

AROUSAL RESPONSES TO SPECIFIC STRUCTURED CLASSROOM  
ACTIVITIES AND EVENTS AS DETERMINED BY  
CARDIAC TELEMETRY

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CARDIAC TELEMETRY

DISSERTATION

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TABLE OF CONTENTS

	Page
LIST OF TABLES . . . . .	iv
LIST OF ILLUSTRATIONS . . . . .	v
Chapter	
I. INTRODUCTION . . . . .	1
Statement of the Problem	
Purposes of the Study	
Hypotheses	
Background and Significance of the Study	
Definition of Terms	
Limitations of the Study	
Basic Assumptions	
II. REVIEW OF RELATED LITERATURE . . . . .	16
III. METHODS AND PROCEDURES . . . . .	40
Subjects	
Design of the Study	
Procedure for Collecting the Data	
Procedure for Treating the Data	
IV. PRESENTATION AND DISCUSSION OF RESULTS . . . . .	53
V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS . . . . .	68
APPENDIX . . . . .	80
BIBLIOGRAPHY . . . . .	87

LIST OF TABLES

Table	Page
I. Friedman Two-Way Analysis of Variance by Ranks, Showing Mean Amplitude and Duration of Arousal for Subjects in the Control Periods and Structured Activities for Both Days . . . . .	57
II. Wilcoxon Test of Significance by Signed Ranks of the Mean Amplitude of Arousal in Beats Per Minute for Subjects in the Four Hypothesized Situations . . . . .	58
III. Wilcoxon Test of Significance by Signed Ranks of the Mean Duration of Arousal in Seconds for Subjects in the Four Hypothesized Situations . . . . .	58
IV. Mean Amplitude of Cardiac Arousal in Beats Per Minute of Subjects in the Hypothesized Situations . . . . .	84
V. Mean Duration of Cardiac Arousal in Seconds of Subjects in the Hypothesized Situations . . . . .	85

LIST OF ILLUSTRATIONS

Figure	Page
1. Group Mean Amplitude of Cardiac Arousal for Subjects in the Six Grouped Situations for Which the Hypotheses Were Formulated . . . . .	54
2. Group Mean Duration of Cardiac Arousal for Subjects in the Six Grouped Situations for Which the Hypotheses Were Formulated . . . . .	55
3. Scatter-Plot of the Mean Amplitude and Duration of Cardiac Arousal for Subjects During the Control Period of the First Day . . . . .	62
4. Scatter-Plot of the Mean Amplitude and Duration of Cardiac Arousal for Subjects During the Activity One of the First Day . . . . .	63
5. Scatter-Plot of the Mean Amplitude and Duration of Cardiac Arousal for Subjects During the Control Period of the Second Day . . . . .	64
6. Scatter-Plot of the Mean Amplitude and Duration of Cardiac Arousal for Subjects During Activity Two of the Second Day . . . . .	65

## CHAPTER I

### INTRODUCTION

For many years now educators and researchers have strongly suspected that there is a relationship between the efficiency and rate of learning and the degree to which the individual is driven, activated, or aroused. Such a belief has been formulated into a theory of arousal or activation by sensitive students of human behavior such as Hebb (22), Duffy (14), Lindsley (32), and Malmö (34). It is this theory of arousal or activation that leads one to believe that there might be an optimal range or level of arousal for effective behavior. Within such a range or level of arousal the individual has a tendency to perform with maximum efficiency and effectiveness.

The arousal or activation of an individual results in a number of changes in the physiological processes within the individual, such as brain-wave activity, muscle tension, skin conductance, heart rate, and respiration rate, which may be utilized together or separately as indices of arousal or activation in the individual. Reliable and valid measures of such indices seem to promise significant relationships between autonomic arousal, mental performance, and classroom activities and events of the teaching-learning process.

While intercorrelations of these physiological measures are generally low, intracorrelations appear to be significantly higher (16). Literature in this area reveals that studies to correlate autonomic arousal and performance have been carried out frequently in laboratory situations, but not as yet in the classroom setting.

Because the physiological indices previously mentioned do provide an indication of autonomic arousal in an individual, it is believed that studies of the physiological responses of students in the classroom encountering activities and events of a teaching-learning process may demonstrate relationships between autonomic arousal, mental performance, and specific events. These relationships could provide clues to possible courses of action for teachers in the classroom. The present investigation involved efforts to explore the relatedness of autonomic arousal and specific classroom activities and events through the use of cardiac telemetry.

#### Statement of the Problem

The problem of this study was to observe, represent, and analyze student arousal response to specific structured classroom activities and events.

#### Purposes of the Study

The purposes of this study were (1) to determine the effects of specific structured classroom activities and



events on the cardiac rates of students in the classroom, (2) to determine whether or not there was a detectable difference in the cardiac rates of students involved in structured classroom activities and events and cardiac rates of students not so involved, and (3) to determine the effects on the cardiac rates of students involved in two techniques of attaining student involvement and attention to a classroom discussion or topic.

#### Hypotheses

Consistent with the purposes of this study, the following hypotheses were formulated:

I. There will be significantly higher mean amplitude and duration of cardiac arousal for the subjects during the experimentally structured periods of activity than during the control periods.

II. There will be significantly higher mean amplitude and duration of cardiac arousal for the subjects during Activity One of the first day than during the control periods of the first day.

III. There will be significantly higher mean amplitude and duration of cardiac arousal for the subjects during Activity Two of the second day than during the control period of the second day.

IV. There will be significantly higher mean amplitude and duration of cardiac arousal for the subjects during

Activity Two of the second day than during Activity One of the first day.

#### Background and Significance of the Study

When attempting to approach a behavioral or psychological process, such as learning, from a psychophysiological standpoint, one must move with extreme caution. In an attempt to understand, illustrate, and communicate to others the functioning of such complex systems as the ascending reticular activating system (ARAS) and others, care must be taken not to oversimplify for clarification purposes the physiological processes involved (9). Investigators in the area of psychophysiology must be careful about drawing conclusions about psychological processes when these conclusions are based solely upon physiological evidence. The implication of relationship between the psychological and the physiological must be well established, well defined, and replicable. It is from studies conducted with such care and caution by individuals such as Bindra (6), Blatt (7), Duffy (14, 15, 16, 17), Hebb (22), Lindsley (31,32), and Malmö (34, 35, 36, 37, 38) that the significance and much of the background for this particular study has arisen.

According to arousal theory there is an optimal range or level of arousal within which a given measure of performance will reach its highest value; the greater the deviation in either direction from the optimum arousal level, the

greater will be the decrease in the performance measure. Such an inverted U-shaped relationship between level of arousal and performance has been suggested by numerous research studies in the area of psychophysiology (6, 14, 19, 22, 32, 34). Advancements of this line of thinking theorize that with increased habit strength of a response, there is an increase in the range of the optimal level of arousal, as well as in the range within which the activity occurs initially (6). When arousal is too low, as for example in drowsiness or extreme relaxation, it might be expected that the individual would lack alertness or sensitivity to his environmental stimuli. One might fail to respond to cues, or his response might lack force and speed. On the other hand, if his level of arousal is too high, there might be excessive impulsion to action and, consequently, a reduction of the range of cue utilization. Also, the nature of the task appears to be an important determinant of the effect upon performance of a high degree of arousal.

Although the possible implications of this type of theorizing are almost limitless for educational processes; it nevertheless presents considerations and problems of emotions, perceptions and concepts, incentives and drives, motivation and other individualized personality elements, and hosts of physiological concomitants for which, as yet, there are no reliable solutions (2, 3, 6, 7, 9, 10, 12, 16, 21, 22, 28, 31, 34, 35, 39, 48). Much of the work done along

these lines that has been done in the past has been centered around autonomic arousal and its relationship with such intervening variables as drive, motivation, and incentives (4, 9, 16, 19, 22). The problem of measurement of autonomic arousal has been a perplexing one to researchers because of the numerous indices of autonomic arousal available, any one of which gives a general indication of autonomic arousal, but perhaps not a complete physiological picture. However, authorities such as Duffy (16), Lindsley (32), and Malmö (34) feel confident that studies utilizing any one of the indices included in the organismic continuum, such as respiration rate, brain-wave activity, muscle tension, skin conductance, and heart rate can reveal significant relationships. This study attempted to utilize the heart rate as an index of autonomic arousal.

Most evidence, according to Malmö (34), indicates that arousal level is in large part a function of environmental stimulating conditions. Comparisons, then, are invariably of the within-individual, within-task kind, which means that the level of arousal which is found to be optimal for one task is not directly compared with the level of arousal which is found to be optimal for a different task. Evidently tasks of differing complexity will have different optimal levels of arousal. It may be concluded that the level of arousal depends to some extent upon the response to cues and that the ability to respond to cues and to inhibit and

coordinate reactions depends in part upon the level of arousal (14, 22, 34).

This study was designed to facilitate the introduction of such environmental cues and stimuli through the structured classroom activities and events (e.g., interaction with the instructor). The occasions of the subjects reacting and responding to these structured classroom activities and events provided psychophysiological observations which will, hopefully, shed some light upon the autonomic energy level of the individual as he engages in certain mental processes. The evidence yielded by this study should be supportive to the prominent theory of an optimal arousal level for mental performance, as well as provide further credence to the hypothesis that this optimal level of arousal varies according to the nature of the task and the psychophysiological nature of the individual.

Much of the psychophysiological functioning during arousal has been described by research studies to the extent that lawful relationships between arousal and behavioral efficiency are now supported by studies involving muscle tension (15, 20), brain wave activity (31, 32, 33, 34), skin conductance (15, 20), and heart rate (2, 3, 7, 45). The cardiac rate was chosen as an indicator of autonomic arousal in this study because a survey of the studies mentioned above seems to reflect the fact that the cardiac rate could be used reliably as an index of arousal. Also, the cardiac

rate could be determined telemetrically, recorded on videotape, and subjected to analysis with relatively fewer problems to confront the researcher due to a lack of highly sophisticated physiological techniques. Because the heart responds very quickly to arousing situations, returns quickly to a basal rate, and can be monitored telemetrically without seriously restricting the individual's physical reactivity, the cardiac rate served as the most functional indicator of arousal for this particular study.

Still another factor that seemed to indicate the need for this type of study is the dearth of literature indicating studies of autonomic arousal relating to behavioral performance in the normal classroom setting. In this study an attempt was made to observe the individual physiologically, psychologically, and sociologically, in the actual contextual setting--the classroom. The cardiac rates of subjects during the classroom activities and events reflect to some extent the degree of significance of the situation as required by the arousal theory and even provide some basis for evaluating stimuli sources.

#### Definition of Terms

For the purpose of this study the following definitions were formulated:

Arousal.--Arousal will be defined in terms of a measure, the cardiac rate, as determined by a cardiometer

telemetrically. An arousal will be determined when the cardiac rate is found to substantially deviate from the base rate.

Base rate.--This measure represents a rate of cardiac activity for the individual below which the cardiac rate does not go for an extended period of time. Under varying conditions an individual may exhibit different base rates.

