THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE EFFECTS OF COMPETITION ON VARIOUS MEASURES OF STRESS ON MALE COLLEGE AGE STUDENTS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

RONALD A. LEE

Norman, Oklahoma

1970

THE EFFECTS OF COMPETITION ON VARIOUS MEASURES OF STRESS

ON MALE COLLEGE AGE STUDENTS

APPROVED BY

Jerome C. Weber

Robert A. Magnuson

Ruth M. Jacobs

Herbert R. Hengst

DISSERTATION COMMITTEE

ACKNOWLEDGMENTS

To the chairman of my dissertation committee, Associate Professor, Dr. Jerome C. Weber, I would like to express my gratitude for his direction of this thesis, and for his suggestions, encouragement, confidence, and assistance freely given throughout my years of graduate study. I would especially like to express my appreciation for his advice and friendship which made these years enjoyable as well as profitable.

To the other members of my dissertation committee, Dr. Herbert R. Hengst, Dr. Albert D. Smouse, and Dr. Paul D. Jacobs, I would like to express my appreciation for their suggestions and criticisms which made possible the completion of this dissertation.

To Dr. Gerald T. Kowitz, Dr. Thomas T. Wiggins, Dr. Larry E. Toothaker, and Dr. Patricia C. Fairchild, I wish to express my appreciation for their assistance and suggestions in the writing of this dissertation.

To coach Jay Markley and the members of the 1970 University of Oklahoma swim team, I would like to express my gratitude for their cooperation throughout the course of the study.

To my wife Althea, I wish to express my appreciation for her assistance in the preparation and typing of this dissertation, and for her encouragement and patience which has contributed as much to the successful completion of this study as have any efforts of my own.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

THE EFFECTS OF COMPETITION ON VARIOUS MEASURES OF STRESS ON MALE COLLEGE AGE STUDENTS

CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Introduction

One of the most fundamental processes of life is that by which an organism adapts to its environment. The evolution of life is the evidence of the adjustments all living things were required to make in order to survive. Today, the demands of the environment are greater than they have ever been in the past. Although man has learned to cope with his physical environment through his gains in technology, he has, in the process, imposed even greater and more complex psychological stresses on himself. Evidence of these stresses can be seen in those individuals who have been unable to adjust. The results can be observed in the number of psychosomatic illnesses and diseases and in the many young people in America who try to escape through drugs and withdrawal (Lazarus, 1961, Ch. 12).

One of the challenges of higher education today is to aid students in their adjustment to the stresses they will face. In the external environment, successful adjustment to the effects of stress have been accomplished through the physical identification of the stressors. Within the internal environment, however, there presumably remains many psychic stressors as yet unidentified and unexplored.

Selye (1956, p. 4), in answering what is the nature of stress, stated,

> This is a fundamental question in the life of everyone; it touches closely upon the essence of life and disease. To understand the mechanism of stress gives physicians a new approach to the treatment of illness, but it can also give us all a new way of life, a new philosophy to guide our actions in conformity with natural law.

It seems reasonable that if higher education is to meet its total responsibilities, the research and measurement of the factors that cause stress is an area in which higher education can contribute towards each individual's well-being.

Theoretical Concept of Stress

"Stress" is an ambiguous term with different connotations. It is used to denote conditions of psychological conflict, frustration, defense, emotions, and many other

complex psychological factors influencing behavior as well as the physiological reactions of the body to noxious stimuli. Although stress is a part of all these conditions, it cannot be defined specifically in terms of any one particular reaction. Selye (1956, p. 54) proposed that ". . . stress is the state manifested by a specific syndrome which consists of all the non-specifically induced changes within a biological system." This specific syndrome, according to Selye, consists of a triphasic reaction that occurs without regard to the nature of the stressor. This non-specific reaction is manifested by a "General Adaptation Syndrome" which consists of three distinct physiological stages.

The first stage is the alarm reaction, which is characterized by two phases. When a stressor is introduced, the initial shock stage is activated. In this phase, physiological defense mechanisms become active. This alarm reaction is typified by adrenaline discharge, autonomic excitability, increase in heart rate, blood composition changes, adrenalcortical enlargement, and gastrointestinal ulceration. Selye described the second stage as the resistance stage where maximum physiological adaptation occurs. The resistance stage is the phase where the body mobilizes its defenses to combat the stress. In this stage, the body tries to restore itself to

the homeostatic condition of the organism prior to the stress. If the stressor is removed or localized to the point where only affected tissues carry on the defense, then the resistance stage is successful and some general bodily adaptation is gained. If the stressor persists or is too great for the defense mechanisms, the final stage of exhaustion occurs. In this stage, the stress defense mechanism of the body cannot maintain its effort against the stressor, and the body returns to symptoms similar to those of the earlier alarm stage. Under this condition, the body uses up its defense energy, and death can follow (Selye, 1956).

In the attempt to localize or remove a stressor, the organism may resort to changes in behavior in such a way as to distort the actual threat of the stressor. Lazarus (1961, Ch. 12) attributed many of the symptoms of psychoneuroses and psychoses to the inability of the organism to fully cope with the stressor. He maintained that to prevent the final stage of exhaustion, the organism may psychologically reduce the stressor to a level which is biologically tolerable. Selye (1950) placed emphasis on the pituitary-adrenal system as the important reactor to stress while Cannon (1939, Ch. 4) emphasized the reactions of the adrenal medulla. Appley and Trumbull (1967, p. 4), interpreting Selye's writing, stated,

> Throughout his extensive writing, Selye emphasizes the fact that a variety of circumstances give rise to a highly stereotyped bodily reaction, as well as reactions peculiar or specific to the insulting agent. It is the general (or common) rather than the specific reaction of the organism which constitutes stress. Both the events in the environment which induce stress and certain concomitant and resultant responses may be quite varied. The system stress response, however, is invariant.

The two currently known biological systems involved in the stress mechanism are the pituitary-adrenocortical system and the sympatho-adrenomedullary system (Levi, 1967). Both of these systems have been shown to indicate stress responses although Euler (1964), in a review of the quantitation of stress, maintained that although both systems are employed in many stress reactions, there are specific stressors which activate only one system or the other. The adrenal-medullary system seems to be involved primarily in the immediate adjustment to stress while the adrenocortical system seems to be involved in the long term adjustments (Funkenstein, 1957). The primary difficulty involved in the physiological quantitative measurement of stress is that direct measurement of the secretion level of the adrenal gland is not possible;[1] therefore, all methods employed are indirect

[1] The adrenal glands are endocrine glands which are ductless and secrete their hormones directly into the circulatory system.

measures of the effect of adrenal secretions on other systems. This method of quantifying is even more complex when human subjects are used because many psychological variables involved in human experiments may affect the physiological measurements. The adrenocortical reaction to stress has been explored by many investigators, and it has been well established that the pituitary-adrenocortical system plays an important role to the adjustment of the human organism to stress (Selye, 1950). Hill and others (1956) have shown heightened adrenocortical activity during periods of emotional involvement, such as in competitive sports. These same types of responses were found to exist in patients anticipating surgery (Franksson and Gemzell, 1954), during final examinations of medical students (Mann and Lehmann, 1952), in postexercise periods (Cureton, 1960), during emotion-arousing interviews (Hetzel, 1955), and in other situations eliciting a stress response. The sympatho-adrenomedullary system shows similar responses to stress and is a classical system used to study varying levels of stress. Elevation of epinephrine levels was shown as the result of competitive sports, operation of a pursuit meter, and in patients appearing before a staff conference (Elmadjian, et. al., 1957, 1958). In a series of studies, Kärki (1956) found increases of epinephrine to be caused by different levels of muscular work.

It is apparent that a variety of physical and psychological stressors can elicit a stress response in man. Because the physiological reaction in man is similar, regardless of the stressor, it seems reasonable to assume that all forms of stress which tax the human organism are essentially related to the same phenomenon. Therefore, research which leads to a better understanding of any form of stress ultimately uncovers knowledge towards the better understanding of tne whole stress phenomenon.

Statement of the Problem

The physiological reactions of the body to various forms of psychic stress are well documented (Lazarus, 1966, Ch. 9), but their relationship to psychological measures of the same stressors remains unclear. Appley and Trumbull (1967, Ch. 1) suggested that part of the problem in personal assessment of stress is that specific stressors have different meanings for different people. This measurement becomes even more complex if unfamiliar sources of stimuli are used as stressors. They also stated that to make a reasonable prediction of the susceptibility of an individual to stress, the condition of the environment, motivational structure, and prior exposure of the individual to a specific stressor must be considered. If the factors influencing anxiety or defensive

behavior are both familiar to and consistent with each individual, the psychological and physiological measures of a given stressor will exhibit less variance and thus be more meaningful (Appley and Trumbull, 1967, Ch. 1).

The nature of stress seems to indicate that all forms of stress, whether psychological or physical, are essentially related to the same phenomenon. The primary problem is still the measurement of levels of stress and interpretation of such measurements. Physiological and psychological indicants of stress have shown low statistical relationship, yet the relationship of both to a common phenomenon cannot be denied. A secondary consideration is that stress may exist at different levels and forms, and attempts have been unsuccessful in the partitioning of the variance contributed by various forms of stress.

The purpose of this study was to separate the stress of competition into various levels (the stress of the performance, anticipation prior to performance, and the additive emotional stress which accompanies performance) and to determine the physiological reactions and psychological stresses contributed by each form.

Importance of the Problem

In the span of three hundred years, higher education has taken a variety of forms. American higher education has broadened the established form of European higher education so that higher learning today is more closely related to the daily concerns of the average citizen. This is shown by the broad and flexible curricula offered in today's postsecondary education. Brubacher and Rudy (1958, p. 374), in speaking about the concept of today's college or university student, stated that "Higher learning now addresses itself to the totality of his life, not just to its intellectual aspects." The concept of preparing students for more than vocational training is even more challenging when the complexity of the society students must face is considered. The inability to adjust to the stresses of today's demanding society may cause many students to turn to other forms of relief, such as joining escapist groups or artifically escaping through the use of drugs.

The problem of educating students to meet the unknown demands of society is so important that the Executive Planning Committee of the University of Oklahoma, in a report to the people, stated that the future mission of the university should be to assist people of all ages in renewing

and adapting themselves to a complicated and changing social world. This same panel emphasized nine major directions with which the university should be concerned. Among these was the concern about the physical and mental environment. They stated that the university should be involved in ". . . understanding those characteristics of man's life and environment which threaten his mental and physical health in the modern world." They also emphasized the importance of the relationship and causes of mental stress and psychological breakdown (Christenson, 1963). If higher education is to fulfill its goal of educating students to meet the complex demands of a changing society, stress and its relationship to each individual must be studied in relation to higher education.

Current research concerning stress is just beginning to interest and involve the total university community. Prior research concerned with stress dealt primarily with what is termed physiological stress, such as illness, physical exertion, and extreme conditions of the physical environment (Selye, 1950). Current research suggests that the same adaptive processes which an organism undergoes in adjusting to physical stress are also involved in adjustment to psychological stress. This opens a new measurement technique for

the evaluation of emotional types of stress which were primarily measured and quantified by subjective techniques.

The primary difficulty in defining stress is that similar responses are shown to occur for various stressors. Therefore, to study the effects of stress, it is necessary to isolate the specific stressor involved. This thesis is primarily concerned with stress reactions that are caused by competitive conditions such as those found in our colleges. Today's students must compete to enter college, compete to stay in college, and compete in society once they graduate. Competition is one of the main stressors throughout a student's life. It is seen in the classroom where students compete for grades; it can be found in extracurricular activities or in intercollegiate athletics where students compete for positions. Competition becomes an inseparable part of every college student's life.

What competition does to each student is yet unpredictable. Some may find it stimulating, some may consider it an integral part of normal life, and some may succumb to the stress imposed by competitive conditions. A primary concern of the study was to determine if the stress of competition results in physiological responses similar to those produced by the performance stress alone, i.e., in the absence of

competition. It has been shown that the lack of adaptation to external or internal stressors results in what Selye called the disease of adaptation. Selye (1956, p. 127) stated,

> Diseases of adaptation are those in which imperfection of the General Adaptation Syndrome plays the major role. Many diseases are actually not the direct result of some external agent but rather the consequence of the body's inability to meet these agents by adequate adaptive reactions. Maladaptation plays a major role in diseases of the heart and blood vessels, diseases of the kidney, eclampsia, rheumatism and rheumatoid arthritis, inflammatory diseases of the skin and eyes, infections, allergy and hypersensitivity, nervous and mental disease, sexual derangements, digestive and metabolic disease, and cancer.

The implication is that psychic stressors such as those precipitated by competition may mean the difference between success or failure. The bodily reactions suggest that these psychic stressors may result in various manifestations of maladjustment if continued to the point at which the body's physiological defenses are depleted. Studies which have been designed to determine each individual's assessment of these conditions have been disappointing when compared to the physiological reaction of the body (Davis, 1956; Krause, 1961; Martin, 1961; Sarason, 1954). However, this should not imply that the relationship should not be studied. Behavioral and physiological indications give different parts of the total picture. What each part measures is not yet clear,

but that they are related to the same phenomenon makes their combined study a worthwhile area of investigation.

