive review of the neurophysiological aspects of the pupillary response. Lowenstein (1920) reported that the pupils of a catatonic schizophrenic dilated to suggestion-induced states such as "pleasure," "displeasure," and to warnings of impending stress. He concluded that the pupillary response was related to internal events as well as to external environmental changes such as alterations in lighting. Hess (1965) then related the pupillary response to attitudes: (1) Pupillary constriction was said to accompany a negative attitudinal reaction to a repeatedly presented stimulus object, consequently reducing the contact with the unpleasant stimulus; (2) pupillary dilation was said to accompany a positive attitudinal reaction when a stimulus object was repeatedly presented.

The notion of pupillary constriction in response to negatively evaluated or aversive stimuli was contrary to the prevailing evidence that all emotional reactions, whether positive or negative, were associated with pupillary dilation (Loewenfeld, 1966). Hess and Polt (1960) and Hess, Seltzer, and Shlien (1965) provided evidence that pupillary dilation accompanied the viewing of pleasant and interesting stimuli, but it was not until an experiment conducted by Hess (1965) that pupillary *constriction* was thought to indicate a *negative* attitude. People viewed pictures that varied in their interest value and pleasantness. When the pictures were viewed initially, pupillary dilation was largest for the interesting pictures regardless of their affective characteristics. But with repeated presentations of the pictures, unpleasant pictures resulted in pupillary constriction. (Repeated presentations rule out a novelty interpretation, because the orienting response habituates during repeated exposure to stimuli.) These results led Hess

(1965) to hypothesize that positive affect would be associated with dilation and that negative affect would be associated with constriction of the pupils. Another less stringent statement of the hypothesis is that pupil size and attitude are positively correlated.

These hypotheses have received considerable attention since 1965 (reviews of this literature are provided by Goldwater, 1972; Hess, 1972; Janisse, 1974; Mueller, 1970; Woodmansee, 1970). Woodmansee (1965) selected persons who were either very favorable or very unfavorable toward blacks. Photographs of blacks, whites, blacks and whites together, neutral content (the numbers 1 through 4 in the corners and 5 in the center of a gray-white background), and unpleasant content (a filthy toilet and surroundings) were presented repeatedly to all subjects. The results revealed that both groups of subjects reacted similarly to the repeated presentation of all photographs, whereas it had been expected that the prejudiced subjects would react differently to the pictures of blacks and whites than would the nonprejudiced subjects. Moreover, no significant pupillary constriction was found in response to the unpleasant photograph.

Much of the subsequent experimentation failed also to support the hypothesized relationship between pupillary responses and attitudes. Woodmansee (1970) varied the number of presentations of the stimulus, the aversiveness of the stimulus, and the time at which persons rated their attitudes toward each stimulus. In two experiments, he found no evidence for a bidirectional pupillary response (i.e., dilation and constriction) to the stimuli; nor did he find that positively evaluated stimuli caused larger pupillary dilation than negatively evaluated stimuli. Pupil size has also failed to differentiate words varying on rated dimensions of good-bad and neutral-very important (Peavler & McLaughlin, 1967); and a person's verbal attitude rating of a picture and the pupillary response to the picture were found to be unrelated (Collins, Ellsworth, & Helmreich, 1967).

However, occasional support for the hypothesis of Hess is reported. Barlow (1969) found that politically liberal subjects showed dilation to pictures of Lyndon Johnson and Martin Luther King, Jr., but constriction to a picture of George Wallace, whereas conservatives showed the opposite pattern of pupillary responding. Hicks and LePage (1976) reported that subjects displayed pupillary constriction when viewing slides of disliked ethnic groups and pupillary dilation when viewing slides of liked ethnic groups, even during their initial presentation. Nevertheless, the bulk of the empirical evidence suggests that attitudes cannot be determined solely by the analysis of pupil size.

Woodmansee (1966, 1970) argued that methodological problems in pupillo-graphic research employing visual stimuli threaten the validity of pupil size as a measure of psychological reactions. Most of the methodological issues discussed by Woodmansee concern the attributes of the testing situation and materials that cause large variations in pupil size even though they have no psychological significance. For instance, pupil size tends to decrease in size during an experi-

ment. Thus, it is important either to randomize or counterbalance the order of the stimulus presentations. Woodmansee (1970) and Goldwater (1972) have suggested that some of these problems could be circumvented by using nonvisual stimuli in research on pupil size and psychological states (e.g., Kirby, 1968). Although the research in which nonvisual stimuli were used is more sparse, "of particular interest is Hess' own report that constriction responses were found only with visual stimuli; unpleasant-tasting liquids and disliked musical selections consistently evoked dilation" (Goldwater, 1972, p. 343).

In summary, the pupil response has been hypothesized to reflect the attitudinal reaction to stimuli. Most empirical evidence, however, suggests that the response is correlated with the interest, attention, or processing capacity elicited by a stimulus rather than with an evaluative reaction (cf. Kahneman, 1973; Libby, Lacey, & Lacey, 1973). Future research could circumvent many of the methodological problems by providing fixation points, constant illumination, and controls for prestimulus pupil size while presenting to subjects nonvisual (e.g., audio) stimuli that vary along the psychological dimensions of interest to the investigator (e.g., affect). Repeated presentations of the stimuli may also provide a means of circumventing the confounding effects of the orienting response to novel stimuli.

