Influences of anxiety on golf performance:

A field test of catastrophe theory

A Dissertation Presented to

the Faculty of the Graduate School

University of Missouri - Columbia

In Partial Fulfillment of

the Requirements for the Degree

Doctor of Philosophy

By
Marshall Robb

Dr. Richard H. Cox, Dissertation Supervisor

December 2005

The undersigned, appointed by the Dean of the Graduate School, have examined the dissertation entitled

INFLUENCES OF ANXIETY ON GOLF PERFORMANCE:
A FIELD TEST OF CATASTROPHE THEORY

presented by Marshall Robb

a candidate for the degree of Doctor of Philosophy

and hereby certify that in their opinion it is worthy of acceptance.

Richard H. Cox
Dr. Richard H. Cox

Tom R. Thomas
Dr. Tom R. Thomas

Richard T. McGuire
Dr. Richard T. McGuire

H S Bhullar
Dr. Hardeep S. Bhullar

Kristofer J Hagglund
Dr. Kristofer Hagglund

The undersigned, appointed by the Dean of the Graduate School, have examined the dissertation entitled

INFLUENCES OF ANXIETY ON GOLF PERFORMANCE:
A FIELD TEST OF CATASTROPHE THEORY

presented by Marshall Robb

a candidate for the degree of Doctor of Philosophy

and hereby certify that in their opinion it is worthy of acceptance.

Dr. Richard H. Cox

Dr. Tom R. Thomas

Dr. Richard T. McGuire

Dr. Hardeep S. Bhullar

Dr. Kristofer Hagglund

ACKNOWLEDGEMENTS

I would like to express sincere gratitude to everyone who helped make this doctoral dissertation possible: to Dr. Richard H. Cox, my advisor, for his guidance, patience, and instruction throughout the entire dissertation and coursework process; to all of my doctoral committee members – Dr. Tom Thomas, Dr. Rick McGuire, Dr. Hardeep Bhullar, and Dr. Kristoffer Hagglund – for their patience, support and direction over the course of my doctoral study; to my friends – Mike Watson, Edward Easterling, Rob Wetzel, Dan Burke, and Mike Paden – for their support and accountability; to my wife, Cindy, who encouraged me, loved me, and supported me throughout this process; my children, Ellen and Stuart, for their patience and love; and finally to my parents, J. C. and Patti Robb, whose love and support made my education possible and developed my love for the game of golf.

INFLUENCES OF ANXIETY ON GOLF PERFORMANCE:

A FIELD TEST OF CATASTROPHE THEORY

Marshall Robb

Dr. Richard H. Cox, Dissertation Supervisor

ABSTRACT

The purpose of this study was to test the basic tenets of Fazey and Hardy's (1988) catastrophe model. Specifically, the purpose was to examine the interaction effects of cognitive anxiety (worry) and physiological arousal (activation) on golf performance. Previous research has had difficulty in assessing the basic constructs of the catastrophe because of the lack of independence between arousal and cognitive anxiety. Four amateur golfers were tested using the Sport Grid-Revised (Ward & Cox, 2001) in competitive play. The Sport Grid-Revised is the most reliable measurement inventory available for catastrophe theory assessment. Physiological arousal and cognitive anxiety ratings as well as performance measures were collected prior to each golf shot taken in four competitive rounds for each of the participants. Multiple regression procedures were utilized to analyze the data.

In the linear analyses of all participants, it can be observed that Wor has a significant negative effect on golf performance. This would lead to support of Martens' et al. (1990) multidimensional theory. Also, in the linear analyses, it is noticed that activation is a positive or neutral effect for the higher skilled golfers. Participant 1's (male, high skill) activation score yielded a positive beta and Participant 3's (female, high skill) activation

score yielded a very slight negative beta. A better skilled golfer is able to cope with increased activation (Spence, 1956).

No evidence for catastrophe theory was observed in the analyses of the full model of all participants. In order for catastrophe theory to be supported, a significant quadratic relationship between activation (Act) and performance must be observed and a significant interaction between the variables, Act and Wor (Act/Wor).