In conclusion, if one of the major goals of higher education is to aid students to meet the demands of college and society, then the study of the student and his reaction to competitive situations should be an area of research vital to the purposes of higher education. It is essential to be able to quantify and measure those conditions which stress each individual, for it is from these levels that the ultimate level of individual stress tolerance is to be determined. It is essential to determine the possible positive carry-over effects of stress from one situation to the other, for the carry-over effect may ultimately be used to raise each individual's stress tolerance.

The importance of investigating physical and psychological stress concurrently should be emphasized. The relationship between physical and psychological stress is one in which physical stress might be considered prophylactic and therapeutic towards the adjustment to emotional stress.

Michael (1957) pointed out in a review on exercise and stress that evidence indicated that exercise may very well produce a degree of protection against stress.

de Vries (1966, p. 167), interpreting his own studies on stress, hypothesized,

> . . . even though the total "bank account" of adaptation energy may be depleted a little early through a life of heavy muscular exercise, the conditioning effect of the exercise might have prevented an even earlier, sudden demise due to a very stressful situation.

It is apparent that stress is an inseparable part of every student's life. The only formal process by which students may gain knowledge and skills toward total life adjustment is through the educational process. The investigation of the effects of stress is, therefore, a most vital area in which higher education should be involved. It seems reasonable that research which may contribute to each individual's well-being should not be separated by disciplinary boundaries.

Definition of Terms

Adrenal Glands - A pair of ductless glands each consisting of a cortex and medulla. They are situated above the kidneys and involved in the physiological adjustment to stress.

Adrenaline - One of the "stress hormones" produced primarily in the adrenal medulla. The synthetic form is generally called adrenaline and the hormonal form called epinephrine.

Autonomic Nervous System - The vegetive nervous system consisting of the sympathic and parasympathic system, which governs the involuntary organs.

Competitive Stress - This term is operationally defined as a physiological condition induced by an intercollegiate swimming contest.

Corticosteroids - The hormones of the adrenal cortex which act on metabolism and influences the electrolite balance of a stressed organism.

Endocrine Glands - Ductless glands which secrete their substance directly into the bloodstream.

Noradrenaline - Also known as norepinephrine. A hormone secreted by both the adrenal medulla and the sympathetic nervous system.

Stress - The non-specific bodily reaction to stimuli. Levi (1967, p. 181-182) stated,

> According to Hans Selye, the common denominator in the organism's response to a variety of influences, stressors, e.g., trauma, infection, intoxication, nervous stimuli, etc. This sterotyped response includes the secretion of certain hormones, such as adrenocorticotrophic hormones (ACTH), corticosteroids, adrenaline, and noradrenaline. The resulting increase in these adaptive or stress hormones is an essential useful adaptive or defense reaction. However, under certain circumstances, it can become the cause of disease, or, at least, predispose the body to the production of morbid changes.

> Any kind of physiological activity (locomotion, heart beat, respiration, glandular secretion) produces some stress in the organism. Complete freedom from stress thus never occurs in living beings; hence stress is not necessarily a pathological phenomenon.

Stressor - The stimuli which elicits the stress response and specifically the general adaptation syndrome.

Urinary Catecholamine - The term is operationally defined as the urinary excretions of epinephrine and norepinephrine.

Physical Stress - This term is operationally defined as that physiological condition induced by the physical exertion of swimming alone.

Limitations of the Study

Due to the considerations of time, cost, and methodology in gathering urinary catecholamine excretions, this study was performed on male intercollegiate swimmers. In this type of study, the limitation of generalizing from a select sample to the population is not severely limited. Generalizations in the study are based on the assumption that each subject was representative of humans on those measures investigated and that the stress factors involved were not necessarily limited to athletics. In addition, when physiological measures are of interest, the generalizability of

these results depends on the control of known extraneous variables. In this study, it was felt that the limitation of using a nonrandom sample were greatly outweighed by the advantages gained in the control of extraneous variables.

Finally, studies of this type serve to determine the direction of future research and to help clarify interpretations of completed research. The final collection of such research will answer the question, "what is the nature of stress?" Thus, in a sense, this study may be thought of as being an extension of completed research, and the interpretation of the results will be made in reference to other investigations involving more heterogenous populations. It was with this understanding that this study was undertaken and the conclusions drawn.

CHAPTER II

REVIEW OF RELATED LITERATURE

Competition in Higher Education

Twentieth-century higher education is based on a highly competitive system by which students are selected and retained in their respective programs. Snyder (1965), commenting on admission standards, stated that recently, competition and autonomy have led to the consideration of candidates for the admission to college on other than the traditional use of high school diplomas. Using more standarized selection criteria, colleges today are placing the prospective student on a national as well as a localized competitive scale. Stendler (1951), in speaking about the classroom atmosphere, emphasized that although cooperation may be encouraged in the classroom, the competitive spirit is nevertheless inherent in the grading systems employed.

Some researchers, using performance as a criterion, have emphasized the more positive effects of competition.

Julian and Perry (1967) and Whittemore (1924) have independently shown that competitive conditions facilitated the performance of various task over cooperative conditions. They concluded that competition is a desirable atmosphere in which to raise the production and quality of student performance.

The negative aspects of competition have also received attention. Campanelle (1965) and Weinberg (1965) suggested that competition is detrimental to education because it produces anxiety, resentment, and apathy on the part of competing students. However, their impressions of competition were not founded on experimental evidence. It seems that even if significant gains can be achieved in student performance, the potential adjustment problems require a more serious look at competition as a desirable form of reinforcement. The primary difficulty in determining any adverse effect of competition is that authentic stress situations are often difficult to duplicate in the laboratory because the many variables that affect the measurement must be either artifically induced or be essentially uncontrolled.

The competitive atmosphere permeates the total university structure. It has become a part of the academic as well as the extracurricula setting. In the area of athletics, this competition is accepted and promoted openly. This same

openness is accorded competition in academic games such as debates and forensic contests, but in other areas of the academic setting, competition is not so readily accepted. Nevertheless, competition infiltrates the total higher education structure regardless of form.

The relative merits and effects of competition on each competitor are still not clear. Those students who are more adept at competing would seem to benefit from the system, while those students not as adept provide evidence which make competition a questionable form of reinforcement.

Competition as Stress

Competition may be viewed from various perspectives, all of which are justified. Pepitone (1967, p. 185) suggested that competition could have detrimental effects, resembling severe conditions of stress, and yet be salubrious at the same time. His explanation of this phenomenon placed the stress of competitiveness in several conjectural constructs:

> . . . there would be no contradiction involved, of course, if it were recognized that competition is injurious only when it is excessive. Or, at a somewhat more complex level, it maybe that when competitiveness is excessive, inappropriate or indiscriminate, it results in some form of punishment by the social environment. According to this view, it is not the competition as such which is stressful, but the negative social consequence of it, or the internal

> tension generated by "competition conflict." A third possibility to consider is that only certain kinds of competition are more than normally stressful. Damaging effects may depend upon the particular constellation of forces and structures which determine the competitiveness.

Bases of Competitiveness

Pepitone (1967, p. 185) suggested that structural competition represents the most familiar form of competition.

> Here, the individual is constrained to act self-interestedly and against others by structural features of the situation. In spacial language, the pathways to the goal are so arranged that for any one individual to move forward towards the goal, the other individuals who have the same goal must be shunted aside or pushed to the opposite direction.

Structural competition would seem to fit the requirements of game theory. Rapoport's (1960, Ch. 1) model of a game provides structurally the same contentions as Pepitone. In game theory several forms of payoff may exist. The sum-zero game accounts for all the payoff by attributing to the winner whatever is given up by the loser. Thus, what is gained by one individual is the total payoff lost.

Flamini (1969), studying competitive strategies of obtaining grades, stated,

> The concept of a sum-zero game is introduced into the classroom through the grading system. If grading is done on a competitive basis, which is the case in most college

> classrooms, the sum-zero strategy becomes a useful tool for the competitive student. If a student can cause another to fail to achieve he may receive a higher grade by default. He has two strategies available to him: He can present a better product or make his opponent's product look less good. A third possible choice is a number of quasi-legal tactics in order to present to the instructor a better appearing product than his competitors.

These same strategies and tactics are employed in athletic games. Here the payoff is even more clear for only one winner can exist and only at the expense of the unsuccessful opponent.

In non-sum-zero games, the payoff is not totally awarded to the winner, i.e., a teacher does not lose knowledge in order for a student to gain knowledge. There is a mutual payoff that can exist in this form of game on the bases of payoff. This latter form of game would reasonably be assumed to be less stressful than the former.

Sport contests seem to fit the structural competitive framework. The rules of the game specify the competitive actions between individuals (or teams) necessary for victory. In academic competition, structural constraints are less well defined. In situations where delimited boundaries are established, performances and behavior seem to parallel situations commonly found in athletics.

Competitive Stress

Deutsch (1949), studying the structural competitive situation using undergraduate students involved in solving human relation problems, found that when grades were awarded by two different methods, the "promotively interdependent" groups showed less conflict. In this study, the students were divided into two different types of problem solving groups. The "promotively interdependent" groups were told that each individual's grade would be based on the total class performance and each individual would be given the average grade of the class. In the "contriently interdependent groups," grades were based on the independent rank of each student within a class, relative to the performance of students in that same class. The latter group showed less coordination of effort, greater redundancy of role behavior, lower levels of communication, less interpersonal liking, and other signs of competitiveness. In the Deutsch study, the aspirations of students were taken to be the same; therefore, the structural constraint of the group was the independent variable. Mintz (1951) manipulated success/failure motivations and held structural constraints constant on subjects involved in performing

a cooperative task.[2] He found that under conditions where subjects were rewarded 25¢ and fined 10¢ for the performance of the task, serious permanent traffic jams occurred in more than 50 percent of the groups while in groups where no incentive was employed, only temporary jams occurred. Although no measures of stress were taken, it would seem that relatively more stress was experienced during the competitive situations. Further interpretation suggests that competitive stress was not so much determined by the grade or reward but was a consequence of the relative position these grades represented in relationship to the group.

In life situations such as competitive athletics, experience seems to bear out the conclusions that events are more stressful if a large emotional component is involved, such as in a league match. de Vries (1966, Ch. 9) suggested that the emotional or psychological stress of competition is an additive component to the stress of performance alone. This would offer an explanation of the decrements in performance that occur when chances of failure or losing are present.

[2] The task was for each subject in the group to cooperatively remove a cone shaped object from a jug into which water was slowly being poured. The subjects, each holding a string attached to the object, were to remove the object within a specified time before it became submerged in water.

These concepts suggest that possibly a self-motivating factor is the actual stimuli eliciting the stress response and that external threats are only stressful if perceived as such. This concept would even be valid in terms of physiological stress if it is contended that noxious stimuli are physiologically evaluated as a threat and that this internal evaluation activates the stress response.

Lazarus (1966, p. 25) supported the concept of threat as being an intervening variable in psychological forms of stress. He further suggested that,

> Once a stimulus has been appraised as threatening, processes whose functions are to reduce or eliminate the anticipated harm are set in motion. They are called the coping processes.

These coping processes may be physiological, behavioral, or both. Lazarus (1966, p. 25) further suggested that stress is indicated by four main classes of reaction: ". . . reports of disturbed affects, motor behavioral reactions, changes the adequacy of cognitive functioning, and physiological changes, both biochemical and autonomic."

Mechanic (1962, pp. 162-163) studied doctoral candidates longitudinally week by week and found that their description of current events changed substantially from the period before the examination to the period immediately after.

Opinions were generally unpleasant prior to examination and acceptable immediately following.

Mechanic further reported that subjective reports of discomfort were accompanied by many physical disabilities such as stomach pains, diarrhea, vomiting, and other signs of stress. Mechanic's study suggested that the threat was not only evaluated but, once it was recognized, manifested itself in physical responses. This appraisal of threat, however, is a highly controversial construct. Conscious and unconscious awareness draws varied opinions from psychoanalysts and behavioral psychologists. Therefore, the consideration here is that appraisal exists in stress reactions regardless of the nature of the appraisal.

The implication of Mechanic and Lazarus is that stressors can be recognized, and therefore, the degree of stress felt may be directly attributable to the evaluation process and the motivational structure it activates. This concept would reasonably lead to a hypothesis that the subjective evaluation of a stressor would, to a great extent, determine the degree of response to such a stressor.

Quantification of Stress

Numerous psychological and physiological indicants have been used in attempts to quantify stress. Psychological

measures tend to concentrate on the meaning of the significance of the stimuli while physiological measures concern themselves with the damage to tissue structure that has already occurred.

Psychological Measures

Anxiety and fear have traditionally been two classical behavioral affective states studied in relation to stress. Other affective states such as aggression, anger, and arousal have made this measurement of affective disturbances a most complex problem. Although there is much disagreement among researchers as to what particular affective state is being measured, there is agreement that disturbed effects accompany periods of stress (Sarason, 1960).

One of the most popular instruments used in measuring anxiety is Taylor's Manifest Anxiety Scale (1953). Other researchers have adapted various forms and abbreviations of this scale for the concerns of various experiments (Castenda, McCandless, and Palermo, 1956; Bendig, 1956; Perlman, 1958). Another often used questionnaire is the Sarason-Mandler Scale (1952). This scale more specifically attempts to measure test or achievement anxiety. The use of other signs as indicants of anxiety resulting from stressful conditions has also been employed. Lindzey and Newburg (1954) used some Thematic

Apperception Test signs of anxiety as valid correlates to clinical ratings, and Moldawsky and Moldawsky (1952) demonstrated that digit span performance on the Wechsler-Bellevue Intelligence Scale (1946) was impaired by stress-producing conditions.