Cardiac rate.--The heart rate (HR) measured in beats per minute will be defined as the physiological indicant of arousal.

Initial rest.--In the classroom setting the control period preceding the beginning of any structured classroom activities or events will be defined as initial rest.

Recitation.--Any oral verbal response by the subjects to the instructor's questions or directions in the classroom will be defined as a recitation.

#### Limitations of the Study

This study was limited to the cardiac rates of subjects as indicants of autonomic arousal which were recorded during the selected, structured classroom activities and events. Any student with a medical history of "heart trouble" or one receiving or taking regular medication or drugs upon a doctor's advice was eliminated as a possible subject. The

matching or controlling of emotional aspects, personality traits, physical attributes, or physiological properties was not attempted because of possible distortions of the "normal" classroom setting. Interpersonal interaction and personal communications of the subjects with the instructor and with the other students were not restricted, for the same reason.

#### Basic Assumptions

It was assumed that the subjects involved in this study received equal exposure to the general psychological and sociological factors available to anyone in the classroom so that any significant findings were not negated by an obvious imbalance in these factors. It was further assumed that the instructors involved in the study were carefully oriented in the design of the study and were able to enact the structured classroom activities and events with relatively equal efficiency and success.

Finally, it was assumed that factors other than those under examination in this study which relate to autonomic arousal would not negate the significance of findings reflected in quantitative changes of cardiac rates during structured classroom activities and events.



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## CHAPTER II

### REVIEW OF RELATED LITERATURE

Although a review of the literature in the area of autonomic arousal reveals that there have been many studies to relate the level of arousal to certain mental activities and performance in general, careful examination of these studies indicates that nearly all of these studies have been performed in settings other than that of the classroom. Consequently, any findings from these studies can only be related to the classroom situation on an inferential basis. However, previous research of this nature has helped to establish certain relationships and rationales of psychophysiology which might be applied to the classroom situation.

Research contributions from such individuals as Armstrong (2), Beebe-Center (5), Cannon (18), Darrow (23), Freeman (35), Jost (49), and Shock (86) helped to establish relationships between autonomic arousal and concomitant changes in mental behavioral processes early in the history of psychophysiology. Substantial evidence has been presented in studies by Duffy (28, 29, 31), Malmö (65, 66, 67, 68, 69), and Schnore (84) to the effect that physiological measures have been found singularly useful in providing objective and reliable indicants which could consistently differentiate

between high and low arousal conditions. Studies done by Schnore (84), Blatt (12), and Duffy (30) seem to demonstrate that during qualitatively and quantitatively different stimulus situations individuals exhibit idiosyncratic but highly stereotyped patterns of somatic and autonomic arousal. According to Duffy (30), this internal consistency is that which is essential for the establishment of a general concept or theory of arousal. She relates that while inter-correlations of physiological measures are generally low, intracorrelations or correlations of measures within the same individual appear to be substantially higher and more reliable.

Still another factor which has had a demonstrable effect upon the level of arousal and performance of an individual is that of the emotional state of the individual. Ho (45) concluded that frustration and its associated physiological concomitants do not appreciably affect complex mental functions. Although the cardiac rate did show a significant increase in his frustrated (goal blocked) group, there was evidence that the arousal did not exceed the optimal level. Jost (49) reports that the physiological tensions that result from frustration are motivational but not directive in action. They are less variable from individual to individual and are thus probably a better measure of the reaction to frustration than are the more variable overt reactions which are so subject to strict social

demands. Deane (24) found that experimentally induced anxiety resulting from the fear of possible electrical shock had the potential to decelerate the heart rate, while anticipatory periods of waiting for the signal preceding the shock brought about a definite acceleration in the cardiac rates. It was speculated that these two cardiac effects might be unlearned responses associated with what may be termed fear and anxiety.

Perhaps the relationship supported by research studies which has the greatest implication for this study is that indicating that the arousal level of an individual and the efficiency of general performance for that individual are significantly related. In a study of cardiac arousal during mental activity, Blatt (12) concluded that efficiency in complex mental activity should be, and in fact is, characterized by heightened arousal which occurs, in part, at important points in the thought process. He showed that at crucial points in a problem-solving process, efficient problem-solvers had a higher level of cardiac activity and a greater variability of cardiac rates than inefficient problem-solvers. It would seem that there is a growing emphasis upon a general dimension of behavior which is related to the intensity of organismic functioning and which, on a physiological level, puts meaning into the often employed concept of "state of the O," according to Stennett (88).



Freeman (36) and Hebb (42) suggest an important hypothesis with regard to the relationship between performance level and this intensive dimension mentioned above, which they choose to call the "arousal continuum." Berlyne (7) refers to intensity as one of the three variables having determinant effects upon arousal, although his approach when carefully analyzed, turns out to be strictly a psychological approach to arousal rather than a psychophysiological one. Hebb (42) goes on to say that there is an optimal level of arousal for effective behavior; that when arousal or drive is at a low level, a response that produces increased stimulation and greater arousal will tend to be repeated. But when arousal is at a high level, a greater stimulation may interfere with delicate adjustments in cue attention and function, thus causing inefficient behavior and possible irrelevant responses from the individual.

Lindsley (62) and Malmö (65), using EEG tracings found a similar relationship between arousal level and performance which they chose to call the "inverted-U relationship." A de-synchronization or flattening in the EEG tracing was found to be consistently associated with increased alertness or arousal in a large number of animal and human subjects. Duffy (28) and Bindra (10) conceived of arousal or activation and "energy mobilization" as a continuum of organismic excitation, varying with the stimulus situation and with internal factors, and producing important changes in behavior

of many kinds. They include in this organismic continuum such indices as EEG, EKG, EMG, and GSR factors.

Duffy's (28) concept of arousal refers not to the energy that is potentially available to the organism, but to that energy actually released through activity in the tissues. Its determinants are thought to be both physiological and psychological. She confirms the inverted-U relationship by showing that a wide variety of measures of physiological processes show relatively consistent changes with alterations in what appear to be the energy requirements of the situation. The direction of the change in these measures seems, in general, to be consistent as the individual goes from the sleeping to the waking state, from waking relaxation to work on easy tasks, and from work on easy tasks to frantic effort or extreme excitement.

The physiological gradients that accompany mental activities do not necessarily indicate increased cortical arousal during a specific behavioral situation, according to a study done by Malmö (67). Because the cortical activities of subjects in his study remained relatively stable while the cardiovascular processes were steadily accelerating, he suspected that physiological gradients were not indices of increasing motivation during a behavioral task, but rather that the degree of change of the gradients was a possible function of the motivation level. Obrist et al. (77) in their studies of autonomic levels and liability with

comparisons of performance times on perceptual and sensory motor tasks found that subjects having a lower basal heart rate demonstrated faster performance times on the sensory motor tasks as well as greater cardiac variability during the performance itself.

Research by Shock and Schlatter (86) suggests that associative processes or thoughts and ideas have a greater potential for affecting cardiac activity than spontaneous sensory stimuli, although the latter does seem to manifest more effect in physiological indices such as GSR, EMG, and BP. Early descriptions by Darrow (23) of the effects of cognitive or ideational stimuli on physiological processes seem to confirm the above research. A study done in 1941 by Berg and Beebe-Center (6) demonstrated that in human subjects the response of "cardiac startle" as it was called could be habituated by repeated sounds and that the response could be disinhibited by the interpolation of either a lapse in time between the stimulus sounds or a different stimulus. Schnore (84), in studies of the EMG and HR of subjects doing mathematical problems and visual-pursuit tracking, found that these physiological measures were reliably correlated with the speed of performance of these particular tasks. Malmo and Davis (68), utilizing the same indices of physiological activity, with the addition of BP obtained relatively similar findings with subjects performing mirror tracings. Most of the research reviewed up to this point

represents what has been called the "basic foundations of psychophysiology." Much of what will be reviewed in the ensuing pages of this chapter will be representative of the ideas, concepts, rationales, and theories that have arisen as a result of the seeds planted by earlier studies in this area of psychophysiology. Although some of the studies that will be reviewed are not directly related to cardiac arousal, they seem to hold some significance to this study in that they point up some of the many variables which may be in effect for this research setting.

Malmstrom, et al. (70), in a study designed to examine the cardiac responses of twenty-two subjects watching a movie, "Subincision," which previous research had shown to be stressful and to stimulate autonomic arousal responses, were able to implement a new technique of analyzing the cardiac rate as an autonomic response indicator. This method, which hopefully smoothes out the irrelevant fluctuation due to respiration (sinus arrhythmia), has been called the method of mean cyclic maxima. This new method, combined with a moving averages technique, seems to offer greater advancement over the former method of measurement of the rate of a single heart beat-to-beat interval at the beginning of each set time period. The heart rate curves derived from the method of mean cyclic maxima also show a closer correspondence to the peaks of psychological stress produced by experimental stimulus sources.

In a study by Gibson and Hall (39), twenty-four subjects in two groups engaged in three intensity dimensions and two duration dimensions of problem-solving for a Lacey type "silent elaboration" task. One group performed under a white noise environment and the other under a silent environment. The results seem to indicate that difficult mental tasks are associated with less heart rate acceleration than easy mental tasks. This was, of course, contrary to general expectations. One possible interpretation or explanation of these results was that cardiac acceleration might serve to augment the blocking of competing stimulation only when irrelevant stimulation is potentially intrusive or when the challenge of a mental problem is not sufficient to prevent distraction by a second stimulus source. In a study done in a similar experimental setting as that described above, Costello and Hall (21) found that certain set degrees of white noise in the absence of mental tasks did not produce a significant increase in the cardiac rates of the subjects involved.

Notterman, et al. (75) report a technique for establishing a conditioned heart rate response in humans during experimentally established anxiety. They presented evidence that, by means of a described technique, a tone which had previously served as an ineffective stimulus acquired the power of exercising a depressant effect upon the cardiac rate, after the tone had been repeatedly associated with an electrical shock.

The early work reported by Darrow (23) concerning the cardiac reactivity of individuals involved in emotional situations was to some extent reinforced by Dykman, et al. (32) in a study reported in 1963. During periods of emotional and non-emotional questioning their subjects demonstrated significantly higher cardiac rates than during a tone period of the same duration. They also found that the autonomic responses of subjects reported to be high and low in general anxiety level could not be interpreted as significant by standard statistical treatment. This lack of correlation between anxiety level and cardiac reactivity was confirmed by a report in 1956 by Lewinsohn (59). Hodges and Spielberger (46) also confirmed this same lack of correlation between cardiac rate and anxiety level with subjects of high anxiety and low anxiety by running them in conditions of threat of shock and no-threat conditions. The threat condition produced a significant mean increase in heart rate as compared to the no-threat condition, but there was no difference in the heart rate response of high anxiety and low anxiety subjects to threat of shock. In this same study, Spielberger (46) makes an attempt to distinguish between what he calls state and trait anxiety.

