PSYCHOLOGICAL AND PHYSIOLOGICAL CHANGES IN COMPETITIVE STATE ANXIETY DURING A CYCLING TASK

by

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DEDICATION

To Mom, Dad, Charlie, Denise, and Kenny
for their support, understanding, and love.

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CHAPTER 1

INTRODUCTION

Anxiety responses in reaction to competitive situations, such as those present in sports, are of particular interest to sport psychologists. Unfortunately, scientists do not agree on the best method to measure competitive anxiety. Some scientists favor paper-and-pencil self-report questionnaires, while others choose physiological indices (e.g., heart rate, blood pressure, muscle tension) of anxiety. Although many researchers have used these anxiety measures, numerous questions remain unanswered concerning the dynamics of anxiety and its relationship to performance.

Some psychologists (Borkovec, 1976; Borkovec, Weerts, & Bernstein, 1977), view anxiety as a multidimensional construct that involves three separate interacting response components; psychological (e.g., cognitive worry, perceived somatic anxiety, doubt); physiological (e.g., rapid heart beat, muscle tension); and behavioral (e.g., performance decrements, trembling). This multidimensional conceptualization of anxiety forces us to consider all three of these components in any assessment of anxiety (Baum, Greenberg, & Singer, 1982; Borkovec, 1976).

Anxiety assessments also must differentiate between anxiety responses as either transitory or persistent emotional responses in reaction to anxiety producing situations. An accepted distinction in the conceptualization of anxiety is the trait-state anxiety theory of Spielberger (1966). The theory distinguishes between anxiety as transitory states, state anxiety, and as a relatively stable personality variable, trait anxiety. Anxiety resulting as a response to a competitive situation is termed competitive anxiety (Martens, 1977). According to Martens (1977), competitive state anxiety reactions will be invoked in competitive situations that are perceived as threatening. Individuals high in competitive trait anxiety, perceiving competitive situations more threatening than individuals low in competitive trait anxiety, will respond to competitive situations with greater elevations in competitive state anxiety (Martens, 1977).

Once competition is underway, events (e.g., winning, losing, opponent's ability, feedback) associated with the competition provide valuable information to the athlete. Athletes continually evaluate their performance, and this source of information is likely to affect anxiety and performance (Zajonc, 1965). One source of evaluative information to the athlete is specific knowledge concerning his or her performance. Knowledge of results, particularly success and failure feedback, may influence anxiety levels; that is, successful performers are likely to decrease state anxiety reactions and unsuccessful performers are likely to increase state anxiety reactions (Martens & Gill, 1976;

Scanlan, 1977; Scanlan & Passer, 1978, 1979).

Liebert and Morris (1967) adopted a multidimensional conceptualization of anxiety and separated state anxiety into cognitive worry and somatic anxiety components. Additionally, they postulated that cognitive worry and somatic anxiety change differently. Specifically, somatic anxiety increases prior to evaluation but cognitive worry only changes when performance actually changes. Furthermore, cognitive worry was consistently inversely related to performance and somatic anxiety related to performance only when cognitive worry was low (Morris & Liebert, 1970). These findings indicate that cognitive worry and somatic anxiety influence performance differently and therefore support a multidimensional conceptualization of state anxiety.

Recently, several sport psychologists have advocated sport specific measures of anxiety. Martens (1977) concluded that a sport-specific measure of trait anxiety (competitive trait anxiety) was a better predictor of state anxiety than general measures of anxiety within competitive sporting situations. Subsequently, Martens, Burton, Vealey, Bump, and Smith (1983) developed a sport specific measure of state anxiety, the Competitive State Anxiety Inventory-2 (CSAI-2). The CSAI-2 measures changes in cognitive worry and somatic anxiety. Additionally, the CSAI-2 measures self-confidence, a variable influenced by *changes in state anxiety.*

Since the initial development of the CSAI-2, researchers have continually supported the multidimensional nature of competitive state anxiety. However, studies have contradicted each other when examining the relationship between anxiety and performance and the changes in anxiety prior to, during ,and after a competition. Gould, Petlichkoff, and Weinberg (1984), for example, found that somatic anxiety and cognitive worry changed differently prior to a wrestling competition and a volleyball tournament. Somatic anxiety increased prior to competition and cognitive worry and self-confidence remained stable. Evidence supporting the relationship between cognitive worry and performance was only partially supported. Karteroliotis and Gill (1987) also found that the subcomponents of the CSAI-2 changed during the course of a competition. Cognitive worry and somatic anxiety followed similar temporal patterns prior to and during competition. Karteroliotis and Gill (1987) did not find a significant relationship between CSAI-2 subscale scores and performance. Burton (1988) found significant correlations between cognitive worry and swimming performance and somatic anxiety and swimming performance.

Psychological assessments of anxiety, as well as physiological assessments provide additional support for the multidimensional nature of state anxiety. Physiological measures may allow for the inference of psychological processes and emotional states (Hatfield & Landers, 1983). Physiological assessments of anxiety, as a result of arousal of the autonomic nervous system, vary from measures such as heart rate, respiration rate, muscle tension, palmar sweating, and blood pressure (Fenz & Jones, 1972; Weinberg & Hunt, 1976). Martens et al. (1983) and Gould et al. (1984) suggested that somatic anxiety as assessed by the CSAI-2 and physiological measures of anxiety should increase similarly prior to and during a competition. The prediction of Martens et al. (1983) and Gould et al. (1984) that somatic anxiety and physiological anxiety should display similar response patterns was empirically examined by Karteroliotis and Gill (1987). They found that the psychological measure, somatic anxiety, was not correlated with physiological measures of heart rates and blood pressures. The task chosen by Karteroliotis and Gill (1987) was not an actual sport task but a peg-board task and may have influenced their results. Thus, further research utilizing actual sport tasks, is needed to determine the relationship between psychological and physiological assessments of anxiety.

Rather than considering anxiety as a multidimensional construct, early studies of anxiety (Martens & Landers, 1970; Fenz & Jones, 1972) conceptualized anxiety as a unidimensional construct. The inverted-U theory *conceptualizes anxiety as a unidimensional phenomenon and predicts that athletes perform best when anxiety is moderate and performance deteriorates when anxiety increases or decreases from this optimal moderate level (Burton, 1988; Sonstroem & Bernardo, 1982; Weinberg & Genuchi, 1980). Sonstroem and Bernardo (1982) recommended an intraindividual analysis that controls for between subject variance when examining the anxiety-performance relationship. An intraindividual analysis accounts for the fact that individuals react differently to competitive situations, an optimal level of arousal for one individual may not be optimal for another individual. Consistent relationships between anxiety and performance were found when variations around each subject's own optimal levels of state anxiety were examined. Subjects performed best under moderate levels of arousal and performance deteriorated when arousal levels were either too low or high.*

Recently, the inverted-U relationship between anxiety and performance has been used to consider the multidimensional construct of anxiety (Burton, 1988; Gould, Petlichkoff, Simons, & Vevera, 1987). State anxiety subcomponents should influence performance differently. Burton (1988) hypothesized that performance should decrease linearly with increases in cognitive worry, increase linearly with increases in self-confidence, and demonstrate an inverted-U relationship with performance.

Burton (1988), utilizing an intraindividual analysis, examined the relationship between swimming performance and anxiety and supported his hypotheses. Gould et al. (1987), on the other hand, examined the relationship between pistol shooting performance and anxiety and found no relationship between cognitive worry and performance, a curvilinear trend between somatic anxiety and performance, and a negative linear trend between self-confidence and performance. Gould et al. (1987) and Burton (1988) reported different results for the inverted-U performance relationship, possibly as a result of examining different skills, pistol shooting vs. swimming.

The results of previous research, although mixed in their findings, advocate a multidimensional nature of state anxiety consisting of psychological, physiological, and behavioral components. The purpose of the present study is to examine interrelationships among these state anxiety components prior to, during, and after competition; and to examine the relationship between anxiety and performance using a multimethod approach, psychological and physiological indices of state anxiety.

Statement of Purpose

The purpose of this study was fourfold: (a) to examine how the psychological and physiological components of state anxiety are related to one another and change prior to, during, and after competition; (b) to examine the *relationship between competitive state anxiety and competitive trait anxiety; (c) to examine the relationship between physiological and psychological assessments of competitive state anxiety; and (d) to examine the relationship between competitive state anxiety and performance.*

<u>Hypotheses</u>

(1) Cognitive worry, somatic anxiety, and self-confidence will be moderately related to one another prior to, during, and after competition.

(2) Trait anxiety will be related to the state anxiety components of cognitive worry and somatic anxiety.

(3) Physiological measures of anxiety will be correlated with somatic anxiety.

(4) Individuals receiving success feedback will experience a decrease in state anxiety.

(5) Individuals receiving failure feedback will experience an increase in state anxiety.

(6) Cognitive worry will be negatively and linearly related to performance.

(7) Somatic anxiety will be nonlinearly related to performance.

(8) Frontalis EMGs will be nonlinearly related to performance.

(9) Self-confidence will be positively and linearly related to performance.

Delimitations

The following delimitations may restrict the extent to which the conclusions may be generalized:

1) Changes in competitive state anxiety were assessed by the CSAI-2 and frontalis muscle EMGs.

2) The competitive cycling task was performed within a lab setting.

3) Subjects were restricted to males between the ages of 18-30.

Limitations

The following limitations may have diminished the validity of the study:

1) Daily variations in emotional states of the subject may have influenced frontalis EMG values during testing.

2) Due to individual response stereotypy, frontalis muscle tension may not be an accurate index of tension or physiological arousal across all subjects.

3) Five different confederates performed as the opponent competing against the subject.

4) Subjects may have answered questionnaires in a manner that they felt was socially desirable rather than reflective of their actual feelings.

5) Responses to item 17 on the CSAI-2, "My heart is racing", may be a reflection of task demands rather than somatic anxiety.

6) The data analysis did not account for a possible sequence effect within the repeated measures design.

CHAPTER 2

LITERATURE REVIEW

Introduction

Many researchers in sport psychology attempt to understand and account for individual differences in behavior and performance in sport settings. Of particular interest is the relationship between anxiety and performance. This chapter will define and consider anxiety as a multidimensional construct, and review the measurement of anxiety, the relationship between anxiety and performance, and the nature of competitive anxiety.

Anxiety Defined

Ambiguity in a conceptual definition of anxiety led Spielberger (1966) to distinguish between anxiety as a transitory state in reaction to specific situations, state anxiety, and as a personality trait, predisposition, or trait anxiety. State anxiety is an immediate emotional reaction in response to a specific situation. State anxiety is characterized by apprehension and tension, and accompanied with increased arousal. Trait anxiety is viewed as an enduring predisposition to be anxious across numerous situations.