Using multidimensional scales, other researchers have measured the relation of stress to depression (Dempsey, 1964), aggression, pleasantness, activation deactivation, egotism, social affection, depression and anxiety (Nowlis and Nowlis, 1956), and changes in mood (Clyde, 1963). The use of such introspective reports and scales in the assessment of stress is necessary if the efficacy of physiological measures of stress is to be evaluated. Although objections exist at various levels as to the use of introspective reports, the emphasis still is to search for the rules that account for the discrepancies. Lazarus (1966, p. 340), commenting on introspective reports, stated,

> Instead of regarding the failures of introspective reports to index threat accurately as errors, we might take a broader view of the problem and recognize that discrepancies between indicators often reveal the nature of important psychological processes, such as appraisal and coping.

Introspective scales designed specifically to measure stress also have been used extensively. This form of measurement considers the affective disturbance of stress as

the common denominator of the reaction. One of the indexes used to measure a subject's own perception of the stressfulness of the situation is the Subjective Stress Scale (Kerle and Bialek, 1958). This instrument has been shown to be most applicable on military samples in field situations where the stressor was relatively strong (Berkun, et. al., 1958, 1962; Kerle and Bialek, 1958). Jacobs and Munz (1968), noting the ubiguitous stress investigations employing college students, developed a subjective stress scale which has been shown to have great possibilities in measuring stress on college samples. Their Perceived Stress Index (PSI) would seem to be a most useful instrument in educational settings when overall stress is of interest.

Reviews on the effects of stress on conditions of cognitive activity and skilled performances have shown these effects to be inconsistent and complex. Some researchers have found impairment of these functions while others have found facilitated performance under stress (Lazarus and Eriksen, 1952; Martin, 1961; Sarason, 1960).

Martin (1961), in discussing experimental literature, stated,

> Thus there appears to be two rather loose empirical generalizations that can be reached on the basis of the studies reviewed: (a) that

> tasks involving relatively stronger and more numerous competing responses are more subject to the impairing effects of stress, and (b) increasing stress results in improved performance up to a point and impairment thereafter.

This same point was supported by Lazarus (1966, p. 350). He stated ". . . in the main, while threat conditions can facilitate performance, the preponderance of data emphasize impairment." This concept of both impairing and facilitating stress has been adopted by some researchers in the development of specific anxiety or stress scales (Alpert and Harber, 1960, p. 209; Sarason and Mandler, 1952).

The constructs explaining the variations in stress responses are numerous and varied. Yet, they all suggest the possible interaction of forces culminating in varied patterns of reaction for each individual. An early hypothesis that this variation was a cause in the difficulty in linear measurements of physiological and psychological stress would seem to be supported by research. The implication here is that although individual correlation of psychological measures and physiological measures may be low, their concurrent consideration must be sought if the intervening structures of stress are to be explained.

Physiological Measures

The physiological measures of stress are response reactions. These various reactions reflect the threat and coping processes which occur and thus are indicants of these processes.

Physiological measures have primarily been concerned with two classes of physiological responses. The two classical systems consist of the autonomic nervous system reactions and the secretions of the adrenal glands. Levi (1967, p. 71) contended that recent developments in biochemical analysis have produced techniques by which important aspects of even the most characteristic and basic mechanisms involved in the stress reaction can be measured. He further stated,

> Hormone analysis of the urine accumulated while a person was exposed to various pressures gives us a useful and practical assessment of the degree of stress within the organism at that time. If, at the same time, one also studies the productivity of different groups of people, together with their behavior, and their subjective feelings, it is possible to achieve a thoroughgoing, comprehensive assessment of the degree of stress present within these groups.

The vastness of the literature concerned with the mechanisms by which the stress response is activated and the technology of measurement suggests physiological measures as being the most promising of stress indicants. Such investigators as Selye (1956, Ch. 13), Funkenstein, King, and

Drolette (1957, Ch. 1), Roessler and Greenfield (1962), and Brady (1966) have each emphasized the various aspects of physiological stress and the mechanism involved in the reaction. All their reviews, however, center on the autonomic nervous system reaction and the adrenal secretions.

Autonomic Nervous System and Stress

The classical work relating stress and the autonomic nervous system is that of Cannon (1939, Ch. 4). Recently, increased sophistication in the electrical measurement of autonomic activity has given impetus to research in this field (Lazarus, 1966, Ch. 9). Lacy (1967), in reviewing somatic responses to stress situations, lists respiration rate, blood volume, finger temperature, electrical conductivity of the skin, and diastolic and systolic rates as being commonly used end-organ responses of the autonomic nervous system to stress. Hess and Polt (1960, 1964) have shown pupillary changes during stress to be related to the activity of the sympathetic autonomic nervous system, while Bixenstine (1955) attributed palmar sweating during stress to increased autonomic activity.

The measurement of these indicants of stress in the laboratory setting has uncovered extensive knowledge about stress. However, the measuring instruments have proved cumbersome in field settings where actual stressors are present

and, in some instances, have increased the stress reaction. In addition, end-organ responses may vary within the same individual, counter-balancing each other in antagonistic ways (Levi, 1967, Ch. 1).

Adrenal Gland Reaction and Stress

The adrenal glands and their secretions have been the most extensively studied organs in relation to stress. Cannon (1915) first placed the importance of adrenal medulla system as the most common response to a variety of stressing factors, but the foundational work of Selye (1950) established the pattern in this area. Selye emphasized the importance of the pituitary-adrenocortical system and its relationship to stress. Nevertheless, both systems are classical physiological indicants used in the quantification of stress.

Since the work of Selye (1950), the relationship between the secretions of the adrenal cortex and stress has been studied extensively. Price, Thaler, and Mason (1957, p. 656) summarized their studies by stating,

> The major conclusion suggested by our findings is that the response of the pituitary-adrenocortical system is related to emotional processes, and further, that it is probably not associated with a single specific emotional state such as fear or anxiety, but rather, is associated with a number of emotional states that have the relatively undifferentiated components of distress involvement.

Other investigators (Korchin and Herz, 1960; Price, Thaler, and Mason, 1957; Persky, Korchin, Basowitz, Board, Sabshin, Hamburg, and Grinker, 1959) have found rough correspondence between the quantity of adrenalcortical secretion and degree of stress, thus suggesting cognitive factors to be stress related.

The adrenalcortical hormones most frequently used as an index by psychologically-oriented researchers are the 17-hydroxycorticosteroids (Persky, 1962). The majority of researchers have found an increase in secretion of hydrocortisone during stress (Handlon, 1962; Price, Thaler, and Mason, 1957; Korchin and Herz, 1960) while others (Brady, Porter, Conrad, and Mason, 1958), using animal subjects, have found inconsistent secretions during severe stress.

Another adrenalcortical hormone used as an indicant of stress is aldosterone. Fortier (1962) suggested that the pituitary secretion of adrenocorticotropic hormones affects aldosterone similarly to hydroxycorticosteroids. However, aldosterone rises are noted to take place independently from increases in 17-hydroxycorticosteroids, which make them questionable responses in relation to adrenocorticotropic hormones (Oken, 1967). Nevertheless, because electrolyte metabolism during stress is related to levels of aldosterone

secretion, their use in the quantification of stress is found extensively in the literature.

Other measures of stress are confined to reactions caused by adrenocortical secretion. Among these measures are decreases in eosonophil count (Ulrich, 1957; Roche, Thorn, and Hill, 1950), circulatory changes (Wolf, 1952), respiratory changes (Bruce, Lovejoy, Pearson, Yu, Brothers, and Velasquez, 1949) and intestinal reaction (Jones, 1954). These end-product measures have the disadvantage of being effect agents whose measure depends on complex interaction conditions in addition to adrenalcortical secretion. Some current literature suggests that the secretion of the adrenal gland still remains the single most reliable physiological indicant of stress.

The secretions of the adrenal medulla have also received extensive attention as indicants of stress. The two most widely-used measures are epinephrine and norepinephrine. Euler (1964, p. 399) stated, "The improved and simplified techniques for the estimation of epinephrine and norepinephrine in the urine have made it possible to follow their release and excretion." The chief advantage of catecholamine analysis of epinephrine and norepinephrine is that it permits the study of hormonal release on relatively short periods

of time, thus reflecting the stress experienced at specified intervals. There is dependable evidence of increased epinephrine production in psychologically stressful conditions (Euler, Luft, et. al., 1951, 1953; Elmadjian, 1963), although these urinary measures mainly represent major state differences.

Norepinephrine secretions have been less consistent as an indicant of stress. This is partly due to norepinephrine being less affected by emotional stimuli (Oken, 1967). Elmadjian, et. al. (1958) and Silverman, et. al. (1961), however, suggested that epinephrine secretions are related to anxiety and norepinephrine to anger. Euler and Hellner (1952) and Euler (1956) have shown that norepinephrine increases with the stress of levels of muscular activity, while Elmadjian, et. al. (1957), in summarizing his own studies, maintained that motor activity alone without involvement would not necessarily increase norepinephrine levels.

The emphasis in the literature has been to employ both epinephrine and norepinephrine in the quantification of stress. Some research suggests that epinephrine secretion is related to fear and norepinephrine secretion is related to anger (Silverman and Cohen, 1960). The work of Levi (1965), using films in eliciting stress responses, suggests that the

relationship of epinephrine and fear, and norepinephrine and anger may be overstated. He concluded "There seems to be a positive correlation between the intensity of emotional arousal, whatever its quality, and the urinary excretion of adrenaline and possibly of noradrenaline" (1965, p. 85).

Work by Frankenhaeuser, Järpe, Svan, and Wrangsjö (1963), using placebo drugs, indicated that the threat appraisal of drugs had direct effect on the secretion of epinephrine and norepinephrine. This latter finding suggests that threat appraisal, as suggested by Lazarus (1966, Ch. 2), is also important in epinephrine and norepinephrine secretion.

In situations such as parachute jumping (Bloom, Euler, and Frankenhaeuser, 1963), flight training (Euler and Lundberg, 1954), mental work (Frankenhaeuser and Järpe, 1963), and students undergoing examination (Pekkarinen, Castrén, Iisalo, Koivusalo, Laihinen, Simola, and Thomasson, 1961), research has shown the extensive possibilities in the use of epinephrine and norepinephrine as indicators of ongoing stress.

In summarizing research on catecholamine measures of stress, Euler (1964) concluded that a definite correlation exists between the urinary excretions of catecholamines and various types of stress. He further emphasized the usefulness of urine catecholamine analysis in the study of stress in group situations.

Summary of Related Literature

On the basis of literature reviewed, competition seems to be related to many facets of higher education. The desirability of competition as a motivational source has met with varied opinions. Using performance as a criteria, competition has shown some positive effects (Julian and Perry, 1967). If individual adjustment is the criteria, competition leaves many areas that still need investigation.

Some research suggests that competition may be viewed in the theoretical framework of stress (Pepitone, 1967; Selye, 1956). Research following this concept allows for both psychological and physiological measures of competition.

In real-life situations, athletics seems to provide a ready-made setting for the observation of competition. Similarities in both psychological and physiological responses to stress in athletic and academic situations strongly suggest that competition is the same regardless of its nature. Thus, inferences drawn in one competitive situation would be applicable in other competitive situations.

Both psychological and physiological measures have been employed in the quantification of stress. Psychological measures have been concerned with the assessment of the intervening threat (Lazarus, 1966), while physiological measures

have been concerned with the reaction of the body to such a threat. The concurrent use of both measures is suggested since some research has provided evidence that cognitive factors enter into the appraisal and response process (Lazarus, 1966, Ch. 2; Levi, 1967, Ch. 1; Appley and Trumbull, 1967, Ch. 6).

Physiological measures of stress have primarily been concerned with the secretions of the adrenal glands (Selye, 1956). Current improved techniques of catecholamine analysis in the urine have allowed for less cumbersome methods in the quantification of stress (Euler, 1964).

The research of Persky (1953) points out the differences between physical and psychological stress. He reported that certain physiological measures of stress are only affected by psychological conditions. His contentions are consistent with others (Frankenhaeuser, et. al., 1963). This suggests that physical forms of stress, such as exercise and physical activity, may affect the adaptive mechanism without entering into the stress reaction caused by the emotion. Thus, situations of competition which contain both physical and psychological components would seem to offer the most fruitful results in terms of understanding the stress response and coping process.

The problem of quantifying stress still remains in the area of measurement. Research suggests that this measurement could be facilitated if the separate components that contribute to the total stress situation could be separated, identified, and quantified.

It is with this background that this study attempted to separate the various sources of stress in a competitive situation in the attempt to measure the various effects contributed by each.

Hypotheses

In light of the literature reviewed, the following hypotheses are offered:

1. The competitive situation elicits a stronger stress response than the noncompetitive situation when the performance is held constant for both introspective reports and physiological measures.

2. Anticipatory stress reaction is greater in a competitive situation than in a noncompetitive situation for the same task in both introspective reports and physiological measures.

3. There is a greater additive effect of the psychological stress component during the competitive situation than in noncompetitive situation with the performance held constant.