In all of the participants, increased worry (Wor) is associated with a decrement in performance and activation is associated with a curvilinear relationship to performance in all participants, except participant 3 (female, high skill). In only one case (female, low skill) was the interaction variable (Act/Wor) significant. In order for the catastrophe theory to be verified the interaction variable must be significant and the quadratic of activation (Act^2) must be significant. In this case, an interaction is observed in Figure 10. But, in Figure 10 you would expect a drop in performance on the high activation line as worry increases. Instead, we see an increase in performance. There is a drop in performance on the low activation line as worry increases, but that is predicted in the multidimensional theory of anxiety (Martens et al., 1990).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Influences of Anxiety on Golf Performance:

A Field Test of Catastrophe Theory

As a participant in the 2000 United States Golf Association Senior Amateur tournament, celebrity Maury Povich experienced the effects of anxiety on his golf game. After shooting a respectful 74 in the first round and cruising the next day at one under through No. 11, Povich sandwiched a double and triple bogey around two bogeys. He commented on the pressure he experienced during the second round, "It was like I went from a decent player to a hacker in four holes. I hit a very bad second shot on 12 and from there on I didn't know where I was" (Skyzinski, 2000). This is an example of the effect competitive state anxiety can have on a sport performer.

Competitive anxiety and the effect it can have on a participant in sport performance has been the source of many research investigations (Burton, 1988; Krane & Williams, 1987; Martens, Burton, Vealey, Bump, and Smith, 1990). How an athlete copes with competitive anxiety and how it affects his performance is important for the success of that athlete. It is important to help athletes reach a level of precompetitive arousal that will result in the best possible performance and also minimize harmful anxiety. Additionally, coaches and athletes could benefit from research that clarifies the relationship between competitive anxiety and performance.

The sport of golf is an activity that induces different levels of competitive anxiety and arousal in athletes (Cook, Gansneder, Rotella, Malone, Bunker, & Owens, 1983). It is common for amateur golfers to play poorly when the pressure is on and when the athlete experiences high levels of anxiety (Raedeke & Stein, 1994). It is important to understand the result of increased anxiety and the influence the anxiety has on performance.

The relationship between arousal and performance has been analyzed from a number of perspectives. Recent attention has been focused on the multidimensional theory of anxiety. Martens, Burton, Vealey, Bump, and Smith (1990) proposed multidimensional theory of anxiety as a means of explaining the anxiety/performance relationship. The investigators argued that anxiety could be divided into mental (cognitive) and physical (somatic) components. Cognitive anxiety is considered to be the negative concerns and self-doubts in relation to performance. Somatic anxiety is concerned with the perceptions of physiological response to psychological stress. (i.e. sweaty palms, pounding heart, etc.) In the multidimensional theory, each type of anxiety is believed to act independent of the other.

Somatic anxiety is a conditioned response that should decrease as the competition begins. Sweaty palms and “butterflies” in the stomach tend to dissipate once the participant is involved in the competition. Cognitive anxiety deals with negative concerns of performance and should only change when the probability of success changes (Hardy, 1990). Based on these findings Martens et al. (1990) proposed that cognitive anxiety would have a negative relationship with performance and somatic anxiety would have a curvilinear relationship with performance. It is theorized that cognitive anxiety is the component that most strongly influences performance (Burton, 1988; Gould, Petlichkoff, Simons & Vevera, 1987; Gould, Petlichkoff & Weinberg 1984).

Several studies have engaged polynomial regression analysis to observe the relationship between the different components of competitive state anxiety and performance on the day of an event (Gould, Petlichkoff, & Weinberg, 1984; Burton, 1988). These studies have indicated a negative linear relationship between cognitive anxiety and performance. Also, an inverted-U shaped relationship between somatic anxiety and performance has been shown. Inconsistencies have been indicated in the effects of cognitive anxiety when somatic anxiety was high (Parfitt, Jones, & Hardy, 1990). These inconsistencies could be explained by an interaction between cognitive anxiety and somatic anxiety. This would explain that cognitive anxiety has a harmful effect upon performance when somatic anxiety is high on the day of an important contest, but a positive effect upon performance when somatic anxiety is low during the days prior to an important contest (Hardy, Parfitt, & Pates, 1994).

Craft et al. (2003) utilized a meta-analysis to explore all the studies that have examined the multidimensional theory through the use of the Competitive State Anxiety Inventory-2 (CSAI-2). They found weak relationships between cognitive anxiety, somatic anxiety, self-confidence and performance. The analysis did display that self-confidence was the strongest and most consistent predictor of performance.

The major dilemma of the multidimensional theory of anxiety is that it attempts to explain the interaction of cognitive anxiety, somatic anxiety and performance in two separate two-dimensional relationships. Multidimensional theory (Martens et al., 1990) makes predictions only about the separate relationships between cognitive anxiety and performance, and somatic anxiety and performance. What is not understood is an explanation of how cognitive and somatic anxieties interact to influence performance (Hardy et al., 1994).