The construct of arousal must also be differentiated from anxiety. Behavior varies along two dimensions, direction and intensity. The intensity level of behavior is arousal. Arousal is a level of physiological activation *which in turn instigates or activates behavior. Duffy (1957) stated that arousal varies on a continuum from deep sleep to high excitement. Arousal can be measured autonomically; that is, measures such as heart rate, blood pressure, skin temperature, and muscle tension are good indicators of physiological arousal (Fenz & Jones, 1972; Weinberg & Hunt, 1976). When arousal levels are high, an individual may experience unpleasant emotional reactions associated with arousal of the autonomic nervous system. These unpleasant emotional reactions are referred to as stress or state anxiety (Landers, 1980).*

Anxiety as a Multidimensional Construct

According to Schacter and Singer (1962), subjectively experienced emotion is the result of an evaluation process in which the subject interprets his/her bodily reactions in relation to the precipitating situation. The subjective emotion depends upon how the subject attributes these bodily responses. Thus, autonomic arousal provides the impetus for an emotional experience, the subject's attribution determines fear, anxiety, happiness, etc. A given level of physiological arousal is not sufficient to determine the presence of anxiety. Rather, anxiety is the integration of both the cognitive and physiological dimensions of behavior.

Borkovec (1976) operationally defined anxiety as a multiple measurement of three separate but interacting *components: cognitive, overt behavioral, and physiological. Additionally, individual anxiety reactions are affected and influenced by different environmental stimuli, resulting in different responses in each of the three interacting components of anxiety (Borkovec, 1976).*

Measurement of Sport-Specific Anxiety

Psychological Measures of Anxiety

Basically, two strategies have been used to measure anxiety, paper-and-pencil self report measures, often termed psychological measures, and the second strategy, an assessment of physiological indices of anxiety. Early researchers measured anxiety with general inventories such as the Taylor Manifest Anxiety Scale (Taylor, 1953), the IPAT Anxiety Scale (Cattell, 1957), and the General Anxiety Scale (Saranson, Davidson, Lighthall, Waite & Ruebush, 1960). Spielberger (1966) recognized that anxiety could also be seen as immediate responses, state anxiety, or as enduring traits, trait anxiety. As a result, Spielberger, Gorsuch and Lushene (1970) developed the State-Trait Anxiety Inventory.

But researchers were finding that situation specific anxiety scales predicted behavior better than general anxiety scales (Martens, 1977). Within the sport context, Martens (1977) developed the Sport Competition Anxiety Test (SCAT), a sport specific competitive trait anxiety scale.

The development of SCAT provided sport psychologists with a valuable research tool to assess competitive trait anxiety. Martens (1977) modified the Spielberger State Anxiety Inventory by identifying items from the twenty item scale which were sensitive to changes in a competitive sport environment. Martens' (1977) work resulted in a ten item, Competitive State Anxiety Inventory (CSAI). Martens, Burton, Rivkin, and Simon (1980) confirmed the reliability and validity of the CSAI.

Endler (1978) asserted that trait and state anxiety were multidimensional, composed of several interacting components. Davidson and Schwartz (1976) and Borkovec (1976) also differentiated between cognitive and somatic components of state anxiety. Considering anxiety as a multidimensional construct, Liebert and Morris (1967) developed the Worry-Emotionality Inventory (WEI), a state anxiety scale assessing cognitive and somatic components of anxiety. Schwartz, Davidson and Goleman (1978) developed the Cognitive-Somatic Anxiety Questionnaire (CSAQ), a trait anxiety scale which assesses both cognitive and somatic anxiety.

Cognitive anxiety, defined by Morris, Davis, and Hutchings (1981) is a "conscious awareness of unpleasant feeling about oneself or external stimuli, worry, disturbing visual images." Somatic anxiety refers to the physiological and affective elements associated with *anxiety which develop from autonomic arousal. Somatic anxiety is reflected in responses such as rapid heart rate, clammy hands, butterflies in the stomach, and tense muscles.*

Based upon the multidimensional nature of state anxiety, Martens, Burton, Vealey, Bump, and Smith (1983) developed a sport specific measure of competitive state anxiety, the Competitive State Anxiety-2 (CSAI-2). The CSAI-2 assesses cognitive and somatic components of competitive state anxiety and also a third variable, self-confidence.

<u>*Physiological Measures of Anxiety*</u>

In addition to self-report measures of anxiety, some researchers have assessed physiological indices of anxiety. According to Hatfield and Landers (1983), physiological measures may allow for the inference of psychological processes and emotional states. Common physiological indices of anxiety include heart rate, systolic and diastolic blood pressures, epinepherine, norepinephrine, palmar sweating, galvanic skin responses, muscle tension, EMG, and EEG (Landers, 1980; Martens, 1974; Weinberg, 1978).

Weinberg (1978) examined the effects of success and failure on the patterning of neuromuscular energy. Subjects were administered SCAT and STAI to distinguish A-state and A-trait subjects. Subjects were required to perform a throwing task and EMG measures were recorded from muscles involved in the throw (biceps, triceps, extensor carpi radialis, and flexor carpi ulnaris). High anxious subjects used more EMG energy than low anxious subjects before, during, and after the throw in both success and failure conditions.

Karteroliotis and Gill (1987) examined the temporal changes in psychological and physiological measures of anxiety. Subjects completed a peg-board task while the experimenters monitored heart rate and blood pressure responses. Karteroliotis and Gill (1987) reported that the psychological and physiological measures were not related at any time of assessment.

Although many researchers have utilized psychological and physiological assessments of anxiety, either independently or in combination, the nature of anxiety is still evasive. This evasiveness may exist because correlations between the two measurements are weak (Bloom, Houston, & Burish, 1976; Morrow & Labrum, 1978) Weak correlations among psychological and physiological measures of anxiety provide support for the conceptualization of anxiety as a complex, multidimensional construct.

Anxiety and Performance

A certain amount of physiological arousal is necessary for optimal athletic performance. Too little or too much arousal may be detrimental to performance (Oxendine, 1970; Sonstroem & Bernardo, 1982; Yerkes & Dodson, 1908). Athletes with insufficient arousal may be lacking motivation and may not be physiologically prepared for optimal performance or competition. Drive theory and the inverted-U theory have been offered as a means of explaining the relationship between anxiety and performance.

Drive Theory and Motor Performance

Drive theory is a complex, mechanistic explanation of motivation and behavior developed by Hull (1943) and modified by Spence (1956). The basic prediction of drive theory is that performance (P) is a function (f) of habit (H) times drive (D) :

$$P = f\ (H \times D)$$

Drive serves to activate or elicit certain behaviors and is synonomous with arousal. Habit refers to learned responses or behaviors. The stronger the habit strength, the greater the likelihood of a particular response being elicited.

Drive theory predicts that as arousal or drive increases, learned behaviors are more likely to occur. If a skill is very simple, or well learned, the dominant response is the correct response, and increased arousal will improve performance. If a skill is complex, or an individual is a beginner and the skill is not well learned, *the dominant response is an incorrect response, therefore increased levels of arousal will impair performance. Increased arousal increases the likelihood that the dominant response will be elicited.*

However, support for drive theory is equivocal. The inherent complexity of the theory makes it difficult to test the relationship between anxiety and performance. Martens (1971) reviewed studies that used the Taylor Manifest Anxiety Scale (TMAS) as a discriminator of individuals in respect to their emotional responsiveness, trait anxiety, and as a result, drive level. Martens' (1971) reviewed thirty-five studies and reported conflicting results within the studies examined. Particularly, studies hypothesizing drive as synonomous with trait anxiety led to mixed results in support of drive theory. When examining athletic performance, one cannot expect that one variable, trait anxiety, would be the sole predictor of performance.

Another approach taken by researchers studying drive theory equates drive with arousal or state anxiety. This approach has been somewhat more successful than equating drive with trait anxiety. Castaneda and Lipsitt (1950), for example, trained subjects to press a button in response to a stimulus light. Subjects performed a dominant tendency correct task in which the lights and response buttons were congruent. Other subjects performed *a dominant tendency incorrect task in which the lights and response buttons were incongruent. Stress facilitated the performance of the dominant tendency correct task and inhibited performance of the dominant tendency incorrect task. Thus, drive theory was supported.*

Ryan (1961) had subjects perform balancing on a stabilometer. Forty male subjects, with no previous experience in the task, practiced for five days. The subjects performed twelve, thirty second trials each day. Half of the subjects received an electric shock during their twelve practice trials. No differences in performance between groups on the first four sessions were found. The experimental stressor, introduced in session five, did not produce a performance difference between the two groups. Stress late in learning did not facilitate performance of a well learned task as predicted by drive theory. Perhaps the stressor was not sufficient to increase arousal.

Ryan (1962) concluded that the correct response was not learned well enough to be considered dominant. In a follow up study, Ryan (1962) introduced a task in which he manipulated task difficulty and hypothesized the externally induced tension, electric shock, would facilitate performance on an easy motor skill, and impair performance on a more difficult skill. Two groups of twenty subjects performed the easy stabilometer task, the experimental group received the unavoidable shock and the control group received no shock. Subjects performed twelve practice trials, and those under stress conditions received shock on seven of the twelve trials. But in this study, no differences were noted between the high and low stress conditions on the simple task. According to drive theory, the stressed group should have shown better performances.

Griffiths, Steel, and Vaccaro (1979) correlated state anxiety with performance scores of complex scuba diving tasks. Subjects with the highest state anxiety scores performed more poorly on the difficult tasks. This finding is in general agreement with drive theory since high levels of drive should interfere with performance of unlearned or complex tasks.

While some studies have supported drive theory, the theory is difficult to test, due to the inability to accurately determine habit strength and drive. An alternative explanation of the relationship between anxiety and performance is the inverted-U theory.

The Inverted-U Theory and Performance

The inverted-U theory, considers anxiety as a unidimensional construct, and proposes that the relationship between anxiety and performance takes the form of an inverted-U. Performance effectiveness increases as arousal increases to an optimal point, further increases in arousal will produce a decrement in performance. According to Yerkes and Dodson (1908), an optimal level of arousal exists for best performances of a particular task. Complex tasks require low levels of arousal for best performances, moderate tasks require moderate levels of arousal, and simple tasks are performed best under high levels of arousal. Numerous studies have examined and supported the the inverted-U theory (Fenz & Jones, 1972; Gould, Petlichkoff, Simons, & Vevera, 1987; Klavora, 1977; Martens & Landers, 1970; Sonstroem & Bernardo, 1982; Weinberg & Genuchi, 1980; Weinberg & Ragan, 1978).