4. There is a positive relationship between introspective reports and physiological measures for the same stress.

CHAPTER III

METHODOLOGY

The interest of this study was to determine if the competitive situation resulted in significantly different secretion levels of catecholamines as compared to practice sessions of the same task. This study further attempted to determine if the competitive situation resulted in significantly different subjective reports of stress as compared to practice sessions of the same task. The task chosen for the experiment was intercollegiate swimming. An analysis of variance for a two-factor, repeated measures design was used to generate the appropriate interaction mean square error term for epinephrine and norepinephrine. The mean square error was in turn used in the analysis of individual planned comparisons among means. No main effects were of interest in this study. The questions that were of interest in this study were:

1. Do pre-post measures of competitive stress differ?
2. Do pre-post measures of practice stress differ?
3. Do pre measures of competitive and practice stress differ?

4. Do post measures of competitive and practice stress differ?

Subjects

Twelve male intercollegiate varsity swimmers, composing the 1970 University of Oklahoma swim team (excluding divers), were selected as subjects. These subjects were chosen for the following reasons:

1. The subjects were a part of both the athletic and academic program.

2. The desirability of timed performance such as found in swimming allowed for consistent estimations of the performance during practice and competition.

3. The environment in which the subjects competed remained constant in water and ambient temperature as regulated by intercollegiate rules.

4. The subjects lived in the same dormitory and had the choice of similar diets on the days measurements and samples were collected.

5. Periods between events in swimming allowed for convenient collection of urinary samples without interfering with the natural competitive setting.

6. The swimming events provided a natural setting in which to observe the effects of competition as a form of stress.

The above considerations, all of which have been shown as possibly affecting catecholamine excretion, were controlled through the use of this particular sample group performing in a natural, unencumbered setting.

Inferences can be safely made to similar groups and competitive settings of a similar nature. The numerous factors that enter into different competitive settings introduce many extraneous variables when using completely random samples. The purpose of this study was to use matched subjects to detect the subtle differences that may be found in the competitive setting. Using completely random subjects performing in unfamiliar tasks would have introduce variables that may have masked the actual effects of competition alone. Because catecholamine excretions are affected by various physiological conditions, it was felt that matched groups would generate more meaningful data of the physiological reactions of subjects to competitive stress. Although generalization to other samples may be slightly limited, the extension of generalization to human physiological conditions greatly outweighs the use of a completely random population.

Instruments

The Perceived Stress Index (PSI, see Appendix J) was used in this study to determine the subjective stress

experienced by subjects during practice and competitive sessions. This index has been shown to be sensitive in the measurement of "situational" rather than "chronic" measures of stress (Jacobs and Munz, 1968). The PSI was developed using University of Oklahoma students as the subject population. It is composed of items developed through a combination of Thurstone's technique and Osgood's Semantic Differential. Thornton and Jacobs (1970, p. 945) stated, "The use of this combined approach should lead to words and phrases which are relatively factor-pure and carry limited connotative meaning."

The administrative instructions and scoring key for the PSI are shown in Appendix J. The item content, median intensity values, semi-interquartile range, and factor loading of the PSI items are shown in Appendix K. These items range along a pleasant to unpleasant continuum.

In a contrived field setting involving stress experienced during adverse testing conditions, subjects that were told they would receive their midterm exam early because of poor prior performance subjectively experienced a greater degree of stress than controls. In a more recent study, the PSI was shown to support the hypothesis that the index was sufficiently sensitive to detect differences in subjective report of affective states at four divergent levels of instructionally induced stress (Thornton and Jacobs, 1970).

This particular index was used in this study for the following reasons:

1. It is an easily scored index which is fast to administer and may be given repeatedly to the same subjects.

2. The PSI was developed on a sample of University of Oklahoma students and has adaptability in the investigation of stress on college samples.

3. The scoring procedure yields a difference score which should be more sensitive to changes in affective states.

4. Construct validity has been developed on this instrument in contrived field settings.

Measures of Catecholamine

The physiological measures analyzed in this study were: (1) epinephrine, (2) norepinephrine, and (3) creatinine. The fluorimetric technique of Euler and Lishajko (1961) has drawn much attention to the use of epinephrine and norepinephrine as indicants of stress. The use of epinephrine and norepinephrine in catecholamine analysis permits the study of hormonal release on relatively short periods of time, thus reflecting stress experienced at specified intervals. Epinephrine has been shown to reflect psychologically stressful conditions (Euler, Luft, et. al., 1951, 1953; Elmadjian, 1963). Euler (1964, p. 403), in a commentary on catecholamine analysis,

concluded that a definite correlation existed between the urinary excretion of catecholamine and different types of stress. He stated,

> Generally, it appears that in the forms of mental stress which are associated with anger, aggression, or exhilaration, the norepinephrine excretion is increased, while in emotional states characterized by apprehension, discomfort, painful or unpleasant feelings, the epinephrine excretion is increased. The usefulness of urine catecholamine analysis in the study of industrial or group stress situation is emphasized.

Creatinine measures were also collected, analyzed, and used as baseline ratios. Because exact timed values of epinephrine and norepinephrine could not be obtained easily without creating an artificial testing situation, ratios of ug.* catecholamine/100 mg. creatinine were used in the statistical analysis. The approximate hourly excretion of epinephrine and norepinephrine is 10 percent less than the figure shown in Appendix D and E in terms of 100 mg. creatinine when corrected by the creatinine coefficient.[3] The ratio values

[3] Data in terms of ug./100 mg. of creatinine may be computed in terms of ng./hr. if the weight of the subject is known. Since the weight of the athlete is highly correlated with muscle mass and creatinine excretion is dependent on muscle mass, the computation of the formula for creatinine coefficient would furnish the creatinine excretion per unit time for a particular weight (Kleiner, 1945).

*The symbol ug. was used to denote microgram.

were used in the statistical treatment instead of ng. catecholamine/min. because statistical values would have been the same under either expression in terms of significant values.

Experimental Procedure

Twelve intercollegiate swimmers competing on the 1970 University of Oklahoma swim team were used as subjects for the experiment. Each subject acted as his own control over all samples collected. Samples of urinary catecholamines and subject's subjective report were collected over several practice and competitive sessions. The final samples analyzed consisted of one practice session and one competitive meet in which performance times were within seconds of being identical times. All samples were collected at the home pool during the same time of day and under similar conditions.

The experiment began in the middle of the competitive season during the month of January. The subjects were never informed as to which samples were the ones actually used in the experiment. On the days in which samples were collected, subjects were asked to void their bladder two hours prior to swimming and to consume approximately 200 ml. of water at that time. The first sample was collected prior to each practice or competitive session. Each subject was asked to void his bladder into a collecting bottle which contained 1 cc. of

concentrated hydrochloric acid. Immediately after voiding, each subject was asked to consume another 200 ml. of water, and complete the first portion of the PSI (see Appendix L). Fifteen minutes following each subject's event, he was asked to again void into a second collecting bottle and to complete the second portion of the PSI (see Appendix M). The same procedures were employed during practice and competitive sessions. On the days samples were collected, swim practice consisted of time trials. These trials were organized such that subjects swam in events in which they would normally compete. Subjects were asked to swim as hard as they could during practice sessions so that times would duplicate competitive times. At no time were subjects informed of the nature of the experiment or which samples would be actually used in the analysis. Subjects were led to believe that all samples would be used. The anticipatory effect of sample collecting was eliminated by employing several practice sessions in which subjects followed the procedures of the experiment without actually giving samples.

The final samples used in the analysis were the second competitive meet recorded and the third time trial. The subjective opinion of the coach was that the swimmers performed as well during this trial as they did in the previous match.

Swim times indicated that most times were close to competitive times and, in some instances, even exceeded the actual meet times.

Immediately on collection, samples were refrigerated at one degree centigrade and remained so until analysis. analyses were performed on epinephrine, norepinephrine, and creatinine. The Medical Art Laboratory in Oklahoma City performed all biochemical analysis on samples. The same time period between sample collection and analysis was maintained for samples collected during competition and samples collected during practice. Approximately 100 ml. of urine were analyzed for each subject during each collecting interval. Total urine volume was not recorded.

Statistical Treatment

An analysis of variance for a two-factor, repeated measures design was used to calculate the appropriate mean square error term (Myers, 1966, Ch. 7). This error term was further used in individual planned comparisons designed to answer the following questions:

1. Does the precompetitive mean equal the postcompetitive mean?

2. Does the prepractice mean equal the postpractice mean?

3. Does the precompetitive mean equal the prepractice mean?

4. Does the postcompetitive mean equal the postpractice mean?

Because overall "F" comparisons were not of interest in this study, the mean square error term was used to calculate "t" values for each planned comparison (Hays, 1963, Ch. 14). These planned comparisons were not used as incidental or post-hoc comparisons but were designed to answer only the four basic questions. In forming the values for each planned comparison, linear combinations with means of weighted sums were formed. The sum of the weighted values were zero for each comparison. The weightings of means not involved in a particular comparison were zeros, while weights for means involved in a particular question were one and minus one. These weights conformed to the requirements for a planned comparison model.

CHAPTER IV

RESULTS AND DISCUSSION

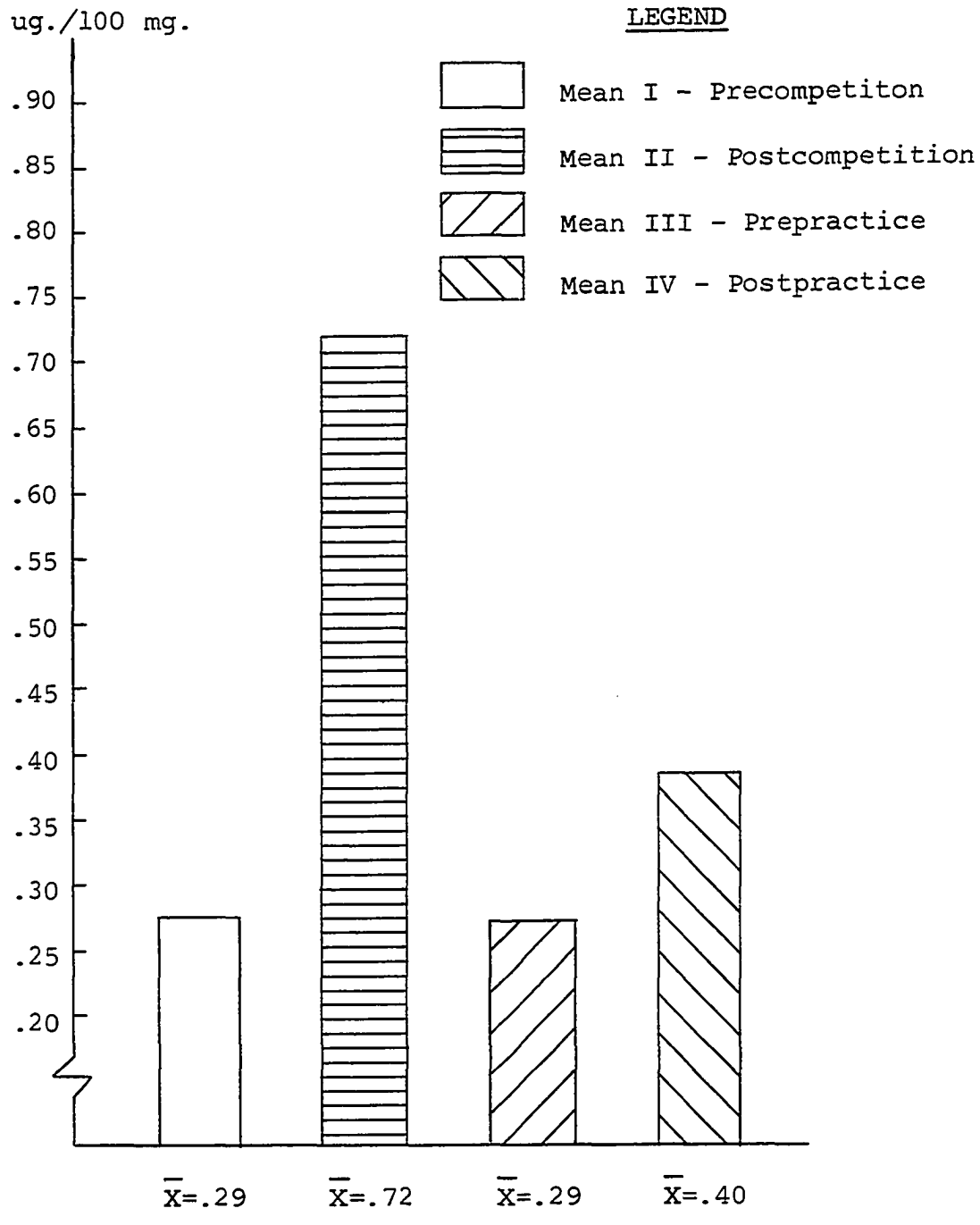
The purpose of this study was to determine the effects of competition on selected physiological and psychological measures of stress. Pre-post measures of matched subjects on measures of catecholamines and each subject's subjective report of stress were taken under comparable practice and competitive swimming conditions. Differences and relationships between the various psychophysiological measures were studied.

Results

The group means of ug. epinephrine/100 mg. of creatinine are presented in Figure 1. The raw data of epinephrine are presented in Appendix A and the ratio data of ug. epinephrine/100 mg. creatinine in Appendix D.

The analysis of variance of a two-factor, repeated measures design for ug. epinephrine/100 mg. of creatinine is presented in Table 1. This particular analysis was used to generate the appropriate interaction error term to be used in individual planned comparisons. Factor A denotes levels of

FIGURE 1.



ug. EPINEPHRINE/100 mg. CREATININE

competition, factor B denotes pre-post conditions, and factor S denotes subject effects.