Deane (24) speculated that when a subject expects a noxious stimulus of unknown degree, a state of anxiety with its accompanying response of heart rate acceleration is found, and if the subjects expect the stimulus at a particular

time, a state of fear with its accompanying response of heart rate deceleration is found immediately prior to and during the time the stimulus is anticipated. In a study of the effects of a signal preceding an electrical shock to college students over an extended period, Kanfer (51) obtained results similar to Deane's as reflected by a continuous verbal response rate and the individual's heart rate.

The effect of threat of shock on heart rate and motor performance was studied by Thackray and Pearson (90) in a situation in which three groups of subjects were used. One group served as a control group, the second was told that shock would be administered randomly, and the third was told that shock would be administered if performance of the motor task fell below a prescribed level. Although no shock was actually administered, the group that had been told that shock would be administered if performance fell below a certain level showed a fear of shock that was accompanied by increased heart rate and impaired performance. Ax (4) showed that intercorrelations of the physiological indices were significantly higher for the emotional state of anger than for that of fear. He concluded that the individual in a state of anger possibly demonstrates greater integration of the elements of his environment. In studies done by Campos and Johnson (16, 17), it was demonstrated that verbal stimuli seemingly have a greater effect on the heart rates of subjects than visual ones. In these studies it was found that

verbalization of instruction to subjects had a significant effect on the cardiac rates while visual instruction caused little, if any, detectable cardiac effects.

Lang and Hnatiow (57) found that in situations in which sensory stimuli were effective on a continuous basis there seemed to be a decelerative effect on the heart rate while the presentation of a task requiring conceptualization seemingly caused an acceleration in the heart rate. Also, the presentation of a noxious stimuli created a condition of cardiac acceleration in the experimental setting of this same study. According to a study conducted by Meyers and Gullickson (73), adults tested in experimental settings tend to display a diphasic pattern of cardiac rate change to simple auditory stimuli. As a result of the deceleration and rapid habituation of the cardiac rate when adult subjects were subjected to a series of white noise periods with accompanying non-signal tones, Chase and Graham (19) concluded that the cardiac deceleration involved in this setting was an element of the basic orienting reflex. Similar results were obtained by Lewis, et al. (60) in a study designed to attempt to correlate cardiac response and attention in infants. Kagan and Rosman (50) found essentially the same phenomenon to be true with a group of first-graders in an experimental setting. Black (11) and Lynch (63) were able to describe essentially the same phenomenon of deceleration and habituation in a laboratory setting using dogs as subjects.



The habituation of the orienting response was not confirmed by Malmo and Survillo (69) in their study of drowsy subjects who had been deprived of sleep over extended periods of time. Utilizing several measures as indicants of autonomic arousal, they found evidence quite to the contrary. Their study indicated that sleep deprivation had the effect of increasing rather than decreasing the level of activation or arousal in the individual. In a study of alert and drowsy subjects, McDonald, et al. (72) found that the cardiovascular response measures of the drowsy groups showed consistently and significantly greater responses on the later trials. This is obviously contrary to the idea of habituation of the orienting reflex. Graham and Clifton (40) suggest that the deceleration phenomenon may be a function of the orienting reflex while acceleration serves as a component of a defensive reflex. It has also been suggested that deceleration in the cardiac response may be related to the attending of the stimuli of an external environment and acceleration as a possible blocking effect to the external stimuli (56).

In a study involving eighty-four male college students in good physical health, Docter, et al. (26) made an attempt to provide additional descriptive data of "spontaneous" heart rate fluctuations by (a) the use of various tests of reproducibility over time, and (b) by describing the sampling distribution of heart rate changes. They attempted to tie these heart fluctuations in with motor performance on certain

tasks. It was concluded, however, that neither heart rate nor galvanic skin response was significantly related to the performance.

A study by Sadler et al. (83) yielded results which suggested that when a non-painful stimulus is combined with a painful one in such a manner that the individual is reacting physiologically to both stimuli, their effects are not accumulative. In fact, the stimuli seem to interact in such a way that the resultant response of the organism is actually lower or at as low as the maximum response for the stronger of the two stimuli. The study mentioned above suggests that perhaps stimulus competition occurs at a physiological level below that of mental or cognitive processes.

The measurement of a subject's physiological arousal level before and after frustration and following an aggressive expression was the goal for a study conducted by Hokanson and Burgess (48). From the results of their study they were able to conclude that goal-blocking and ego-threat frustration cause the autonomic arousal level to be increased. Direct verbal or physical aggression inflicted on someone of a peer nature who had induced frustration seemed to reduce or "relieve" the post-frustration arousal level of physiological activity. The type of aggression, the frustrator's status, and the target of aggression all seemed to function as determining elements of this "cathartic" phenomenon.

Averill (3), in a recent study of the effects of sadness and mirth on physiological processes, reported that films shown to subjects with the intention of inducing sadness and mirth actually reflected significant changes in certain physiological processes. A type of sympathetic arousal was evident in the physiological processes for both emotions. The emotion of sadness was more pronounced by changes in the cardiovascular processes while the emotion of mirth seemed to be more closely linked to the processes of the respiratory system. In a study dealing with changes in electroencephalograms and other physiological measures during certain types of behavioral performance, MacNeilage (64) showed that EEG amplitude usually co-varied with the cardiac rate and other arousal indices in such a way that would be predicted by the arousal theory as stated by Lindsley (62) and Malmo (65).

Elliott (34), in a study comparing the physiological activity and performance in adults and children, demonstrated that children differed from the adults in that they showed (a) no covariation between quality of performance and level of physiological activity, (b) lower intra-individual correlations between the different physiological response, (c) little adjustment during the experimental observation sessions, (d) less relatedness between inter-stimulus intervals and reaction times, and (e) increased in the amplitudes of the

various EEG tracings with increasing motivational and physiological activity.

In a study dealing with sex differences and autonomic responses during instrumental conditioning, Graham et al. (41) found that experimental groups of both men and women demonstrated a tendency of cardiac deceleration during periods when behavior was inhibited by verbal instruction. In this particular experimental setting the female group demonstrated a higher level of cardiac activity but with considerably less galvanic skin response than that of the male group.

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## CHAPTER III

### METHODS AND PROCEDURES

#### Subjects

To carry out the purposes and test the hypotheses of this study twenty-three students were enlisted as subjects from the introductory education classes (Education 162) that meet in the experimental classroom (Education Building Room 332), which is equipped with observational one-way windows and microphones suspended from the ceiling. All of the subjects enlisted were of the male sex since provisions for the attachment of the chest electrodes on females would have necessitated the addition of a female member to the research team, as well as separate facilities for privacy during electrode placement. The sections of classes from which these subjects were chosen were those meeting in the experimental classroom on Monday, Wednesday, and Friday, at the following hours: eight, nine, ten, one, and two o'clock.

Physically, the subjects ranged in height from a maximum of six feet, four inches down to a minimum of five feet, seven inches. The weights of the subjects ranged from a maximum of 250 pounds down to a minimum of 136 pounds, with only four subjects weighing over 200 pounds. The subjects ranged in age from seventeen to twenty-six years, with the average age being twenty and one-half years.

Of the subjects in this study, there were nine freshmen, nine sophomores, four juniors, and one senior. Consequently, many of the subjects had completed the physical activities portion of the University's physical education program and were no longer involved in any organized program of physical training or conditioning. From the information gained through the utilization of a Biographical Inventory (Appendix A), it was established that six of the subjects were moderate to light (one-half to one pack per day) smokers, while the remaining seventeen subjects were non-smokers. Approximately three-fourths of the subjects slept an average of six to eight hours per night. Subjects who had a medical history of "heart trouble" or who were receiving or taking medication or drugs upon a doctor's advice were eliminated as possible subjects due to the possible introduction of cardiac variability beyond the range and scope of this study. Within each class there were four subjects chosen to participate in the activities and events of this study during each of two class days (Monday and Wednesday of the same week) for a period of two non-consecutive weeks (November 17th and 19th, December 8th and 10th). Specific information concerning individual subjects can be obtained from Appendix E.

### Design of the Study

The aid of the three instructors who were in charge of the six classes chosen to participate in this study was secured for enlisting and orienting possible subjects from the student population of the six classes. The three instructors participating in this study were males ranging in age from twenty-six to forty-one. The maximum years of teaching experience in public schools of these individuals were ten, while the minimum was three. Each of the instructors held a master's degree and was currently working toward a doctoral degree in education. Two of the three instructors had taught the course being utilized in this study for two previous semesters.

During each recording session when the subjects were experiencing the activities and events of this study, four subjects were monitored with the cardiac telemetry equipment. Because of the limited number of cardiotelemeters (two), only two subjects were monitored simultaneously during a given observation period. Consequently, during all monitoring sessions, the pairs of subjects being monitored were alternated by changing the bio-telemetry receiver controls on a specified interval basis. This allowed for adjustment of the receivers to frequencies of other transmitters, as well as to provide a reasonable period of observation of the subjects and their cardiac rates, reflecting significant or extended activities for all four subjects.



The activities and events structured for this study occurred on a Monday and Wednesday (November 17th and 19th) of the initial week of recording. The same design of activities and events were repeated on a Monday and Wednesday (December 8th and 10th) of still another week. There were two intervening weeks set aside for searching, analyzing, and collecting of all data recorded on the video tapes during the two days' observations of the initial week. The following is a description of each day's activities and events.

First day (Monday).--The first day of activities and events consisted of two major divisions, a control period, and Activity One.

A. Control period: This period of approximately twenty minutes allowed for one nine-minute period of observation on each pair of subjects. It was during these nine-minute periods that a basal rate was established for each subject through careful examination of their cardiac rates. The control period consisted of a condensed lecture session on a particular topic from which the instructor intended to raise an opinionated-type question during the structured period or Activity One. Any involvement of the subjects in the class proceedings during this period was self-initiated, and with the exception of the fact that the subjects knew that they were wired telemetrically, this represented a segment of

"normal" classroom proceedings. The subjects had no knowledge concerning the structure of any of the observation periods.

B. Activity One: Following the control period, the instructor was notified by means of a light mounted on the back wall of the classroom that the control period had ended. This light also indicated to the instructor that he should initiate Activity One. Consequently, upon seeing the light flashed, the instructor then posed a question to the class as a whole, requesting that each member of the class, subjects included, put down in some written form a personal response to that question. The question was related to the text of what the instructor intended to discuss for the rest of that period and was one that required an opinion for a response. Although the question used in each of the six classes was not the same, the general text of each question was based primarily upon the same subject, that of the role of a teacher in the classroom. Questions that would have proven to be inherently arousing or controversial for college students were not used in these observation periods. In general, these questions were restricted to the varying aspects of motivation, student interests, etc., as they affect the teacher's role in a classroom. After having posed this question, the instructor then proceeded with the class discussion related to the text of the question posed. During this period the instructor actively sought out student

participation in the discussion but did not seek subject participation unless it was obviously self-initiated. Near the end of the period all students, subjects included, were requested to once again respond in writing to the question posed earlier in view of the entire class proceedings. During this period of approximately thirty minutes, there was one fifteen-minute observation period for each pair of subjects recorded on video tape, the last observation period terminating with the bell to end the class period.

Second day (Wednesday).--The second day of activities and events consisted of three major divisions: a control period, Activity Two, and a questioning-and-reciting period.