Martens and Landers (1970) tested the inverted-U theory in a motor performance task with junior high school boys. Subjects performed a tracking task under low, moderate, or high stress conditions. The three stress conditions provided three levels of arousal and performance scores formed an inverted-U pattern with the best performances occurring in the moderate stress condition.

Sonstroem and Bernardo (1982) using an intraindividual analysis compared female basketball players lowest, median, and highest pregame state anxiety scores with the athlete's composite performance scores for those three games. An intraindividual analysis controls for between subject variance when examining the anxiety-performance relationship. The analysis accounts for the fact that individuals respond differently in reaction to competitive situations (Lacey, Bateman, & Van Lehn, 1953). Sonstroem and Bernardo (1982) found the best performances associated with moderate levels of state anxiety and the poorest performances associated with high levels of state anxiety. Additionally, high trait anxious athletes experienced the greatest decrements in performance under high state anxiety levels.

Gould, Petlichkoff, Simons, and Vevera (1987) examined the relationship between pistol shooting performance and subcomponents of the CSAI-2. They examined the relationship between anxiety and performance considering anxiety as a multidimensional construct. Using intraindividual analysis, results indicated that cognitive anxiety was not related to performance, somatic anxiety was related to performance in the form of an inverted-U, and that self-confidence was negatively related to performance.

Burton (1988), also defined anxiety as a multidimensional construct and examined the relationship between anxiety and performance. Burton (1988) found that somatic anxiety and performance demonstrated an inverted-U relationship. Cognitive worry displayed a positive linear relationship with performance and self-confidence displayed a negative linear relationship with performance.

However, Burton (1988) and Gould et al. (1987) reported conflicting results. Differences in results may be attributed to different tasks, swimming vs. pistol shooting. Additionally, difficulty exists in testing the inverted-U theory (Landers, 1980; Martens & Landers, 1970). In order to accurately test whether a linear or curvilinear (inverted-U) relationship exists between performance and anxiety, researchers must make at least three different anxiety assessments. These anxiety assessments must be distinct, and significantly differ from one another.

Drive theory and the inverted-U theory have been offered as possible explanations to explain the relationship between anxiety and performance. Both theories have weaknesses and inherent complexities when empirically examining the theories. However, the inverted-U theory, when considering anxiety as a multidimensional construct, begins to clarify the complex relationship between anxiety and performance.

Competitive Anxiety

Sport competition is an objective situation that can result in increased stress or anxiety. An individual in a competitive environment is subject to self-evaluation and evaluation by others, both of which have the potential of influencing one's behavior. As stated earlier, the most common psychological assessment of competitive trait anxiety in sport is the Sport Competition Anxiety Test (SCAT) (Martens, 1977). Competitive state anxiety has also been assessed with the Competitive State Anxiety Inventory (CSAI) (Martens, 1977; Martens, Burton, Rivkin, & Simon, *1980), and the Competitive State Anxiety Inventory-2 (CSAI-2) (Martens, Burton, Vealey, Smith, & Bump, 1983). Additionally, some researchers have also employed physiological assessments of anxiety. Many studies have examined and attempted to explain the nature of competitive anxiety and its effects upon the athlete. Some of this research will be reviewed and presented in two subdivisions: (a) precompetitive anxiety, and (b) temporal changes in competitive anxiety.*

Precompetitive Anxiety. Gould, Horn, and Spreeman (1983) examined the pattern of precompetitive anxiety for high and low trait anxious wrestlers. Subjects were administered a demographic questionnaire, a list of thirty-three items from Kroll's (1980) study of stress, SCAT, and asked to rate perceived anxiety at different times prior to competition, all completed forty-eight hours prior to competition. Perceived state anxiety was assessed at different times before a match: one week, one day, one hour, minutes before the match, and immediately prior to the match. State anxiety increased steadily until minutes prior to the competition, and then decreased. A significant difference also existed between the high and low trait anxious athletes. Athletes high in competitive trait anxiety responded with greater levels of state anxiety than those low in competitive trait anxiety.

Krane and Williams (1987) examined changes in somatic anxiety, cognitive anxiety, and self confidence prior to competition. Gymnasts and golfers were administered the CSAI-2 twenty-four hours, one hour, and ten minutes prior to a competition. They hypothesized that somatic anxiety should increase prior to competition and cognitive anxiety and self-confidence should remain stable. Gymnasts increased in cognitive and somatic anxiety and decreased in self confidence. Golfers decreased in cognitive anxiety, increased in self confidence, and somatic anxiety remained stable. The hypothesis of Krane and Williams (1987) was partially supported, different skills involve differing anxiety patterns prior to competition. The increased somatic anxiety or arousal prior to competition may be beneficial to the gymnast, who must execute gross body movements, and detrimental to the golfer, who must execute fine and precise movements (Oxendine, 1970).

Researchers have reported a relationship between precompetitive state anxiety and performance (e.g., Gould, Horn, & Spreeman, 1983; Sonstroem & Bernardo, 1982; Weinberg & Genuchi, 1980). Precompetitive anxiety differs in experienced and inexperienced athletes and appears to follow a very distinctive pattern. Precompetitive anxiety increases prior to a competition and appears to decrease once the competition begins. The temporal changes in anxiety during the course of a competition need to be *further examined in order to understand the nature of anxiety.*

<u>Temporal Changes in Competitive Anxiety</u>. Martens, et al. (1983) developed the Competitive State Anxiety Inventory (CSAI-2). The inventory assesses subcomponents of state anxiety, cognitive, somatic, and self-confidence. The researchers showed that each influenced performance differently and followed different temporal patterns. Somatic anxiety reached its peak at the onset of competition and decreased once the contest began. Cognitive anxiety showed little temporal fluctuation over the course of a competition, and changed only with the expectation of success.

Gould, Petlichkoff, and Weinberg (1984) using the CSAI-2 found that somatic anxiety increased prior to competition, while cognitive anxiety and self-confidence remained stable. Gould, et al. (1984) were the first to examine temporal changes in competitive state anxiety. However, they only assessed the psychological components of state anxiety and did not look at anxiety during the actual competition. Karteroliotis and Gill (1987) examined both psychological and physiological changes in state anxiety during a competition.

Karteroliotis and Gill (1987) found that cognitive and somatic anxiety followed similar temporal patterns as the competition progressed. Somatic anxiety did not increase *from baseline to precompetition as expected. Somatic anxiety did increase from precompetition to midcompetition and decreased at postcompetition. Cognitive worry increased from precompetition to midcompetition and then decreased. Self-confidence increased from midcompetition to postcompetition, and neither cognitive worry nor self-confidence returned to baseline values as somatic anxiety did. The physiological measures, heart rate (HR) and systolic blood pressure (SBP), significantly increased from baseline to precompetition. Both HR and diastolic blood pressure (DBP) significantly increased from precompetition to midcompetition. HR, SBP, or DBP did not decrease from midcompetition to postcompetition. Karteroliotis and Gill (1987) concluded that somatic anxiety as assessed by the CSAI-2 and physiological arousal should not be interpreted as the same response.*

Summary

Competitive state anxiety is a multidimensional construct composed of cognitive worry and somatic anxiety subcomponents. A third variable, self-confidence, is influenced by changes in state anxiety. The subcomponents of state anxiety also follow different temporal patterns prior to, during, and after a competition.

Basically, two strategies have been used to assess anxiety, self-report, psychological measures, and physiological measures. Studies have revealed that these *two measures are often distinct and do not follow similar temporal patterns during competitive situations. The fact that psychological and physiological measures are weakly correlated lends support for the conceptualization of anxiety as a complex and multidimensional construct.*

Drive theory and the inverted-U theory have been offered as possible explanations for the anxiety-performance relationship. Both theories have inherent weaknesses are are difficult to examine empirically. When considering anxiety as a multidimensional construct rather than unidimensional construct, the inverted-U theory begins to clarify the relationship between anxiety and performance. Furthermore, tasks requiring different motor skills (e.g. gross vs. fine) are differently influenced by anxiety levels.

Sonstroem and Bernardo (1982) utilized an intraindividual analysis when they examined the relatio ship between anxiety and performance. The intraindividual analysis controls for between subject variance when examining the anxiety-performance relationship. The analysis accounts for the fact that individuals respond differently to competitive situations. An optimal level of arousal for one individual will not necessarily be optimal for another individual.

Future studies examining the relationship between anxiety and performance should attempt to examine anxiety *as a multidimensional construct. Multiple psychological and physiological assessments of anxiety should be examined within actual sporting tasks using an intraindividual analysis to control for variance between subjects.*

CHAPTER 3

METHOD

The purpose of this chapter is to outline the procedures employed in the study. The method section consists of the following subareas: (a) subjects, (b) competitive sporting task, (c) dependent variables, (d) independent variables, and (e) testing procedures.

Subjects

Twenty-four male undergraduate students, ranging in age from 18 to 25 years, enrolled in Physical Education classes at Kansas State University volunteered to participate in the experiment. All subjects had previous competitive athletic experience at the high school level. Informed consent was obtained prior to participation in the experiment (see Appendix A). Data were assigned a code number and results processed using only these code numbers to ensure subject confidentiality.

Competitive Sporting Task

The task chosen was a modified version of a bicycle ergometer task utilized by Corbin and Nix (1979) and Duncan and McAuley (1987). Two Quinton Monarch ergometers were utilized and the tension set at 2 KP. The subject rode one of the ergometers and a confederate rode the other ergometer. The ergometers were wired to a portable scoreboard via a manipulation panel. In the experimental conditions, competition/success and competition/failure, scores were electronically manipulated by biasing one of the bicycles to register only 80% of its total score. The scoreboard included a timer and registered scores for each of the two bicycle ergometers simultaneously. The scoreboard, placed directly in front of the subjects, allowed them to see their own and opponent's score, as well as the time elapsed in each competitive session. A partition separated the bicycle ergometers so that the subject could only see the opponent from the waist up, concealing apparent differences in pedaling rates.

Dependent Variables

Three dependent measures were employed in the study: a) competitive trait anxiety; b) competitive state anxiety; and c) electromyographic assessment of the frontalis muscle.

Competitive Trait Anxiety. Competitive trait anxiety was assessed by the Sport Competition Anxiety Test (SCAT) developed by Martens (1977). SCAT is composed of fifteen items which require a Likert-type response (see Appendix B). Martens (1977) reported strong reliability and validity for SCAT and the questionnaire has been widely used in sport psychology research (Gould, Horn,& Spreeman, 1983; Sonstroem & Bernardo, 1982; Weinberg & Genuchi, 1980).