Table 1. Analysis of Variance of a Two-Factor Repeated Measures Design for ug. Epinephrine/100 mg. Creatinine

Source	Sums of Squares	Degrees of Freedom	Mean Squares
A	.32	1	
B	.88	1	
S	.47	11	
AB	.31	1	
AS	.50	11	
BS	.52	11	
ABS	.27	11	.02
Total	3.27	47	

Individual planned comparisons were performed on the four basic questions of the study. The mean positions and constant weights are shown in Table 2.[4]

[4] Comparisons for questions 1 and 2 and questions 3 and 4 are orthoginal. Comparisons for questions 1 and 3, and questions 2 and 4 are not orthoginal. The redundant comparisons were controlled by setting the error rate at .05 for the series of test or .0125 for each comparison.

Table 2. Mean Values and Constant Weights for Individual Planned Comparisons

	Means			
	I	II	III	IV
Question				
1	1	-1	0	0
2	0	0	1	-1
3	1	0	-1	0
4	0	1	0	-1

Individual t tests for planned comparisons were performed on each question. These individual comparisons detected significant differences between means I and II (question 1), and means II and IV (question 4), probability less than .01. The mean values were for the following measures: I = precompetition, II = postcompetition, III = prepractice, and IV = postpractice (see Table 3.). The error rate of .05 was maintained for the entire series of comparisons.

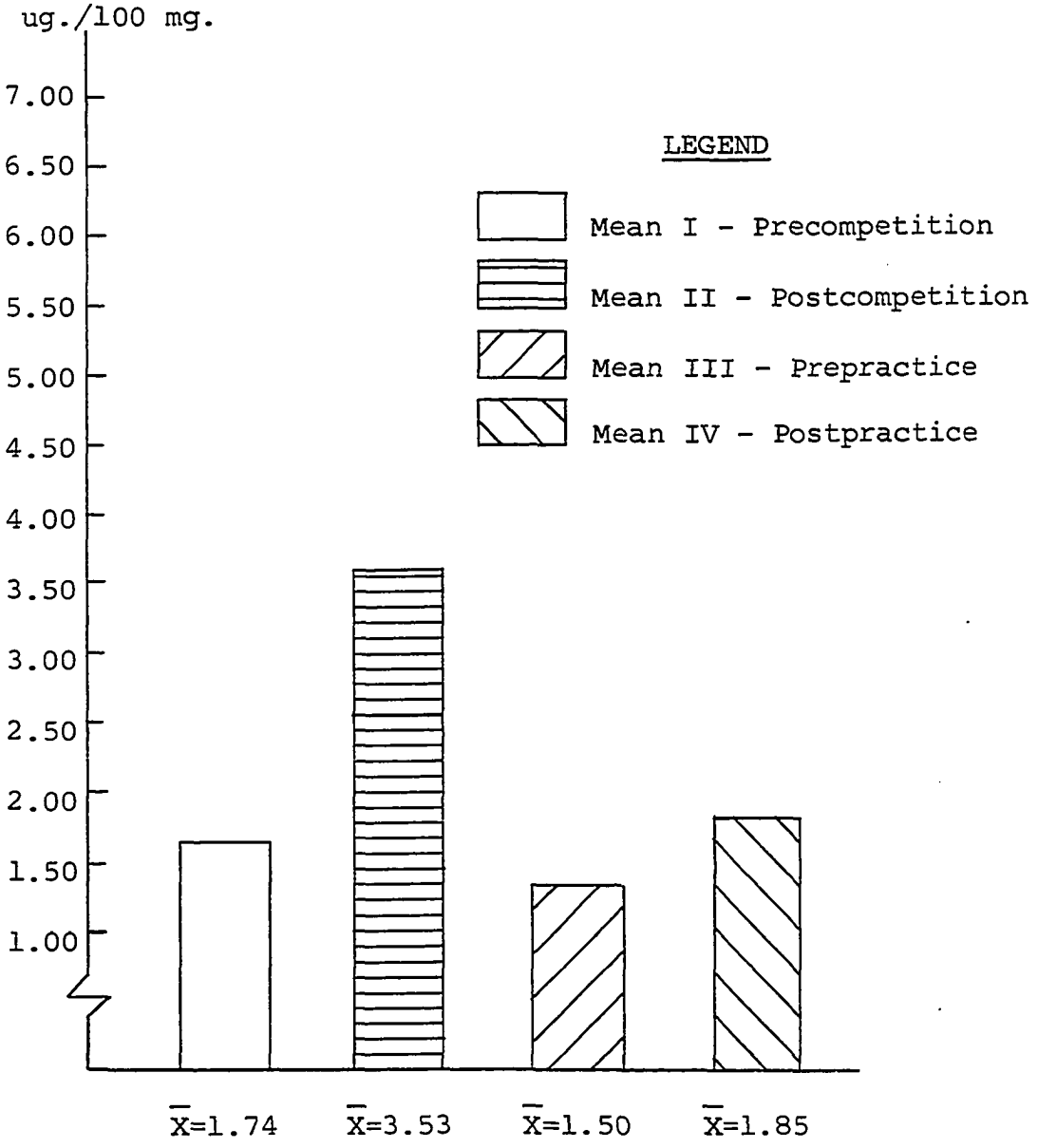
Table 3. Planned Comparisons for Excretion of Epinephrine ug./100 mg. Creatinine

		Means					
		I	II	III	IV		
Question	N					t	
1	12	.29	.72			-6.80	p. $<$.01
2	12			.29	.40	-1.74	n.s.
3	12	.29		.29		0.00	n.s.
4	12		.72		.40	5.00	p. $<$.01

The group means of ug. norepinephrine/100 mg. of creatinine are presented in Figure 2. The raw data of norepinephrine excretion are presented in Appendix B and the ratio data of ug. epinephrine/100 mg. creatinine in Appendix E.

The analysis of variance of a two-factor, repeated measures design was used to generate the appropriate error term used in the individual planned comparisons. The results are presented in Table 4.

FIGURE 2.



ug. NOREPINEPHRINE/100 mg. CREATININE

Table 4. Analysis of Variance of a Two-Factor Repeated Measures Design for ug. Norepinephrine/100 mg. Creatinine

Source	Sums of Squares	Degrees of Freedom	Mean Squares
A	11.05	1	
B	13.79	1	
S	14.42	11	
AB	6.23	1	
AS	26.74	11	
BS	18.34	11	
ABS	15.86	11	1.44
Total	106.43	47	

Individual planned comparisons were performed on the four basic questions of the study. The mean positions and constant weights are shown in Table 2. These individual comparisons detected significant differences between means I and II (question 1), and means II and IV (question 4), probability less than .01. The error rate of .05 was maintained for the entire series of comparisons (see Table 5.).

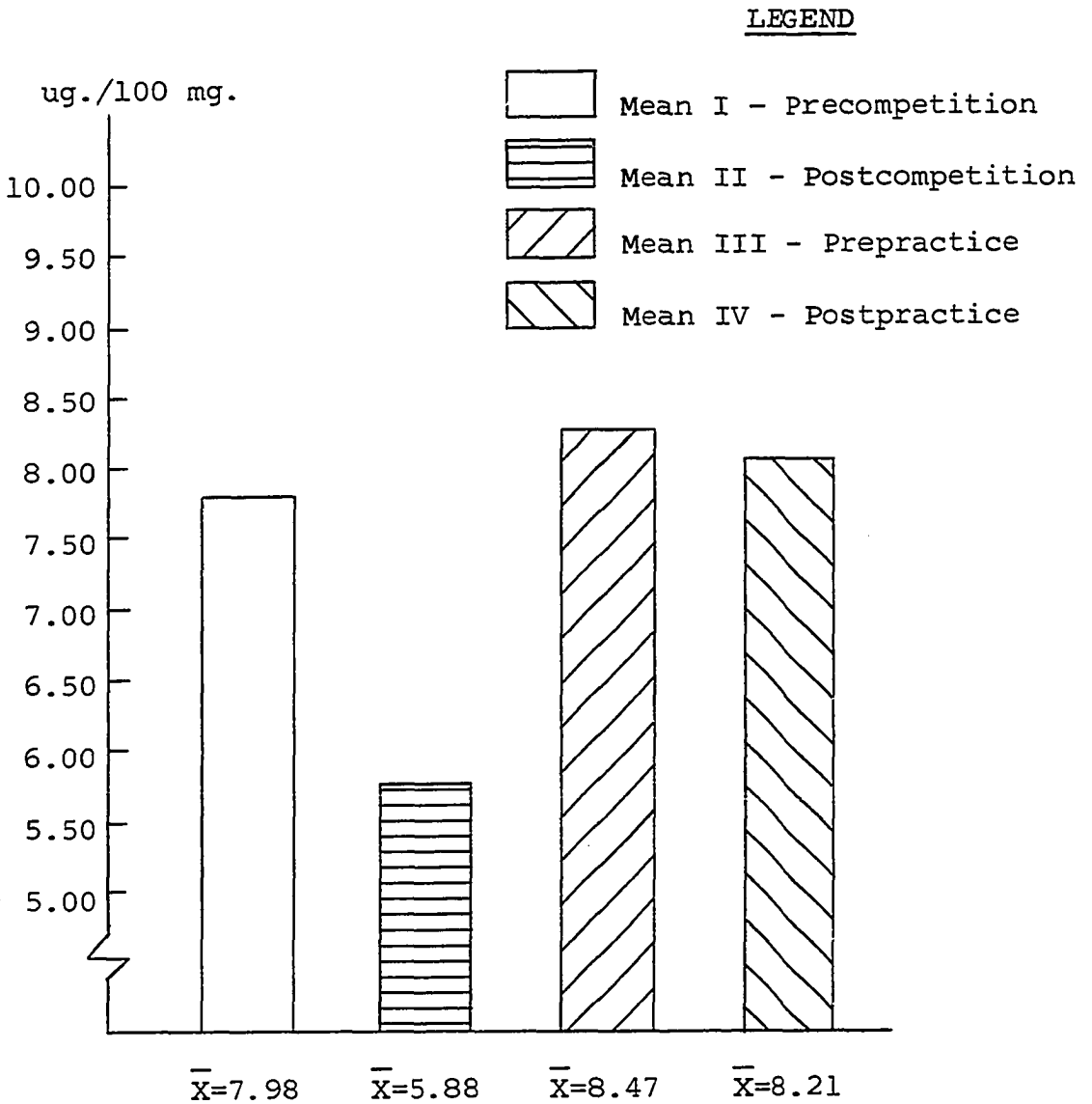
Table 5. Individual Planned Comparisons Between Means for Excretion of ug. Norepinephrine/100 mg. Creatinine

		Means					
		I	II	III	IV		
Question	N					t	
1	12	1.74	3.53			-3.69	p. $<$.01
2	12			1.50	1.85	- .78	n.s.
3	12	1.74		1.50		.49	n.s.
4	12		3.53		1.85	3.46	p. $<$.01

The PSI group means are presented in Figure 3. The raw data are presented in Appendix F for the practice session and Appendix G for the competitive session. The PSI scores are shown in Appendix H for the practice session and Appendix I for the competitive session.

The analysis of variance of a two-factor, repeated measures design for the PSI is presented in Table 6. The mean square interaction term was used as the appropriate error value for the individual planned comparisons between means.

FIGURE 3.



PERCEIVED STRESS INDEX SCORES

Table 6. Analysis of Variance of a Two-Factor Repeated Measures Design for PSI Scores

Source	Sums of Squares	Degrees of Freedom	Means Squares
A	23.84	1	
B	16.79	1	
S	20.03	11	
AB	10.04	1	
AS	41.06	11	
BS	15.19	11	
ABS	26.31	11	2.39
Total	153.26	47	

Individual planned comparisons were performed on the four basic questions. The mean position and constant weights are shown in Table 2. Individual t tests for planned comparisons were performed on each question (see Table 7.). These individual comparisons detected significant differences between means I and II (question 1), and means II and IV (question 4), probability less than .01. The mean values represented are, in order, precompetition, postcompetition, prepractice, postpractice. Negative t values are shown because

low mean values indicate greater subjective stress on the PSI scale.

Table 7. Planned Comparisons for PSI Scores

		Means					
		I	II	III	IV		
Question	N					t	
1	12	7.98	5.88			3.33	p.< .01
2	12			8.47	8.21	.41	n.s.
3	12	7.98		8.47		- .78	n.s.
4	12		5.88		8.21	-3.70	p.< .01

Discussion

The results indicated that competition was a sufficient stressor to elicit significant increases in the secretion of epinephrine and norepinephrine, and on the scores of the PSI scale. This is in keeping with current literature and in support of the hypothesis that the competitive situation elicits a stronger stress response than the non-competitive situation when performance is held constant for both introspective reports and physiological measures. This finding would tend to support current literature suggesting

that competition, regardless of type, is a stressor which elicits the stress response.

The hypothesis that the anticipatory stress reaction is greater in a competitive situation than in a noncompetitive situation for the same task in both introspective reports and physiological measures was not supported. This finding was not significant for several possible reasons. The subjects were thoroughly familiar with the competitive situation, and competing in the middle of the season may not have caused enough anticipatory stress to generate a significant response.

