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A primary purpose of the present investigation was to show that an experimental situation requiring relatively little effort on the part of the subjects would be sufficiently arousing to cause concomitant variations in physiological responses. An additional objective was to determine whether physiological indicants of activation level varied in relation to levels of manifest anxiety and achievement. Activation level was altered by changing the incentive but not the actual difficulty of the task. This was accomplished by having S discriminate between flashes of blue and green light after being told (a) her responses were not recorded; and (b) her responses were recorded. In the latter condition, Ss were interrupted while responding. Manifest anxiety level was varied by using Ss with high, medium and low MAS scores. Achievement level was determined by selecting from these subjects those whose obtained grade point averages deviated more than plus or minus one standard deviation from their predicted grade point averages. Thirty Ss were divided according to MAS scores and achievement level into six equal groups. Measures of heart rate, skin conductance and cortical activity were recorded simultaneously for each of 30 Ss under each of the conditions described above.

Significant changes for skin conductance and heart rate were found as a function of minimal alterations in activation level. Differential changes were observed over time for skin conductance and heart rate. These results tend to support the conclusion that

physiological responsitivity varies in a concordant, though not undifferentiated, manner with changes in activation level.

Neither physiological measure varied as a function of changes in levels of manifest anxiety or achievement per se. From the former result it would appear that MAS scores did not accurately indicate levels of activation; because of the problems associated with determining levels of achievement the latter result was not interpreted as precluding the possibility of a relationship between levels of activation and achievement.

THE EFFECTS OF SITUATIONAL ANXIETY, MANIFEST ANXIETY AND ACHIEVEMENT ON SKIN CONDUCTANCE AND HEART RATE

by

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APPROVAL SHEET

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CHAPTER I

INTRODUCTION

The Intensity Dimension of Behavior

For the purpose of permitting more exactitude in scientific investigation, suggestions for the revision of the conceptual categories of psychology were presented some time ago by Duffy (1941, 1948). These revisions contend that two basic dimensions are both necessary and sufficient to describe the behavior of an organism at any given moment in time. These dimensions are: (a) the direction behavior assumes, i.e., approach or withdrawal, which may be overt or covert with respect to any aspect in or of the person's environment; and (b) the intensity of the behavior or the degree to which an organism mobilizes energy in response to the demands of the situation. The intensity dimension, referred to as activation, is defined as the internal release of energy by an organism in preparation for or anticipation of an overt activity and in accompaniment and sustenance of this activity should it actually occur (Duffy, 1962).

An organism experiences degrees of excitement ranging along a continuum from low to moderate to high. Activation describes the psychology and physiology of these conditions with reference to their causes and probable effects. The degree to which a given individual is activated at any given moment depends upon several factors: his particular pattern of autonomic responsivity, which is apparently discernible from the early days of life (Shirley, 1931; Lipton, Steinechnieder & Richmond, 1960), combined with the sum total of his experience up to the moment and the situation of the moment as he perceives it. Thus activation may be considered a measurable physiological intervening variable produced by organismic, experiential and situational factors and resulting in certain predictable effects upon various aspects of response (Duffy, 1962).

The importance of activation as a measurable dimension of behavior has long been stressed by Duffy (1951, 1957, 1962) and Freeman (1948). Such physiological responses as skin conductance, heart rate, muscle tension and cortical activity such as the electroencephalogram (EEG) and evoked cortical potentials (ECP) have been used to measure variations in the degree of activation. Most studies have shown an ordered relationship between levels of physiological activity, (and hence activation), and degree of significance of the situation or the amount of effort required by it. Thus, with the exception of Lacey and his associates (Lacey, 1959, 1967; Lacey, Kagan, Lacey & Moss, 1963; Lacey & Lacey, 1958, 1962), who apparently conceive activation as an overall undifferentiated arousal of the sympathetic nervous system and thereby resist the concept of a general state of activation, most studies lend support to Duffy's theory of activation. This theory contends the degree of significance which an individual attaches to a situation (including its stressfulness, incentive value and the effort it requires) is reflected on a continuum of activation measurable by concordant changes in autonomic, somatic and central nervous systems (Duffy, 1962, 1969). However, most of the aforementioned studies have investigated either very high or very low levels of activation in experimental situations involving extreme degrees of threat, stress or effort required. Thus, a principal goal of this study is to emphasize the continuum aspect of activation and to obtain information in support of Duffy's hypothesis by employing conditions varying from minimal to low degrees of threat or stress and requiring a constant but minimal actual effort.

Measuring Differences in Activation Between Individuals

It has been previously stated that the degree to which any individual is activated at a given moment depends on an interaction between his particular organismic and experiential characteristics and of the situation of the moment. Thus, any observed level of arousal is a product of the individual characteristics of the respondent and the situation. Since there are also intraindividual differences in the responsivity of various physiological functions, the problems of measuring differences in activation between individuals are great even under carefully controlled laboratory conditions. There are three apparently significant, though not wholly unrelated, aspects of these measures useful in reflecting changes in activation level. These aspects are (a) the level of functioning over a period of time, (b) changes or fluctuations in functioning over a period of time, and (c) the time required for a measure to return to its pre-stimulus level. The changes may reflect either characteristic, i.e., "spontaneous" or experimentally induced differences within the same individual or between individuals operationally defined as similar. This study will employ measures of heart rate and skin conductance to investigate the above aspects (a and b) between groups of individuals operationally defined as similar in ability but varying in levels of manifest anxiety as measured by the Taylor (1953) Manifest Anxiety Scale and college achievement. The experimental situation described below is presumed to be minimally but differentially stressful to the groups and to require very little effort.