A. Control period: This period was essentially the same as the control period of the first day, except its duration was for one six-minute period of observation for each pair of subjects, or a total of approximately twelve minutes. Again, the condensed lecture procedure was the predominant activity.

B. Activity Two: Following the control period for the second day, the instructor was signaled with the light on the back wall of the classroom that the control period had been completed and that Activity Two should begin. The instructor then posed another question to the class related to that day's lesson, asking that everyone in the class, subjects included, respond in writing to this opinionated-type question. After having paused briefly for the students

to respond but before beginning the discussion for that day, the instructor at this point informed the subjects collectively that he intended to return to them individually near the end of the period for oral responses to the question posed. At this point, periods of observation began and continued until one twelve-minute period had been recorded for each pair of subjects. The instructor, in the meantime, had proceeded with the discussion related to the question posed. Again, student ideas and participation were actively sought and incorporated into the discussion.

C. Questioning and reciting period: Approximately ten minutes before the end of the class period, the instructor was again signaled by means of the light on the back wall that he was to now pose the original question again to two subjects (designated before the session began), allowing them to respond orally. After the first pair of subjects had responded and the receivers in the observation area had been adjusted to the frequencies of the other two transmitters, the signal light was again flashed to indicate to the instructor that he should now ask for individual responses to the question from the second pair of subjects.

#### Procedure for Collecting Data

The subjects who participated in this study reported to the observation area adjoining the experimental classroom prior to the beginning of class on each of the four days of

observation and recording. At that time the subjects were prepared for cardiac monitoring by the placement of chest electrodes and a biotelemetry transmitter (see Appendix C). One electrode (red lead) was placed on the episternal region and the second (black lead) was placed approximately one inch below the nipple of the left breast. For certain subjects, it was necessary to prepare the skin surface for electrode placement by shaving body hair from the surface and then bathing the area with alcohol and drying. The electrodes were prepared for body contact by applying electrode paste to the well of the electrode and attaching adhesive washers to the outer walls of the electrodes. The electrode connector and antenna were then inserted into the transmitter itself. The transmitter was then secured to the subject's skin just below the rib cage on the right side. A small pad of foam rubber (two inches by one inch by one-quarter inch) was placed between the transmitter and subject's skin to hold the transmitter away from the subject. The transmitter was then taped securely in place along with the electrode leads to prevent transmitter movement which could cause artifact in the signal. During the placement of electrodes and transmitter, each subject was questioned as to his current mental and physical status (items 11 and 12 of Biographical Inventory, Appendix A). After all four subjects had been wired telemetrically, they were monitored for a brief period while in the observation area to make certain

that all systems of transmission and reception were in order. This was done by tuning the two biotelemetry receivers (see Appendix C) to the appropriate FM frequencies of the four respective transmitters. The frequencies used for this study were 88, 89, 89.5, and 91 mc. The subjects, in addition to having a designated subject number, were assigned an alphabetical code of A, B, C, or D to correspond to the frequencies stated above, respectively. This frequency code appeared on a small slip of paper by the cardiometer dial for each respective subject during the video recordings. Subjects coded A and B were recorded simultaneously as were those coded C and D.

The instructors were given a General Guide for Structuring Activities and Event Sheet (Appendix B), which aided them in structuring the activities and events for each day. The receivers and cardiometers (Appendix C), as well as the video taper (Appendix C), were located in the observation area adjacent to the experimental classroom behind the one-way windows. A stationary camera (Appendix C) was located in the experimental classroom and was focused on the four subjects, requiring that the subjects sit in designated seats in view of the camera. A video tape was made of each recording session, incorporating both the classroom audio-video and a view of the subjects' cardiometers by means of a split-screen television technique. Another camera mounted over and focused on the cardiometers was located

in the observational area along with a special-effects generator (see Appendix C) for TV split-screening. Approximately three-fourths of the video portion of each tape was from the camera in the classroom, with the remaining video portion coming from the camera focused on the cardiometers by means of the special-effects generator.

Consequently, all experimental data accumulated in these settings were recorded on one video tape for an entire class period. The data were then taken from the tapes and studied when the tapes were viewed during the weeks that followed the recording sessions. The replay capabilities of the video taper permitted the careful analysis and examination of the activities and events of this study, as well as the subjects' body movements and physiological (cardiac rates) reactions concurrent with these structured activities and events.

From each of the video tapes, information as to the mean amplitude and duration of cardiac arousal was derived for each subject during the control periods and the structured activities. This was accomplished by studying the cardiac reaction of the individual subjects on tape, with special notation of specific amplitude and duration being made when there was visible evidence that the individual's cardiac rate was substantially above the base rate with no apparent overt physical movement. During the recording of the amplitude and duration of arousal from the video tapes,

special care was taken to note any overt physical movement on the part of the subject being observed. Notations of suspected overt physical movement during arousals were made on the data sheets and further examinations of the tapes were made. If further examination of the tape revealed that overt physical movement did accompany the arousal under observation, the data for that particular arousal was discarded. In certain instances where overt physical movement was in evidence at the beginning of the arousal, the data for that particular arousal was not recorded at all.

#### Procedure for Treating the Data

The tenability of the hypotheses of this study was determined by nonparametric statistical analysis of the data collected. Nonparametric statistical analysis and treatment were chosen for this study because of the nature of the data being collected (cardiac rates), the nature of the subject population, and the fact that subjects were not selected randomly. The .05 level of confidence was used to reject the hypotheses.

To test the differences in mean amplitude and mean duration of cardiac arousal for the different experimental settings, as predicted by Hypotheses I, II, III, and IV, the Wilcoxon signed-ranks test of significance (3) for matched groups was utilized. Before this test was performed in each of the settings as defined by the hypotheses, the mean



amplitude and duration of arousal was established for all the control periods combined, all the structured activities combined (Activity One and Two of both weeks), the control period of the first day of both weeks, the control period of the second day of both weeks, Activity One of both weeks, and Activity Two of both weeks.

The Friedman two-way analysis of variance by ranks test (3) was used to test the difference in the means of the amplitude and duration of cardiac arousal measures of the twenty-three subjects observed in four observational settings where one variable was considered to be the subjects and the other variable was the mean cardiac measures.

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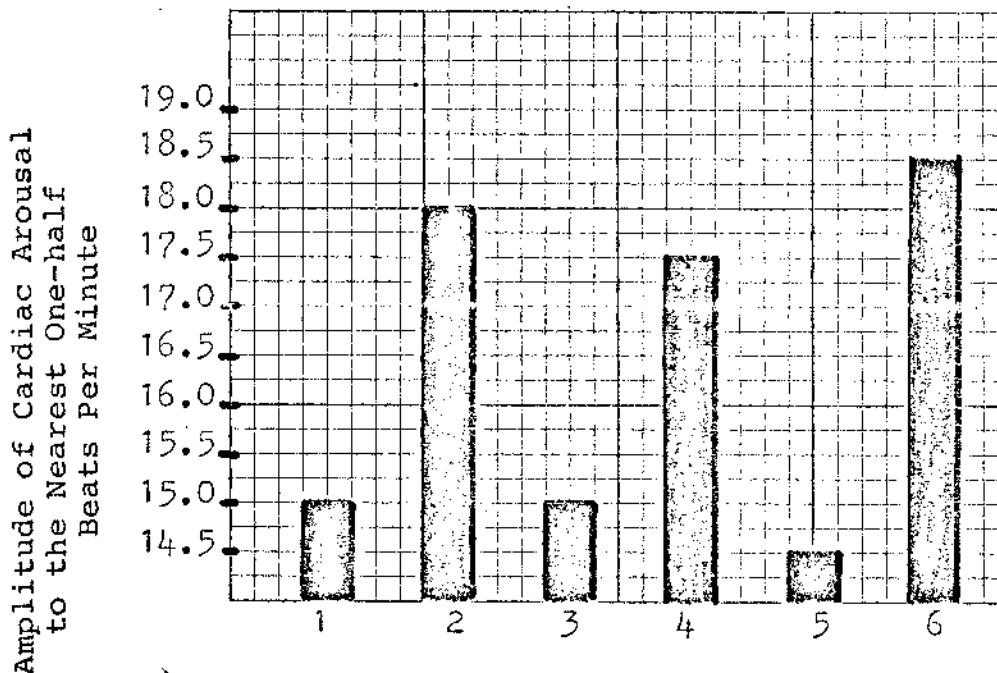
## CHAPTER IV

### PRESENTATION AND DISCUSSION OF RESULTS

The problem of this study was to observe, represent, and analyze student arousal responses to specific structured classroom activities and events. The purposes of the study were (1) to determine the effects of specific structured classroom activities and events on the cardiac rates of students in the classroom, (2) to determine whether or not there was a detectable difference in the cardiac rates of students involved in structured classroom activities and events and cardiac rates of students not so involved, and (3) to determine the effects on the cardiac rates of student involvement and attention to a classroom discussion or topic.

Twenty-three subjects were utilized in this study. The observational situations were the control period and Activity One and the control period and Activity Two. From each observation there was recorded and compiled a set of data listing the mean amplitude of arousal in beats per minute and the mean duration of arousal in seconds for each subject during that situation. The mean amplitude and duration derived represent a combination of the means for the repeated situations. These means are presented in Tables IV and V which are located in Appendix D.

The following discussions, statistical treatments, and representations are based upon the raw mean data of these two tables. Collectively, the twenty-three subjects in this study showed a greater amplitude of arousal during the experimentally structured activities (Activities One and Two) than during the control periods. This can be seen initially in Figure 1, where the mean amplitude of arousal for all



Occasions for Comparison\*

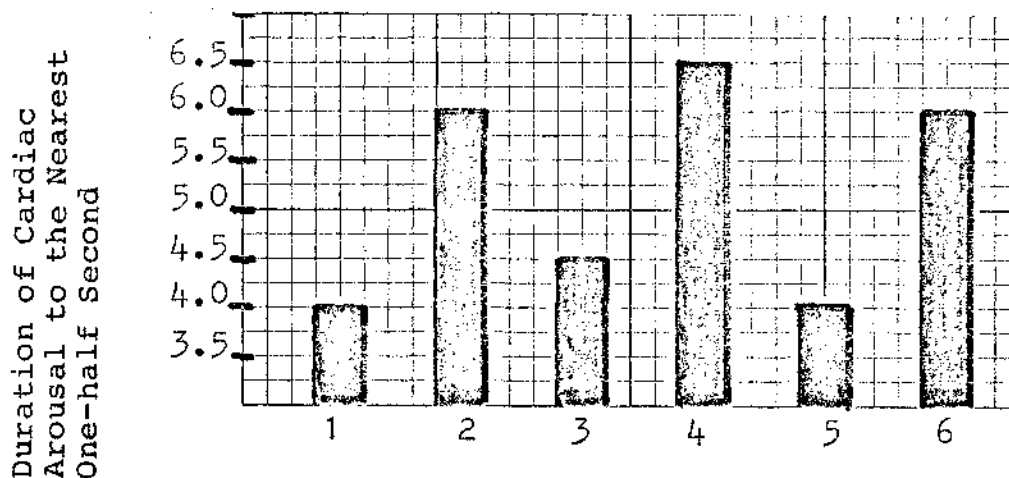
\*1: Control periods; 2: structured activities; 3: control period of first day; 4: Activity One; 5: control period of second day; 6: Activity Two.