A second explanation may be that measures were taken too early prior to the competitive event and thus did not indicate the stress felt immediately prior to the event. Measures for all presamples were taken approximately 30 minutes before the beginning of the first event. This was the only possible time to collect samples without hindering the natural competitive session. This time period may have been too early to generate the anticipatory response.

A third explanation may be that the subjects viewed the practice session as stressful as the competitive session. Because the meet was during the middle of the swimming season, subjects may have viewed the time trials as indicants of their potential performance and not as a regular practice session.

This last contention would seem to have some support since the subjects rated change on the PSI toward unpleasantness from how they normally felt in both the practice and competitive sessions.

A fourth reason why the hypothesis was not supported may have been that the competition was viewed as being less stressful than a regular practice session in which subjects were generally heavily exercised to prepare for actual competition which lasts only a few minutes. A final explanation why no significant anticipatory effect was shown prior to competition is that subjects through their regular exercise regimens may have acquired some degree of adaptation to the anticipatory stress. This contention would seem to be consistent with Michael's (1957) hypothesis of acquiring adaptation to psychological stress through physical conditioning.

Significant differences between the precompetitive means and the postcompetitive means of epinephrine, norepinephrine, and on the PSI scores support the hypothesis that a greater additive effect of the psychological stress component existed in competitive than in the noncompetitive situation. The results of no significant differences between the prepractice means of epinephrine, norepinephrine, and on the PSI scores suggest that post measures could be considered

indicants of the additive effect of competition. The results of no significant differences between prepractice means and postpractice means further suggest that the psychological variable in a competitive setting was the major effect in the significant findings.

Significant differences between the post means of epinephrine, norepinephrine, and PSI scores indicate that the psychological variable associated with competition alone was strong enough to elicit the stress reaction. This last finding offers some explanation as to why competitive situations in general seem stressful. If the psychological stress component is present in all competitive situations, competition would possibly show the general stress reaction.

The significant finding between means was the same for all three measures taken. This suggests that the introspective reports as measured by the PSI and the physiological measures of epinephrine and norepinephrine all indicate similar degrees of stress. This finding further suggests that a common factor variance was acting to cause significant findings in a similar direction, and thus implies a positive relationship between measures. No statistical measure of relationship between PSI scores and physiological measures was made. The raw data were plotted; a linear relationship between

measures did not appear to exist. In fact, a linear measure may have distorted the degree of association between measures. A possible explanation of nonlinearity is that the stress reaction seems to be an interaction of multiple variables of which subjective awareness is just a part. This would account for the wide difference in reaction between individuals. Group means seem to be a more consistent indicant of affective change in stressful situations.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Summary

The purpose of this study was to investigate the effects of competition on physiological and psychological indicants of stress. Previous investigators have emphasized the use of epinephrine and norepinephrine as physiological measures of physical and psychological stress (Euler, 1964). Although the relationship between physiological and psychological indicants of stress have proved disappointing, their relationship to a common stress phenomenon cannot be denied (Appley and Trumbull, 1967, Ch. 14). The approach of this study was to separate the stress of competition into various levels through the use of pre-post comparisons between competition and practice sessions of the same task. The task chosen for this study was swimming, and subjects were composed of members from the 1970 University of Oklahoma swim team. Highly trained subjects were particularly desirable for this study to detect the subtle changes that might occur between practice and competition.

The PSI was chosen as the psychological indicant of stress. This index was developed on University of Oklahoma students and is particularly applicable to college samples. It has the advantage of measuring affective change from how subjects normally feel to conditions of pleasant or unpleasantness.

Several hypotheses were proposed suggesting that the competitive session elicits a stronger stress response than the practice session on all measures of stress investigated. A secondary hypothesis suggested that the anticipatory effect to competition was greater in the competitive session than a similar practice session. A third hypothesis suggested that the additive effect of psychological and physical stress during performance causes increased secretions of catecholamines and more stressful subjective reports on the part of subjects.

The subjects for this study were twelve intercollegiate swimmers on the 1970 University of Oklahoma swim team. These subjects were measured through the use of catecholamine excretions and introspective reports of stress. Pre and post measures of epinephrine, norepinephrine, and PSI scores were collected for comparable practice and competitive sessions. An analysis of variance of a two-factor, repeated measures design was used to generate the appropriate error term. This

interaction mean square value was used in individual planned comparisons between means for all stress measures.

No significant differences were found between prepractice and precompetitive means. No significant differences were found between prepractice and postpractice means.

Significant differences between precompetitive and postcompetitive means, and between postpractice and postcompetitive means were found, the postcompetitive means being respectively greater on all measures investigated.

Conclusions

The purpose of this study was to separate the stress of competition into various levels (the stress of the performance, anticipation prior to performance, and the additive emotional stress which accompanies performance), and to determine the physiological reactions and psychological stresses contributed by each form. The results of this study lead to the following conclusions:

1. The stress of competitive swimming is a sufficient stressor to cause variation in levels of epinephrine and norepinephrine secretions.

2. The stress of competitive swimming is a sufficient stressor to elicit subjective reports on the PSI scale indicating stress.

3. The major factor contributing to increased levels of stress in the competitive setting, as compared to practice sessions of the same task, is primarily psychological.

4. The measures of epinephrine, norepinephrine, and PSI scores generate significant differences in the same direction and thus suggest a positive relationship between stress measures. This indicates that cognitive factors may contribute to increases in catecholamine excretions.

5. There is a positive relationship between stress measures which is nonlinear.

6. The anticipatory precompetitive stress has no greater effect on the measures investigated than the anticipatory pre-practice stress.

7. No significant differences between pre and post measures of stress existed under practice conditions. This indicates that physical exertion of short duration is not a sufficient stressor to cause significant differences in levels of catecholamine excretions and increases in subjective reports of stress as indicated by PSI scores.

Implications

The results suggest that psychological factors associated with competition are sufficiently strong to cause increased stress responses. The fact that highly trained subjects were used in this study further suggests that physical training alone may not be sufficient to adapt individuals to psychological forms of stress.

The fact that competitive stress is a part of the total higher education structure as it exists today makes competition and its study an integral part of higher education research. The psychological stress associated with competition seems to add to the stress of the performance of the task alone. If this contention is true, then all competitive situations may have a psychological additive effect which is a common variance in each competitive situation. If this common variance can be measured through the use of introspective reports, the study of one competitive setting would afford information towards the understanding of the phenomenon of competitive stress.

Recommendations for Further Research

1. There is a need for further exploration of the effects of competition as a form of stress on a variety of different competitive settings. Criterion measures other than

improved performance must be considered when attributing desirable effects to competitive situations.

2. There is a need to study the effects of physical and psychological stress longitudinally to determine the adaptive effect of various forms of training and conditioning.

3. Further exploration between the various physiological and psychological indexes of stress must be explored to explain their relationship to the common stress phenomenon.

4. As subjects in this study were representative of a limited population, further investigations should be conducted using samples representative of other competitive populations.

5. There is a need to investigate further the desirability of competition in the academic setting to determine if other forms of reinforcement may afford the desired results.

6. There is a need to isolate further the stress of task performance from the additive psychological effect of competition to determine the stressfulness of differing degrees of competition and performance.

7. There is a need to investigate further the psychological and physiological stress threshold of various groups to determine adaptability and susceptibility of various groups to stress.

REFERENCES

REFERENCES

Alpert, R., and Haber, R. N. Anxiety in academic achievement situations. Journal of Abnormal Social Psychology, 1960, 61, 207-215.

Appley, M. H., and Trumbull, R. Psychological Stress. New York: Appleton-Century-Crofts, 1967.

Barry, A. J. Physical activity and psychic stress and strain. Canadian Medical Association Journal, 1967, 96(12), 848-853.

Bendig, A. W. The development of a short form of the manifest anxiety scale. Journal of Consulting Psychology, 1956, 20, 384.

Berkun, M. M., Bialek, H. M., Kern, R. P., and Yagi, K. Experimental studies of psychological stress in man. Psychological Monographs, 1962, 76, (15 Whole No. 534).

Berkun, M. M., Timiras, P. S., and Pace, N. Psychological and physiological responses in observers of an atomic test shot. Psychological Report, 1958, 4, 679-682.

Bevan, W., and Macer, R. A. Emotional tension and the generality of its effect upon intellectual performance. Journal of Personality and Social Psychology, 1958, 26, 330-336.

Bixenstine, V. E. A case study of the use of palmar sweating as a measure of psychological tension. Journal of Abnormal Social Psychology, 1955, 50, 138-143.

Bloom, G., Euler, U. S., and Frankenhaeuser, M. Catecholamine excretion and personality traits in paratroop trainees. Acta Physiologica Scandinavica, 1963, 58, 77-89.

Brady, J. V. Psychophysiology of emotional behavior. In R. S. Lazarus (Ed.), Psychological Stress and the Coping Process. New York: McGraw-Hill, 1966, 18-21.

Brady, J. V., Porter, R. W., Conrad, D. G., and Mason, J. W. Avoidance behavior and the development of gastroduodenal ulcers. Journal of Experimental Animal Behavior, 1958, 1, 69-72.

Brubacher, J. S., and Rudy, W. Higher Education in Transition. New York: Harper & Row, 1958.

Bruce, R. A., Lovejoy, F. W., Jr., Pearson, R., Yu, P. N. G., Brothers, G. B., and Velasquez, T. Normal respiratory and circulatory pathways of adaptation in exercise. Journal of Clinical Investigation, 1949, 28, 1423-1430.

Campanelle, T. Motivational development of adolescents. Education, 1965, 85, 310-313.

Cannon, W. B. Bodily Changes in Pain, Hunger, Fear and Rage. New York: D. Appleton & Company, 1915.

Cannon, W. B. The Wisdom of the Body. (2nd. ed.), New York: W. N. Norton Company, 1939.

Carron, A. V. Motor performance under stress stabilometer. Research Quarterly, 1968, 39, 463-469.

Castenda, A., McCandless, B. R., and Palermo, D. S. The children's form of the manifest anxiety scale. Child Development, 1956, 27, 317-326.

Chapman, D. W. A brief introduction to contemporary disaster research. In G. W. Baker and D. W. Chapman (Eds.), Man and Society in Disaster. New York: Basic Books, Inc., 1962, 3-22.

Christenson, G. A. (ed.) The Future of the University. Norman, Oklahoma: University of Oklahoma Press, 1969, 33.

Clyde, D. J. Manual for the Clyde Mood Scale. Coral Gables, Fla.: University of Miami Biometric Laboratory, 1963.

Cureton, T. K. Anatomical, physiological, and psychological changes induced by exercise programs (exercise, sports, games) in adults. In Exercise and Fitness. New York: The Athletic Institute, 1960, 152-182.

Davis, S. Stress in combat. Scientific America, 1956, 194, 32-35.

Dempsey, P. A unidimensional depression scale for the MMPI. Journal of Consulting Psychology, 1964, 28, 364-370.

Deutsch, M. The effects of cooperation and competition upon group process. Human Relation, 1949, 2, 129-152.

de Vries, H. A. Physiology of Exercise. Dubuque, Iowa: W. C. Brown, 1966.

Elmadjian, F. Excretion and metabolism of epinephrine and norepinephrine under stress. In G. Pincus (Ed.), Recent Progress in Hormone Research. New York: Academic, 1963, 54, 513-545.

Elmadjian, F., Hope, J. M., and Lamson, E. T. Excretion of epinephrine and norepinephrine in various emotional states. Journal of Clinical Endocrinology, 1957, 17, 608-620.

Elmadjian, F., Hope, J. M., and Lamson, E. T. Excretion of epinephrine and norepinephrine under stress. Recent Progress in Hormone Research, 1958, 14, 513-553.

Euler, U. S. Stress and catechol hormones. In H. Selye and G. Heuser (Eds.), Fifth Annual Report on Stress. New York: M. D. Publications, 1956, 125-137.

Euler, U. S. Commentary: Quantitation of stress by catecholamine analysis. Clinical Pharmacology and Therapeutics, 1964, 5, 398-404.

Euler, U. S., Gemzell, C. A., Levi, L., and Ström, G. Cortical and medullary adrenal activity in emotional stress. Acta Endocrinologica, 1959, 30, 567.

Euler, U. S , and Hellner, S. Noradrenaline excretion in muscular work. Acta Physiologica Scandinavica, 1952, 26, 183-191.

Euler, U. S , and Lishajko, F. Improved techniques for the fluorimetric estimation of catecholamines. Acta Physiologica Scandinavica, 1961, 51, 348-355.

Euler, U. S., Luft, R., and Sundin, T. Noradrenaline output in urine after infusion in man. British Journal of Pharmacology, 1951, 6, 286-288.

Euler, U. S., Luft, R., and Sundin, T. Excretion of urinary adrenaline in normals following intravenous infusion. Acta Physiologica Scandinavica, 1953, 30, 249-257.

Euler, U. S., and Lundberg, U. Effects of flying on the epinephrine excretion in air force personnel. Journal of Applied Physiology, 1954, 6, 551-558.

Farber, I. E. The role of motivation in verbal learning and performance. Psychological Bulletin, 1955, 52, 311-327.

Faw, V. Learning to deal with stress situation. Journal of Educational Psychology, 1957, 48, 135-144.

Flamini, D. Competitive Strategies in Obtaining Grades. Unpublished doctoral dissertation, University of Oklahoma, 1969, 13.

Fortier, C. Adenohypophysis and adrenal cortex. Annual Review of Physiology, 1962, 24, 223-258.

