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The purpose of the present study was to investigate heart rate, skin conductance, and reaction time as reflected in changes in arousal level in an effort to resolve some of the conflict between the various interpretations of the activation process. Three interpretations have been stressed in this paper: (a) general arousal theory, (b) stimulus specific theory, and (c) the Webb and Obrist Model. The last theory is considered to be part of a more general behavioral response which might have a common origin and be mediated by central processes.

The subjects were four graduate psychology students, two male and two female, aged 21 to 43 years. The independent variables were threat of shock, schedule of stimulus presentation, and presence of relevant and irrelevant stimuli. The dependent variables included reaction time, heart rate, and skin conductance. Arousal level was manipulated by the use of shock and fixed and variable interval schedules.

The idea that arousal or activation varies along a single continuum in accordance with the energy requirements of the situation and the direction of behavior was supported by the present study. Changes in both heart rate and skin conductance transient from one stimulus to the next reflected similar variations. Also, there appeared to be an increase in physiological activity across all subjects concomitant with increased arousal level despite individual idiosyncracies.

VARIATION IN PHYSIOLOGICAL AND BEHAVIORAL

ACTIVITY AS REFLECTED IN CHANGES IN

AROUSAL LEVEL

by

Patricia Ann Johnson

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Approved by

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APPROVAL PAGE

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General Statement of Problem

The present study investigates the role of various physiological and behavioral changes in relation to arousal. The complexity of experimental situations and of electrocortical, autonomic, somatic, and behavioral responses during various stages of arousal has led to diverse and often contradictory findings.

A common view regarding the concept of arousal and its effect on physiological and behavioral activity is reflected by Hokanson (1969) who stated that "the term 'level of arousal' has been used essentially to describe, in an over-all way, the degree of biological activity manifested by the organism at any partiuclar moment [p. 12]." Hokanson's position is consistent with that of Malmo (1959), Lindsley (1960), Duffy (1962), and Eason and Dudley (1970) who suggested that a wide variety of measures, physiological and behavioral, are positively correlated with changes in general arousal level. In contrast to this point of view, Lacey (1967), Feldman and Waller (1962) and others believed that the various physiological and behavioral measures are dissociated and consequently reflect multiple continua of arousal dependent upon the specific stimulus condition rather than changes in general arousal along a single continuum. Evidence is offered below which indicates that while such dissociation may indeed occur, it does not necessarily mask or override changes in general arousal mediated by a common underlying neural mechanism such as the brainstem reticular formation.

The thesis of the present paper is that both views are in part correct and are not necessarily incompatible. The idea that both general and specific arousal mechanisms are operative concomitantly was touched upon by the work of Webb and Obrist (1967) who stated, in their study of the complexity of cardiac activity during arousal, that both peripheral somatic-motor activity and cardiac events seem to have a common origin and to be mediated by central processes. An earlier study dealing directly with this problem was conducted by Dudley (Eason & Dudley, 1970).

Physiological Measures as Indicants of Arousal

Numerous physiological measures have been utilized as indicants of level of arousal. These include heart rate, skin conductance, muscle tension, and electroencephalograms.

Heart rate. Heart rate changes have been observed during different levels of arousal which seem to be independent of both blood pressure and respiration (Notterman, Schoenfeld, & Bersh, 1952; Perez-Cruet, Black, & Brady, 1963; Malmo, 1964; Perez-Cruet, McIntire, & Pliskoff, 1965). Considerable controversy of opinion has occurred concerning the significance of direction of heart rate changes during different levels and types of arousal. One of the more interesting changes in heart rate is that occurring between two successive stimuli. This biphasic cardiac activity during interstimulus intervals may reflect short-term changes in arousal level. Meyers, Valenstein, and Lacey (1963) found an accelerative and a decelerative component in the response to hypothalamic and septal stimulation respectively. In human Ss, who were warned that shock would occur at a certain time or concomitant with a certain stimulus, a sharp acceleration in cardiac rate first appeared followed by a deceleration just prior to and during the expected locus of the shock (Zeaman & Wegner, 1954; Deane & Zeaman, 1958; Wood & Obrist, 1964; Hastings & Obrist, 1967; Obrist & Webb, 1967; Deane, 1969).

Cardiac acceleration was proportional to increased somatic-motor activity and cardiac deceleration occurred concomitantly with an inhibition of electromyographic activity during interstimulus intervals (Obrist & Webb, 1967; Obrist, 1968; Webb & Obrist, 1970). Webb and Obrist (1970) used various preparatory intervals in an attempt to separate cardiac and somatic-motor activity. They found that a cardiac response could be prevented from occurring. Each S received a total of 96 trials, including 24 trials each of 2, 4, 8, and 16-sec. preparatory intervals. There were three groups: (a) the ascending regular group which received 24 2-sec. trials and 24 4-sec. trials, etc., (b) the descending regular group which received 24 16-sec. trials and then 24 8-sec. trials, etc., and (c) the irregular group which received the same number of trials in a restricted random order. All three groups showed a predicted cessation of chin muscular tension, eye movements, and eye blinks concomitant with a deceleration of heart rate for all preparatory intervals in a time period exceeding 2 seconds. It was found that not only was heart rate reduced in the 2-sec. preparatory interval (it was eliminated only in the irregular group), but the degree of responsiveness on the other measures was also markedly reduced. On the basis of these findings, the two response systems, cardiac and somatic-motor, could not be divorced. The authors stated that future experiments within the central nervous system were needed to find whether or not cardiac changes are caused by the motor response.

Skin conductance. Skin conductance also seems to fluctuate with arousal level. Eason, Beardshall, and Jaffee (1965) found that relaxation and boredom, due to continued subjection to an environmental situation and an easy discrimination task, resulted in a decrease in performance as well as skin conductance. The study involved four vigils per S, with each vigil being 1 hour in length. A total of six Ss were used with only one vigil being performed on a given day by the same S. During two of the four vigils, Ss were required to attend to a light flash presented randomly at the rate of two flashes a minute. During the other two vigils, light flashes were presented randomly at the rate of one every 2 minutes. The two presentation rates were appropriately counterbalanced across sessions and Ss. A significant decrease in performance and skin conductance during the course of a vigil was reported. Muscle tension level increased while heart rate remained unchanged. The authors claimed that the semi-impoverished environmental situation as well as the easy discrimination task induced a progressive state of relaxation and even boredom. They expressed the view that "the decrease in skin conductance, resulting from a decrease in the activity level of the sympathetic branch of the autonomic nervous system, my be attributed to the calming and drowsiness effects of the environmental situation [p. 10]." It was further suggested that neck muscle tension level seemed to reflect