Fig. 1--Group mean amplitude of cardiac arousal for subjects in the six grouped situations for which the hypotheses were formulated. (Shown for all control and all structured activities combined.)

is plotted for six grouped situations. These plotted means are recorded across the bottom row of Table IV.

The mean amplitude of arousal was generally greater during Activity One of the first day and Activity Two of the second day, as compared to the control periods of the same days. Activity Two of the second day showed the greater increase relative to the control periods. The control period of the second day demonstrated the lowest mean amplitude of arousal of all periods of observation.

Figure 2 illustrates essentially the same trend for mean duration of arousal for the subjects as a group in the



Occasions for Comparison\*

\*1: Control periods; 2: structured activities; 3: control period of first day; 4: Activity One; 5: control period of second day; 6: Activity Two.

Fig. 2--Group mean duration of cardiac arousal for subjects in the six grouped situations for which the hypotheses were formulated. (Shown for all control and all structured activities combined.)

same six grouped situations. The subjects, as a group, showed greater duration of arousal during the experimentally structured activities (Activity One and Two) than during the control periods. The greatest increase was shown in the duration of arousal during Activity One, whereas the greatest increase of amplitude of arousal was evident during Activity Two.

The overall trend depicted by Figures 1 and 2 indicates that the events of the experimentally structured activities (Activity One and Two) provided some degree of varying stimuli which resulted in greater amplitude and duration of arousal during such activities and events. These experimentally structured activities, as well as the control periods, were further analyzed, presented illustratively, and treated statistically for additional information that might yield insight into existing relationships or trends of arousal in these experimental settings.

Table I shows the results of the Friedman (5, p. 219) two-way analysis of variance by ranks as applied to the mean amplitude and duration of arousal of subjects in the control periods and structured activities for both days. This statistical treatment is used to determine whether or not there is a significant difference among a group of events or occasions. Analysis of the mean amplitude and duration of arousal via this treatment reveals Chi square scores of

TABLE I

FRIEDMAN TWO-WAY ANALYSIS OF VARIANCE BY RANKS, SHOWING MEAN AMPLITUDE AND DURATION OF AROUSAL FOR SUBJECTS IN THE CONTROL PERIODS AND STRUCTURED ACTIVITIES FOR BOTH DAYS

Indicant of Cardiac Arousal	Chi Square Ratio	P
Amplitude	43.23	< .01
Duration	37.02	< .01

N = 23; df = 3.

43.23 and 37.02, respectively. Both are significant at greater than the .01 level of significance.

This level of significance indicates that there was definitely a significant difference among the four observational settings of this study. Determination of the significance of the difference between the individual observed situations was accomplished through the use of the Wilcoxon (5, p. 217) test of significance by signed ranks. The four hypotheses of this study, each with its own implied magnitude of hypothesized direction, were tested individually with the Wilcoxon treatment. The results of these treatments are reported in Tables II and III.

The first hypothesis of this study predicted that there would be significantly higher mean amplitude and duration of arousal of subjects during the experimentally structured periods of activity than during the control periods of activity. Examination of Tables II and III will reveal that the hypothesis can be accepted. There was significantly

TABLE II

WILCOXON TEST OF SIGNIFICANCE BY SIGNED RANKS OF THE MEAN AMPLITUDE OF AROUSAL IN BEATS PER MINUTE FOR SUBJECTS IN THE FOUR HYPOTHESIZED SITUATIONS\*

Hypothesis	T Score	P
I-Combined Structured Activities and Combined Control Periods	1	< .01
II-Activity One and Control Period of the First Day	20	< .01
III-Activity Two and Control Period of the Second Day	0	< .01
IV-Activity Two and Activity One	59	< .05

\*Ns-r = 23.

TABLE III

WILCOXON TEST OF SIGNIFICANCE BY SIGNED RANKS OF MEAN DURATION OF AROUSAL IN SECONDS FOR SUBJECTS IN THE FOUR HYPOTHESIZED SITUATIONS\*

Hypothesis	T Score	P
I-Combined Structured Activities and Combined Control periods	0	< .01
II-Activity One and Control Period of First Day	4.5	< .01
III-Activity Two and Control Period of Second Day	1	< .01
IV--Activity Two and Activity One	121.5	< .05

\*Ns-r = 23.

higher mean amplitude and the duration of arousal shown for subjects during the experimentally structured activities than during the control periods. The Wilcoxon (5) test of



significance reveals that these increases were significant at greater than the .01 level.

In the second hypothesis it was predicted that there would be significantly higher mean amplitude and duration of arousal for subjects during Activity One of the first day than during the control period of that same day. The results of the statistical treatments for this particular hypothesis, as shown in Tables II and III, clearly show that these means were significantly higher. Again, the hypothesis was accepted because the statistical level of significance was found to be greater than .01.

Hypothesis III stated that there would be significantly higher mean amplitude and duration of arousal of subjects during Activity Two of the second day than during the control period of the second day. It was found that these means in this situation were statistically significantly different at greater than the .01 level of significance, and the hypothesis was accepted (Tables II and III).

The data and statistical treatments of the data for these first three hypotheses suggest a general trend that should be noted. There was an increase in the cardiac activity of individuals when an effort was made to actively engage them in an interaction process, but not overtly, rather than allowing them to be merely passively present in a classroom.

The fourth hypothesis stated that there would be significantly higher mean amplitude and duration of arousal of subjects during Activity Two of the second day than during Activity One of the first day. Because this hypothesis was, as were the others, based upon two indicators of arousal--amplitude and duration--it is necessary to consider the results separately.

As shown in the last row of Table II, the mean amplitude of arousal of subjects was significantly greater during Activity Two of the second day than during Activity One of the first day. This increase was statistically significant at greater than the .05 level, and consequently, this portion of the hypothesis was accepted. However, examination of the last horizontal column of Table III will reveal that although there was increase of duration of arousal for subjects during this same comparative period, it was not statistically significant at the .05 level of confidence accepted for this study. This portion of the hypothesis could not be accepted.

Although there was a lack of complete statistical confirmation of the degree of increased cardiac activity in this fourth hypothesized situation, there seemed to be little reason to doubt the direction of increased activity in this situation.

In order to further illustrate the changes that took place in the amplitude and duration of arousal for subjects

during the control period and Activity One of the first day and the control period and Activity Two of the second day, a scatter-plot for each of the four situations was prepared. By locating an individual subject on the four scatter-plots, it is possible to find the changes in the amplitude and duration of arousal through the different hypothesized situations. These scatter-plots are presented in Figures 3, 4, 5, and 6. It should be noted that the scales for different scatter plots may be different due to the varying range of amplitude and duration and, consequently, exact position on the plot is not necessarily indicative of the change that may have occurred.

The research data presented in this study do indicate that differently structured activities and events in the classroom are attended by varying cardiac reactions or arousals of individuals. When the combined structured activities were compared with the combined control periods, the mean differences of amplitude and duration of arousal were found to be 3.16 and 2.05, respectively. It seems warranted to suggest that there are certain common kinds of response or tendencies of response to the stimuli provided by the environmental situation.

By following an individual subject in this study through the series of varying environmental conditions represented by Figures 3, 4, 5, and 6, variability of reactivity or arousal can be seen in the individual, not only in magnitude

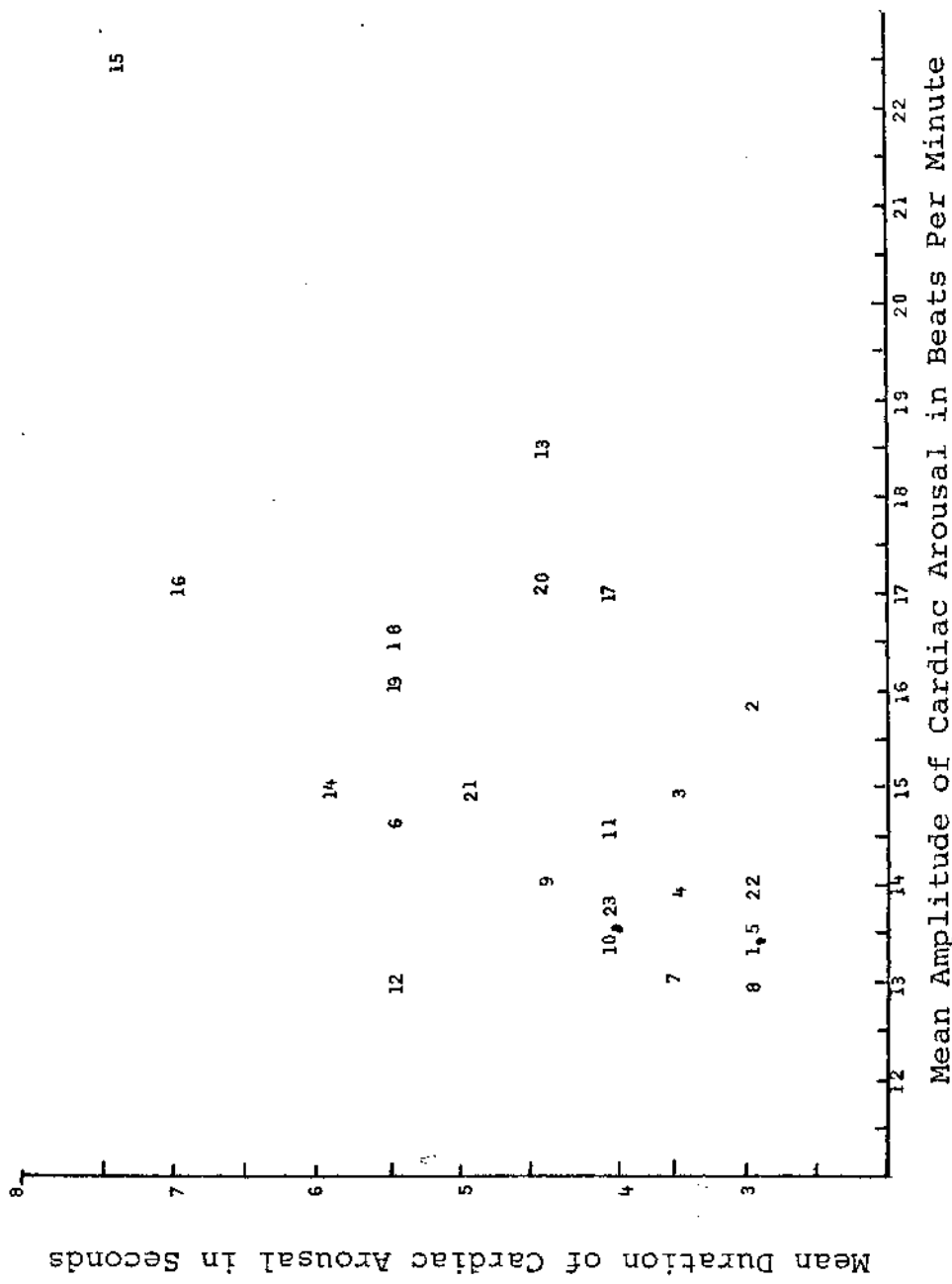


Fig. 3--Scatter-plot of the mean amplitude and duration of cardiac arousal for subjects during the control period of the first day. (All means rounded off to the nearest one-half; plotted numbers represent subjects.)