Physiological Indicators of Differences in Activation Under Different Situational Demands

Skin conductance. There is a good deal of evidence that both level and functioning of skin conductance reflect activation in relation to the difficulty of the task or other demands of the situation. Carrier and Orton (1964) indicate that subjects show increased skin conductance in test situations as opposed to rest situations and that the increases are associated, for normal subjects, with the difficulty of the test. Studies involving the learning of nonsense syllables indicate that increased skin conductance is associated with new learning (Andreassi & Whalen, 1966). Subjects instructed to learn lists of syllables show increased skin conductance when compared with subjects instructed just to look at the lists. Schönpflag (1963) and Stern (1964) report higher conductance level for a group reporting "autokinetic movements" as compared with a rest group.

Eason and his associates (Eason, 1959, 1963; Eason, Aiken, White & Lichtenstein, 1964; Eason, Beardshall & Jaffee, 1965; Eason, Harter & Storm, 1964) have done extensive work with variations in task difficulty and incentive level. Although this work has been concerned principally with measures of muscle tension and evoked cortical potentials, it has shown a consistent relationship between these, as well as other, physiological variables and degree of task difficulty. Both specific and general characteristics of activation were shown by Eason, Harter and Storm (1964). General activation was demonstrated through variations in skin conductance, heart rate and muscle tension which were concordant with variations in task difficulty. Specificity was reflected through unique changes in each of the above measures both within and between trials.

Evidence from early studies indicating that both the initiation and difficulty of a task are reflected in level of skin conductance (White, 1930; Kuno, 1930; R. C. Davis, 1934) has been extensively reviewed by Duffy (1962, 1969).

Heart rate. There is considerable evidence to support the contention that increased heart rate is associated with increases in task difficulty. The studies, particularly those of Eason and his associates, previously mentioned, and those of Malmo and Shagass (1952), Malmo, Shagass and Smith (1951), and Malmo, Shagass and Helsam (1951) are recent examples of such evidence. The earlier work of Bitterman and Soloway (1946) obtained higher heart rates for subjects doing clerical work as compared with rest. A more recent investigation by Campos and Johnson (1966) suggests significant changes in heart rate and skin conductance as a result of verbalization alone. They found significant increases in heart rate and skin conductance for subjects required to verbalize responses when compared with no verbalization requirement.

Physiological Indicators of Activation in Relation to Levels of Stress or Excitation

Skin conductance. A variety of situations judged to be exciting or stressful have produced concomitant changes in skin conductance. Such experiences as listening to exciting music (Zimmy & Weidenfeller, 1963) or riding a Ferris wheel (Laties, 1939) are among such conditions. Significant increases in conductance have been associated with conditions involving physically noxious stimuli such as thermal stimulation perceived as painful (Darrow, 1965), and electric shock or threat of shock (Dudley, 1968; Grings & Lockhart, 1966; Katkin, 1965; Hodges & Spielberger, 1966; Wilson, 1964).

Conditions of psychological stress involving such stimuli as erotic movies (Dysinger & Ruckmick, 1933), telling a lie (Ellson, Davis, Saltzman & Burke, 1952), the "stressor" films used by Lazarus and his associates (Lazarus, 1964; Lazarus & Opton, 1966; Speisman, Osborn & Lazarus, 1961), and agreement or disagreement with majority opinion (Murray, 1938) have shown variations in skin conductance corresponding with differences in the situation. With the exception of a few investigations most studies investigating activation level and employing physiological measures have used conditions of extreme stress in addition (in most cases) to variations in task difficulty.

Heart rate. Evidence has been presented that heart rate both increases and decreases in response to stimulation. Since many investigators have been dealing with situations perceived as unpleasant it would appear that the ensuing controversy over the functional relationship of activation (as measured by heart rate) and stress is at least partly determined by stimulus type as suggested by Lacey and his associates (1958, 1959, 1962, 1963, 1967). It seems that studies using electric shock have presented a good deal of the conflicting evidence (see reviews by Duffy, 1962, 1969; Dudley, 1968). Findings in which an increase in heart rate is associated with stress induced by threat or shock are reported by Dudley, 1968; Hodges and Spielberger, 1966; Lewinsohn, 1956; and Willis, 1964.

Increased heart rate has been demonstrated by Lazarus and his associates (1964, 1966) concurrent with "stressor" movies. Campos and Johnson (1967) have reported increases in heart rate in association with verbalization but not dependent upon the "stressfulness" of the stimulus.

Suggested Behavioral "Indicators" of Activation

Manifest anxiety. It has been suggested by certain investigators that manifest anxiety as measured by the MAS can be described as a "personality trait" or enduring characteristic of the individual. "Trait anxiety" as defined by Cattell and Scheier (1961) on the basis of factor analyses has been found to correlate .85 with scores on the MAS (Spielberger, 1966). It has been described as having characteristics similar to those of acquired behavioral dispositions (Campbell, 1963), motives (Atkinson, 1964), and potential energy (Spielberger, 1966). Taylor and Spence (1952), Farber and Spence

(1953) and others have suggested that anxiety operates as an acquired drive. Whether designated as a personality trait or acquired drive, the physiological responses associated with anxiety have been variously described as changes in heart rate, skin conductance, muscle tension, and cortical activity (Bindra, 1959; Katkin, 1965; Lewinsohn, 1956; Martin, 1958). As these are the same variables associated with activation level many studies have investigated the relationship between MAS scores and activation. The results of these studies have been conflicting, with some writers reporting a correlation between physiological measures and scores on the MAS (Haywood & Spielberger, 1964) and others reporting no such relationship (Hodges & Spielberger, 1966; Katkin, 1965; Lewinsohn, 1965; Matarazzo & Matarazzo, 1956; Rosenstein, 1960). The results of studies using other measures of manifest anxiety have been equally contradictory (Beam, 1955; Goldstein, 1964; Lader & Wing, 1965). Most of the studies mentioned above were conducted under threat or shock or other highly stressful conditions or with psychiatric patients. Hence, another objective of this study is to gather information from a normal population on any possible relationship between scores on the Taylor (1953) Manifest Anxiety Scale and levels of activation under conditions of minimal stress.