Summary of Research Using the Emotional Response Approaches. Experimentation utilizing the unidirectional emotional response approach, for the most part, has concerned the relationship between electrodermal activity and attitudes. This is unfortunate, because the electrodermal response is sensitive to many irrelevant stimuli and makes properly controlled experiments difficult to conduct.

Experimentation employing the bidirectional emotional response approach has typically measured the pupillary response to visual presentations of attitude objects. The pupillary response does not appear to reflect the evaluative reactor to a stimulus consistently, although the evidence is not yet definitive on this issue. It is doubtful, however, that a *single* measure exists that differentiates affective states (see reviews by Fehr & Stern, 1970; Lang, Rice & Sternbach 1972; Strongman, 1973).

Early research on emotions also failed to reveal consistent response syndromes indicating positive and negative emotional reactions. However, several recent experiments using multiple measures of physiological activity (e.g., electrodermal activity, electromyography, heart rate, respiratory activity, blood pressure) have provided some evidence for distinguishable response patterns among affective states (e.g., Averill, 1969; Ax, 1953; Sandman, 1971, 1975; Schwartz Fair, Salt, Mandel, & Klemman, 1976a, 1976b).

For instance, Schwartz et al. (1976b) have presented evidence that the emotional states of happiness, sadness, and anger are associated with specific patterns of electromyographic (EMG) activity in the muscles of the face; these

responses are not easily distinguishable by either the subject or the experimenter. They also found that patients suffering from depression displayed EMG patterns normally characteristic of sadness and anger but displayed attenuated EMG patterns characteristic of happiness. When the depressed patients were asked to think of a typical day, the EMG patterns displayed were characteristic of sadness (Schwartz et al., 1976a). These investigations, each of which relied upon the study of response patterns rather than single responses, provide an example of a research methodology that may be applicable to the study of the subtle affective states characteristic of most attitudes.¹

Classical Conditioning Approach

The emotional response approach utilized the measurement of naturally occurring physiological responses thought to be indicative of affective states. An alternative approach involves assessing an induced (classically conditioned) physiological response to measure attitudinal reactions. Razran (1939) demonstrated that once a conditioned stimulus (CS) is classically conditioned to a response (CR), the verbal equivalent of the actual CS also elicits the CR. That is, words that have the same meaning as the CS are conditioned semantically to the CR because they elicit the CR only after conditioning. Words that have a meaning similar to the CS elicit a weaker form of the CR after conditioning, a phenomenon termed *semantic generalization*.

Investigators studying attitudes have suggested using an evaluative word such as *good* as the CS while using a physiological response as the CR. After conditioning, attitude objects could be presented to subjects. As displayed in Fig. 4.2, the magnitude of the physiological response that served as the CR could then denote the strength of the attitude toward the object (e.g., Cook & Sellitz, 1964). This approach, termed here the *classical conditioning model*, could be extended by conditioning a physiological response (e.g., vasomotor activity) to evaluative words opposite in meaning to each other (e.g., *good* vs. *bad*). The physiological response activated by the presentation of the attitude object (e.g., vasomotor dilation vs. constriction) should indicate whether the attitude is favorable or unfavorable, and the intensity of the CR should indicate the relative strength of the attitude.

¹Although Cannon (1927) hypothesized that physiological functioning increased in a highly intercorrelated manner, and that any physiological measure would suffice as a measure of this "arousal," the experimental literature has failed to support this hypothesis completely (e.g., Blaylock, 1972; Darrow, 1929; Davis, 1957; Lacey, 1967; Malmlo, 1972; Schwartz, 1975). Instead, there appear to be various central nervous system control centers that operate upon specific subsets of peripheral physiological responses (Cacioppo & Petty, 1979a). In other words, subarousal processes and response patterns exist (Schwartz, 1975). Hence, a multiple-measure approach appears preferable to determine the relationships between psychological functioning and physiological phenomena (cf. Cacioppo, Petty, & Snyder, 1979).

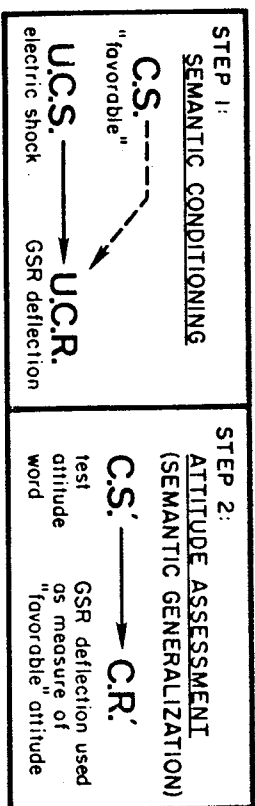


FIG. 4.2. The classical conditioning approach.

In a review of the Russian literature on semantic conditioning, Razran (1961) reported a relevant experiment by Volkova (1953). In Volkova's study, a young boy was conditioned to salivate to the spoken word *good* but not to the word *bad*. After conditioning, the boy exhibited large salivary responses to sentences in which the word *good* was embedded and to sentences that had favorable meanings (e.g., "The Soviet army was victorious"). The same boy showed only small salivary responses to sentences with the word *bad* and to sentences that had unfavorable meanings (e.g., "The Fascists destroyed many cities"). Thus, the conditioned physiological response (salivation) appeared to reflect the boy's attitudinal reaction to the statements.