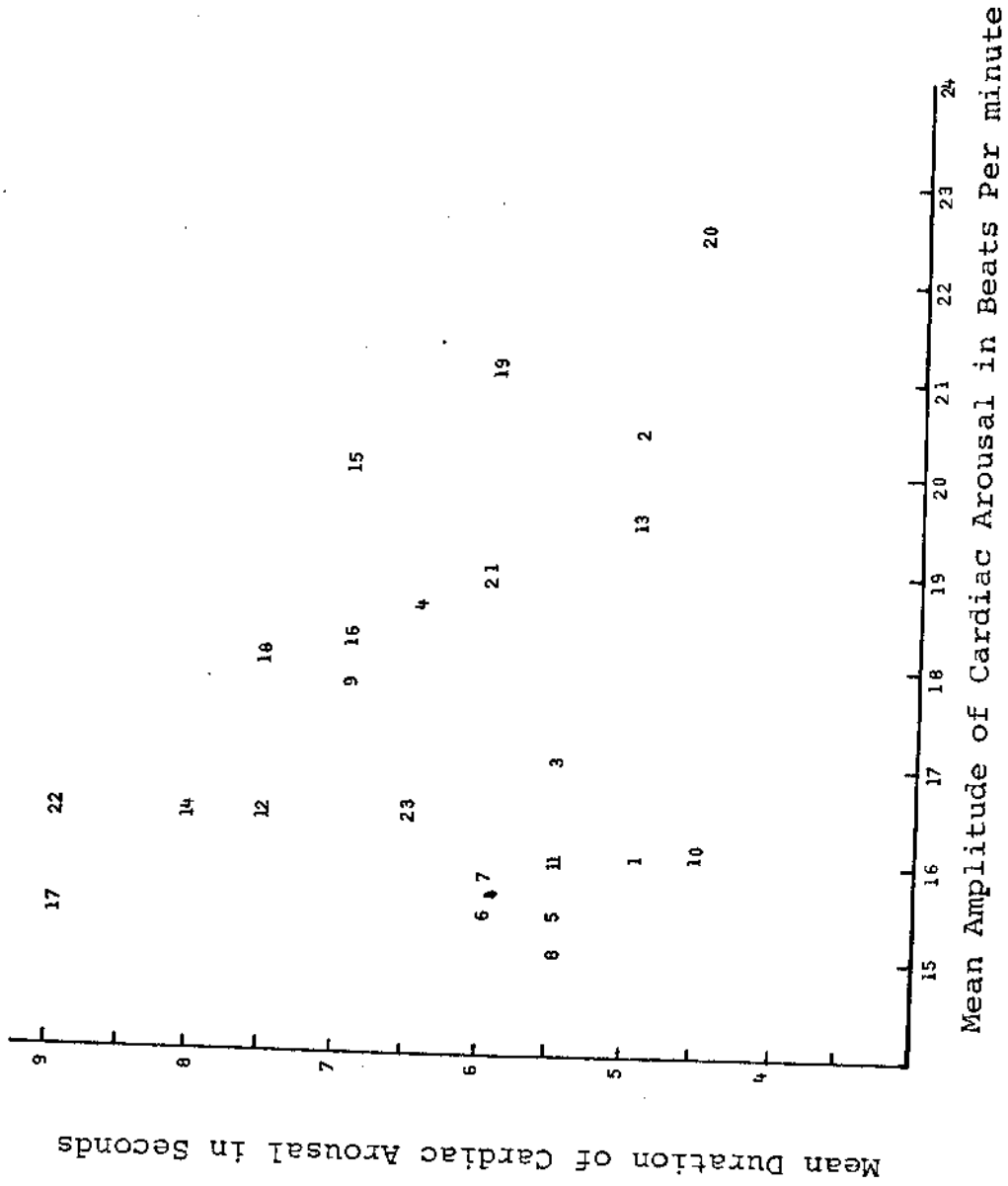


Fig. 4--Scatter-plot of the mean amplitude and duration of cardiac arousal for subjects during Activity One of the first day. (All means rounded off to the nearest one-half; plotted numbers represent subjects.)

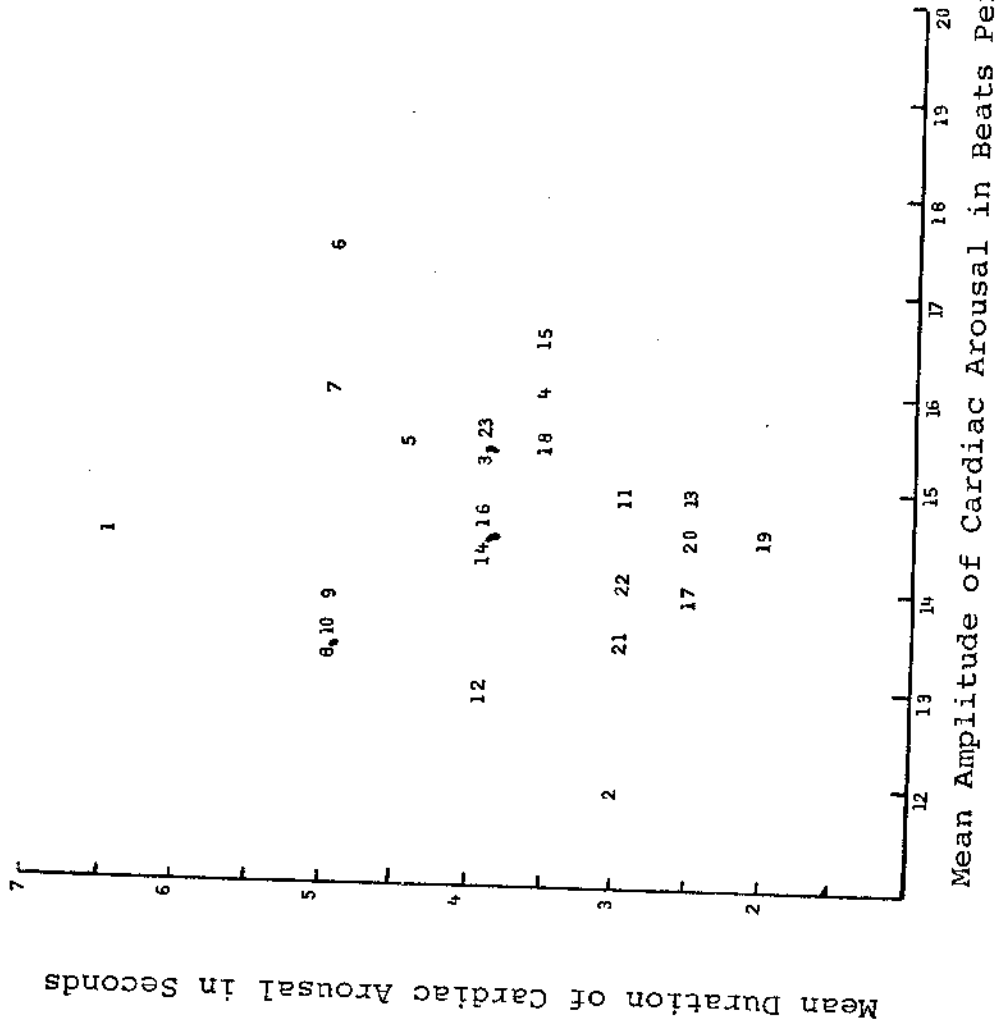
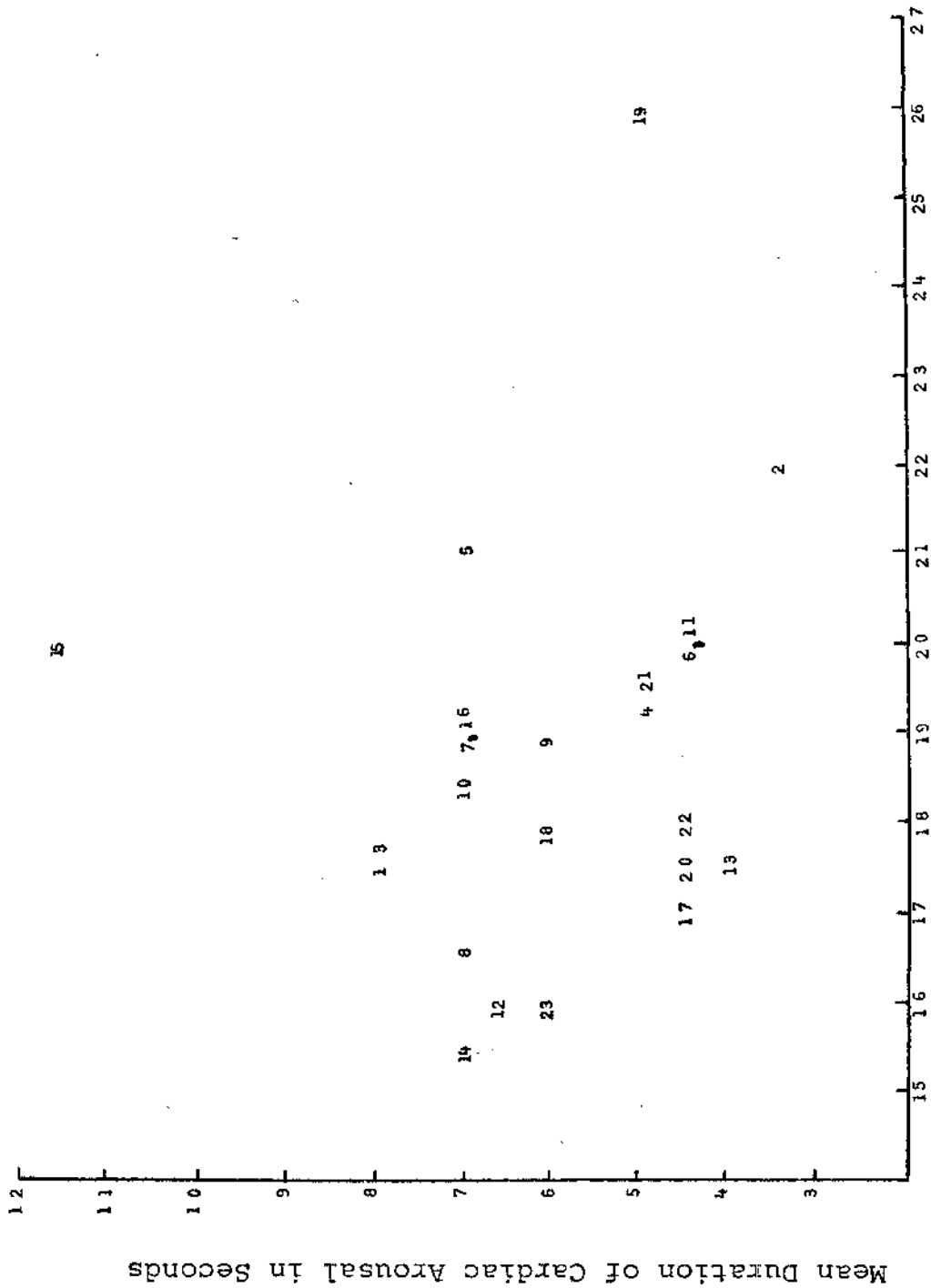


Fig. 5--Scatter-plot of the mean amplitudes and durations of cardiac arousal for subjects during the control period of the second day. (All means rounded off to the nearest one-half; plotted numbers represent subjects.)