Achievement. Factors relating to school achievement have been extensively investigated in the past five years. Differences in achievements variously have been related to differences in levels of anxiety, emotional inhibition, reactivity, attentiveness and motivation (Cattell & Sealy, 1965; Mandler & Sarason, 1952; Spence & Farber, 1953; Spielberger, 1966). The above characteristics suggest degrees of physiological arousal. With the exception of the work of Bry and Daniel (1967) with cortical activity, there have been few attempts to relate physiological measures of activation to achievement. Another objective of this study is to make such an attempt.

Purpose of the Investigation

This study sought to determine the relationships between several purported physiological and behavioral indicants of activation under conditions of experimentally induced stress. It was particularlarily concerned with determining whether an experimental situation requiring a relatively small degree of "ego involvement" or effort on the part of the subjects would be minimally but sufficiently stressful to cause concomitant variations in physiological responses. Another important concern was to demonstrate whether, and, if so, how the temporal pattern of these physiological responses to stress varied with the manifest anxiety and achievement levels of the subjects. Also of interest was the determination of whether the level of heart rate or skin conductance varied concomitantly with levels of manifest anxiety and achievement.

Specific Statement of the Problem

Manifest anxiety level was varied by using subjects with high, medium and low scores on the Taylor (1953) Manifest Anxiety Scale.

Achievement level was determined by selecting from these subjects those whose obtained grade point averages (OGPA) deviated more than plus or minus one standard deviation from their predicted grade point averages (PGPA). Subjects (Ss) thus were divided into six groups each with five members according to manifest anxiety and achievement (Table 1, Appendix B). Activation level in the experimental situation was varied by altering the incentive or involvement of the subject in a very simple task in the following manner. In the context of presumably demonstrating superior female sensitivity to color, Ss discriminated shades of blue and green presented by a flashing light after being told (a) her responses would not count toward her rank in the experiment (low arousal); (b) her responses were being counted for the color sensitivity data and toward her rank in the experiment (high arousal). In the latter condition Ss were interrupted while responding and reminded of the instructions.

Information concerning the functioning of the autonomic nervous system was obtained by analyzing the analog records for skin conductance and heart rate. These measures were recorded simultaneously for each of thirty Ss under each of the conditions described above. Measures from the central nervous system, electroencephalogram (EEG) and evoked cortical potential (ECP), were also recorded for possible later examination.

CHAPTER II

METHOD

Subjects

The subjects (Ss) were 30 female undergraduates enrolled in an introductory psychology course at the University of North Carolina at Greensboro who obtained high, average and low scores on the MAS and fitted the criteria for underachievement or overachievement. These subjects were selected from a group of 423 students given the MAS four months prior to the experiment. Subjects scoring between 26 and 33 (mean 27.8) were designated as the High Anxious (HA) Group; subjects obtaining scores between 8 and 10 (mean 8.4) were designated the Low Anxious (LA) Group; subjects obtaining scores between 17 and 20 (mean 18.2) were designated the Middle Anxious (MA) Group. The HA and LA groups were drawn from approximately the upper and lower 15% of the distribution after the extreme high and low scores had been removed. The MA group was drawn from scores within 1.6 MAS points of the mean of this distribution. The HA, MA and LA groups were then subdivided as underachievers (UA) and overachievers (OA). This division was made on a basis similar to the one commonly used in studies of underachievement. Operationally, an underachiever is a student receiving grades at least one standard deviation below those predicted for him from his high school record and college entrance examination scores. An overachiever is a student earning grades at least one standard deviation above those predicted for him. The six groups thus designated HAUA, HAOA, MAUA, MAOA, LAUA AND LAOA each contained 5 Ss. The mean MAS score, predicted grade point average (PGPA) and obtained grade point average (OGPA) for each group are represented in Table 1. The mean OGPA for underachievers was 1.53 in a 4.0 system; the mean OGPA for overachievers was 2.79. The PGPA's were 2.17 and 2.14 respectively. The groups thus were equated within .03 of a point with respect to anticipated academic achievement.

Experimental design. Each subject participated in one experimental session. The session lasted approximately 45 min. and consisted of an adaptation period and four trials, two each for the low and high stress conditions. Each trial lasted about 2 min. and there was a 5-min. rest period between trials. The order in which subjects received the experimental conditions was counterbalanced within and across anxiety and achievement groups.

Apparatus and Data Recording

Throughout the recording periods of the experimental session the subject was seated in an electrically insulated "cage" illuminated by a dim light located outside the "cage." The remainder of the laboratory was in semi-darkness, the only source of light being a small lamp shielded from subject's view. All recording and stimulus presentation equipment was located outside the insulated "cage."

The measures of skin conductance (SC), heart rate (HR) and visually evoked cortical responses (ECP) obtained in this experiment were recorded by a Grass Model 7 Polygraph and the required preamplifying equipment, a Mnemotron 400 B computer of average transients (CAT) and a Moseley X-Y Plotter (Model 20-2).

Skin conductance. Dime-sized silver electrodes, polished before each session, were attached to the fingertips of the index and third fingers of the subject's right hand. Skin resistance was recorded with a Grass 7P1 pre-amplifier. Calibration was such that resistance could be read directly into ohms from the polygraph record. The record was marked off in twenty-second intervals. The average skin resistance was determined by measuring the distance from the midpoint of a visually drawn "best fit" line through each segment to the base line of known ohm value. The resulting ohms resistance units were converted to conductance units (micro-mhos) by multiplying their obtained reciprocals by one million.

Heart rate. Silver electrodes encased in plastic were placed on the inside of the left wrist and the right ear lobe in order to record heart rate. The 7P4 Tacheograph pre-amplifier was calibrated at the beginning of each day subjects were run. The polygraph record was marked off in 20-second intervals. Five readings from each segment were measured against the calibration data and averaged to obtain heart rate.