Competitive State Anxiety. Competitive state anxiety was assessed by the Competitive State Anxiety Inventory-2 (CSAI-2) developed by Martens, Burton, Vealey, Bump, and

Smith (1983). The CSAI-2 assesses multidimensional aspects of competitive state anxiety (somatic anxiety, cognitive worry, and self-confidence). The inventory is composed of twenty-seven items which require a Likert type response (see Appendix C). Martens et al. (1983) reported content, concurrent, and construct validity of the inventory by comparing the CSAI-2 with other validated inventories such as the Sport Competition Anxiety Test, the State-Trait Anxiety Inventory, and the Achievement Anxiety Test. Reliability coefficients for the CSAI-2 range from .70 to .90 (Martens et al., 1983).

Electromyographic Assessment of the Frontalis Muscle.

Muscle action potentials (MAP) represent the amount of electrical activity within a muscle. The integration of MAPs provide a measure of total electrical activity of the muscle as some function of time. Integrated electromyographic readings were recorded from the frontalis muscle to record muscle activity.

Integrated electromyograms (iEMG) were monitored using bi-polar surface disc electrodes applied over the frontalis. Surface electrodes were set on the frontalis in accordance with Waters, Williamson, Bernard, Blouin, and Faulstich (1987). Electrodes were attached one inch above each eyebrow, centered above the pupil of the eye while the subject gazed forward. Electrode sites were prepared by cleaning the skin surface with alcohol. Electrical resistance between a pair of electrodes was kept under 10,000 ohms. A multitester was used to check resistance between electrodes and wires.

Frontalis muscle activity was measured on a Coulbourn high gain bioamplifier with the gain set at 10,000 X (X represents times) and the time constant at 10 volt seconds. The output was subsequently channeled through a digital converter and displayed on a readout meter giving integrated (iEMG) values over consecutive 5 sec intervals.

The frontalis muscle was chosen based upon high test-retest reliability, .95, (Arena, Blanchard, Andrasik, Cotch & Meyers, 1983; Waters, Williamson, Bernard, Blouin, & Faulstich, 1987;) and because the frontalis muscle is not directly involved in the cycling task, thereby reducing artifacts produced by the activity. Additionally, Blais and Vallerand (1986) reported that the frontalis is correlated with psychological measures of anxiety (Smith, 1973) and is also less affected by posture and gravity than other muscles.

iEMG values were recorded at 5 sec intervals during the two minutes allotted at precompetition, midcompetition, and postcompetition for the subject to complete the CSAI-2.

Independent Variables

Success and Failure Conditions. The subject performed the competitive cycling task against an opponent, confederate, in the success and failure conditions. The CSAI-2 was administered before, mid, and postcompetition. Success was manipulated by biasing the manipulation panel to record 100% of the subject's total score and 80% of the confederate's score. The subject and confederate completed two 45 sec trials on the ergometer. After the first trial, at midcompetition, the subject was verbally informed that he was winning the competition (success feedback). The experimenter told the subject, "At this point in the competition, you are winning the competition." The subject was able to see that his score was greater than the confederate's on the scoreboard. Another cycling trial followed and at the completion of the cycling task, the subject was informed that he won the competition.

Failure was manipulated by biasing the manipulation panel so that 80% of the subject's total score and 100% of the confederate's total score was displayed on the scoreboard. The subject and confederate completed two 45 sec trials on the ergometer. After the first trial, at midcompetition, the subject was verbally informed that he was losing the competition. The experimenter told the subject, "At this point in the competition, you are losing the competition." The subject was also able to see that his *score was lower than the confederate's on the scoreboard. Upon completion of the second trial, the subject was told that he lost the competition.*

Testing Procedures

A repeated measures design was implemented with each subject participating in three counterbalanced experimental conditions: noncompetition, competition/success, and competition/failure (See Appendix D). The experiment required subject participation over three days. Prior to testing, the subject was informed of the procedures, and consent obtained for participation in the study. In the noncompetitive session, all subjects were administered the Sport Competition Anxiety Test (SCAT).

Noncompetition Condition. Subjects completed the cycling task alone in the noncompetition condition. The subject entered the lab and was administered the SCAT. After completing the SCAT the subject cleansed his forehead with an alcohol pad. Surface electrodes were then applied at the appropriate sites of the frontalis muscle.

The subject sat on the bicycle and began the bicycle task. The subject warmed up for two minutes to prepare for the task. After the subject warmed up he was administered the CSAI-2 (precompetition), while seated on the bicycle. After completing the CSAI-2, the experimenter instructed the subject that the task required him to ride as fast as he could for 45 sec, in order to get as high a score as possible. After the completion of the 45 sec ride, the CSAI-2 was administered (midcompetition). The subject then completed another 45 sec trial and upon completion was administered the CSAI-2 (postcompetition).

iEMG values were recorded at 5 sec intervals for two minutes while the subject completed the CSAI-2 at pre-, mid-, and postcompetition.

Competition Conditions. In the competition/success and competition/failure conditions, the subject performed the cycling task against an opponent, confederate. The CSAI-2 was administered before, mid-, and postcompetition to assess state anxiety levels. Two minutes were allotted for the subject to complete the CSAI-2. During the two minutes that the subject was completing the CSAI-2, iEMG values were recorded at 5 sec intervals.

After entering the laboratory, the subject was seated and after cleansing the appropriate sites of the frontalis muscle with alcohol, electrodes were applied. The confederate secured a strap with three electrodes attached, around his chest, with the lead going to a Quinton 650 heart rate monitor. The confederate was wired so that the subject would believe that multiple physiological measures were being recorded. (The confederate's heart rate was not actually recorded.) The subject and confederate were then seated on the bicycles and instructed to warm up for two minutes.

The subject and confederate were administered the CSAI-2 after the warm up. After completing the CSAI-2, the subject and confederate were informed that they would be competing against one another. The confederate knew prior to the competition that he would either win or lose. The subject and confederate were instructed by the experimenter to ride to get the highest score that he can. The subject and confederate then rode for 45 sec. The subject's score was displayed on the scoreboard as greater/lower than the confederate's score, depending upon the condition. The subject could see his and the confederate's score and elapsed time on the scoreboard while competing. After the first 45 sec trial, the subject was verbally informed that he was winning/losing the competition. The subject and confederate remained on the bicycle and were administered the CSAI-2 (midcompetition). After completing the CSAI-2 both completed another 45 sec trial on the bicycle. After completing the 45 sec ride, the subject was told that he won/lost the competition. The subject and confederate remained seated on the bicycle and were administered the CSAI-2 (postcompetition). The competition/success or competition/failure session was completed after the CSAI-2 was returned to the experimenter.

Upon completion of testing, all subjects were debriefed using a protocol approved by the University Human Subjects Committee (see Appendix E).

CHAPTER 4

RESULTS

The results are divided into the following sections: a) descriptive statistics, b) correlations among measures, c) changes in psychological and physiological measures across time and conditions, and d) relationship between psychological and physiological measures and performance.

Descriptive Statistics

Means and standard deviations for each CSAI-2 subcomponent, cognitive worry, somatic anxiety, and self-confidence; frontalis EMG; and performance scores are summarized in Table 1. The data are summarized according to condition, (noncompetition, success, and failure) and time, (precompetition, midcompetition, and postcompetition).

Means and standard deviations for cognitive worry were lower than those reported by Gould, Petlichkoff, Simons, and Vevera (1987) (M = 16.91, SD = 5.96) who examined the relationship between pistol shooting and performance. Self-confidence scores reported by Gould et al. (1987) (M = 25.56, SD = 6.40), were lower than those reported in Table 1.

Means and standard deviations reported by Martens et al. (1983) from a wrestling competition were higher for cognitive worry, and somatic anxiety and lower for self-confidence than values reported in Table 1.

TABLE 1
Means and Standard Deviations For CSAI-2 Scores, Frontalis EMGs and Performance

	Pre-		Mid-		Post-	
	M	SD	M	SD	M	SD
Noncompetition						
Cognitive worry	11.46	2.92	11.21	2.99	10.88	3.53
Somatic anxiety	11.92	3.03	14.67	3.78	14.58	3.28
Self-confidence	29.00	4.61	27.67	5.13	28.50	5.31
EMG	21.24	32.02	21.85	37.58	21.18	35.43
Performance	51.96	5.18	53.21	3.44	NA	NA
Success						
Cognitive worry	12.71	3.90	11.75	4.18	11.08	3.01
Somatic anxiety	13.38	4.17	15.54	3.75	16.00	3.24
Self-confidence	28.25	5.31	28.04	5.92	28.67	5.65
EMG	26.58	29.99	25.95	23.95	25.12	26.07
Performance	53.63	6.79	53.67	4.15	NA	NA
Failure						
Cognitive worry	11.33	3.40	14.29	5.92	14.54	5.85
Somatic anxiety	12.50	3.23	15.29	4.05	15.67	4.69
Self-confidence	28.46	5.02	24.79	5.52	23.67	6.01
EMG	20.42	20.82	17.98	14.08	27.25	33.20
Performance	53.79	5.64	53.75	4.37	NA	NA

Karteroliotis and Gill (1987) reported higher values for cognitive worry and lower values for somatic anxiety. Self-confidence values were similar, except that subjects in the present study had higher precompetition scores than those reported by Karteroliotis and Gill (1987).

Mean and standard deviation scores in the present investigation are lower than those reported by previous researchers (Gould, et al., 1987; Karteroliotis & Gill, 1987; Martens, et al., 1983). A possible explanation may be that the task and competition in the present study did not produce high levels of anxiety in the subjects due to the simplicity and short duration of the task (Landers and Boutcher, 1986). Additionally, subjects may have had little interest in the contrived competition within a lab setting.

Correlations Among Measures

Intercorrelations Among CSAI-2 Subcomponent Scores.

Correlations among the CSAI-2 subcomponents were calculated in order to test the hypothesis that the CSAI-2 subcomponents would be moderately related to one another. Results are presented in Table 2.