Mean Amplitude of Cardiac Arousal in Beats Per Minute

Fig. 6--Scatter-plot of the mean amplitudes and durations of cardiac arousal for subjects during Activity Two of the second day. (All means rounded off to the nearest one-half; plotted numbers represent subjects.)

and direction of cardiac responses, but also in the type of cardiac response. Some subjects demonstrated responses to the structured activities by changes in the amplitude of arousal, whereas others would show increases of the duration of arousal to the same structured activities. The data plotted in these figures are those taken from Tables IV and V in Appendix D.

Manning (3), in a study of actual classroom situations, reported that overt participation of subjects in classroom events is far more arousing or activating than simply sitting in a classroom without being so involved. The increased mean amplitude and duration of arousal as reported above not only support the findings of Manning (3), but also provide some suggestive evidence to the effect that monitored cardiac activity may possibly offer some basis for evaluating specific classroom events and stimuli sources in terms of arousing or activating potential.

It should be emphasized here that this study made no attempt to directly relate learning with arousal. Many more studies of this nature will be needed to provide even the slightest potential for making that relationship. However, in the light of the research data provided by this study, it is possible to begin to look at the role of the teacher from the standpoint of the shaping or structuring of activities and events with optimum arousal in mind. Herein lies the potential value of this study and others of this nature.



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## CHAPTER V

### SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

#### Summary

The problem of this study was to observe, represent, and analyze student arousal responses to specific structured classroom activities and events. The purposes of the study were (1) to determine the effects of specific structured classroom activities and events on the cardiac rates of students in the classroom, (2) to determine whether or not there was a detectable difference in the cardiac rates of students involved in structured classroom activities and events and the cardiac rates of students not so involved, and (3) to determine the effects on the cardiac rates of students involved in two techniques of attaining student involvement and attention to a classroom discussion or topic.

In this study a total of twenty-three male students from six introductory education classes were used as subjects. Each of the four subjects chosen from these six classes was observed during a control period and Activity One of a first day and a control period and Activity Two of a second day. This entire procedure was then repeated on a non-consecutive week, with the data reflecting the means of the combined similar activities and events. These subjects,

while having their cardiac rates monitored biotelemetrically, were introduced to a series of control and structured periods of classroom activities and events. The subjects' hearts were being monitored during these sessions. By split-screen television technique, the subjects and the cardiometers showing heart rates were recorded simultaneously and the classroom audio events were also recorded on video tape.

A two-way analysis of variance by ranks was made to test for a significant difference among the four hypothesized situations, while another test of significant difference by signed-ranks was made for the comparisons of structured activities and control periods. For the testing of the four hypotheses, the .05 level of confidence was used to accept the research hypotheses.

Hypothesis I predicted that there would be significantly higher mean amplitude and duration of cardiac arousal for the subjects during the experimentally structured periods of activity than during the control periods. A test of significant difference by signed-ranks revealed a significant T ratio ( $P < .01$ ), indicating that the structured activities did indeed evoke cardiac arousals that were significantly higher in amplitude and duration than the arousal responses during the control periods. The hypothesis was accepted.

The second hypothesis predicted that there would be significantly higher mean amplitude and duration of cardiac arousal for the subjects during Activity One of the first

day than during the control period of the first day. Statistical treatment revealed a significant T ratio ( $P < .01$ ), indicating that Activity One, with its structured events, had evoked greater cardiac arousal responses of amplitude and duration than had the control period of that same day. Again, the hypothesis was accepted.

Hypothesis III predicted that there would be significantly higher mean amplitude and duration of cardiac arousal for the subjects during Activity Two of the second day than during the control period of the second day. When subjected to a test of significant difference by signed-ranks, the mean cardiac rates for subjects during these two periods reflected a T ratio that was highly significant ( $P < .01$ ). The mean amplitude and duration of cardiac arousal was significantly higher for subjects during Activity Two of the second day than during the control period of that same day. The hypothesis was accepted.

The fourth hypothesis predicted that there would be significantly higher mean amplitude and duration of cardiac arousal for the subjects during Activity Two of the second day than during Activity One of the first day. The results of the statistical treatment of this hypothesis were less conclusive than those of the first three hypotheses. Tests of significance of difference in this case revealed that the mean amplitude of cardiac arousal was significantly higher during Activity Two than during Activity One ( $P < .05$ ), but

that the mean duration of cardiac arousal, although demonstrating some increase during Activity Two as compared to Activity One, did not reflect a significant difference according to the level of confidence adopted for this study ( $P > .05$ ).

In order to make some comparative analysis of the two control periods and the two structured activities, a two-way analysis of variance by ranks was made to test statistically for significant difference among these four periods. When statistically comparing the mean amplitude of the subjects in these four settings, a Chi square ratio was obtained that was highly significant ( $P < .01$ ). The mean duration of arousal by the same treatment for the same four settings also proved to be significantly different at greater than the .01 level of confidence.

In summary, the findings of this research were as follows:

1. The subjects were found to demonstrate significantly higher mean amplitude and duration of cardiac arousal during the experimentally structured activities (Activity One and Two) than during the control periods.

2. The subjects reflected significantly higher mean amplitude and duration of cardiac arousal during Activity One of the first day than during the control period of that same day.

3. The subjects reflected significantly higher mean amplitude and duration of cardiac arousal during Activity Two of the second day than during the control period of that same day.

4. The subjects were found to have significantly higher mean amplitude of cardiac arousal during Activity Two than during Activity One.

5. There was a significant difference found among the four periods of observation in this study.

These findings are discussed and presented, following, in view of the teaching-learning process, other research studies, and the arousal theory in general.

### Conclusions

The following conclusions were formulated upon the basis of the findings in this study:

1. Students can be aroused physiologically as a result of experiencing certain structured classroom activities and events.

2. Classroom situations which provide for the interaction of student and teacher create a more arousing environment than does a situation in which the student is passively involved (e.g., listening to a lecture).

3. Students become physiologically aroused in an interaction type of classroom situation even though they, themselves, are not overtly interacting with the teacher or with other students.

4. Students become more physiologically involved, activated, or aroused when placed in a classroom situation in which they know that they are expected to participate overtly (e.g., a situation in which they are requested to interact with the teacher).

5. The findings of this study were consistent with the arousal theory.

In addition to the findings and conclusions presented above, several tendencies or trends were observed which were not subjected to analysis and statistical treatment, but which nevertheless proved to be of interest. On several occasions the introduction of certain words or phrases into the classroom discussions seemed to evoke rather pronounced cardiac arousal responses in the subjects. These words and phrases seemed to represent cues for the individual to which he responded with both increased amplitude and duration of cardiac arousal. It can be speculated that these words or phrases represented the significance of the particular word or phrase for the individual. Terms such as "authority" or "sex" seemed to evoke aroused responses in some subjects which might indicate that these terms represented situations of elevated importance to the individuals. Past experiences and/or perceptions of the situation represented by the word or phrase suggests but one of many possible explanations to this phenomenon.

Another observation in this study for which no quantification or statistical analysis was attempted was that of what might be termed a "writing phenomenon." It was noted that during the time when the entire class, subjects included, was asked to briefly respond in writing to a question at the beginning of each structured activity, the cardiac rates of the subjects reflected an increase which seemed to be fairly consistent in magnitude from subject to subject. Although this type of increased cardiac activity was not reflected in the analysis of amplitude and duration of cardiac arousal, simple inspection of the heart rate itself revealed, in most cases, an increase of approximately five to seven beats per minute.

Additional acceleration of cardiac activity above and beyond this "writing phenomenon" during the overt event of writing could be due to the individual's attention to the context of what is being written. Just as mental or psychological situations would be expected to evoke different degrees of arousal in an individual, one might expect that physical activities would also evoke varying degrees of physiological response. However, observations of the heart rate during this study tended to indicate that there was a great deal of similarity in the increases shown by the subjects.



### Recommendations

Based upon the research findings and conclusions of this study in conjunction with arousal theory, the following recommendations are made. These recommendations fall into two basic categories: those having educational implications as a base, and those of a research nature which might aid others in exploiting and extending the concepts and procedures used in this study.

1. In this study it was concluded that students can be aroused physiologically as a result of experiencing certain structured classroom activities and events. In the light of this it is recommended that classroom teachers pay special attention to activities and events that they choose for their classrooms. Although there is currently no known optimal range or level of arousal for learning, arousal theory suggests that the individual would be more facile in and receptive to the learning process when in an aroused state. Therefore, activities and events for classroom involvement should be inspected and selected on the basis of the potential arousal or activation that they might evoke.

2. It was also concluded that classroom situations which provide for the interaction of students and teacher create a more arousing environment than does a situation in which the student is passively involved (e.g., listening to a lecture). It is therefore recommended that classroom teachers so organize and structure their classroom activities

and events as to insure that the interaction of teacher and students is an integral component of the learning environment.

3. It was concluded in this study that students become physiologically aroused in an interaction type of classroom situation even though they, themselves, are not overtly interacting with the teacher or with other students. It would be deemed advisable in the light of this conclusion to recommend that teachers actively seek out responses from some of the students so that the arousal level of other students might be potentially raised. The teacher should help to focus attention upon a particular area or topic to which the student would feel compelled to render an opinion or react. In certain situations it might be appropriate for a teacher to call on certain students individually in order to sustain and perpetuate the interaction process.

4. In light of the growing educational interests in mental activity, it is recommended that research be conducted in the area of psychophysiological arousal to try to relate physiological arousal, as indicated by cardiac rate or any other suitable physiological indicant, to specific kinds of mental activities. A study might be so designed and structured as to monitor the physiological processes of students in an actual classroom setting while the students were performing simple, intermediate, and complex mental tasks. In such a situation, subjects might be monitored on a pretest

and posttest basis as certain mental activities were experienced. In a carefully controlled situation it might be possible to correlate such mental activities with actual observed increases in physiological processes. Furthermore, it might be possible to monitor the physiological processes of subjects as they directed their attention to a certain mental task without the benefit of a teacher's instructions and then at a later date monitor the same subjects attending to a similar task with the benefit of the instructions of a teacher.