Acker and Edwards (1964) successfully conditioned 24 of 29 volunteer hospital patients to show constriction of the blood vessels in the left index finger: half the patients were conditioned to display vasoconstriction to the word *good* and half to the word *bad*. Seventy-five words rated previously by the patients on a good-bad bipolar scale were then presented to each person while vasomotor activity was monitored. Results were consistent with the classical conditioning model: Words that had been rated as bad on the pretest were accompanied by constriction of the vessels if the CS had been the word *bad*, whereas words that had been rated as good on the pretest were accompanied by constriction of the vessels only if the CS had been the word *good*.

Tognacci and Cook (1975) investigated the usefulness of the classical conditioning approach as a bidirectional indicator of attitudes by selecting persons who held either strongly favorable or unfavorable attitudes toward blacks. Galvanic skin response (GSR) served as the conditioned response (CR); negatively evaluated statements served as the conditioned stimulus (CS+); and positively evaluated statements served as the unreinforced (CS-) conditioned stimulus (i.e., the CS was not followed by the UCS). Thus, sentences evaluated negatively were conditioned to elicit GSR deflections, and sentences evaluated positively were conditioned not to elicit GSR deflections. Sentences were then presented to subjects: Some of the sentences were favorable toward blacks, some were unfavorable, and some were unrelated to racial issues. During the presentation of these "test" sentences, GSR was monitored. The expectation was that the

GSR would indicate the subjects' attitude toward each sentence. That is, sentences toward which subjects possessed a negative attitude were expected to elicit a GSR response.

The results indicated that the classically conditioned GSR measure generalized to the attitude statements only for subjects who held positive attitudes toward blacks. The authors noted that the large discrepancy between the personally held (i.e., negative) attitude of the prejudiced subjects and the socially desirable (i.e., positive) attitude toward blacks could account for the failure of the conditioned GSR to reflect their attitudes; that is, the conditioned physiological response served as an index of attitude only where the personally held attitude was also acceptable socially. This explanation assumes that a person's cognitive set or expectations can influence the classically conditioned GSR—an assumption that has been supported in recent investigations (Biferno & Dawson, 1977; Dawson & Reardon, 1969; Grings, 1973; Hill, 1967). Thus the results of the Tognacci and Cook (1975) experiment indicate that the classical conditioning approach (at least using GSR) may be applicable only if the persons are willing to report their true attitudes. This, of course, removes one of the major advantages of physiological assessment. Research using vasomotor activity or other less easily controlled physiological responses may prove more promising for this approach.

Summary of Research Using the Classical Conditioning Approach. The classical conditioning approach to assessment of attitudes may provide a bidirectional measure that circumvents problems of response bias in self-report measures (which are totally under the voluntary control of subjects). The approach involves monitoring an induced physiological response rather than a naturally occurring physiological response to an attitude object. Accordingly, the conditioning of the response is a necessary antecedent to attitude measurement. The recent evidence that a classically conditioned autonomic response (particularly GSR) can be inhibited cognitively (cf. Grings, 1973; Lazarus, 1967) provides forewarning that the classical conditioning approach is not a cure-all for problems in attitude measurement, because subjects may be able to control both the verbal response and the physiological response.

ASSESSING AND AFFECTING COGNITIVE RESPONSES PHYSIOLOGICALLY

As documented in the preceding section, attempts to obtain direct relationships between attitudes and physiological processes have met with only moderate success. In this section, a psychophysiological cognitive response model is presented that postulates a relationship between physiology and attitudes because of the organism's biological propensity for processing information (Cacioppo, 1977, 1979; Cacioppo & Petty, 1979a; Cacioppo, Sandman, & Walker, 1978).

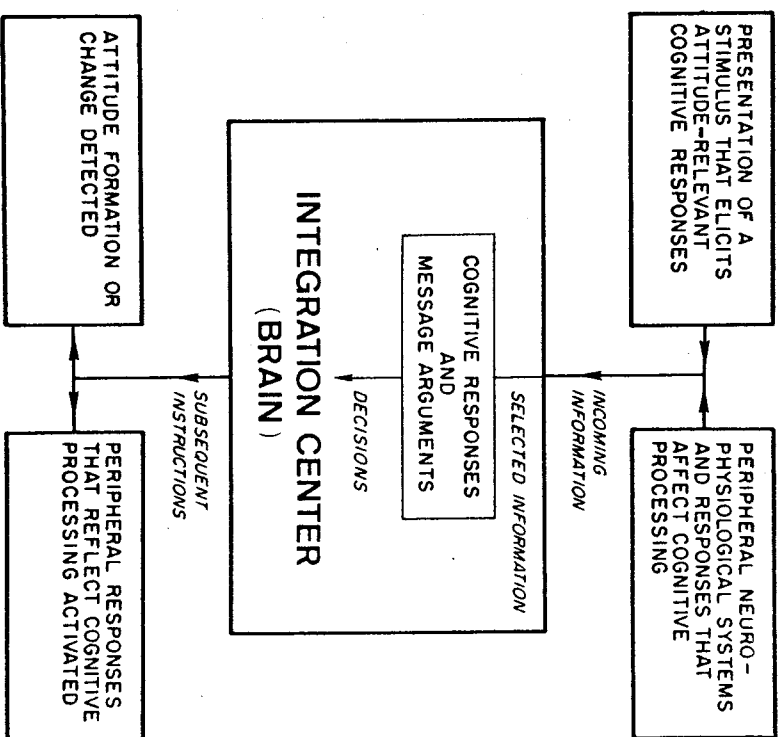


FIG. 4.3. The psychophysiological cognitive response approach.