Fazey and Hardy (1988) developed a catastrophe model that ties together the relationship of physiological arousal and cognitive anxiety on performance. Thom (1975) first developed catastrophe theory as a way of explaining discontinuous models that were normally continuous. Zeeman (1976) popularized catastrophe theory by applying the principles to behavioral sciences. Basically the catastrophe theory supports the multidimensional theory of anxiety. However, instead of analyzing cognitive anxiety and physiological arousal independently, catastrophe theory attempts to explain the interaction of cognitive and physiological arousal and their subsequent effect on performance (Fazey & Hardy, 1988).

The most common of the seven fundamental catastrophe models to be studied is the “cusp catastrophe”, illustrated in Figure 1 (Hardy & Parfitt, 1991). Fazey and

---

Insert Figure 1 about here

Hardy’s (1988) “cusp catastrophe” model is a three-dimensional model consisting of four surfaces. The four surfaces of the catastrophe model demonstrate distinct interactions between cognitive anxiety and physiological arousal in association to performance. The catastrophe model contains perpendicular x, y, and z axes. Physiological arousal is denoted as the x-axis and runs horizontally along the lower back wall of the model. Cognitive anxiety, the y-axis, runs perpendicular to physiological arousal and runs along the lower left side of the model. Cognitive anxiety is referred to as the splitting factor. Performance is denoted as the z-axis and is the height of the performance surface. For every x-y coordinate (somatic and cognitive anxiety interaction), represented on the floor of the model, there is a performance measure z, directly above it (Durr & Cox, 1997).

Catastrophe theory proposes that cognitive anxiety acts as the splitting factor that determines whether the effect of physiological arousal will be small and smooth, large and catastrophic or somewhere between these two extremes (Fazey & Hardy, 1988). Stated in statistical terms, cognitive anxiety is conceptualized as a moderator of the relationship between physiological arousal and performance. When cognitive anxiety is low the model predicts that the relationship between physiological arousal and performance should be uniform or inverted-U shaped. When physiological arousal is high on the day of competition, the model predicts a negative correlation between high cognitive anxiety and performance. When physiological arousal is low during the days prior to competition, the model predicts that cognitive anxiety should lead to enhanced performance. Finally, when cognitive anxiety is elevated, the model predicts that the effect of physiological arousal upon group performance could be either positive or negative depending on how high cognitive anxiety reaches (Hardy, 1990).

A key component of the catastrophe theory is the concept of hysteresis. Under conditions of high cognitive anxiety, performance will follow a different path when physiological arousal is increasing to the path than it follows when physiological arousal is decreasing. This is demonstrated on the front face of the model. When an athlete’s cognitive anxiety is high and physiological arousal increases to a critical level, a catastrophe in performance is expected. To return to the pre-catastrophe level of performance, physiological arousal will need to be reduced to a level below when the catastrophe originally occurred. This is hysteresis. When cognitive anxiety is low, hysteresis will not occur and the physiological arousal – performance curve will follow the same path whether physiological arousal is increasing or decreasing. This is represented on the back face of the model (Hardy et al., 1994). The concept of hysteresis is also demonstrated by Maury Povich in the 2000 U.S. Senior Amateur Golf Championship when he was cruising along in his round and suddenly had a number of bad holes in a row before he settled back down (Skyzinski, 2000).

Summarizing catastrophe theory, Fazey and Hardy (1988) proposed four hypotheses:

1. Physiological arousal and the associated somatic anxiety are not necessarily detrimental to performance. However, they will be associated with catastrophic effects when cognitive anxiety is high.
2. Hysteresis will occur under conditions of high cognitive anxiety. That is to say, performance will follow a different path when physiological arousal is increasing compared to the path it follows when physiological arousal is decreasing. Hysteresis will not occur under conditions of low cognitive anxiety.
3. Intermediate levels of performance are most unlikely in conditions of high cognitive anxiety. More precisely, performance should be bimodal under conditions of high cognitive anxiety and unimodal under conditions of low cognitive anxiety.
4. It should be possible to fit precise “cusp catastrophes” to real-life data.

Hardy et al. (1994) using crown green bowlers examined these concepts. Cognitive anxiety was manipulated by testing participant’s 2 days before and 2 days after an important tournament. Physiological arousal was used instead of somatic anxiety and was controlled by elevating and lowering the heart rate through exercise. They analyzed their data using a 2 x 2 x 5 repeated-measures ANOVA. The ANOVA revealed the predicted three-way interaction of cognitive anxiety, heart rate, and the direction of change in heart rate upon performance, with follow-up tests indicating that the interaction was due to hysteresis occurring in the high cognitive anxiety condition but not in the low cognitive anxiety condition. However, the results did not provide clear support for the catastrophe model of anxiety and performance.