TABLE 2
Intercorrelations Between CSAI-2 Subcomponent Scores

	Intercorrelations		
Time	Cognitive Worry and Somatic Anxiety r	Cognitive Worry and Self-confidence r	Somatic anxiety and Self-confidence r
Noncompetition			
Pre-	.24	$-.40^a$	-.34
Mid-	$.64^b$	-.31	-.39
Post-	$.46^a$	$-.50^b$	-.34
Success			
Pre-	$.42^a$	$-.42^a$	$-.48^a$
Mid-	$.69^b$	$-.50^b$	-.36
Post-	.28	-.38	-.18
Failure			
Pre-	.33	-.19	$-.59^b$
Mid-	$.58^b$	$-.40^a$	-.35
Post-	$.54^b$	$-.57^b$	-.32

Note: ^{a} $p<.05$; ^{b} $p<.01$

Results revealed moderate positive correlations between cognitive worry and somatic anxiety, cognitive worry and self-confidence, and somatic anxiety and self-confidence.

Martens et al. (1983) reported the following precompetition correlations: cognitive worry and somatic anxiety (r = .50), cognitive worry and self-confidence (r = −.51), and somatic anxiety and self-confidence (r = − .52). Inspection of Table 1 reveals that these correlations were lower in the case of cognitive worry and somatic anxiety and cognitive worry and self-confidence, and higher for somatic anxiety and self-confidence.

Gould et al. (1984) reported moderate correlations between cognitive worry and somatic anxiety, and negative correlations between cognitive worry and self-confidence and somatic anxiety and self-confidence.

The hypothesis that the CSAI-2 subcomponents would be moderately related to one another was supported and consistent with results reported by Martens et al. (1983) and Gould et al. (1984). Therefore, state anxiety consists of separate but related components of cognitive worry and somatic anxiety.

Correlations of CSAI-2 Subcomponents and EMGs with SCAT. Pearson product-moment coefficients were calculated in order to examine the relationship of trait anxiety (SCAT) with CSAI-2 subscale scores, and EMGs. Pearson product-moment coefficients are presented in Table 3.

TABLE 3
Correlations of CSAI-2 Subcomponents, Frontalis EMGs, and SCAT

	Cognitive worry $\underline{r}$	Somatic anxiety $\underline{r}$	Self-confidence $\underline{r}$	EMG $\underline{r}$
SCAT				
Noncompetition				
Pre-	.10	.38	$-.40^a$	.34
Mid-	$.58^b$	$.62^b$	$.41^a$	.04
Post-	$.52^b$	$.62^b$	$.43^a$	.30
Success				
Pre-	.37	.34	-.39	.03
Mid-	.28	.25	-.22	-.13
Post-	.15	.05	-.14	-.10
Failure				
Pre-	.19	$.43^a$	-.26	.22
Mid-	.20	.20	-.30	-.08
Post-	.12	-.01	-.34	.15

Note: ^{a} $p<.05$; ^{b} $p<.01$

Results revealed significant correlations between SCAT and CSAI-2 subcomponents during the noncompetition condition. No significant correlations existed between SCAT and CSAI-2 subcomponents or EMG during the success or failure condition, with the exception of somatic anxiety and SCAT at failure. Results for somatic anxiety and SCAT were consistent with those reported by Martens et al. (1983). Cognitive worry and SCAT results were higher than results reported by Gould et al. (1984) (r = .32). Self-confidence and SCAT results were not completely consistent with Karteroliotis and Gill (1987) who reported a significant negative correlation with SCAT and self-confidence at midcompetition (r = -.32) and postcompetition (r = -.28).

The hypothesis that trait anxiety will be related to the state anxiety components of cognitive worry and somatic anxiety was supported at the noncompetition condition. The lack of significant correlations among SCAT and state anxiety components during success and failure conditions is surprising. Both Martens (1977) and Gould et al. (1984) reported significant correlations between trait and state anxiety. In the present study, trait anxiety may not have correlated with state anxiety in the success and failure conditions due to low levels of state anxiety (See Table 1). Furthermore, trait anxiety, a personality variable, may not be as strong of an influence on state anxiety levels as situational factors such as, the presence of another, social and self-evaluation, winning or losing, or outcome information (Zajonc, 1980).

Relationships Among Psychological and Physiological Measures of Anxiety.

Correlations Between Somatic Anxiety and Frontalis EMGs. Pearson product-moment correlations were calculated for EMG values and CSAI-2 somatic anxiety scores, in order to test if the physiological measure correlated with the psychological measures. The results, presented in Table 4, revealed significant correlations between somatic anxiety and frontalis EMGs at midcompetition and postcompetition in the noncompetition condition.

TABLE 4
Correlations Between
Somatic Anxiety and Frontalis EMGs

	Frontalis EMG		
	Pre- *r*	Mid- *r*	Post- *r*
Somatic anxiety			
Noncompetition			
Pre-	-.03		
Mid-		.45[a]	
Post-			.46[a]
Success			
Pre-	-.23		
Mid-		.10	
Post-			.33
Failure			
Pre-	-.28		
Mid-		.14	
Post-			.09

Note: [a] $p<.05$

Results revealed that while the psychological measures of competitive state anxiety were interrelated, the physiological measure, frontalis EMG, was not significantly correlated with the psychological measure in the success and failure conditions.

The hypothesis predicting that psychological measures of anxiety would be correlated with physiological measures of anxiety was only supported at midcompetition and postcompetition in the noncompetition condition. A possible explanation for this finding may be that subjects misinterpreted physiological arousal, as a result of the task, as somatic anxiety due to low levels of anxiety at noncompetition.

Predicting Physiological Anxiety from Psychological Anxiety. *Multiple regression analyses using an intraindividual analysis were conducted using CSAI-2 subscales as predictor variables and frontalis EMG values as the criterion variable to examine if a nonlinear relationship existed between psychological and physiological measures of anxiety. Means and standard deviations were calculated for each subject's subscale scores and frontalis EMG values. Standard scores were then computed for each subject's subscale scores and frontalis EMG values in order to negate between subject response variation.*

Results revealed no relationship between cognitive worry, $F(1,213) = 2.10$, $p<.15$; somatic anxiety, $F(1,213) = .12$, $p<.73$; or self-confidence, $F(1,213) = .17$, $p<.68$ with frontalis EMG values.

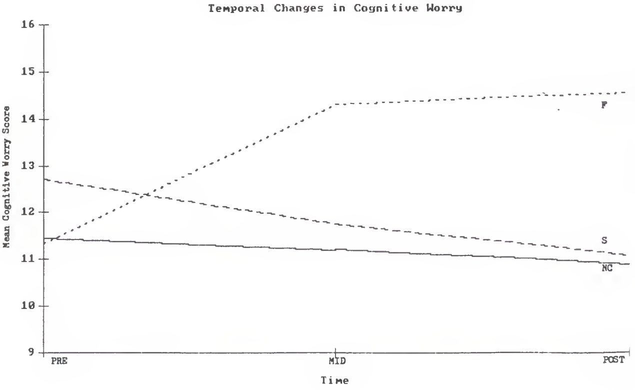
Results examining the relationships among psychological and physiological measures of anxiety are partially consistent with findings of other studies reporting no significant relationships between psychological and physiological measures (Karteroliotis & Gill, 1987; Morrow & Labrum, 1978). The psychological measures of anxiety did not allow for the prediction of physiological anxiety. The significant correlations between somatic anxiety and physiological measures found in the noncompetition condition may be the result of subjects interpreting physiological arousal as somatic anxiety.

Changes in Psychological and Physiological Measures Across Time and Conditions

Karteroliotis and Gill (1987) reported that the subcomponents of state anxiety, cognitive worry, somatic anxiety, and self-confidence followed different temporal patterns during the course of a competition. Therefore, analyses were conducted to determine if changes for each subcomponent of state anxiety occurred across type of condition, noncompetition, success, and failure. Univariate two-way condition (noncompetition, success, failure) by time (pre-, mid-, post-) ANOVAs were conducted *for each CSAI-2 subcomponent, frontalis EMGs, and performance. To control for experiment wise error rate, the alpha level was divided by the number of ANOVAS conducted (e.g. .05/4 = .0125). Significant interactions between time and condition were followed up by employing one-way univariate ANOVAs separately for each condition. Significant time or condition effects were followed by Tukey's studentized range test.*

__Cognitive__ __Worry__. The temporal changes in cognitive worry are presented in Figure 1. A univariate two-way ANOVA revealed a significant time by condition interaction for cognitive worry, $\underline{F}(4,92) = 9.93$, $\underline{p}<.001$.

FIGURE 1



A follow up one-way univariate ANOVA revealed a significant time effect, $F(2,46) = 5.70$, $p<.01$, in the success condition. Cognitive worry significantly decreased from precompetition ($M = 12.71$) to postcompetition ($M = 11.08$). This decrease in cognitive worry may be a result of the positive visual and verbal feedback provided to the subject informing him that he won the competition.

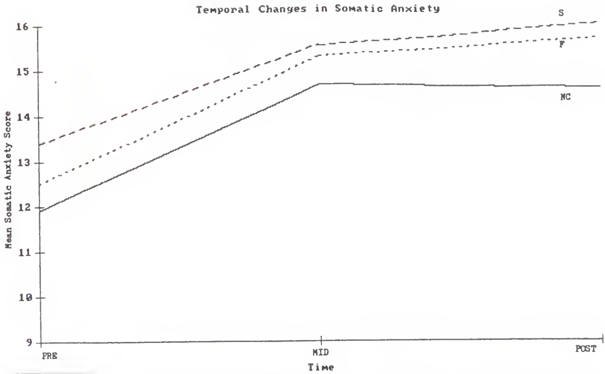
A follow-up one-way univariate ANOVA revealed a significant time effect in the failure condition, $F(2,46) = 12.63$, $p<.001$. Cognitive worry significantly increased from precompetition ($M = 11.33$) to midcompetition ($M = 14.29$) and from precompetition to postcompetition ($M = 14.54$). A possible explanation for the increase in cognitive worry may be attributed to negative feedback given to the subject which may have been perceived as threatening thus causing an increase in anxiety.

There were no significant changes across time in cognitive worry during noncompetition.

Results revealed that over time, cognitive worry significantly decreased in the success condition and significanly increased in the failure condition. Cognitive worry did not change in the noncompetition condition.

Somatic Anxiety. The temporal changes in somatic anxiety are presented in Figure 2. A univariate two-way ANOVA revealed a significant condition effect for somatic anxiety, $F(2,46) = 15.88$, $p<.001$.

FIGURE 2



Somatic anxiety was significantly higher in the success condition ($\underline{M}$ = 14.97) than the noncompetition condition ($\underline{M}$ = 13.72). The success and failure conditions were not significanly different from one another. The failure and noncompetition conditions were not significantly different.