Peripheral neurophysiological circuits and responses can reflect and/or influence cognitive processing, either because of the effects of the afferent activity from the peripheral response on brain functioning or because of the neural commands from a subcortical system influencing both information processing and peripheral response. Hence, when cognitive responses are elicited by the presentation of an attitude object or opinion issue, the pattern of peripheral activity that is related to cognitive processing provides an indication of and perhaps an input to the cognitive responses that occur. Peripheral neurophysiological systems and responses that do not reflect cognitive processing may be irrelevant to this approach (see Fig. 4.3). Two physiological responses that have been found to be related to cognitive processing are discussed here; they are cardiac and speech-muscle activity.

Heart Rate Reflects Cognitive Processing

Bonvallet, Dell, and Hiebel (1954) and Bonvallet and Allen (1963) researched the effects of transient pressure changes associated with heart rate on cortical excitability. They found that pressure-sensitive receptors (baroreceptors) in the

cardiovascular system transmitted the information of arterial pressure changes to the brain and thereby changed the excitability of the cortex (cf. Schwartz, Davidson, & Pugh, 1976). As shown in Fig. 4.3, these transient changes in the internal environment of the organism may affect the integration capabilities of the brain. Specifically, the dynamic feedback system Bonvallet and his associates described operates to increase cortical excitability temporarily (perhaps decreasing sensory thresholds) when heart rate is elevated.² On the basis of this neurophysiological evidence, the Lacey's (Lacey & Lacey, 1974; Lacey, 1967; Lacey, Kagan, Lacey, & Moss, 1963; Lacey & Lacey, 1970) speculated that accelerated heart rate was associated with the cognitive elaboration (facilitated processing) of material whereas decelerated heart rate was associated with (facilitated) sensory intake. Experimental tests of this position have indicated that sensory intake is facilitated during operantly conditioned lowered heart rate (McCanne & Sandman, 1974) and during transient decreases in heart rate and pulse pressure (Sandman, McCanne, Kaiser, & Diamond, 1977), although conflicting evidence exists (Edwards & Alsip, 1969; Surwillo, 1971).

Several investigators using different kinds of stimulus materials have provided support for the hypothesis that tasks requiring processing of complex information are accompanied by accelerated heart rate (e.g., Baker, Sandman, & Pepinsky, 1975; Blaylock, 1972; Kaiser & Sandman, 1975; Lacey et al., 1963; Tursky, Schwartz, & Crider, 1970). For instance, when persons engage in tasks such as spelling words backwards, mental arithmetic, and constructing multiple sentences (each beginning with the same first letter of the alphabet), heart rate increased from baseline levels. However, when persons performed tasks requiring attention and with minimal demands for cognitive elaboration, storage, and retrieval (e.g., watching light flashes), heart rate decreased from baseline levels (Lacey et al., 1963). Furthermore, when persons listened to a series of digits to be used later, heart rate decelerated; when the digits were then reordered, heart rate accelerated; and the more complex the digit-transformation task, the higher the heart rate during the transforming process (Tursky et al., 1970).

We too have found evidence that increased cognitive work is associated with increased heart rate. When persons were unscrambling the letters of infrequently used words, they displayed higher heart-rate levels than when they were unscrambling the letters of frequently used words (Kaiser & Sandman, 1975). But are these increases in heart rate due to the cognitive requirements or to the stressfulness of the tasks? To address this question, we had persons view slides of autopsies, solve anagrams and arithmetic problems, and memorize digit strings (Cacioppo & Sandman, 1978). Half the problems for each of the three cognitive

tasks required a simple solution, and half required a complex solution. If the increased heart rate was caused by the stressfulness of processing the complex problems rather than by the increased processing requirements necessary to solve them, then an accelerated heart rate should also be found when comparing the heart rate during viewing autopsy slides that were highly stressful with the heart rate during viewing slides that were slightly stressful. (Stressfulness was measured by ratings of unpleasantness, and the slides used were rated as being just a unpleasant or stressful as the cognitive problems.) As expected, we found the subjects' heart rate was higher when performing the complex (and highly stressful) cognitive tasks than when performing the simple (and slightly stressful) cognitive tasks. And, importantly, subjects' heart rate was *not* affected by the stressfulness of the slides of autopsy (during which cognitive requirements were equally low). These results suggest that the accelerated heart rate we observe was attributable to the increased cognitive processing involved in the complex cognitive tasks rather than to a stress reaction elicited by the more complex problems (see also Jones & Johnson, 1978; Leber & Johnson, 1976).

Speech-EMG Activity Reflects Cognitive Processing

The activity of the muscles used during speech represents yet another peripheral measure of cognitive processing. Sokolov (1969) reviewed a series of experiments in which the electromyographic (EMG) activity of the speech musculature was monitored during a variety of processing tasks. He found that increases in speech-EMG activity resulted when complex linguistic reasoning was required (e.g., recalling sentences) but that processing the same input repeatedly was accompanied by a return of speech-EMG activity to the baseline level. In other words, the response became automatic, requiring little thought for its elicitation as this occurred, speech-EMG activity again became quiescent.