Hardy and Parfitt (1991) also studied the catastrophe theory using eight female, collegiate basketball players. Physiological arousal was manipulated while the basketball players performed a set shooting task under varying conditions of high and low cognitive anxiety. The data was analyzed using curve-fitting procedures and other tests of significance In general they found support for the catastrophe theory, however, their conclusions did not support the view that cognitive anxiety is the only significant predictor of performance.

Edwards et al. (2002) used a qualitative analysis approach to investigating the catastrophe model on eight elite performers. The performers were asked structured questions to explore their catastrophic experiences during competition. Both inductive and deductive approaches were utilized in the study. The inductive approach allows for themes and categories to emerge from the interviews. The deductive approach has pre-determined questions in the investigation. From the analysis, two higher order dimensions were identified, “sudden, substantial drop in performance” and “ performance continued to deteriorate.” This is in direct support of the catastrophe model, in that, performance decrements do not follow a smooth and continuous path.

A major concern in examining catastrophe theory is the relationship of physiological arousal to somatic anxiety. Can somatic anxiety replace physiological arousal in the model? Physiological arousal has been defined in terms of level or intensity, such as a universal physiological and psychological initiation of the organism that varies on a continuum from deep sleep to intense excitement (Gould & Krane, 1992). The classic 'fight or flight' response to threatening environmental stimuli is what is best thought of as physiological arousal. Fazey and Hardy (1988) argued that this response might be partially reflected by somatic anxiety, or other indicators of arousal. However, the peculiarities of different situations, physiological subsystems and task demands could apply to specific deviations from the comprehensive response of any physiological indicators.

There is disagreement among researchers on the correlation of physiological arousal and somatic anxiety. Studies have attempted to link the relationship of these two parameters. Some studies show that physiological arousal (as measured by heart rate) and somatic anxiety show a similar time course, making physiological arousal a strong indicator of somatic anxiety (Parfitt et al., 1990; Hardy & Parfitt, 1991). Although these studies have shown that physiological arousal follow a similar time course, there are important differences regarding the means by which physiological arousal and somatic anxiety might play a role in performance. Physiological arousal could cause direct effects on performance through the limiting of resources (hormones and blood flow) to performers (Hockey & Hamilton, 1983). Physiological arousal, which is associated with anxiety, has been shown to continue to fluctuate during performance (Baddeley and Idzikowski, 1983). Fazey and Hardy (1988) argued that this response might be partially reflected by somatic anxiety, or other physiological indicators of arousal. This causes a problem in the relationship of physiological arousal and somatic anxiety, in that somatic anxiety is hypothesized to dissipate once performance begins (Martens, et al., 1990).

Fazey and Hardy (1988) selected cognitive anxiety as the splitting factor in their cusp catastrophe model and physiological arousal as the normal factor. They projected that cognitive anxiety determines whether performers interpret their physiological arousal positively or negatively, thereby determining whether the effects of physiological arousal upon performance will be small and continuous, large and catastrophic, or somewhere in between these two extremes. The model allows the likelihood of physiological arousal exerting both direct and indirect effects upon performance (Hardy et al., 1994).

A study by Durr and Cox (1997) attempted to examine the catastrophe theory using a somatic anxiety inventory to explain physiological arousal and their interactive effect on diving performance. This study had limited success in explaining the relationship of cognitive and somatic anxiety on performance. It is possible that somatic anxiety is too closely related to cognitive anxiety to be able to measure the tenets independently (Durr & Cox, 1997). This brings in another possible problem. For the catastrophe model to be effective, there should be a low correlation between the independent variables (physiological arousal and cognitive anxiety). In the study by Durr and Cox (1997), cognitive anxiety and somatic anxiety were shown to have a high correlation ($r = .745$). This high correlation violates the basic assumption of catastrophe theory that the two constructs in the model that predict performance are independent of each other.