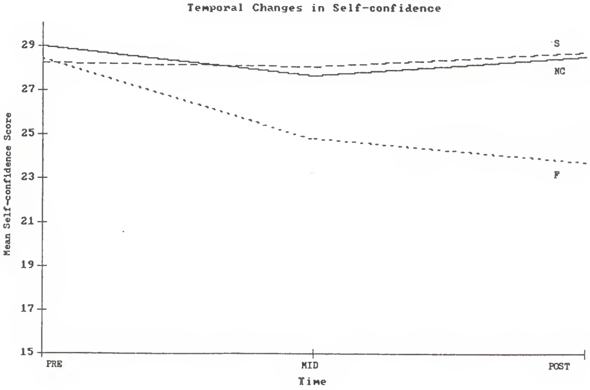
Within each condition, somatic anxiety significantly increased from precompetition ($\underline{M}$ = 12.60) to midcompetition ($\underline{M}$ = 15.17) and from precompetition to postcompetition ($\underline{M}$ = 15.42).

Results are inconsistent with those reported by Karteroliotis and Gill (1987) findings that somatic anxiety decreased at postcompetition. In the present investigation, somatic anxiety may not have decreased as a *result of the task requiring and producing high levels of physiological arousal. The high levels of physiological arousal may have been misinterpreted by the subjects as somatic anxiety.*

Somatic anxiety was significantly higher in the success condition than the noncompetition condition. Changes in somatic anxiety over time did not differ as a result of the condition.

Self-confidence. The temporal changes in self-confidence are presented in Figure 3.

FIGURE 3



A univariate two-way ANOVA revealed a significant time by condition interaction, $F(4,92) = 7.91$, $p < .001$, for self-confidence.

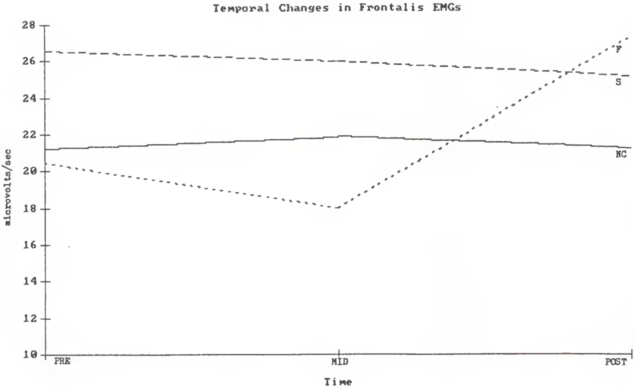
A follow-up univariate one-way ANOVA revealed a significant time effect, $F(2,46) = 11.98$, $p < .001$, at noncompetition. Self-confidence significantly decreased during noncompetition from precompetition ($M = 29.00$) to midcompetition ($M = 27.67$). The decrease in self-confidence may be a result of uncertainty within the subject about what constitutes a good performance. Verbal feedback was not provided to the subject at noncompetition, the only information available was the subject's score.

A univariate one-way ANOVA revealed a significant time effect for failure, $F(2,46) = 14.56$, $p < .001$. Self-confidence significantly decreased from precompetition ($M = 28.46$) to midcompetition ($M = 24.79$) and from precompetition to postcompetition ($M = 23.67$). Self-confidence may have decreased as a result of the negative evaluation from losing the competition.

The temporal changes in self-confidence differed according to time and condition.

Frontalis EMG. *Figure 4 illustrates the temporal changes in frontalis EMGs.*

FIGURE 4



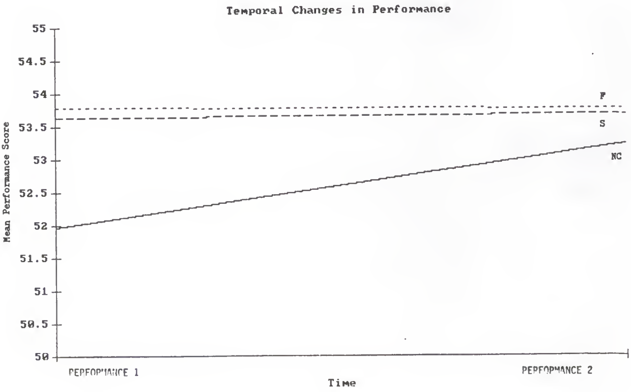
A univariate two-way ANOVA revealed no significant changes in frontalis EMGs either across time, $F(2,46) = .32$, $p<.73$, or condition, $F(2,46) = .60$, $p<.55$.

Frontalis EMGs did not significantly change either across time or conditions. Figure 4 illustrates the changes in frontalis EMGs and it appears as if there would be a significant increase in frontalis EMGs from precompetition to postcompetition and from midcompetition to postcompetition. The nonsignificant results may be explained by the large amount of variance observed in EMG values. Table 1 summarizes means and standard deviations for each condition and time. In the failure condition, there was a 62% increase in the standard deviations from precompetition to postcompetition. This large amount of variance may be attributed to individual response differences (Lacey, Bateman, & Van Lehn, 1953) and specifically in reaction to failure.

Frontalis EMGs did not change over time or conditions.

Performance. Temporal changes in performance are displayed in Figure 5.

FIGURE 5



A univariate two-way ANOVA revealed no significant changes in performance either across time, $F(2,46) = .74$, $p<.40$, or condition, $F(2,46) = 1.39$, $p<.26$.

Results revealed that performance did not significantly change over time or conditions. A possible explanation for consistent performances may be the nature of the task. The short duration task was not subject to many extraneous variables such as decision making, differing perceptual characteristics or differing motor response characteristics (Landers & Boutcher, 1986). Therefore, the task may not have been sufficiently complex or long enough to be influenced by changes in state anxiety levels.

The hypotheses predicting an increase in state anxiety during failure and a decrease in state anxiety during success were partially supported. State anxiety displayed different changes across time and within different conditions. The results support the hypothesis that state anxiety is a multidimensional construct that displays different changes across time and conditions. Furthermore, knowledge of results, success and failure feedback, influences cognitive worry and self-confidence but not somatic anxiety.

Relationships Among Psychological and Physiological Measures and Performance

Correlations Between CSAI-2 Subscale Scores, and Frontalis EMGs with Performance. The relationship between performance and CSAI-2 subscale scores and frontalis EMGs are presented in Table 5.

TABLE 5
Correlations Between CSAI-2 Subscale Scores SCAT, and Frontalis EMGs with Performance

	Cognitive worry	Somatic anxiety	Self-confidence	EMG	SCAT
	r	*r*	*r*	*r*	*r*
Performance					
Noncompetition					
Pre-	-.10	.14	.19	.19	.27
Mid-	.19	.29	-.15	.21	.79[b]
Success					
Pre-	-.09	.17	-.12	.34	.36
Mid-	-.04	.19	-.09	.36	.31
Failure					
Pre-	-.14	-.11	.09	.15	.34
Mid-	.17	.27	-.39	.13	.38

Note: [b] $p<.01$.

Pearson product-moment correlation results revealed no significant correlations between CSAI-2 subscale scores or frontalis EMGs with performance. SCAT and performance were highly correlated at midcompetition in the noncompetition condition.

The results found are inconsistent with results reported by Burton (1988). Burton (1988) reported significant correlations for cognitive worry and self-confidence with performance. A possible explanation for no correlation between anxiety and performance in this study may be the simplicity of the task. The task was not cognitively demanding and did not require complex motor skills. Futhermore, factors other than performance scores may have stronger influences on competitive state anxiety, (e.g., social and self-evaluation, negative feedback).

The hypothesis predicting that cognitive worry would be more strongly related to performance than somatic anxiety was not supported.

Intraindividual Polynomial Trend Analysis

Using an intraindividual regression analysis (Sonstroem & Bernardo, 1982), the relationships among CSAI-2 subscale scores and frontalis EMG with performance were examined to determine whether linear or curvilinear trends existed between performance and anxiety. Means and standard deviations were calculated for each subjects' scores for each condition (noncompetition, success, failure) and at each time of assessment (pre-, mid-, post-); cognitive worry, somatic anxiety, self-confidence, and frontalis EMG, (each with nine scores); and performance (six scores). Intraindividual standard scores were then computed for each CSAI-2 subscale, frontalis EMG values, and performance *scores to negate between subject response variation. Separate polynomial trend analyses were then used to test for linear or curvilinear relationships between each of the standardized subscale scores, and EMG values with intraindividual performance scores.*

Results revealed no interpretable linear or curvilinear trend between cognitive worry, $F(1,143) = 3.65$, $p<.06$, somatic anxiety, $F(1,143) = .29$, $p<.60$, or self-confidence, $F(1,143) = .05$, $p<.82$ with performance. The frontalis EMG-performance relationship was best explained by a positive linear trend, $F(1,143) = 3.86$, $p<.05$, $R^2 = .03$.

The frontalis EMG-performance linear trend may be accounted for by the nature of the task. Specifically, the task required an all out effort for 45 sec, therefore, high levels of physiological arousal were probably necessary to perform the task.

Table 5 revealed no relationship between frontalis EMG and performance while the intraindividual trend analysis revealed a significant linear trend. The discrepancy between the two findings may be attributed to variance in individual responses. The raw score analysis was not able to account for differences in responses between subjects as the intraindividual analysis did. No significant results were found between frontalis EMG and performance in the raw score correlations due to large amounts of variance in frontalis EMG values (See Table 1).

The hypotheses predicting linear and curvilinear trends between anxiety and performance were not supported. The frontalis EMG-performance relationship was best explained by a positive linear trend rather than curvilinear as predicted.

CHAPTER 5

SUMMARY, DISCUSSION AND CONCLUSIONS

This chapter consists of the following sections: a) summary, b) correlations among measures, c) changes in psychological and physiological measures across time and conditions, d) relationships among psychological and physiological measures and performance, e) conclusions, and f) recommendations for future research.

Summary

The results of this investigation supported the hypotheses that state anxiety is a multidimensional construct that consists of psychological and physiological components that are are moderately related to one another and change differently over time. Furthermore, each subcomponent is influenced differently by competitive conditions and task demands.

Correlations Among Measures

Psychologists (Liebert & Morris, 1967; Schwartz, Davidson, & Goleman, 1978) and sport psychologists (Gould et al., 1984, Karteroliotis & Gill, 1987; Martens et al., 1983) found that cognitive worry and somatic anxiety, components of state anxiety, are independent and related to one another in highly competitive situations. The moderate relationships found among anxiety subcomponents in the present study were consistent with results reported by Martens et al. (1983), Gould et al. (1984), and

Karteroliotis and Gill (1987).

The moderate positive correlations obtained between cognitive worry and somatic anxiety, as well as the moderate negative correlations between cognitive worry and self-confidence and somatic anxiety and self-confidence support the conception that the CSAI-2 is a multidimensional anxiety measure with separate subscales.