Sokolov (1967) hypothesized that the speech areas of the cortex are excited by incoming (afferent) information that involves linguistic processing. These speech centers then transmit (efferent) impulses down pathways to the speech musculature and cause "covert, soundless articulation ('inner speech') [p. 6]." The muscle activity involved in inner speech then excites afferent nerves that affect cortical areas involved in linguistic processing (but see also Smith, Brown, Toman, & Goodman, 1947).

Hansen & Lehmann (1895; reported in Edfeldt, 1960) noticed that persons participating in a "mind-reading" experiment produced whispering sound though neither the person nor the experimenter could detect lip movement. These results, which suggested that cognitive and subvocal activity occur together, led to more objective experimentation. McGuigan (1970, 1978) and Garrity (1977) provide comprehensive reviews of the literature investigating the involvement of speech-muscle activity during the silent performance of language tasks.

²Hilton (1965) has demonstrated that the dynamic autoregulation system via the baroreceptor reflex is inactive in the case of extreme responses, such as during a strong defense reaction. Consequently, this mechanism and its psychological concomitants would be inoperative during these periods (see Lacey, 1967).

The importance of this approach is demonstrated in three experiments conducted by McGuigan and Bailey (1969). Persons performed five tasks with relaxation periods preceding each task. The tasks were silent reading, memorizing prose, listening to prose, listening to music, and listening to "nothing." The first three tasks involved linguistic processing, whereas the last two tasks did not. Speech-EMG activity increasing during the silent reading and memorization tasks and was greater during these tasks than during the performance of the nonlanguage tasks. Breathing rate and preferred-forearm-muscle activity were also greater during the performance of language tasks than nonlanguage tasks. The muscle activity in a preferred (writing) forearm during linguistic processing is due to the involvement of those muscle groups in writing (McGuigan, 1967; McGuigan & Rodier, 1968). This interpretation follows from Jacobsen's finding that persons imagining that they are exerting physical effort display an increase in muscle activity in the body part that would be involved in the physical effort (cf. Jacobsen, 1973) if it were real.

Testing the Psychophysiological Cognitive Response Model

The psychophysiological cognitive response model can be stated and tested in terms of the following propositions: (1) Peripheral responses that reflect cognitive processing (e.g., speech-EMG) should become more active during a period in which *cognitive responding* is present than during a baseline (cognitively quiet) period; (2) the increased activity in these peripheral measures should be independent of peripheral measures not related to cognitive processing (e.g., back-muscle activity); (3) the increased activity of these peripheral measures should be due to the processing task, and similar changes should not be noted during simple intake or attentional tasks not involving language stimuli; (4) the manipulation of the activity of one of these peripheral physiological measures or patterns (*ceteris paribus*) should affect cognitive responding and persuasion. Heart rate and speech-muscle activity appear to be appropriate peripheral measures of (linguistic) cognitive processing, both on neurophysiological and empirical grounds.

Physiological Assessment of Cognitive Responses. Cacioppo & Petty (1979a) conducted a test of the first two propositions of this model. Subjects were informed that the experiment would have two parts: In the first part, they would be told the topic and position of several communications that they would be hearing; and in the second part, the communications would be presented. The purpose of the first part of the experiment, subjects were told, was to allow them time to adapt to the experimental setting and to collect their thoughts on the issues they were to hear about later.

Six forewarnings were presented to each subject. Each forewarning was attributed to a highly credible source and concerned an involving and highly counterattitudinal topic. For instance, subjects were told that the university board of regents was considering a proposal to increase student tuition by \$90 per quarter. Heart rate, speech-muscle (lip, chin, and throat) activity, back-muscle (trapezius) activity, breathing rate, and the pulse amplitude of the blood flowing to the brain were monitored during the minute preceding each forewarning (during which time subjects were asked to sit quietly) and during the minute following each forewarning (during which time they were asked to "collect their thoughts"). Following the latter period, subjects were asked to list everything about which they had thought during the preceding ("collect thoughts") interval and to include only the thoughts they had had during that interval.

It was expected that subjects would generate cognitive responses concerning the forewarned opinion issues (cf. Petty & Cacioppo, 1977; see also Chapter 10). Further, it was expected that these cognitive responses would be reflected in increased activity of the heart and speech musculature but would not lead to increased activity of the nonoral muscle group in the back. The results, presented in Fig. 4.4, supported these predictions. The thought listings revealed that pre-

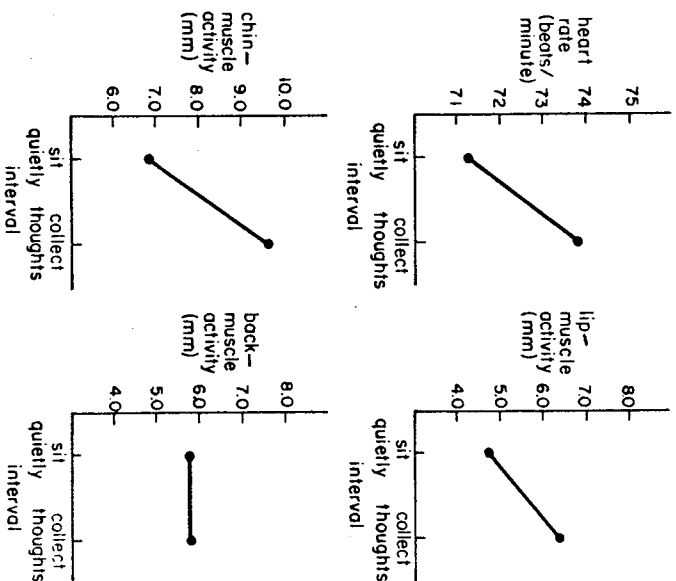


FIG. 4.4. Cognitive responding was associated with increased heart rate (top left panel) and covert oral activity (top right and lower left panels) but not with general muscle activity (lower right panel). (Adapted from Cacioppo & Petty, 1979a.)