Hardy et al. (2004) proposed that self-confidence might play a role in the relationship with stress and performance. The butterfly catastrophe model (Hardy, 1996a) is an extension of the basic cusp catastrophe model that consists of two other dimensions, a bias factor and a butterfly factor. The bias factor will move the cusp forward in the model and also to the left or to the right. Hardy (1990, 1996a) has considered that self-confidence might be the bias factor in the butterfly catastrophe model. Self-confidence is proposed to shift the cusp to the right in conditions of high self-confidence and to the left in conditions of low self-confidence. Hardy et al. (2004) tested this proposal on eight male golfers prior to teeing off on each golf hole of an 18-hole golf tournament. The golfers were instructed on how to use the CSAI-2 measurement tool for assessing cognitive state anxiety, somatic state anxiety and self-confidence. During the training session the subjects filled out original CSAI-2's with respect to prior performances. This was performed to teach the subjects to provide a single-integer score for each of the subscales (Likert score 0-27). During the actual testing, subjects would provide a single score on each subscale prior to teeing off on each hole. The single score CSAI-2 and the full CSAI-2 had Pearson correlation coefficients of $r = 0.67$ for cognitive anxiety, $r = 0.72$ for somatic anxiety and $r = 0.80$ for self-confidence. After analysis of the data through a series of two-way (Cognitive Anxiety x Somatic Anxiety) analysis of variance's (ANOVA). The maximum interaction effect was analyzed at varying levels of self-confidence. The ANOVA's supported the moderating role of self-confidence in the butterfly cusp catastrophe model (Hardy et al., 2004). This method of assessing pre-competitive anxiety is an interesting alternative to the field. It is problematic for catastrophe model, in that it still assesses somatic anxiety and not physiological arousal.

Accurate assessment of an athlete's anxiety is imperative to investigation of anxiety/performance relationships. Sport psychology anxiety researchers have developed different methods of measurement of sport-specific anxiety. Martens et al (1990) developed the Competitive State Anxiety Inventory-2 (CSAI-2) to assess an athlete's disposition before performance. The CSAI-2 is a twenty-seven-item inventory that assesses cognitive anxiety, somatic anxiety and self-confidence. Each subscale includes nine questions and the inventory provides reliable measures. The major limitation of the CSAI-2 inventory is amount of time to administer. It can take an athlete from 3 to 10 minutes to complete. Most athletes and coaches would rather not have their sport preparation time interrupted for that amount of time. Researchers suggest that anxiety studies should consider situational facets within the athletic environment related to the measures of anxiety. This is important because, during a competition, situations involving different levels of perceived importance will occur sporadically. One can suspect that the accompanying anxiety levels also will change during the course of the athletic contest. For example, in golf, each hole will present different challenges and each situation will produce varying levels of competitive anxiety (Krane, Joyce, & Rafeld, 1994). In an effort to solve this problem a number of researchers have developed less intrusive measures of competitive state anxiety.

Murphy, Greenspan, Jowdy, and Tammen (1989) developed the Mental Readiness Form (MRF) as an alternative to the CSAI-2 for measuring competitive state anxiety. The MRF assessed competitive state anxiety (cognitive and somatic) in single inventories. The original MRF consisted of a bipolar continuous scale defined with a 10-centimeter line on which subjects marked their level of affect. The athlete is to place a mark on the ruled line as to how he or she is thinking (worried --- calm), physically feeling (tense --- relaxed), or as to his or her confidence (confident --- scared). Each of the three questions corresponds with the cognitive anxiety, somatic anxiety, and self-confidence subscales of Martens et al's. (1990) CSAI-2. In Krane (1994), the MRF was modified to an 11-point Likert scale, thus providing a more systematic and accurate method for scoring cognitive anxiety, somatic anxiety and self-confidence. The same root words were used in the MRF-Likert as in the original MRF. A third version was created, MRF-3, which contained true bipolar terms (worried --- not worried; tense --- not tense; confident --- not confident). Results from Murphy et al's. (1989) study revealed that all three MRF versions exhibited concurrent validity to the CSAI-2, but the MRF-Likert or MRF-3 are preferred because of their clarity in Likert scales. The MRF-Likert and MRF-3 are considered sufficient options for the investigation of competitive state anxiety with minimal imposition of the sport situation.

In a study of collegiate softball players, Krane et al. (1994) tested the catastrophe prediction that somatic anxiety would differentially relate to performance depending upon the level of cognitive anxiety with the use of the MRF-Likert. Softball players were assessed their state anxiety every time they reached the "on deck" status using Krane's (1994) MRF-Likert. Results showed that athlete anxiety changes during performance and that somatic anxiety differentially relates to performance depending on the degree of cognitive anxiety. Somatic anxiety was found to differentially relate to performance under conditions of situation criticality lending some support to Fazey and Hardy's

(1988) catastrophe theory. The relationship of somatic anxiety and performance when cognitive anxiety was extremely high, however, was not fully explored in this study. Therefore Krane et al. (1994) did not observe a catastrophe between the anxiety measures and performance. They concluded that further research was needed on the relationship of cognitive state anxiety, somatic state anxiety, and athletic performance.