Frankenhaeuser, M., and Järpe, G. Psychophysiological changes during infusion of adrenaline in various doses. Psychopharmacology, 1963, 4, 424-432.

Frankenhaeuser, M., Järpe, G., Svan, H., and Wrangsjö, B. Psychophysiological reactions to two different placebo treatments. Scandinavian Journal of Psychology, 1963, 4, 245-250.

Frankenhaeuser, M., and Patkai, P. Catecholamine excretion and performance during stress. Perceputal and Motor Skills, 1964, 19, 13-14.

Frankenhaeuser, M., Sterky, K., and Järpe, G. Psychophysiological relations in habituation to gravitational stress. Perceptual and Motor Skills, 1962, 15, 63-72.

Franksson, C., Gemzell, C. A., and Euler, U. S. Cortical and medullary adrenal activity and allied conditions. Journal of Clinical Endocrinology and Metabolism, 1954, 14, 608.

Funkenstein, D. H., King, S. H., and Drolette, M. E. Mastery of Stress. Cambridge, Mass.: Harvard University Press, 1957, 27.

Guthrie, F. A. Varying conditions of stress and performance on an academic type task. California Journal of Educational Research, 1966, 17, 41-47.

Handlon, J. H. Hormonal activity and individual responses to stresses and easements in everyday living. In R. Roessler and N. S. Greenfield (Eds.), Physiological Correlates of Psychological Disorder. Madison: University of Wisconsin Press, 1962, 157-170.

Hays, W. L. Statistics for Psychologist. New York: Holt, Rinehart & Winston, 1963, 454-459.

Haythorn, W. W., and Altman, I. Personality factors in isolated environment. In M. H Appley and R. Trumbull (Eds.), Psychological Stress. New York: Appleton-Century-Crofts, 1967, 363-399.

Hennis, G. M., and Ulrich, C. Study of psychic stress in freshman college women. Research Quarterly, 1958, 29, 172-179.

Hess, E. H., and Polt, J. M. Pupil size as related to interest values of visual stimuli. Science, 1960, 132, 349-350.

Hess, E. H., and Polt, J. M. Pupil size in relation to mental activity during simple problem-solving. Science, 1964, 143, 1190-1192.

Hetzel, B. S., Schottsteadt, W. N., Grace, W. J., and Wolff, H. G. Changes in urinary 17-hydroxycorticosteroid during stressful life experiences in man. Journal of Clinical Endocrinology, 1955, 15, 1057-1068.

Hill, S. R., Goetz, F. C., Fox, B. J., Murawski, B. J., Krakauer, L. J., Reifenstein, R. W., Gray, S. J. Reddy, W. J., Hedberg, S. E., St. Mark, J. R., and Thorn, G. W. Studies on adrenocortical and psychological response to stress in man. Archives of Internal Medicine, 1956, 97, 269-298.

Howard, A., and Scott, R. A. A proposed framework for the analysis of stress in the human organism. Behavioral Science, 1965, 10, 141-160.

Howell, M. L. Influence of emotional tension on speed of reaction and movement. Research Quarterly, 1953, 24, 22-32.

Jacobs, P. D., and Munz, D. C. An index for measuring perceived stress in a college population. Journal of Psychology, 1968, 70, 9-15.

Janis, I. L. Psychological effects of warnings. In G. W. Baker and D. W. Chapman (Eds.), Man and Society in Disaster. New York: Basic Books, Inc., 1962, 55-92.

Jones, F. A. Stress and the gut. Practitioner, 1954, 172, 23-28.

Julian, J. W., and Perry, F. A. Cooperation with intra-group and inter-group competition. Sociometry, 1967, 30, 79-90.

Kärki, N. T. The urinary excretion of noradrenaline and adrenaline in different age groups, its diurinal variation and the effect of muscular work on it. Acta Physiologica Scandinavica, 1956, 39, 7-91.

Kerle, R. H., and Bialek, H. M. The construction, validation, and application of a subjective stress scale. Staff Memorandum, U. S. Army Leadership Human Research Unit, Monterey, California, 1958.

Kleiner, I. S. Human Biochemistry. St. Louis: C. V. Mosby, 1945, 317.

Korchin, S. J., and Herz, M. Differential effects of "shame" and "disintegrative" threats on emotional and adrenocortical functioning. Archives of General Psychiatry, 1960, 2, 640-651.

Krause, M. S. The measurement of transitory anxiety. Psychological Review, 1961, 68, 178-189.

Lacy, J. I. Somatic response patterning and stress: some revisions of activation theory. In M. H. Appley and R. Trumbull (Eds.), Psychological Stress. New York: Appleton-Century-Crofts, 1967, 14-42.

Lazarus, R. S. Adjustment and Personality. New York: McGraw-Hill, 1961, 330-380.

Lazarus, R. S. Psychological Stress and the Coping Process. New York: McGraw-Hill, 1966.

Lazarus, R. S., and Eriksen, C. W. Effect of failure stress upon skilled performance. Journal of Experimental Psychology, 1952, 43, 100-105.

Levi, L. A new stress tolerance test with simultaneous study of physiological and psychological variables. Acta Endocrinologica, 1961, 37, 38-44.

Levi, L. The urinary output of adrenaline and noradrenaline during experimentally induced emotional stress in clinically different groups. Acta Psychotherapeutica Et Psychosomatica, 1963, 11, 218-227.

Levi, L. The urinary output of adrenaline and noradrenaline during pleasant and unpleasant emotional states: a preliminary report. Psychosomatic Medicine, 1965, 27, 80-85.

Levi, L. Stress Sources, Management, and Prevention. New York: Liveright Publishing Corporation, 1967.

Lindzey, G., and Newburg, A. S. Thematic apperception test: a tentative appraisal of some "sign" of anxiety. Journal of Consulting Psychology, 1954, 18, 389-395.

Mann, A., and Lehmann, H. The eosinophil level in psychiatric conditions. Canadian Medical Association Journal, 1952, 66, 52-58.

Martin, B. The assessment of anxiety by physiological-behavioral measures. Psychological Bulletin, 1961, 58, 234-255.

Mechanic, D. Students Under Stress. New York: Free Press, 1962.

Meyers, J. L. Fundamentals of Experimental Design. Boston: Allyn and Bacon, 1966, 152-173.

Michael, E. D. Stress adaptation through exercise. Research Quarterly, 1957, 28, 50-54.

Mintz, A. Non-adaptive group behavior. Journal of Abnormal Social Psychology, 1951, 46, 150-159.

Moldawsky, S., and Moldawsky, P. C. Digit span as an anxiety indicator. Journal of Consulting Psychology, 1952, 16, 115-118.

Nowlis, V., and Nowlis, H. H. The description and analysis of mood. New York Academy of Science Annals, 1956, 65, 345-355.

Oken, D. The psychophysiology and psychoendocrinology of stress and emotion. In M. H. Appley and R. Trumbull (Eds.), Psychological Stress, New York: Appleton-Century-Crofts, 1967, 43-76.

Pekkarinen, A., Castrén, O., Iisalo, E., Koivusalo, M., Laihinen, A., Simola, P. E., and Thomasson, B. The Emotional Effect of Matriculation Examinations on the Excretion of Adrenaline, Noradrenaline, 17-Hydroxycorticosteroids into the Urine and the Content of 17-Hydroxycorticosteroids in the Plasma, Biochemistry, Pharmacology and Physiology. New York: Pergamon Press, Inc., 1961, 117-137.

Pepitone, A. Self, social environment, and stress. In M. H. Appley and R. Trumbull (Eds.), Psychological Stress. New York: Appleton-Century-Crofts, 1967, 185.

Perlman, M. An investigation of anxiety as related to guilt and shame. A. M. A. Archives of Neurology and Psychiatry, 1958, 80, 752-759.

Persky, H. Response to stress: evaluation of some biochemical indices. Journal of Applied Physiology, 1953, 6, 369-374.

Persky, H. Adrenocortical function during anxiety. In R. Roessler and N. S. Greenfield (Eds.), Physiological Correlates of Psychological Disorder. Madison: University of Wisconsin Press, 1962, 171-191.

Persky, H., Korchin, S. J., Basowitz, H., Board, F. A., Sabshin, M. A., Hamburg, D. A., and Grinker, R. R. Effects of two psychological stresses on adrenocortical function. A. M. A. Archives of Neurology and Psychiatry, 1959, 81, 219-226.

Price, D. B., Thaler, M., and Mason, J. W. Preoperative emotional states and adrenal cortical activity. A. M. A. Archives of Neurology and Psychiatry, 1957, 77, 646-656.

Rapoport, A. Fights, Games and Debates. Ann Arbor: University of Michigan Press, 1960.

Rasch, P. J. Effects of tournament stress on electrocardiograms of U. S. olympic free style wrestlers. Research Quarterly, 1958, 29, 193-199.

Roche, M., Thorn, G. W., and Hill, A. G. The level of circulating eosinophils, and their response to ACTH in surgery. New England Journal of Medicine, 1950, 242, 307-314.

Roessler, R., and Greenfield, N. S. Physiological Correlates of Psychological Disorder. Madison: University of Wisconsin Press, 1962, 5-23.

Ryan, E. D. Effects of stress on motor performance and learning. Research Quarterly, 1962, 33, 111-119.

Sarason, I. G. Emperical findings and the theoretical problems in the use of anxiety scales. Psychological Bulletin, 1960, 57(5), 403-415.

Sarason, S. B. The Clinical Interaction: With Special Reference to the Rorschach. New York: Harper & Row, 1954.

Sarason, S. B., and Mandler, G. Some correlates of test anxiety. Journal of Abnormal Social Psychology, 1952, 47, 810-817.

Selye, H. The Physiology and Pathology of Exposure to Stress. Montreal: Acta, Inc., 1950.

Selye, H. Annual Report on Stress. Montreal: Acta, Inc., 1951.

Selye, H. The Story of the Adaptation Syndrome. Montreal: Acta, Inc., 1952.

Selye, H. The Stress of Life. New York: McGraw-Hill, 1956.

Silverman, A. J., and Cohen, S. I. Affect and vascular correlates to catecholamines. Psychiatric Research Review, 1960, 12, 16-30.

Silverman, A. J., Cohen, S. I., Shmavonian, B. M., and Kirshner, N. Catecholamines in psychophysiologic studies. Recent Advances in Biological Psychiatry, 1961, 3, 104-118.

Snyder, R. K. Developing nationwide standards. In L. Wilson (Ed.), Emerging Patterns in American Higher Education. Washington, D. C.: American Council on Education, 1965, 222.

Stendler, C., Damrin, D., and Haines, A. C. Studies in cooperation and competition: I. the effects of working for group and individual rewards on the social climate of children's groups. Journal of Genetic Psychology, 1951, 79, 173-197.

Stish, E. E. Anthropokinetics. Journal of Health and Physical Education, 1964, 35, 33.

Sundin, T. The effects of body posture on the urinary excretion of adrenaline and noradrenaline. Acta Medica Scandinavica, 1958, 161(Suppl. 336).

Taylor, J. A. A personality scale of manifest anxiety. Journal of Abnormal Social Psychology, 1953, 48, 285-290.

Thaler, M. Effects of stressful situations on learning. Psychiatric Research Report, 1956, 3, 46-49.

Thornton, J. W., and Jacobs, P. D. Further validation of the perceived stress index scale sensitivity. Perceptual and Motor Skills, 1970, 30, 944.

Ulrich, C. Measurement of stress evidenced by college women in situation involving competition. Research Quarterly, 1957, 28, 160-172.

Wallace, A. F. Human Behavior in Extreme Situations: A Survey of the Literature and Suggestions for Further Research. Washington: National Academy of Science National Research Council, Disaster Study No. 1, 1956.

Wechsler, D. The Wechsler-Bellevue Intelligence Scale, Form II Manual for Administering and Scoring the Test. New York: Psychological Corp., 1946.

Weinberg, C. The price of competition. Teacher College Record, 1965, 67, 106-113.

Whiddon, T. R., Sharkey, B. J., and Steadman, R. J. Exercise stress, and blood clotting in men. Research Quarterly, 1969, 40, 431-433.

Whittemore, I. C. The influence of competition on performance: an experimental study. Journal of Abnormal and Social Psychology, 1924, 19, 236-253.

Wolf, S. Circulatory responses to life situations. Bulletin of the New York Academy of Medicine, 1952, 28, 168-188.

Wright, J. I. Reported personal stress sources and adjustment of entering freshman. Journal of Counseling Psychology, 1967, 14, 371-373.