dominantly counterarguments were generated during the "collect thoughts" period. Heart rate, lip- and chin-muscle activity, and breathing rate increased during the "collect thoughts" interval from baseline ("sit quietly") levels, whereas back-muscle activity did not change. Furthermore, the change in heart rate was consistent with the position of the Lacey's regarding cognitive elaboration and heart-rate acceleration, although the increased breathing rate may have contributed to the accelerated heart rate.

Festinger and Maccoby (1964), Brock (1967), and Keating and Brock (1974) have emphasized both the importance of counterargumentation in resistance to persuasion and the subvocal nature of counterargumentation. Analyses in the preceding experiment (Cacioppo & Petty, 1979a) indicated that counterargumentation indeed appeared to be more important than favorable or neutral thoughts in mediating the subsequent agreement with an opinion position. However, neither any single physiological response nor any combination of physiological responses obtained could differentiate among counterarguments, favorable thoughts, and neutral thoughts. Thus, these results support a more general hypothesis: Subvocalization is a correlate of cognitive responding whether it be counterarguing, favorable thinking, or neutral thinking.

Physiological Manipulation of Cognitive Responses. The fourth proposition of the psychophysiological cognitive response model states that the manipulation of one of the peripheral measures should affect cognitive responding and, subsequently, attitudes. The specific changes in heart rate and its theoretically predictable effects on the brain's propensity to process information provide a rationale for this proposition. Cacioppo et al. (1978) conducted a test of this proposition by training 20 males over a 5-day period to increase and decrease their heart rate, reinforcing them to sustain it at the attained levels. Subjects were taught to accomplish this feat without major changes in breathing rate or muscle activity by using a systematic form of biofeedback (discriminative operant conditioning).³ In other words, the changes in heart rate were not simply due to changes in the muscular or respiratory activity of the organism.

On the 5th day, counterattitudinal communications that were designed to elicit counterargumentation were presented to the subjects during an accelerated, decelerated, and basal (noncontrolled) heart rate trial (each trial lasting approximately 1 minute). It was expected that heart rate would affect cognitive responding and thereby affect the attitude that resulted from the presentation of the counterattitudinal communication.⁴ Accelerated heart rate was expected to be

³Discriminative operant conditioning refers to a type of training in which one stimulus (e.g., a blue light) signifies that reinforcement (e.g., money) is to be given only for a desired response (e.g., accelerated heart rate), and a second stimulus (e.g., a yellow light) signifies that reinforcement is to be given only for a different desired response (e.g., decelerated heart rate).

⁴Whether the peripheral change in heart rate affected a controlling subcortical mechanism or the conditioning was accomplished as a result of changes in the subcortical mechanism, the expectation remains that the conditioned heart rate, when uncoupled from somatic and respiratory controlling mechanisms, should affect cognitive responding and persuasion.

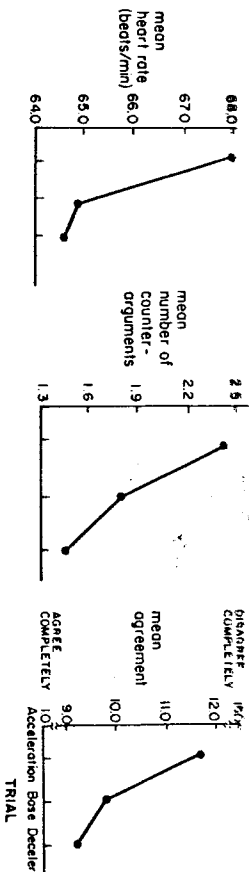


FIG. 4.5. Manipulated heart rate (left panel) significantly affected counterarguing (middle panel) and agreement (right panel) (adapted from Cacioppo, Sandman, & Walker, 1978).

associated with increased counterargumentation and resistance to persuasion whereas decelerated heart rate was expected to have the opposite effects.⁵ It is important to note that transiently and specifically increased heart rate is not associated with resistance to persuasion *per se* but rather with facilitated information processing. Because the presentation of the messages led pilot subjects to generate predominantly counterarguments, increased heart rate was expected to facilitate counterargumentation and, hence, resistance to persuasion.

The results are presented in Fig. 4.5. Conditioning of accelerated heart rate was associated with the generation of more counterarguments and greater resistance to persuasion than decelerated heart rate. The implications of these findings are that (1) the cognitive responding during the presentation of a persuasive appeal (affected by the conditioning trial) affects the resistance to persuasion and (2) consciousness (e.g., attitudes) is associated in a predictable manner with alterations of the internal environment (i.e., physiological states). The subjects not only were affected differentially by the counterattitudinal communications; a function of their (manipulated) heart rate, but they also were unaware of it. The hypothesis that heart rate would influence cognitive responding and resistance to persuasion.⁶ Nor did subjects report awareness that the heart-rate manipulation affected their reactions to the attitudinal stimuli. Thus, subjects' attitudes and cognitive responses were altered even though subjects were unaware of any changes in their thinking or feeling.