Cohen et al. (2003) employed the MRF-Likert to assess cognitive anxiety and somatic anxiety in 16 male dart throwers. Participants would throw darts after having somatic anxiety manipulated on a treadmill (hr adjustment via speed on treadmill). Utilizing a RM MANOVA to assess 18 somatic and cognitive anxiety values, the results of the study failed to support the catastrophe model.

Cox, Russell and Robb (1998, 1999, 2001) developed the Anxiety Rating Scale (ARS) as a short form for assessing competitive state anxiety during and immediately prior to competition. The ARS is meant to be a short version of the CSAI-2. The ARS was developed directly from the CSAI-2 and contains brief statements obtained from the CSAI-2 to measure cognitive state anxiety, somatic state anxiety and self-confidence. College intramural athletes were administered the CSAI-2 approximately 15 minutes prior to a game. Using the appropriate subscale score as the dependent variable and the appropriate item scores as independent variables, stepwise multiple regression was utilized to determine the best three variable predictive models. From this analysis, two independent anxiety rating scales were developed, the somatic state anxiety component (ARS-S) and the cognitive state anxiety component (ARS-C). The results of the study suggest that the ARS-somatic and ARS-cognitive are reliable predictors of competitive state anxiety and may be used as an alternative for the CSAI-2 when time is a consideration. A revision to the ARS was later made in order to improve athlete's interpretation of the items (Cox, Robb, & Russell, 2000). Construct validity was established through multiple regression and multivariate analysis of variance techniques (Cox, Robb, & Russell, 2001).

In a study by Durr and Cox (1997), swimming divers were tested using the anxiety rating scale (ARS) during several diving competitions. Divers rated their somatic and cognitive state anxiety prior to each dive during each competition. Raw scores and standardized ipsative z-scores were tested in regression models. Linear and quadratic relationships were observed between somatic anxiety and performance. The inverted-U relationship between somatic anxiety and performance was not observed. The performance results did not offer support for the catastrophe theory. The relationship of somatic anxiety and physiological arousal needs to be addressed when assessing participants' feelings. It has already been determined that somatic anxiety and arousal produce dissimilar results on performance (Hardy et al., 1994). The catastrophe model proposed by Fazey and Hardy (1988) requires using physiological arousal as the normal factor. A key component of testing the catastrophe theory would consist of a measurement tool that accurately assessed participant physiological arousal as well as cognitive anxiety independently.

In a similar attempt to develop a shortened version of the CSAI-2, Thomas et al. (2002) developed the Immediate Anxiety Measurement Scale (LAMS). Through concurrent validity testing with the MRF-3 to the criterion scale, CSAI-2, it was determined that the LAMS displayed a stronger validity than the MRF-3. The strength of the LAMS is in assessing state anxiety closer to and during competition.

The Sport Grid, as developed by Raedeke and Stein (1994), is a modified version of Russell, Weiss, and Mendelsohn's (1989) affect grid. The Sport Grid is a 9 x 9 grid. The participant places an X in the box that best describes how they feel at the moment. The vertical component measures perceived arousal level, and the horizontal component measures thoughts/feelings (cognitive anxiety). In order to place a score on the self-measurement, the scores are given by counting boxes from the bottom for the arousal score and from the left for the thoughts/feelings score. In Raedeke and Stein's (1994) study, the Sport Grid has demonstrated construct and criterion validity based on responses of 72 undergraduate athletes. In the study, the participants completed several instruments including the CSAI-2, three Likert scales measuring arousal levels, and a subjective performance rating. Sport Grid and CSAI-2 correlation were in the expected direction and range of values, thus further supporting the sport grid's construct validity ($r = .40$ and $-.47$; $p < .001$). Arousal on the Sport Grid moderately correlated ($r = .40$) with somatic anxiety. The correlation makes sense because, although somatic anxiety and arousal are both based on arousal perceptions, arousal is more inclusive than somatic anxiety. Arousal includes perceptions of arousal independent of whether those perceptions are associated with positive or negative affective states, whereas somatic anxiety refers only to the perceptions of arousal associated with negative affect. Furthermore, the Sport Grid exhibits independence between the two constructs that it measures ($r = .11$), making it potentially ideal for testing the catastrophe model (Raedeke & Stein, 1994).

The Sport Grid (Raedeke & Stein, 1994) has problems when it comes to testing the catastrophe theory, specifically the Sport Grid's inability to measure cognitive anxiety independent of self-confidence. The Sport Grid measures both cognitive anxiety and self-confidence through the "thoughts and feelings" segment. The dimension range of "extremely negative thoughts and feelings" measures cognitive anxiety and "extremely positive thoughts and feelings" measures self-confidence. Having these two diverse constructs on the same measurement makes it difficult to determine exactly what is being measured (Ward & Cox, 2001). To address the shortcoming of the Sport Grid, Ward and Cox (2001) developed a revised version of the Sport Grid (Sport Grid-R) (see figure 2).