EEG and ECP. Skin resistance was reduced below 10,000 ohms by rubbing the site for the recording electrodes and reference electrodes with a special electrode jelly. The recording electrode, located one inch above and to the right of the inion, was held in position by an adjustable rubber headband. The reference electrode, commercial silver disc housed in a plastic clip, was attached to the right ear lobe. The EEG was recorded with a Grass 7PS Polygraph. The electrical cortical responses evoked by the flashing light were rendered observable by summing the obtained EEG activity for .5 sec. following each flash. A complete description of the operation is given in detail by Eason, Aiken, White and Lichtenstein (1964).

The measures of cortical activity thus recorded were not quantified for analysis in this experiment.

Stimulus materials and presentation. The stimulus was a series of colored light flashes presented fifty times during a given trial. These flashes were presented at an average rate of one every two seconds. They were presented to Ss via a tubular light guide which terminated slightly to the right of center of a white convex screen located directly in front of the subject within the experimental "cage." The flashes were generated with a Grass PS-2 Photo-Stimulator and rate of presentation controlled by a programmed tape loop. The color of the flash was controlled by the manual rotation of a filter wheel located between the light source and receptor end of the light guide. The wooden wheel was approximately six inches in diameter and consisted of five theatrical filters in four varying but discriminable shades of blue-green and one neutral grey filter. Colors were presented in a random but predetermined order by the experimenter.

Procedure

Instructions. The experimenter (E) and the laboratory assistant spent the first fifteen minutes of each experimental session acquainting the subject with the laboratory and apparatus, giving her instructions, and attaching the appropriate electrodes. It was emphasized to each subject that she would receive no electrical shock during the course of the experiment.

A standard set of instructions (see Appendix A) was given by E in a conversational tone to each S at the beginning of the session. The subject was told E was investigating the notion that women are more sensitive than men. The subject was informed she was to participate in a color discrimination experiment because women's superior color sense was one way to demonstrate their sensitivity. The experimenter said she was collecting data from UNC-G women selected (on the basis of an earlier questionnaire not identified to S as the MAS) for their sensitivity and comparing it with data gathered on other campuses.

The flashing light was demonstrated to S. The experimenter said the light would flash in shades of green and blue. When a color flashed S was to say blue if the flash was more blue than green. She was to say green if the flash was more green than blue. She must always decide if the flash was blue or green. She was instructed to respond as soon as possible after each colored flash. The subject was told that half of the time she spent doing the task her responses to the colored light would be recorded and would count toward her rank in the experiment. This was called the experimental run. The other half of the time, E said she would be calibrating the machinery and, although S should respond as usual, the responses would not be counted.

This was called the calibration run. The subject was assured that she would always be told which condition was in force on any given trial.

Experimental conditions. Preceding the low stress condition (LS), defined for S as the calibration run, the experimenter said, "Now just relax and take it easy. This is a calibration run. What you say doesn't count but please go on and respond blue or green anyway." At the end of 50 flashes E said, "O. K., that was fine." The various physiological events were recorded throughout the trial.

Preceding the high stress condition (HS), defined for S as the experimental run, the experimenter said, "Now, remember, this is an experimental run; your responses will count for the color sensitivity data and for your rank in the experiment." After ten flashes had been presented (physiological responses were not recorded for these introductory flashes) S was interrupted and told, "Let's stop a minute. I want to be sure you understand the instructions. If the flash is more blue than green say blue as quickly as you can. If the flash is more green than blue say green as quickly as you can. O. K., let's try it again." The subject was then presented 50 flashes and the physiological responses were recorded.

Experimental precautions and control. As S toured the laboratory and received her instructions, every effort was made to make sure she understood what to expect during the experiment. The experimenter and the laboratory assistant explained the purpose of the recording apparatus and told S what each electrode was to record as it was attached. During the adaptation period S was told to assume a comfortable position and to avoid any unnecessary movement. She was allowed approximately 10 min. to adjust to the electrically-shielded "cage," the light flashes, and to being "wired for sound." So that S would not be distracted by any incidental noise, "white noise" was fed into the "cage" through a speaker. The amplitude of this noise was such that S's responses were audible to E if made in a normal tone of voice.

All instructions were memorized by E and delivered verbatum to each S. Scheduling of subjects was handled in such a manner that neither E nor the laboratory assistant knew the achievement or anxiety levels of any given S. The experimenter was equally unaware of such classifications while quantifying the polygraph data.

CHAPTER III

RESULTS

A four-way analysis of variance allowing for repeated measures on two variables was performed on two of the physiological variables (skin conductance and heart rate) to determine if each changed significantly (a) with achievement level; (b) with variations in trait arousal level, i.e., manifest anxiety level; (c) with variations in situational arousal level, i.e., stress conditions; (d) within trials, i.e., across the 30-sec. intervals. The first-, second-, third- and fourth-order interactions among these variables were also considered important.

Findings Based on Variance Analysis

Situational anxiety (high versus low stress). As can be seen (Figure 1), the high stress condition produced significant increases in heart rate ($p > .01$) and skin conductance ($p > .05$) for all groups of subjects regardless of achievement of manifest anxiety level. The broken line (Figure 1) represents an average of the distance between the high and low stress condition for each of the five 20-sec. intervals. This line is approximately straight and illustrates that changes in heart rate under both conditions did not reflect the passage of time. Changes in skin conductance (Figure 1) decreased across time under both conditions and this decrement is significant at the .01 level. A closer inspection of the high and low stress