⁵The order of conditioning trials and messages was randomized to control for differences in cognitive responding and persuasion due to the order of presentation or the message presented. At the presentation of the three messages, subjects were asked to list what they had thought during each of the message presentations. The thoughts listed by the subjects were counted as a counterargument if they stated logical or emotional points against the proposal of the message or derogated the source of the message.

⁶Postexperimental protocols revealed that subjects could not state the hypothesis that heart rate would influence cognitive responding or that heart rate would influence attitude ratings. The findings are consistent with the demands made by the experimenter when he asked subjects to answer as honestly as possible by reporting their true feelings about the opinion issues when asked. Furthermore, Detweiler and Zanna (1976) found that false feedback about a subject's heart rate led to increased attitude change whether the feedback indicated that heart rate was increasing or decreasing. These bits of evidence together argue against a demand characteristics interpretation of the results.

A second test of the proposition that transient and specific changes in heart rate affect cognitive processing was conducted, because the methodology employed by Cacioppo et al. (1978) did not allow the determination of whether heart-rate *changes* or heart-rate *conditioning* affected counterargumentation (i.e., information processing). What was needed to test this hypothesis were persons with heart rates that could be altered transiently and specifically (i.e., without altering other physiological processes) and without the persons' knowl-

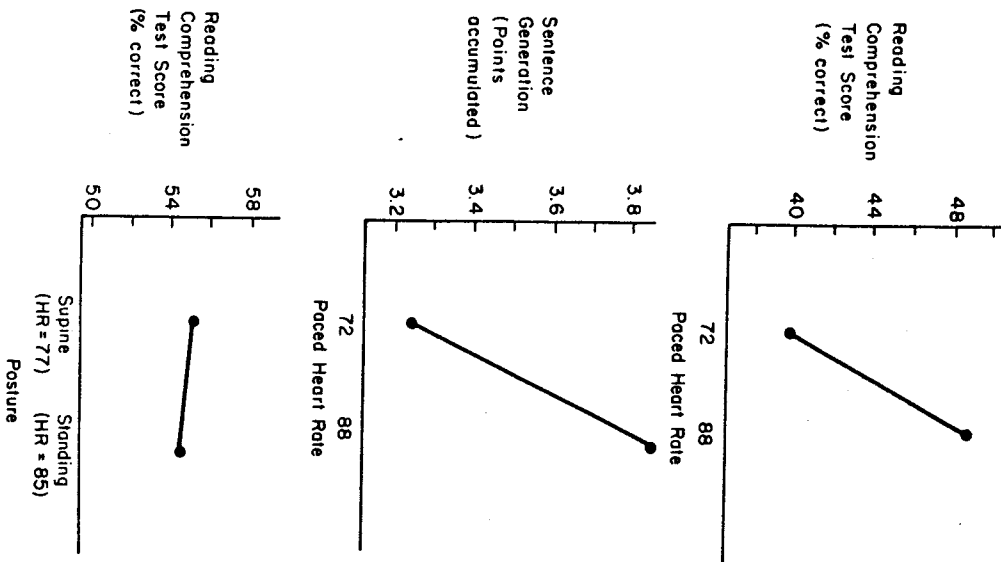


FIG. 4.6. Pacemaker-induced heart-rate changes significantly affected reading comprehension (top panel) and marginally affected sentence generation (middle panel). Posture-induced heart-rate changes did not affect cognitive performance (bottom panel)—see Cacioppo, 1979).

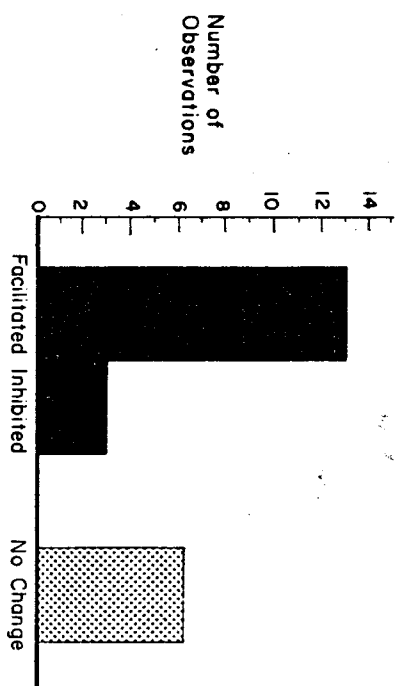


FIG. 4.7. Pacemaker-induced heart-rate changes significantly affected the number of counterarguments generated. (Adapted from Cacioppo, 1979.)

edge that their heart rates were being altered. Such an experiment was conducted using cardiac-pacemaker patients who were visiting their cardiologist for their regular (9-month) checkups (Cacioppo, 1979). All persons who participated in the experiment were articulate and in good health, consented to participate, and appeared motivated to perform well. Their basal heart rates were 72 beats per minute (bpm). But when a magnet was placed over a reed within the pacemaker, their heart rates increased immediately to 88 bpm (although subjects were not aware of whether or when their heart rates were changed). Subjects performed reading comprehension and sentence generation tasks while their heart rates were either increased (by placing an uncapped magnet over the reed) or ostensibly increased (by placing a capped magnet over the reed). As expected, the results indicated that subjects indeed processed the information better when their heart rates were accelerated than during basal heart-rate levels (see Fig. 4.6). In a second experiment, pacemaker patients read counterfactual communications while their heart rates were either accelerated or not. As is illustrated in Fig. 4.7, we found that an accelerated heart rate led to greater counterargumentation. And, as in the conditioning study, counterargumentation was associated with resistance to persuasion.