Insert Figure 2 about here

The measurement of felt arousal was maintained on the vertical axis with the anchors being adjusted from "extremely high arousal" and "extremely low arousal" to "extremely high activation (extremely pumped-up) and "extremely low activation (extremely flat or sluggish). The reason for this change was to use more familiar terminology for athletes. The horizontal measurement now indicates cognitive anxiety rather than positive or negative thoughts/feelings. The cognitive anxiety is measured through the continuum of "not worried" to "very worried". Intramural athletes in volleyball and basketball were assessed the Sport Grid, the Sport Grid-R, and the Competitive State Anxiety Inventory-2 approximately 10 minutes before competition. Results indicated that felt arousal as measured by the Sport Grid and Sport Grid-R was not related to somatic anxiety as measured by the CSAI-2 ($r = .06$ and $r = .04$, respectively). The Sport Grid-R's measure of cognitive anxiety (worry) had a larger correlation with cognitive anxiety as measured by the CSAI-2 than did the Sport Grid's measure of thoughts/feelings ($r = .43$ versus r = -.25) and also in the same desired positive direction. Also, the correlation between cognitive anxiety and felt arousal for the Sport Grid-R was smaller, and thus less dependent, than the correlation between thoughts/feelings and felt arousal as measured by the Sport Grid (r = -.07 versus r = .13) (Ward & Cox, 2001).

In summary, Ward and Cox (2001) have developed the ideal measurement tool to accurately assess the catastrophe theory. The correlation between somatic anxiety and cognitive anxiety as measured by the ARS, MRF, and CSAI-2 are all relatively high (r = .40 - .70). For this reason, these inventories cannot be used to test catastrophe theory. The constructs of cognitive anxiety and physiological arousal are independent in catastrophe theory. If they were not, you could not have a low level of physiological arousal simultaneously with a high level of cognitive anxiety and vise versa. Therefore, to test the model you must use an instrument that can measure these two as independent measures. The attraction of the Sport Grid-R is the low correlation between cognitive anxiety and felt arousal (r = .04) and the ability to accurately measure cognitive anxiety without self-confidence influence. It is for this reason that the Sport Grid-R (Ward & Cox, 2001) will be used in this study.

Successful testing of the catastrophe theory has been associated with many problems (Cox & Durr, 1997; Krane, 1994). The primary problem being the moderately high correlation of somatic anxiety and associated physiological arousal to cognitive anxiety (r = .70 and r = .51) in the measurement tools utilized (ARS and MRF-3). The purpose of this study will be to test the catastrophe theory assumption that physiological arousal would be differentially related to golf performance depending on the level of cognitive anxiety. According to the theory, the relationship between physiological arousal and golf performance would follow an inverted-U curve when cognitive anxiety was low and constant. However, when cognitive state anxiety is high, performance will have catastrophic results when physiological arousal is increasing. In an attempt to accurately measure physiological arousal independent of cognitive anxiety, the current study will utilize the Sport Grid-R (Ward & Cox, 2001).

Specific research hypotheses to be tested are:

1.) It is predicted that the relationship between felt arousal and golf performance will take the form of the inverted-U, and that the nature of the relationship will be moderated by cognitive anxiety. Specifically, it is hypothesized that:

  a) Under conditions of low cognitive anxiety, the relationship between felt arousal and golf performance will take the form of a smooth inverted-U.

  b) Under conditions of high cognitive anxiety, the relationship between felt arousal and golf performance will be catastrophic but quadratic in nature.

2.) Fazey and Hardy (1988) do not specifically address the issue of skill level in their model. Specifically it is hypothesized that a catastrophe in performance will be more readily observed in the less skilled (higher handicapped) golfer. A gender difference is not predicted.

Method

Participants

The participants in this study were competitive amateur golfers. Four participants, two male and two female completed the process. Two of the participants were recruited from a local college varsity golf team and two were recruited from a local golf club through word of mouth advertising. One male was a low handicapper (0-5, U.S.G.A.) and the other male was a moderate to high handicapper (10-18, U.S.G.A.). One female was a low handicapper (0-8, U.S.G.A.) and the other female was a moderate to high handicapper (14-20, U.S.G.A.). A lower handicap is associated with high skill. The golfers volunteered for the study and confidentiality was maintained. The subjects signed an informed consent form and were allowed to discontinue at any point in the study.