Trait anxiety, a personality variable should be related to state anxiety, transitory anxiety states, in competitive situations. Individuals perceiving competitive situations as threatening will respond with increased state anxiety reactions. Therefore, trait anxiety levels should influence cognitive worry and somatic anxiety in competitive situations. The results of this investigation supported the hypothesis that trait anxiety is related to state anxiety in the noncompetition condition.

Results are inconsistent with results reported by Martens et al. (1983) and Gould et al. (1984). Martens et al. (1983) and Gould et al.(1984) found that trait anxiety correlated with the state anxiety components of cognitive worry and somatic anxiety in competitive situations. In the present study, the contrived cycling competition may not have simulated an actual competitive sporting task.

Trait anxiety was not significantly correlated with state anxiety components in the competitive success and failure conditions. The lack of significant correlations *among trait and state anxiety during the success and failure conditions is surprising. In the present study, the contrived competitive situation may not have produced high levels of state anxiety, therefore, the correlations between trait and state anxiety are lacking. One must also consider that trait anxiety is a personality variable, during the competitive conditions against an opponent, situational variables, such as the presence of another person, social and self-evaluation, and outcome uncertainties, may represent more powerful influences on state anxiety levels than personality variables (Zajonc, 1980).*

Thus, even though correlations were found among state and trait anxiety at noncompetition, in competitive situations, variables other than trait anxiety may influence state anxiety to a greater extent.

Psychophysiology examines the interrelationships among psychological and physiological variables (Hatfield & Landers, 1983). According to Hatfield and Landers (1983), physiological measures may allow for the inference of psychological processes and emotional states. In this study, the influences of psychological variables (e.g. trait anxiety, state anxiety, effects of feedback) upon physiological responses (frontalis muscle tension) were examined. The results revealed significant relationships among psychological and physiological measures during the noncompetition condition.

A muscle that is frequently examined by anxiety researchers is the frontalis muscle. According to deVries (1968), a weakness of the frontalis muscle is that there is a better indicator of generalized tension than the frontalis, the right biceps brachii. The frontalis muscle was examined in the present study based upon high test-retest reliability, .95 (Arena, Blanchard, Andrasik, Cotch, & Meyers, 1983; Waters, Williamson, Bernard, Blouin, & Faulstich, 1987). Additionally the muscle was chosen because it was not directly involved in the cycling activity, thereby reducing artifacts produced by the activity. Blais and Vallerand (1986) reported that the frontalis is correlated with psychological measures of anxiety and is less affected by posture and gravity than other muscles. Furthermore, biofeedback training studies have shown significant reductions in frontalis muscle tension and improved performances (Sabourin & Rioux, 1979; French, 1978; Zaichowsky, Dorsey, & Mulholland, 1979) after biofeedback training.

Significant correlations between psychological and physiological measures were found in the noncompetition condition. Several explanations must be offered to account for the lack of significant correlations between psychological and physiological measures during the success and failure conditions.

Deffenbacher (1980) stated that perceived physiological responses (e.g. somatic anxiety) and physiological responses (e.g. heart rate, muscle tension) should not be considered synonomous because they affect performance differently. Apparently, perceived physiological arousal and actual physiological arousal may be separate components that are differently affected within competitive situations.

The design of the present experiment may also have influenced the results. The repeated measures design required subject participation over three days. Daily variations in emotional states of the subjects may have influenced the results. Additionally, the reapplication of electrodes from condition to condition may have resulted in slight variations in the actual site recorded.

Another problem that exists is that electromyography records muscle activity, or arousal, which may not actually be anxiety. In the present study, high levels of physiological arousal (e.g. heart rate) may have resulted due to the task demands, therefore, subjects may have interpreted physiological arousal as perceived physiological arousal (e.g. somatic anxiety).

Another possible explanation accounting for the lack of correlations among psychological and physiological measures of anxiety may be due to individual response stereotypy (Lacey, Bateman, & Van Lehn, 1953). Individuals tend to *respond differently in response to stress, some individuals may be heart rate responders while others are muscle tension responders. In the present study, the frontalis may have been a good indicator for some subjects due to the large amount of variance observed in the failure condition.*

Lastly, several researchers have questioned the validity of the frontalis muscle as an indicator of general muscular tension (Alexander, 1975; McGowan, Haynes, & Wilson, 1979; Nidever, 1959). Nidever (1959) performed a factor analytic study of general muscular tension in twenty-three muscles of the body. Nidever's (1959) findings showed that the frontalis muscle is one of four muscles that does not appear to be an indicator of overall body tension at rest. The biceps brachii of the right arm rated as the highest common tension factor. Graham, Cook, Cohen, Gerkovich, Phelps, and Fotopoulos (1986) provided evidence that frontalis EMG activity is responsive only to changes in head and neck muscles and does not correlate with exercise induced changes in muscular tension in the rest of the body. Therefore, the frontalis muscle may not be a valid indicator of general body tension, resulting in low correlations with psychological measures of anxiety.

Changes in Psychological and Physiological Measures Across Time and Conditions.

The results of the present study revealed that competitive state anxiety changes across time and within different competitive conditions.

Cognitive worry decreased from precompetition to postcompetition in the success condition possibly as a result of positive feedback given to the subject about his performance. In the failure condition, cognitive worry significantly increased from precompetition to postcompetition possibly as a result of the negative feedback about performance. These findings support the hypothesis of Martens et al. (1983) that cognitive worry changes when failure occurs or performance expectations change.

Somatic anxiety was significantly higher in the success condition than in the noncompetition condition, possibly as a result of situational variables associated with the competition (e.g. social and self-evaluation, outcome uncertainties, the opponent's ability).

In each condition, somatic anxiety increased from precompetition to midcompetition and from precompetition to postcompetition. These results do not corroborate the findings of Karteroliotis and Gill (1987) who found that somatic anxiety decreased significantly at postcompetition. A possible explanation for the increase in somatic anxiety in each condition may lie in the demands of the task. Specifically, the task required an all out effort for two 45 sec trials. The 45 sec trial may not have allowed sufficient time for arousal levels to decrease *and what may appear as somatic anxiety may actually be heightened levels of actual physiological arousal, e.g.,increased heart rate, rather than perceived somatic anxiety.*

Self-confidence significantly decreased over time in the noncompetition condition, possibly as a result of an increase in uncertainty of what constitutes a good performance. The subject performed alone and perhaps as a result of uncertainties about the outcome of his performance his self-confidence decreased. The subject's only source of evaluation was the score on the scoreboard and information was not available regarding an opponent's score nor feedback from the experimenter.

Self-confidence significantly decreased from precompetition to postcompetition in the failure condition. This result is consistent with Martens et al. (1983) prediction of a decrease in self-confidence as a result of failure. Self-confidence probably decreased as a result of negative feedback provided to the subject during the failure condition. The negative feedback may be perceived as threatening information, indicating possible negative evaluation by others, resulting in a lack of confidence in their ability to perform successfully in later situations (Scanlan, 1977).

The temporal changes in cognitive worry, somatic anxiety, and self-confidence supported the prediction that state anxiety is a multidimensional construct that changes over time and conditions. If state anxiety was unidimensional, each subcomponent would have shown similar fluctuations during the competition; rather, each displayed different changes over time. Success and failure experiences and feedback are powerful influences on state anxiety that serve to alter anxiety levels as well as performance expectancies.

Relationships Among Psychological and Physiological Measures and Performance

The results of this investigation revealed no support for the prediction that state anxiety components are differentially related to performance. Additionally, no support was found for the predicted linear or curvilinear relationships between anxiety and performance. The frontalis EMG relationship was best explained by a positive linear trend.

Other studies have supported relationships among anxiety measures and performance. For example, Burton (1988) reported significant correlations between cognitive worry and self-confidence with performance. A possible explanation for no correlation between anxiety and performance in this investigation may be the simplicity of the task (Landers & Boutcher, 1986). The task was not cognitively demanding nor did the task require complex motor skills, therefore limiting performance impairment as a result of anxiety. Additionally, the contrived competitive situation did not induce high levels of anxiety. Anxiety levels in the present study were lower than state anxiety levels reported by Gould et al. (1987), Karteroliotis and Gill (1987) and Martens et al. (1983).

Gould et al. (1987) reported a curvilinear trend for the somatic anxiety-performance relationship and a negative linear trend for the self-confidence-performance relationship. Burton (1988) reported a negative linear trend for the cognitive worry-performance relationship, a curvilinear trend for the somatic anxiety-performance relationship and a positive linear trend for the self-confidence-performance relationship. Differences in the results reported by Gould et al. (1987) and Burton (1988) can probably be attributed to different tasks, pistol shooting versus swimming.

A possible explanation for the lack of significant findings among anxiety and performance in the present study may be due to the fact that performance scores, unlike psychological variables, did not significantly change over time or conditions. The short duration of the task may not have allowed sufficient time for the task to be affected by high levels of state anxiety. Landers and Boutcher (1986) suggested that task complexity also affects the *anxiety-performance relationship. The low complexity cycling task in the present study was not cognitively demanding, did not require fine neuromuscular control, and did not involve a changing perceptual field. Therefore, the short duration, low complexity cycling task performed in a lab setting may not be affected by changes in state anxiety as much as pistol shooting performances or tennis performances. Additionally, variables other than performance scores may influence competitive state anxiety to a greater extent (e.g., social and self-evaluation, opponent). Furthermore, since the task was relatively imple and short, it is possible that scores could not have improved or deteriorated greatly. In essence, there may have been a floor or ceiling effect for performance scores.*

Several additional explanations must be offered in presenting the results of this study. The design of this investigation may have had an affect on the results observed or not observed. Specifically, knowledge of results from a previous trial may have influenced anxiety and performance scores in a subsequent condition. Also, the analyses employed in the experiment did not account for possible sequence or carry over effects occurring. The study also used five different confederates to compete against the opponent, thus conditions may have differed from one another in terms of the amount of anxiety produced as a result of subjects' perceptions of the confederates.

Lastly, the use of a self-report measure of competitive state anxiety may have influenced the results. Subjects may have answered questionnaires in a manner they felt was socially desirable rather than reflective of their actual feelings.

Thus, the relationship between anxiety and performance still remains elusive. Further research should attempt to discern the influences of success and failure on performances within actual competitive settings. Additionally, characteristics of the task (e.g. short duration, high complexity) or sport (e.g. softball, weight lifting) analyzed should be considered due to the potential differing influences upon performance.