5. Although the literature in the area of psychophysiology indicates that the general physiological reactivity of males and females is basically similar, there is a clear-cut need for the inclusion of females in studies of this type. With females included in studies similar to the present study, the subjects could be categorized on the basis of sex and the data collected could be grouped and statistically treated on that basis. This can be accomplished by the addition of a female member to the research team or by having a suitably trained female student in each class in the experiment be responsible for electrode and transmitter placement.

6. Studies should be conducted in the light of the implications presented by the arousal theory to determine the general arousal level reflected by the individual in an educational situation who is charged with the responsibility

of guiding and directing an educational process. Perhaps the degree of significance of the situation might be revealed by the physiological arousal level (heart rate) of a teacher in a classroom, a counselor in a counseling session, or even a coach during a practice session or during an actual athletic contest.

7. Additional research is needed in the area of psychophysiological arousal to give a better picture of the role played by the emotional and psychological nature of the individual in the arousal phenomenon. Studies dealing with the arousal level of individuals with differing anxiety levels, frustration tolerances, and personality traits might suggest new dimensions of the variability of arousal.

8. In certain situations the true significance of an arousal situation can be assessed only by the individual that was aroused. Consequently, there is a need of provision for immediate and spontaneous feedback information from the subjects to the researcher. Studies that will attempt to assess the significance of physiological arousal to psychological events must have this feedback from the subjects.

Video taping, as used in this study, provides a delayed means of having the subject give an assessment of the situations, but this is impractical for extended periods of time. One possibility that might be explored as a system for this type of feedback would be the use of the Raytheon 600 Mediamaster Learning System. It might be feasible to

categorize a set of possible responses concerning patterns of thought processes using this Edex system and have the subject being monitored, upon seeing a signal indicating observed physiological arousal, depress an appropriate response key in the system for the category most closely related to the individual's psychological state at the time of the arousal.

APPENDIX A

BIOGRAPHICAL INVENTORY

1. Name \_\_\_\_\_ Subject No. \_\_\_\_\_
2. Address \_\_\_\_\_ Phone \_\_\_\_\_
3. Age \_\_\_\_\_ Height \_\_\_\_\_ Weight \_\_\_\_\_ Classification \_\_\_\_\_
4. Are you now receiving any kind of medical treatment or taking any kind of drugs upon a doctor's advice? \_\_\_\_\_
5. Have you ever had any kind of "heart trouble"? \_\_\_\_\_
6. Are you now engaged in any type of physical or athletic training? \_\_\_\_\_
7. Do you smoke? \_\_\_\_\_ 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ or more packs per day?
8. Do you eat 1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ or more meals per day?
9. Do you sleep (average) 4-6 \_\_\_\_\_ 6-8 \_\_\_\_\_ or more hours per day?
10. Do you usually feel "nervous" or excited when called upon to recite in class, or to give an oral report or when taking a quiz? \_\_\_\_\_
- \*11. Have you experienced anything exciting or disturbing today? \_\_\_\_\_
- \*12. What did you do within the last hour? (e.g., physical activity, kinds and quantity of drinks or food taken in, etc.) \_\_\_\_\_

\*Items 11 and 12 are to be completed during electrode placement just prior to observational periods.

APPENDIX B

GENERAL GUIDE FOR STRUCTURING ACTIVITIES AND EVENTS

Classroom Activity or event	Role of Instructor in Structuring Activities and Events
<p><u>First Day:</u>            1. <u>Control Period</u>-this will be an experimentally unstructured period (approx. 20 min.)</p>	<p>. . . No events or specific activities are planned to purposely involve the subjects directly. Subjects are to be involved only to the extent that they voluntarily involve themselves.</p>
<p>2. <u>Activity One</u>-posing of a pre-arranged question to the class as a whole and class discussion related to the question posed (approx. 30 min.)</p>	<p>. . . Upon seeing the signal light activated on the back wall, ask the class, subjects included, to respond in writing (on scratch paper) to an opinionated question which you intend to discuss in that day's lecture-discussions.            . . . Next, proceed with the lecture-discussion for the day which is related to the question posed.            . . . Near the end of the period ask the entire class to once again respond in writing to the question posed.</p>
<p><u>Second Day:</u>            1. <u>Control Period</u>-unstructured; voluntary participation of subjects only (approx. 12 min.)</p>	<p>. . . This period is to be unstructured as far as the experimental design is concerned. Only voluntary participation on the part of subjects is desired.</p>
<p>2. <u>Activity Two</u>-posing of another question to the class as a whole with provision for subject involvement (approx. 28 min.)</p>	<p>. . . Upon seeing the signal light on the wall activated, ask the class to respond in writing to a new question which is related to that day's discussion, but before proceeding with the lecture-discussion, <u>inform the subjects that you will return to them</u></p>

Classroom Activity or Event	Role of Instructor in Structuring Activities and Events
	<p><u>individually later in the period for responses to the question posed.</u>  . . . Proceed with your planned lecture-discussion for the day.</p>
<p><u>3. Questioning and Reciting Period</u>  (approx. 10 min.)</p>	<p>. . . Approximately ten minutes before the end of the period you will see the signal light again indicating that it is time to ask the subjects for responses to the question posed. Allow the two subjects on your left to respond to the question individually.  . . . After the first two subjects have finished reciting and the signal light is again flashed, carry out the questioning and reciting with the two remaining subjects.</p>



## APPENDIX C

### SPECIAL EQUIPMENT USED IN THE STUDY

Biotelemetry receiver: E & M Telemetry Receiver, model FM-1100-6.

Biotelemetry transmitter: E & M Telemetry Transmitter, model FM-1100-E2.

Cardiotachometer: BioTach 4710C. The model 4710C is nominally calibrated to  $\pm 2\frac{1}{2}\%$  at full scale deflection. This means that near the high end of the scale, the reading may be off as much as ten beats per minute. However, this is well within the required accuracy range for most physiological measurements and very seldom during the observations was the meter even at half scale deflection.

Special-effects generator: Microtex Select-Effect: Program Control.

Video cameras: Panasonic, model WV-220P.

Video taper: Ampex 660B.

## APPENDIX D

TABLE IV

MEAN AMPLITUDE OF CARDIAC AROUSAL IN BEATS PER MINUTE OF  
SUBJECTS IN THE HYPOTHESIZED SITUATIONS

Subjects	Combined Structured Activities for Both Days	Combined Control Periods of Both Days	Control Periods of First Days	Activities One First Days	Control Periods of Second Days	Activities Two of Second Days
1	16.79	14.02	13.60	16.08	14.50	17.50
2	20.95	14.57	15.78	20.48	12.14	21.88
3	17.14	15.32	15.13	16.85	15.50	17.43
4	19.03	15.11	14.18	18.69	16.05	19.37
5	18.18	14.55	13.67	15.50	15.43	20.87
6	18.57	14.92	14.52	15.32	17.70	19.93
7	17.83	15.03	13.06	15.58	16.02	18.96
8	15.71	13.22	13.18	14.85	13.25	16.56
9	18.51	13.86	13.90	18.14	13.82	18.88
10	17.17	13.52	13.54	16.02	13.51	18.31
11	17.82	14.57	14.34	15.82	14.79	19.83
12	16.20	12.81	12.72	16.57	12.90	15.84
13	18.54	16.22	18.33	19.65	15.17	17.44
14	15.84	14.74	15.19	16.25	14.29	15.43
15	19.85	18.58	22.61	19.75	16.56	19.96
16	18.16	15.99	16.86	17.75	14.25	18.97
17	15.94	15.95	16.93	15.54	14.00	16.75
18	18.00	16.05	16.58	17.99	15.53	18.01
19	22.80	15.50	15.99	21.14	14.52	26.11
20	20.08	15.82	17.11	22.48	14.53	17.68
21	19.22	14.27	15.11	19.10	13.43	19.35
22	17.69	14.22	14.00	16.67	14.11	18.20
23	16.13	14.52	13.54	16.48	15.50	15.78
M*	18.09	14.93	15.21	17.51	14.67	18.65

\*M, mean.

TABLE V

MEAN DURATION OF CARDIAC AROUSAL IN SECONDS OF SUBJECTS  
IN THE HYPOTHESIZED SITUATIONS

Subjects	Combined Structured Activities for Both Days	Combined Control Periods of Both Days	Control Periods of First Days	Activities One of First Days	Control Periods of Second Days	Activities Two of Second Days
1	6.56	4.82	3.20	5.04	6.44	8.09
2	4.36	2.75	3.19	4.75	2.86	3.58
3	6.80	3.83	3.53	5.74	4.13	7.87
4	5.77	3.33	3.26	6.36	3.40	5.17
5	6.07	3.76	3.17	5.34	4.35	6.79
6	5.21	5.08	5.34	5.85	4.83	4.57
7	6.67	4.47	3.28	5.81	5.07	7.09
8	6.24	4.13	3.16	5.51	5.09	6.98
9	6.44	4.67	4.47	6.79	4.88	6.10
10	5.76	4.42	3.82	4.36	5.01	7.16
11	4.99	3.52	3.93	5.56	3.11	4.42
12	7.04	4.79	5.48	7.71	4.10	6.38
13	4.61	3.01	4.33	5.19	2.36	4.04
14	7.40	4.82	5.83	8.01	3.81	6.80
15	9.26	4.78	7.35	7.09	3.50	11.45
16	6.81	6.09	7.16	6.80	3.95	6.83
17	7.50	3.35	3.81	8.91	2.44	4.70
18	6.70	4.40	5.36	7.33	3.45	6.07
19	5.61	4.40	5.62	5.96	1.95	4.93
20	4.59	3.41	4.29	4.65	2.53	4.54
21	5.42	3.97	4.82	5.97	3.13	4.87
22	6.15	3.02	3.00	9.14	3.04	4.66
23	6.23	4.14	4.12	6.68	4.16	5.79
M*	6.18	4.13	4.41	6.28	3.81	6.04

\*M, mean.

## APPENDIX E

## PERSONAL DATA ON INDIVIDUAL SUBJECTS

Subject No.	Height in Inches	Weight in Pounds	Age in Years	Smoker	Class Period
1	67	140	18	No	8:00 A.M.
2	72	150	19	No	8:00 A.M.
3	70	155	19	No	8:00 A.M.
4	73	250	21	No	8:00 A.M.
5	74	210	19	No	9:00 A.M.
6	71	160	22	Yes	9:00 A.M.
7	69	140	20	No	9:00 A.M.
8	68	140	19	Yes	10:00 A.M.
9	73	145	20	Yes	10:00 A.M.
10	69	165	23	No	10:00 A.M.
11	69	160	19	No	10:00 A.M.
12	71	152	23	Yes	1:00 P.M.
13	69	177	26	No	1:00 P.M.
14	69	140	20	No	1:00 P.M.
15	68	175	18	No	1:00 P.M.
16	70	160	23	No	2:00 P.M.
17	74	150	19	No	2:00 P.M.
18	70	165	24	No	2:00 P.M.
19	75	220	23	No	2:00 P.M.
20	69	139	24	No	11:00 A.M.
21	69	136	17	Yes	11:00 A.M.
22	72	205	20	No	11:00 A.M.
23	76	170	17	Yes	11:00 A.M.

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