The foregoing model can also account for several existing experiments on persuasion and heart rate. For instance, Katz, Cadoret, and Abbey (1965) found that heart rate was faster when acceptable or unacceptable statements were presented to a subject for the first time than when neutral statements were presented. Katz et al. (1965) gave the example "There definitely is no God" as being typical of unacceptable statements, and "Most modern religions are monotheistic" as being typical of neutral statements. If it is assumed that the acceptable and unacceptable statements stimulated more cognitive activity than neutral statements (e.g., because of their more involving nature), then the increased heart rate

could have resulted from greater cognitive processing during the presentation of the acceptable and unacceptable statements than during the presentation of the neutral (less controversial) statements.

Of course, experiments of the relationship between attitudes and cardiac activity exist that are not pertinent to this model. For instance, Burdick (1972) employed heart-rate variability and change scores (regardless of direction) rather than measures of the duration, direction, extent, and specificity of heart-rate responses. In another investigation, Buckhout (1966) discussed the association between heart rates that were characteristic of different individuals (rather than heart-rate changes within a person) and attitude change. These studies are mentioned to designate areas in which the cognitive response approach does not apply. Nevertheless, they do suggest other possible associations between attitudes and physiology.

Other interesting relationships exist between a person's cognitive set (e.g., attitudes, beliefs, expectations) and physiological reactions to stressful stimuli. For instance, Ikemi and Nakagawa (1962) demonstrated that when subjects were led to believe that they were being touched by the leaves of a tree to which they were allergic when in fact they were being touched by harmless leaves, all subjects displayed allergic reactions. When the subjects were led to believe they were being touched by harmless leaves when in fact they were being touched by the allergy-producing leaves, 11 of the 13 subjects did *not* show allergic reactions. Similar effects have been found by Graham (1962; Graham, Kabler, & Graham, 1962) and Lazarus (1966; Lazarus, Opton, Nomikos, & Rankin, 1965).

Physiological measures have also been used in attempts to measure arousal or motivational states relevant to attitude change, such as cognitive dissonance. For instance, finger-pulse amplitude was smaller (an indication of stress) after persons made a difficult (high-dissonance-arousing) rather than an easy (low-dissonance-arousing) choice between preferences (Gerard, 1967). Consequently, there is some evidence suggesting that a high state of cognitive dissonance is stressful. It is unclear, however, whether or not the state of cognitive dissonance leads to a general and diffuse state of physiological arousal (cf. Kresler & Pallak, 1976).

Summary of Research Using the Cognitive Response Approach. A psychophysiological cognitive response model has been described, and experimentation testing various propositions of the model has been reviewed. This model is based on the assumption that psychological and physiological phenomena are two aspects of the same fundamental biological process. Hence, it accounts for a relationship between attitudes and physiology in terms of the organism's biological aptitude for processing information. It appears from the evidence to date that when an attitude object or opinion issue elicits cognitive responding, the state of certain physiological patterns (e.g., accelerated heart rate and quiescent nontask EMG activity) may have predictable effects on psychologi-

cal states (e.g., cognition, attitudes). Further research is necessary to assess replicability and to delineate the boundaries of this approach.

CHAPTER SUMMARY

Although the earliest definitions of attitudes were stated in terms of bodily processes, current definitions stress the general evaluative reaction individuals have to objects or issues. Physiological responses are of interest because of the belief that they may reflect the affect associated with an attitude. In the *emotional response approach* to the physiological assessment of attitudes, natural occurring physiological responses that are thought to indicate affective states are monitored to provide information about the intensity and/or direction of attitudes. Research using electrodermal (skin) measures (primarily GSR) has indicated that increased electrodermal activity may be more indicative of the unexpected nature of the stimuli (novelty) than of an affective reaction to the stimuli. Research employing the pupillary response suggests that this measure may be more indicative of the interest, attention, or processing capacity elicited by a stimulus than of the affective reaction. Recent evidence indicates that although no single physiological measure may tap an attitudinal reaction, different affective states may be reflected in subtle, yet distinguishable, facial electromyographic response patterns. In the *classical conditioning approach*, induced (classically conditioned) physiological response is used to measure the intensity and direction of the attitudinal response. The fact that a classical conditioned autonomic response can be inhibited cognitively presents an assessment problem that future research must address.

A psychophysiological cognitive response model was described that posited relationship between attitudes and bodily processes because of the organism's biological propensity for processing information. Just as increased heart rate or activity of the speech musculature have been found to accompany performance on tasks requiring processing of complex information, these same physiological responses have been shown to accompany cognitive responses elicited in anticipation and during the presentation of highly involving counterattitudinal communications. In addition, physiological manipulations were found to affect cognitive responses and persuasion. Specifically, operantly conditioned or pacemaker-induced accelerated heart rate led to the generation of more counterarguments and greater resistance to persuasion compared to basal or decelerated heart rate.