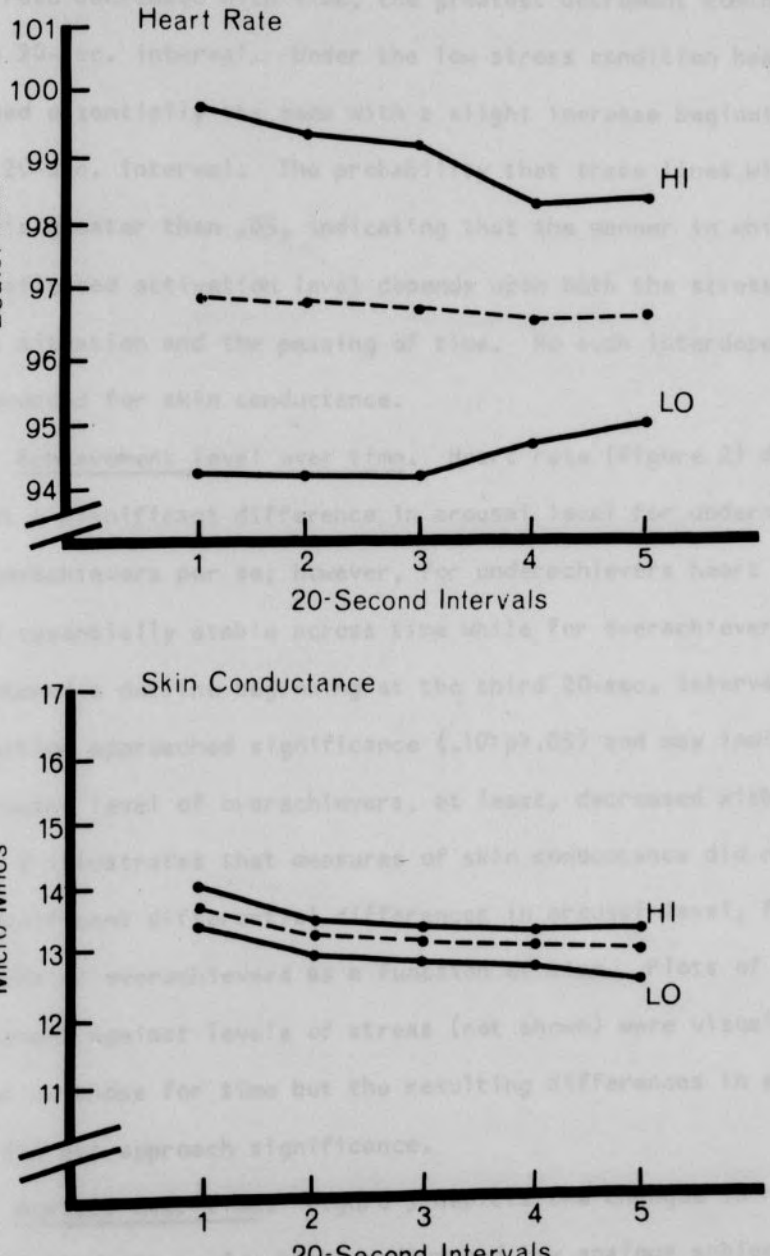

Figure 1. Effects of Stress on Skin Conductance and Heart Rate During a 100-second Response Period.

curves (Figure 1) illustrates that under the high stress condition heart rate decreased with time, the greatest decrement coming in the fourth 20-sec. interval. Under the low stress condition heart rate remained essentially the same with a slight increase beginning at the third 20-sec. interval. The probability that these lines will converge is greater than .05, indicating that the manner in which heart rate reflected activation level depends upon both the stressfulness of the situation and the passing of time. No such interdependence was recorded for skin conductance.

Achievement level over time. Heart rate (Figure 2) did not reflect a significant difference in arousal level for underachievers and overachievers per se; however, for underachievers heart rate remained essentially stable across time while for overachievers heart rate showed a decline beginning at the third 20-sec. interval. This interaction approached significance ($.10 > p > .05$) and may indicate that the arousal level of overachievers, at least, decreased with time. Figure 2 illustrates that measures of skin conductance did not reflect any significant differential differences in arousal level, for underachievers or overachievers as a function of time. Plots of levels of achievement against levels of stress (not shown) were visually similar to those for time but the resulting differences in arousal level did not approach significance.

Anxiety over time. Figure 3 depicts the changes in heart rate and skin conductance for high, medium and low anxious subjects averaged over trials in 20-sec. intervals. Levels of skin conductance