APPENDICES

APPENDIX A

EPINEPHRINE IN ug.%

	Pre-competition	Post-competition	Pre-practice	Post-practice
Dahlberg	0.180	0.170	0.330	0.220
Hahne	0.240	0.480	0.750	0.480
Harper	0.370	0.190	0.650	0.130
Howell	0.780	1.280	0.200	1.200
Langstrom	0.510	1.120	0.410	0.090
Leydorf	0.074	0.160	0.076	0.350
McKinney	0.470	0.330	0.990	1.470
Mueller	0.170	0.820	0.340	1.850
Peters	0.440	0.350	0.580	1.230
Troiano	0.520	1.680	0.370	0.510
Wolfson	0.560	0.270	0.250	0.200
Woodlan	0.690	1.060	0.280	0.100

APPENDIX B

NOREPINEPHRINE IN ug.%

	Pre-competition	Post-competition	Pre-practice	Post-practice
Dahlberg	0.88	1.65	1.71	1.51
Hahne	1.56	1.79	2.27	7.00
Harper	1.50	1.79	2.10	1.05
Howell	10.24	3.27	3.00	0.67
Langstrom	1.30	3.22	2.69	1.69
Leydorf	1.05	0.91	1.03	0.61
McKinney	2.80	1.91	3.21	1.20
Mueller	1.47	2.75	1.62	3.67
Peters	1.35	1.67	3.40	6.90
Troiano	3.64	5.75	1.10	0.97
Wolfson	3.40	2.25	0.62	2.29
Woodlan	1.79	4.53	2.28	1.91

APPENDIX C

CREATININE IN mg.%

	Pre-competition	Post-competition	Pre-practice	Post-practice
Dahlberg	.60	.20	1.10	.65
Hahne	.95	.70	1.70	1.50
Harper	1.10	.90	1.95	.50
Howell	2.35	1.25	1.85	2.40
Langstrom	1.55	1.05	1.25	1.50
Leydorf	1.00	.25	1.10	.60
McKinney	1.40	.35	2.30	2.00
Mueller	1.00	1.15	1.55	2.40
Peters	1.25	.60	1.05	1.70
Troiano	1.25	1.75	1.50	2.10
Wolfson	1.80	.75	1.05	1.30
Woodlan	2.05	1.55	1.05	.80

APPENDIX D

ug. EPINEPHRINE/100 mg. CREATININE

	Pre-competition	Post-competition	Pre-practice	Post-practice
Dahlberg	.30	.85	.30	.33
Hahne	.25	.68	.44	.32
Harper	.33	.21	.33	.26
Howell	.33	1.02	.10	.50
Langstrom	.32	1.06	.32	.06
Leydorf	.07	.64	.07	.58
McKinney	.34	.94	.43	.73
Mueller	.17	.71	.21	.77
Peters	.35	.58	.55	.72
Troiano	.41	.96	.24	.24
Wolfson	.31	.36	.23	.15
Woodlan	.33	.68	.26	.12
Sum	3.51	8.69	3.48	4.78
Mean	.29	.72	.29	.40

APPENDIX E

ug. NOREPINEPHRINE/100 mg. CREATININE

	Pre-competition	Post-competition	Pre-practice	Post-practice
Dahlberg	1.46	8.75	1.55	2.32
Hahne	1.64	2.55	1.33	4.66
Harper	1.36	1.98	1.07	2.10
Howell	4.35	2.61	1.62	.27
Langstrom	.83	3.06	2.15	1.12
Leydorf	1.05	3.64	.93	1.01
McKinney	2.00	5.45	1.39	.60
Mueller	1.47	2.39	1.04	1.52
Peters	1.08	2.78	3.23	4.05
Troiano	2.91	3.28	.73	.46
Wolfson	1.88	3.00	.82	1.76
Woodlan	.87	2.92	2.17	2.38
Sum	20.90	41.91	18.03	22.25
Mean	1.74	3.53	1.50	1.85

APPENDIX F

PSI RAW SCORES PRACTICE SESSION

	PREPRACTICE		POSTPRACTICE	
	Normally Feel	At This Moment	During Competition	At This Moment
Dahlberg	2.99	6.50	2.99	2.99
Hahne	4.47	4.47	7.60	7.60
Harper	4.47	5.98	8.24	8.74
Howell	2.99	6.50	6.50	6.50
Langstrom	5.12	4.47	4.47	7.60
Leydorf	2.99	4.77	2.99	6.50
McKinney	5.12	7.60	7.60	5.12
Mueller	5.68	7.60	8.74	7.60
Peters	5.12	5.98	5.12	4.47
Troiano	5.12	7.60	7.60	7.60
Wolfson	4.47	4.47	7.60	5.98
Woodlan	4.47	5.68	5.12	5.98

APPENDIX G

PSI RAW SCORES COMPETITIVE SESSION

	PRECOMPETITION		POSTCOMPETITION	
	Normally Feel	At This Moment	During Competition	At This Moment
Dahlberg	2.99	4.47	10.04	2.99
Hahne	2.99	4.47	8.24	7.60
Harper	5.68	7.60	9.38	8.24
Howell	2.99	5.12	8.24	2.99
Langstrom	5.12	8.24	7.60	7.60
Leydorf	5.77	7.60	6.50	2.30
McKinney	5.12	7.60	7.60	5.12
Mueller	5.68	6.50	4.47	5.12
Peters	5.12	6.50	10.04	2.30
Troiano	5.12	4.47	7.60	7.60
Wolfson	4.47	7.60	9.38	5.98
Woodlan	4.47	7.60	10.72	5.12

APPENDIX H

PSI PRACTICE SESSION SCORES

	Normally Feel-At This Moment	Normally Feel-During Competition	Normally Feel-At This Moment
Dahlberg	6.49	10.00	10.00
Hahne	10.00	6.87	6.87
Harper	8.49	6.23	5.73
Howell	6.49	6.49	6.49
Langstrom	10.65	10.65	7.52
Leydorf	8.52	10.00	6.49
McKinney	7.52	7.52	10.00
Mueller	8.08	6.94	8.08
Peters	9.14	10.00	10.65
Troiano	7.52	7.52	7.52
Wolfson	10.00	6.87	8.49
Woodlan	8.79	9.38	8.49
Sum	101.69	98.47	96.33
Mean	8.47	8.21	8.03

APPENDIX I

PSI COMPETITIVE SESSION SCORES

	Normally Feel-At This Moment	Normally Feel-During Competition	Normally Feel-At This Moment
Dahlberg	8.52	2.95	10.00
Hahne	8.52	4.75	5.39
Harper	8.08	6.30	7.44
Howell	7.87	4.75	10.00
Langstrom	6.88	7.52	7.52
Leydorf	6.17	6.17	11.47
McKinney	7.52	7.52	10.00
Mueller	9.18	9.18	10.56
Peters	8.62	5.08	12.82
Troiano	10.65	7.52	7.52
Wolfson	6.87	5.09	8.49
Woodlan	6.87	3.75	9.35
Sum	95.75	70.58	110.56
Mean	7.98	5.88	9.21

APPENDIX J

THE PERCEIVED STRESS INDEX

Paul D. Jacobs and David C. Munz[1]

Psychology Department

University of Oklahoma

Following are the instructions recommended for use, with the PSI. Presentation difference(s) have been found between the "normally feel" and the "at this moment" scales. The authors suggest the order of presentation as it appears in this booklet.

The scale values appearing on the checklist are those assigned to the words on the phrases by our College sample. The following is the recommended scoring procedure.

> PSI = ("normal" scale value minus "this moment" scale value) + 10

The constant, 10, eliminates scoring problems dealing with sign, and scores may be interpreted in the following manner:

> PSI above 10 indicates scores moving toward pleasant end of scale.
>
> PSI below 10 indicates scores moving toward unpleasant end of scale.

Thus a PSI of 1.25 indicates movement from extremely pleasant to extremely unpleasant; while a score of 18.75 indicates movement from extremely unpleasant to extremely pleasant.

The authors would appreciate reports of data gathered using this checklist.

[1] The autnors wish to express their appreciation to Mrs. Frances Everett and Miss Rita Hall for their assistance in developing this scale.

Appendix J (Continued)

PSI SCORING KEY

8.24	DISTRESSED
5.68	UNRUFFLED
8.74	THREATENED
4.47	AT EASE
7.21	TIMID
10.72	EXTREMELY TERRIFIED
9.38	FEARFUL
7.60	UNEASY
2.30	MARVELOUS
5.12	ALL RIGHT
5.98	NOT MATTERING
1.97	THRILLED
2.99	FEELING GOOD
10.04	SCARED STIFF
6.05	LACK OF INTEREST
3.77	KEEN

Appendix J (Continued)

INSTRUCTIONS

On the following page is a list of words and phrases which can be used to describe your feelings. Please check the word or phrase which best describes the way you NORMALLY FEEL. So that you will become familiar with the general range of feeling that they cover or represent, read the entire list before making your selection. Check only one word or phrase.

Appendix J (Continued)

_____ DISTRESSED

_____ UNRUFFLED

_____ THREATENED

_____ AT EASE

_____ TIMID

_____ EXTREMELY TERRIFIED

_____ FEARFUL

_____ UNEASY

_____ MARVELOUS

_____ ALL RIGHT

_____ NOT MATTERING

_____ THRILLED

_____ FEELING GOOD

_____ SCARED STIFF

_____ LACK OF INTEREST

_____ KEEN

Appendix J (Continued)

INSTRUCTIONS

On the following page is a list of words and phrases which can be used to describe your feelings. Please check the word or phrase which best describes the way you feel AT THIS MOMENT. So that you will become familiar with the general range of feeling that they cover or represent, read the entire list before making your selection. Check only one word or phrase.

Appendix J (Continued)

_____ DISTRESSED

_____ UNRUFFLED

_____ THREATENED

_____ AT EASE

_____ TIMID

_____ EXTREMELY TERRIFIED

_____ FEARFUL

_____ UNEASY

_____ MARVELOUS

_____ ALL RIGHT

_____ NOT MATTERING

_____ THRILLED

_____ FEELING GOOD

_____ SCARED STIFF

_____ LACK OF INTEREST

_____ KEEN

APPENDIX K

ITEM CONTENT, MEDIAN INTENSITY VALUES, SEMI-INTERQUARTILE RANGES (Q) AND FACTOR LOADINGS FOR THE PSI ITEMS

Item no. and content	Median intensity value	Q	Factor loading I	II
6. Extremely terrified	10.72	.50	-.92*	.30
14. Scared stiff	10.04	.54	-.91*	.28
7. Fearful	9.38	.64	-.85*	.44
3. Threatened	8.74	.63	-.91*	.36
1. Distressed	8.24	.64	-.80*	.58
8. Uneasy	7.60	.65	-.75*	.60
5. Timid	7.21	.69	.95*	-.03
11. Not mattering	5.98	.32	.96*	.05
2. Unruffled	5.68	.68	.87*	-.37
10. All right	5.12	.80	.85*	-.39
4. At ease	4.47	1.01	.75*	-.44
15. Keen	3.77	.70	.27	-.92*
13. Feeling good	2.99	.50	.38	-.91*
9. Marvelous	2.30	.64	.32	-.92*
12. Thrilled	1.97	.60	.18	-.98*

*$p < .05$.

APPENDIX L

PSI PRETEST INSTRUCTIONS

On the following page is a list of words and phrases which can be used to describe your feelings. Please check the word or phrase which best describes the way you NORMALLY FEEL. So that you will become familiar with the general range of feeling that they cover or represent, read the entire list before making your selection. Check only one word or phrase.

Appendix L (Continued)

_____ DISTRESSED

_____ UNRUFFLED

_____ THREATENED

_____ AT EASE

_____ TIMID

_____ EXTREMELY TERRIFIED

_____ FEARFUL

_____ UNEASY

_____ MARVELOUS

_____ ALL RIGHT

_____ NOT MATTERING

_____ THRILLED

_____ FEELING GOOD

_____ SCARED STIFF

_____ LACK OF INTEREST

_____ KEEN

Appendix L (Continued)

INSTRUCTIONS

On the following page is a list of words and phrases which can be used to describe your feelings. Please check the word or phrase which best describes the way you feel AT THIS MOMENT. So that you will become familiar with the general range of feeling that they cover or represent, read the entire list before making your selection. Check only one word or phrase.

Appendix L (Continued)

_____ DISTRESSED

_____ UNRUFFLED

_____ THREATENED

_____ AT EASE

_____ TIMID

_____ EXTREMELY TERRIFIED

_____ FEARFUL

_____ UNEASY

_____ MARVELOUS

_____ ALL RIGHT

_____ NOT MATTERING

_____ THRILLED

_____ FEELING GOOD

_____ SCARED STIFF

_____ LACK OF INTEREST

_____ KEEN

APPENDIX M

PSI POSTTEST INSTRUCTIONS

On the following page is a list of words and phrases which can be used to describe your feelings. Please check the word or phrase which best describes the way you feel DURING COMPETITION. So that you will become familiar with the general range of feeling that they cover or represent, read the entire list before making your selection. Check only one word or phrase.

Appendix M (Continued)

_____ DISTRESSED

_____ UNRUFFLED

_____ THREATENED

_____ AT EASE

_____ TIMID

_____ EXTREMELY TERRIFIED

_____ FEARFUL

_____ UNEASY

_____ MARVELOUS

_____ ALL RIGHT

_____ NOT MATTERING

_____ THRILLED

_____ FEELING GOOD

_____ SCARED STIFF

_____ LACK OF INTEREST

_____ KEEN

Appendix M (Continued)

INSTRUCTIONS

On the following page is a list of words and phrases which can be used to describe your feelings. Please check the word or phrase which best describes the way you feel AT THIS MOMENT. So that you will become familiar with the general range of feeling that they cover or represent, read the entire list before making your selection. Check only one word or phrase.

Appendix M (Continued)

_____ DISTRESSED

_____ UNRUFFLED

_____ THREATENED

_____ AT EASE

_____ TIMID

_____ EXTREMELY TERRIFIED

_____ FEARFUL

_____ UNEASY

_____ MARVELOUS

_____ ALL RIGHT

_____ NOT MATTERING

_____ THRILLED

_____ FEELING GOOD

_____ SCARED STIFF

_____ LACK OF INTEREST

_____ KEEN