Conclusions

Within the limits of the study, competitive state anxiety is a multidimensional construct composed of separate interrelated components, cognitive worry and somatic anxiety. Changes in state anxiety also influence a third variable, self-confidence. Trait anxiety correlated with state anxiety in the noncompetition condition. No significant correlations were found among trait anxiety and state anxiety during the success and failure conditions Psychological measures of anxiety did not significantly correlate with physiological measures of anxiety. Results analyzing changes in competitive state anxiety across time and conditions revealed that competitive state anxiety *differently changed over time (pre-, mid-, post-) and condition (noncompetition, success, failure). An intraindividual polynomial trend analysis (Burton, 1988; Sonstroem & Bernardo, 1982) revealed no significant linear or curvilinear trends between anxiety and performance. The frontalis EMG-performance relationship was best explained as a positive linear trend.*

Recommendations for Future Research

1. Further examination of the temporal changes in anxiety in different tasks, i.e. complex vs. simple, or short duration vs. long duration.

2. Replication of the present investigation employing different physiological measures, i.e. another muscle group, heart rate.

3. An examination of the anxiety-performance relationship with respect to individual differences such as competitive orientations, win (outcome) vs. goal (performance) oriented.

4. Examination of the anxiety-performance relationship within an actual sport context, outside the lab, in order to obtain several different performance measures.

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APPENDICES

APPENDIX A

INFORMED CONSENT

The purpose of this project is to examine reactions to competitive activities.

You will be asked to complete a stationary bicycle task against an opponent on three separate occasions. On two occasions you will be competing against an opponent. A partition will be separating you and your opponent. Each session will be comprised of a 45 sec ride, a two minute break, and another 45 sec ride. You will be asked to ride as fast as you can for 45 sec to get a high score. Your score will be displayed on a scoreboard during the trial. Questionnaires will be administered on the first day of testing and prior to competition, at midcompetition, and immediately following the competition. Surface electrodes designed to measure muscular activity will be applied to your forehead. The skin under the electrodes will be prepared by cleansing the skin with alcohol. Application of the surface electrodes does not involve any discomfort to you.

You will be asked to pedal the stationary bike as fast as you can for a two 45 sec periods each session. It is very unlikely that you will experience any discomfort during the trials. However, if you feel any type of discomfort, pain, nausea, dizziness or difficulty in breathing, please let the experimenter know immediately so *that the trial can be stopped.*

I understand that the data derived from participation in the project will remain confidential. Your questionnaires and results will be assigned a code number and processed using these code numbers. I will be informed of the results of my trials, but I will not be identified in any way in any subsequent presentation or publication of results of the study.

I have been completely informed and understand the nature and purpose of study. I understand that if any questions arise concerning the procedures or purpose of the study, the researchers will answer them. I understand that I will be able to withdraw from the study at any time.

I understand that the regulations of the state prohibit Kansas State University from carrying insurance for financial compensation in the event of physical injury resulting from the testing. I understand the procedures involved, and voluntarily consent to be a participant. I am between the ages of eighteen and thirty and have no known history of heart disease or medical conditions that prevent me from performing the task described above.

*Signature:*__________________________

*Date:*__________________________

*Age:*__________

APPENDIX B

SPORT COMPETITION ANXIETY TEST
FORM A

Directions: Below are some statements about how persons feel when they compete in sports and games. Read each statement and decide if you HARDLY-EVER, or SOMETIMES, or OFTEN feel this way when you compete in sports and games. If your choice is HARDLY-EVER, blacken the square labeled A, if your choice is SOMETIMES, blacken the square labeled B, and if your choice is OFTEN, blacken the square labeled C. There are no right or wrong answers. Do not spend too much time on any one statement. Remember to choose the word that describes how you usually feel when competing in sports and games.

	Hardly-Ever	Sometimes	Often
1. Competing against others is socially enjoyable.	A ☐	B ☐	C ☐
2. Before I compete I feel uneasy.	A ☐	B ☐	C ☐
3. Before I compete I worry about not performing well.	A ☐	B ☐	C ☐
4. I am a good sportsman when I compete.	A ☐	B ☐	C ☐
5. When I compete I worry about making mistakes.	A ☐	B ☐	C ☐
6. Before I compete I am calm.	A ☐	B ☐	C ☐
7. Setting a goal is important when competing.	A ☐	B ☐	C ☐
8. Before I compete I get a queasy feeling in my stomach	A ☐	B ☐	C ☐
9. Just before competing I notice my heart beats faster than usual.	A ☐	B ☐	C ☐
10. I like to compete in games that demand considerable physical energy	A ☐	B ☐	C ☐
11. Before I compete I feel relaxed.	A ☐	B ☐	C ☐
12. Before I compete I am nervous.	A ☐	B ☐	C ☐
13. Team sports are more exciting than individual sports.	A ☐	B ☐	C ☐
14. I get nervous wanting to start the game.	A ☐	B ☐	C ☐
15. Before I compete I usually get up tight.	A ☐	B ☐	C ☐

APPENDIX C

COMPETITIVE STATE ANXIETY INVENTORY-2

Directions: A number of statements which athletes have used to describe their feelings before competition are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel right now-at this moment. There are no right or wrong answers. Do not spend too much time on any one statement, but choose the answer which describes your feelings right now.

	Not at All	Somewhat	Moderately So	Very Much So
1. I am concerned about this competition	1	2	3	4
2. I feel nervous	1	2	3	4
3. I feel at ease	1	2	3	4
4. I have self-doubts	1	2	3	4
5. I feel jittery	1	2	3	4
6. I feel comfortable	1	2	3	4
7. I am concerned that I may not do as well in this competition as I could,	1	2	3	4
8. My body feels tense	1	2	3	4
9. I feel self-confident	1	2	3	4
10. I am concerned about losing	1	2	3	4
11. I feel tense in my stomach	1	2	3	4
12. I feel secure	1	2	3	4
13. I am concerned about choking under pressure	1	2	3	4
14. My body feels relaxed	1	2	3	4
15. I'm confident I can meet the challenge	1	2	3	4
16. I'm concerned about performing poorly	1	2	3	4
17. My heart is racing	1	2	3	4
18. I'm confident about performing well	1	2	3	4
19. I'm worried about reaching my goal	1	2	3	4
20. I feel my stomach sinking	1	2	3	4
21. I feel mentally relaxed	1	2	3	4
22. I'm concerned that others will be disappointed with my performance	1	2	3	4

	Not at All	Somewhat	Moderately So	Very Much So
23. My hands are clammy	1	2	3	4
24. I'm confident because I mentally picture myself reaching my goal	1	2	3	4
25. I'm concerned I won't be able to concentrate	1	2	3	4
26. My body feels tight	1	2	3	4
27. I'm confident of coming through under pressure	1	2	3	4

APPENDIX D

Counterbalanced Experimental Design

Subjects				Conditions 1	2	3
1	7	13	19	NC	S	F
2	9	15	21	S	F	NC
3	11	17	23	F	NC	S
4	8	14	20	NC	F	S
5	10	16	22	S	NC	F
6	12	18	24	F	S	NC

APPENDIX E

DEBRIEFING

At the completion of testing, the subjects will be debriefed in the following manner:

1.) Subjects will be informed that their scores were manipulated and be shown how this was accomplished. In addition, following the verbal explanation will be read to each subject.

> *In order to accurately assess anxiety changes during competition, we had to make sure that you felt you were winning (losing) in the bicycle competition. The scores you saw on the scoreboard were not your actual scores. We were able to adjust your score so that your score would be higher (lower) than your opponent's score. Demonstrate manipulation by pedaling pedals.*

2.) After the subject has been debriefed regarding the manipulation of scores, the researcher will determine the subject's feelings about the manipulation.

> *Now that you know that the scoreboard indicated that you won (lost), you might have actually won (lost), how do you feel about this? Does it bother you that your actual score was not registered?*

If the subject exhibits discomfort with the manipulation, the researcher will explain that the subject was not the only one who was involved in the study and who was placed in this situation. The subject will be told that the score he received was biased and is not reflective of his actual ability.

4.) Subjects will be told that iEMG values were recorded *from the frontalis muscle to measure physiological anxiety or arousal.*

5.) Subjects will be told that they were competing against a confederate. The confederate knew the subject would win or lose prior to the start of the competition. The confederate was necessary to ensure control of the experimental conditions, success and failure.

6.) The researcher will offer to answer any questions.

7.) Results of the study will be made available to subjects. The subjects will be asked not to discuss the nature of the study with others until testing is completed. The researcher will then thank the subject for participation in the experiment.

PSYCHOLOGICAL AND PHYSIOLOGICAL CHANGES IN COMPETITIVE STATE ANXIETY DURING A CYCLING TASK

by

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Abstract

This study examined the relationships among components of the Competitive State Anxiety Inventory-2; somatic anxiety, cognitive worry, and self-confidence, to each other, to trait anxiety, to physiological measures, and to performance prior to, during, and after competition. Twenty-four male subjects participated in three counterbalanced conditions: a) noncompetition, b) success, and c) failure. Subjects completed two 45 sec trials on a stationary bike in each condition. Each subject competed against a confederate in the success and failure conditions. Competitive state anxiety was assessed at pre-, mid-, and postcompetition in each condition by use of the CSAI-2 (Martens et al., 1983). Frontalis muscle activity was recorded while the subject completed the questionnaire. Results revealed that competitive state anxiety is a multidimensional construct composed of correlations among cognitive worry, somatic anxiety, which influence a third variable, self-confidence. Trait anxiety as assessed by SCAT (Martens, 1977) correlated with state anxiety in the noncompetition condition. No significant correlations were found among trait and state anxiety either during the success or failure conditions. Results revealed that psychological measures of anxiety were not significantly correlated with the physiological measure of anxiety, frontalis EMG, during the success and failure

conditions. An intraindividual regression analysis revealed no significant linear or curvilinear trends between cognitive worry, somatic anxiety, or self-confidence with performance. The frontalis EMG-performance relationship was best explained by a linear trend. In conclusion, competitive state anxiety is a multidimensional construct composed of interrelationships among cognitive worry, somatic anxiety, and self-confidence. Trait anxiety correlated with state anxiety components during noncompetition but not in the success or failure condition. Psychological and physiological measures of competitive state anxiety were only correlated at noncompetition. Additionally, there was no discernable linear or curvilinear trend between cognitive worry, somatic anxiety, or self-confidence with performance. The frontalis EMG-performance relationship was best explained by a linear trend. Results revealed that psychological and physiological changes in competitive state anxiety displayed different changes over time and within different conditions. Future research should include replication of the present study using other physiological assessments, and examine the anxiety-performance relationship with respect to different competitive orientations, win oriented vs. goal oriented.