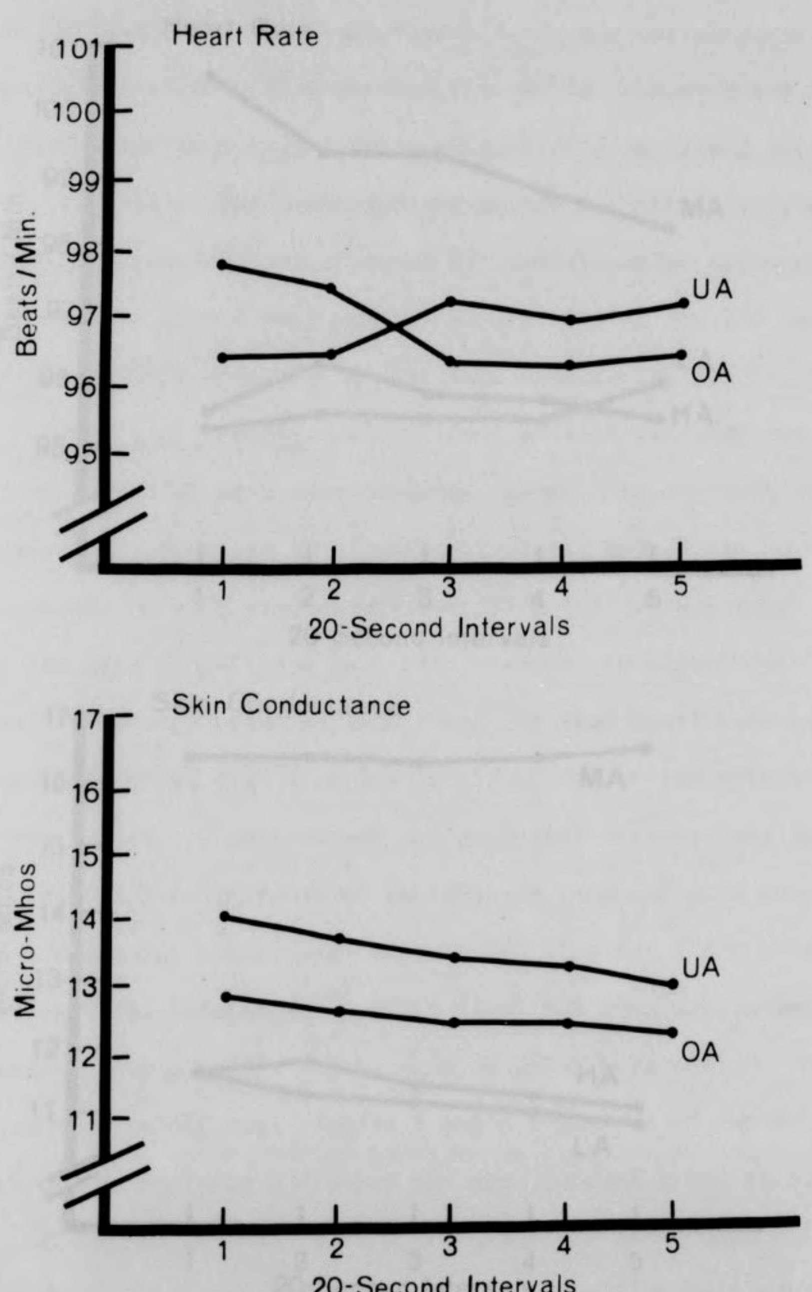

Figure 2. Effects of Achievement Level on Skin Conductance and Heart Rate During a 100-second Response Period.

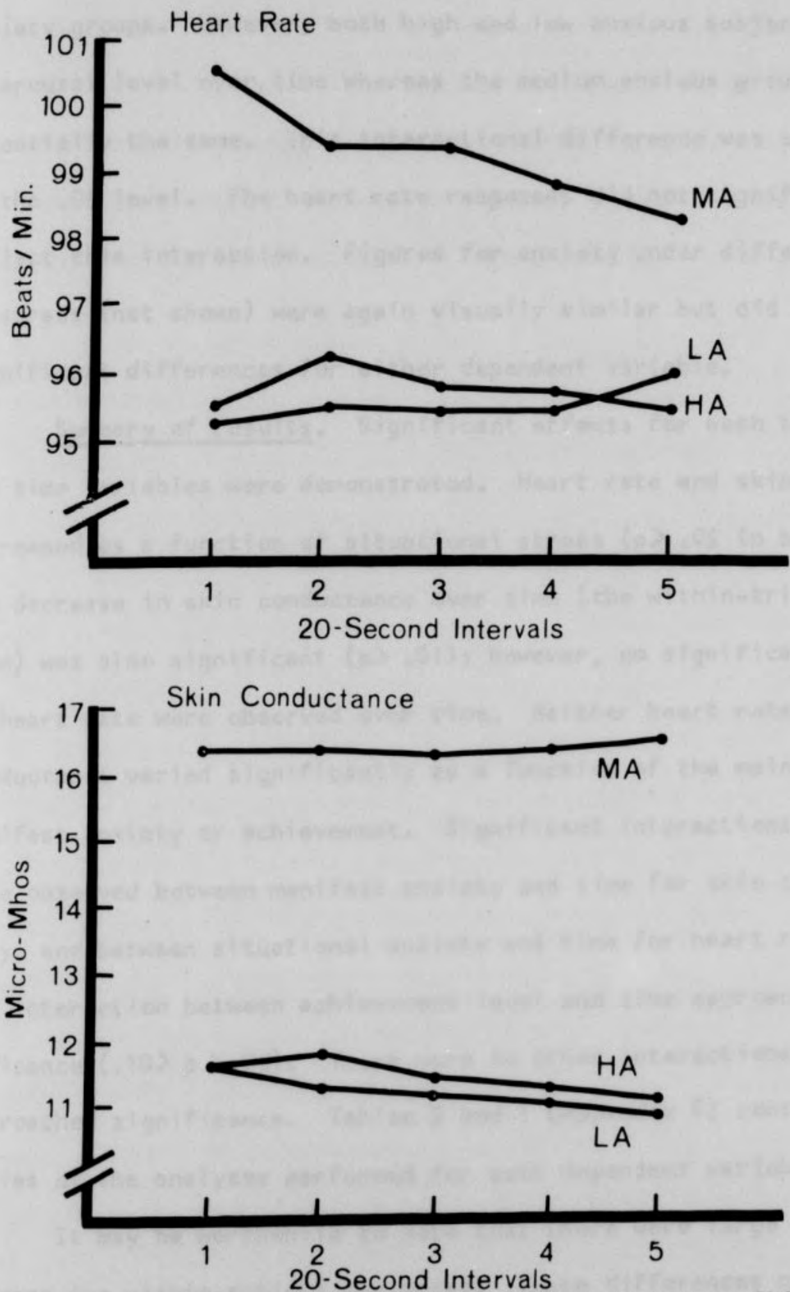

Figure 3. Effects of Manifest Anxiety Level on Skin Conductance and Heart Rate During a 100-second Response Period.

did not significantly differentiate levels of activation for the anxiety groups. However, both high and low anxious subjects declined in arousal level over time whereas the medium anxious group remained essentially the same. This interactional difference was significant at the .05 level. The heart rate responses did not significantly reflect this interaction. Figures for anxiety under different levels of stress (not shown) were again visually similar but did not depict significant differences for either dependent variable.

Summary of results. Significant effects for both the stress and time variables were demonstrated. Heart rate and skin conductance increased as a function of situational stress ($p > .05$ in both cases). The decrease in skin conductance over time (the within-trial dimension) was also significant ($p > .01$); however, no significant changes in heart rate were observed over time. Neither heart rate nor skin conductance varied significantly as a function of the main effects of manifest anxiety or achievement. Significant interactions ($p .05$) were observed between manifest anxiety and time for skin conductance only, and between situational anxiety and time for heart rate only. The interaction between achievement level and time approached significance ($.10 > p > .05$). There were no other interactions that approached significance. Tables 2 and 3 (Appendix B) contain summaries of the analyses performed for each dependent variable.

It may be worthwhile to note that there were large differences between the within-subject variances. These differences may be accounted for by the fact that several subjects within a single group presented atypical levels of heart rate or skin conductance. It is not certain that these differences are within the confidence boundaries of the *F* test used. The interactions reported in this study would be the only results whose significance might be affected. Although these interactions may be somewhat suspect because of non-homogeneity of variance, they were interpreted as if the *F* test used were valid.

CHAPTER IV

DISCUSSION

Variations in Activation in Response to Stress (Physiological Indicants).

The principal findings of this investigation indicate that minimal changes in goal significance tend to produce corresponding variations in activation level in the absence of changes in the level of actual difficulty of the task. It further suggests that these changes were reflected concomitantly by two (i.e., skin conductance and heart rate) measures of autonomic nervous functioning. These results seem to contribute to the existing support for Duffy's (1951, 1957, 1962, 1969) theory that activation is a measurable physiological intervening variable which operates in a predictable manner along a continuum of intensity. This theory suggests that the functioning of various physiological processes reflect levels along this continuum of activation in a concordant and integrated manner.

These results are consistent with the findings of others (Andreassi & Whalen, 1966; Dudley, 1968; Lazarus, 1966; Malmo, 1966; Speisman, Osborn & Lazarus, 1961; Stern, 1964; Uno & Grings, 1965) who find changes in several measures of physiological functioning to vary congruently with the difficulty or significance of the experimental situation. In the studies cited above, changes in activation level were induced by (a) varying the difficulty of the task; (b) varying the significance of the task; (c) or varying both conditions at the same time. In some cases, the experimental tasks themselves required differential amounts of energy to perform. In other instances attentiveness, alertness or general effort exerted was manipulated by introducing a threat of shock. Situations of this type appear to increase significantly the energy requirements of a situation and these changes are reflected in the various physiological measures employed in the studies. Interpretations of the results of such studies in terms of energy requirements are offered by Eason (1959).

Lazarus and his associates, in the work cited throughout this study, have compared the physiological responses and subjective reports of subjects to "stressful" and "non-stressful" films. The films defined as psychologically stressful (Lazarus, 1964) portrayed both physical assault and pain. From the findings of these studies, it appears that vicarious as well as actual threat produces increases in activation which are concordantly reflected in variations in heart rate and skin conductance.

In the present study the subjects were required to perform exactly the same task under both experimental conditions. The significance level was assumed to change minimally between conditions as subjects were allowed to resume the task after being interrupted (Mandler & Watson, 1966) and no subject was sufficiently interested in her rank in the experiment to inquire about it. The resulting changes in activation level reported here are consistent with those found by Mandler and Watson (1966) and by Murray (1938). However, the former investigator did not employ physiological measures of stress and the latter measured only the galvanic skin response.

This study fails to lend support to Lacey's (1959) contention that heart rate does not indicate activation level. The results herein indicate a congruent increase in heart rate and skin conductance according to the apparent significance of the task.

Across Time Changes

Level of skin conductance decreased during the experimental session in a similar and significant manner for both conditions. However, while heart rate declined with time under the relatively high level of activation, it remained essentially the same for the lower level. Whereas these findings are similar to those reported by Dudley (1968), Eason, Harter and Storm (1964), Harter, Eason and White (1964), they are not as readily explained (as these authors do) as a result of a tendency for concomitant changes in autonomic and somatic activity to offset one another. It is possible, however, that some increases in the tension level of the cranial muscles involved in speech may have occurred during the higher stress situation. Any such changes would have been accompanied by an increase in the activity level of the somatic nervous system. It also seems possible that decline in heart rate may reflect the interruption aspect of the experimental condition, in a manner similar to the decline in heart rate following shock. In any event these findings are in accord with Duffy's (1962) contention that activation does not reflect an undifferentiated state of nervous arousal.

Manifest Anxiety

No significant relationship between levels of manifest anxiety and arousal were obtained in this investigation. From these results it would appear that scores on the Taylor (1953) Manifest Anxiety Scale are not accurate indicators of activation. Since many others have found no relationship between MAS scores and various physiological events, this appears to be a consistent interpretation.

Alternative explanations have been offered by Cattell and Scheier (1961) and Spielberger (1966). These investigators differentiate between state and trait anxiety with scores on the Manifest Anxiety Scale correlating .85 with trait anxiety (Spielberger, 1966). Cattell (1966) has suggested that "state" or situational anxiety is more heavily loaded with autonomic variables than is "trait" anxiety. Spielberger (1966) has proposed that the critical factor in obtaining a relationship between what he calls A-trait and activation is the subject's perception of the experimental situation as threatening or anxiety provoking.

Students with MAS scores of 34 and above and six and below were not used as subjects in this study. Such scores were eliminated because (a) there is some evidence to indicate that extreme MAS scores may be typical of a pathological rather than a normal population (Taylor, 1953); and (b) subjects with extreme MAS scores did not meet the achievement criteria in sufficient numbers to justify their inclusion. It is possible that a significant relationship between scores on the MAS and activation might have been found if students with extreme scores had been used in the investigation.

Achievement

This investigation found no significant relationship between underachievement or overachievement and levels of activation. Taking into consideration the problems associated with the accurate prediction of grade point averages and the scarcity of investigations attempting to relate activation (particularly as measured via autonomic nervous functioning) to achievement, these findings are not interpreted as precluding the possibility that such a relationship, in fact, may exist. This type of conclusion would seem justified in the light of the work of Bry and Daniel (1967).

CHAPTER V

SUMMARY

The present investigation was concerned with illustrating the relationships between several purported physiological and behavioral indicants of activation. The primary purpose was to demonstrate whether an experimental situation requiring a relatively small degree of effort or involvement on the part of the subjects would be sufficiently arousing to cause concomitant variations in physiological responses. An additional objective was to determine if two physiological indicants of activation (skin conductance and heart rate) varied systematically under these conditions for subjects differing in levels of manifest anxiety and college achievement.

Thirty subjects were divided into six groups each with five members according to levels of manifest anxiety and achievement in the following manner. Subjects obtaining MAS scores ranging between 26 and 33, 17 and 20, and 8 and 10 were designated respectively as high, medium and low anxious groups. The resulting anxiety groups were then subdivided as underachievers and overachievers. An underachiever was defined as a student receiving grades at least one standard deviation below those predicted for him from his high school record and college entrance examination scores; an overachiever earned grades at least one standard deviation above those predicted for him.

Activation level was altered by changing the incentive level of the task. In the context of presumably demonstrating superior female sensitivity to color, S discriminated between shades of blue and green presented by a flashing light after being told (a) her responses would not count toward her rank in the experiment (low arousal); and (b) her responses would be counted for the experimental data and toward her rank in the experiment (high arousal). While S was responding in the latter condition she was interrupted and reminded of the instructions. Measures of heart rate, skin conductance and cortical activity were recorded simultaneously for each of 30 Ss under each condition.

Significant main effects were obtained for both the stress and time variables. Heart rate and skin conductance increased as a function of situational stress ($p > .05$ in both cases). The decrease in skin conductance over time (the within-trial dimension) was also significant ($p > .01$); however, no significant changes were observed for heart rate on this dimension. These results were interpreted as lending support to the conclusion that physiological responsiveness varies in a concordant, though not undifferentiated manner, with minimal changes in activation level.

Neither physiological measure varied as a function of changes in levels of manifest anxiety or achievement per se. From these results, MAS scores apparently did not accurately indicate levels of activation; however, because of the problems associated with predicting levels of achievement, the possibility of an actual relationship between levels of activation and achievement was not precluded.

Significant interactions ($p > .05$) were observed between manifest anxiety and time for skin conductance and between situational anxiety (stress) and time for heart rate. The interaction between achievement level and time approached significance ($.10 > p > .05$). These interactions, although they may be somewhat suspect because of non-homogeneity of variance, were interpreted as suggestive of a relationship between the physiological and behavioral indicants of activation that operates in a somewhat non-systematic manner as a function of time.

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APPENDIX A

STANDARDIZED INSTRUCTIONS

"Since this is a pretty straight forward experiment I'm going to tell you a little bit about it before we begin. Most people say women are more sensitive than men. Recently there has been some research done that indicates this may be very true. It seems women are really superior to men in making fine discriminations between stimuli. Things like telling the difference in noises, smells, tastes, faces and so forth. It also turns out that women can discriminate shades of color a lot better than men. I am interested in getting data on color discrimination from UNC-G women that I think are particularly sensitive (you remember that questionnaire you filled out in September?) and comparing it with data gathered on other campuses. I am going to rank all the subjects in this experiment according to how well they do and I'll make this ranking available at a later date. So please do the very best you can.

"I am also interested in the physiological correlates of this color sensitivity in women which is why we will be recording your physical responses while you do the task. I need to spend part of each run calibrating the machinery. During that time I want you to respond as usual to the colors but I won't be able to record your responses so naturally they won't count toward your rank. I'll tell you when we start counting your responses. We'll have two calibration runs that don't count and two experimental runs that do count.

"As you have seen in going through the laboratory, there is no way you will be shocked or hurt in any other way by the apparatus used in this experiment."

APPENDIX B

TABLE 1

MEAN MAS SCORES, PGPAs AND OGPAs FOR HIGH, MEDIUM AND LOW ANXIOUS OVERACHIEVERS AND UNDERACHIEVERS

GROUP	N	MAS	PGPA	OGPA	PGPA-OPGA
Overachievers	15	18.6	2.14	2.79	+.65
High anxious	5	28.4	2.06	2.79	+.68
Medium anxious	5	18.2	2.16	2.83	+.67
Low anxious	5	9.2	2.20	2.82	+.62
Underachievers	15	17.9	2.17	1.53	-.63
High anxious	5	27.2	2.06	1.40	-.66
Medium anxious	5	18.2	2.16	1.53	-.63
Low anxious	5	8.4	2.30	1.68	-.63

TABLE 2

VARIANCE ANALYSIS SUMMARY FOR HEART RATE

Source of Variation	df	MS	F
Between Subjects	29		
Achievement (A)	1	2.05	--
Manifest anxiety (B)	2	442.59	--
A x B	2	2786.68	1.42
Subjects within groups	24	1960.2	
Within Subjects	270		
Stress (C)	1	1524.6	38.16**
A x C	1	4.88	--
B x C	2	5.67	--
A x B x C	2	58.45	1.46
C x Subjects within groups	24	39.95	
Time (Trials) (D)	4	3.35	--
A x D	4	8.96	2.34[1]
B x D	8	5.02	1.31
A x B x D	8	3.53	--
D x Subjects within groups	96	3.83	
C x D	4	13.46	3.34*
A x C x D	4	13.61	--
B x C x D	8	2.44	--
A x B x C x D	8	4.06	1.05
CD x Subjects within groups	96	3.86	
Total	299		

*Significant at .05 level.
**Significant at .01 level.
[1]Significant between .10 and .05 levels.

TABLE 3

VARIANCE ANALYSIS SUMMARY FOR SKIN CONDUCTANCE

Source of Variation	df	MS	F
Between Subjects	29		
Achievement (A)	1	72.45	--
Manifest anxiety (B)	2	796.69	1.92
A x B	2	400.67	--
Subjects within groups	24	413.8	
Within Subjects	270		
Stress (C)	1	13.82	7.01*
A x C	1	1.67	--
B x C	2	2.21	1.12
A x B x C	2	3.77	1.91
C x Subjects within groups	24	1.97	
Time (Trials) (D)	4	2.30	9.46**
A x D	4	.097	--
B x D	8	.61	2.5*
A x B x D	8	.11	--
D x Subjects within groups	96	.24	
C x D	4	.25	--
A x C x D	4	1	--
B x C x D	8	1	--
A x B x C x D	8	1	--
CD x Subjects within groups	96	92.20	
Total	299		

*Significant at .05 level.
**Significant at .01 level.