Materials

Demographic survey. Each golfer filled out a demographic survey that included information about their age, gender, golf handicap (USGA), and years of golf playing experience.

Sport Grid-R. Cognitive state anxiety and felt arousal were measured using the relatively unintrusive Sport Grid-R (Ward & Cox, 2001). The Sport Grid-R is a 9 x 9 grid where participants assessed their cognitive state anxiety on the continuum “not worried - - - - very worried” and felt arousal on the continuum “very high activation (very “pumped-up”) - - - - very low activation (very flat or sluggish)”. The vertical continuum assesses arousal level and the horizontal continuum assesses cognitive anxiety on a 9-point scale. Ward and Cox, (2001) have showed that the Sport Grid-R constructs of felt arousal and worry are not correlated (r = -.07). They concluded that the Sport Grid-R's ability to independently measure arousal and cognitive anxiety made it an ideal instrument for testing the catastrophe model. In catastrophe theory, the constructs of cognitive anxiety and physiological arousal are independent and the Sport Grid-R is able to assess this accurately.

Golfers utilized a separate assessment sheet for each hole with 4 Sport Grid-R's per sheet. The golfer utilized this measurement tool to accurately assess their cognitive anxiety and felt arousal/activation prior to every shot. This helped to insure careful placement of each observation and its subsequent analysis with performance.

Recent researchers (Krane, 1994; Cox et al., 1998) have suggested using single question measures because of their unobtrusive nature and specifically can be administered immediately prior to performance. It was important to measure these psychological traits immediately prior to each shot in golf, because they change rapidly depending on the degree of difficulty of the shot and status of the tournament.

Rating of Performance. After each shot was played the researcher/shot evaluator evaluated the result of the shot based on the criteria shown in Table 1. The shots were

---

Insert Table 1 about here

---

evaluated on the following criteria: 3 = excellent shot, 2 = average shot, 1 = poor shot, and 0 = catastrophic shot. Examples of an excellent shot include were a long drive (+240 yds.) in the fairway, an approach shot on the green within 10 feet of the flag or a long putt (>10 ft.) made. Examples of an average shot included a short drive (<240 yds.) in the fairway, an approach shot on the green further than 10 ft. from the hole, a made short putt (<10 feet), or a close long putt (within 2 feet). Examples of a poor shot were a drive into the rough; an approach shot that misses the green, and a missed short putt (2-10 feet). A catastrophic shot included driving the ball out-of-bounds or into the water, a shanked chip shot, or missing a very short (<2 feet) putt. The researcher set criteria to evaluate each shot played specific for each player. In order to obtain objectivity in assessment of performance, a second researcher/shot evaluator independently rated the performance of each shot by the golfer during the practice session and first round. The two independent performance evaluations were then correlated to determine agreement. When a high correlation (> 0.75) was attained, the main investigator's rating of performance was used as the performance criterion for the first round and all subsequent rounds.

The researcher/shot evaluators placed their data on a golf stroke evaluation form. The shot was labeled a tee shot, approach shot, chip shot or putt. The shots were numbered by stroke and hole. This insured proper analysis with the appropriate Sport Grid-R observation of each participant.

Procedures

The participants were briefed about the study and each participant completed a training session (9 holes) to have practice using the Sport Grid-R. Participants were provided with definitions of cognitive state anxiety and felt arousal, highlighting specific feelings a person could have in these states. Before each round, the participant's read a social desirability statement to explain that anxiety is a normal reaction to competition. The participants rated their perceived cognitive state anxiety and felt arousal prior to each shot attempted in four rounds of golf. The participant placed an "X" in the appropriate

Sport Grid-R space. Four (4) Sport Grid-R's were on each sheet for the participant for each hole played (Appendix, p. 117). The participant's kept the Sport Grid-R measurements themselves and kept them hidden from the researcher/shot evaluator. This insured that the researcher/shot evaluator did not have bias in their assessment of the shot performance based on the participant's response on the Sport Grid-R.

The researcher/shot evaluator followed the golfers on every shot during the 72 holes and evaluated each shot on the set performance criteria. The researcher/shot evaluator walked with the group but neither the golfer nor the researcher/shot evaluator examined the other's observations.

Competition

The golfers/participants were playing in competitive matches with other golfers. The golfers were playing in tournament play for monetary rewards or the golfers were playing in qualifying tournaments for selection/placement onto the college varsity golf team, which increased their chances of heightened state anxiety and arousal. Data was collected from four 18-hole competitive matches per person.

Analysis of Data

Logic of Analysis. Previous field research with catastrophe theory has been monolithic in nature with a focus upon grouped data (Durr & Cox, 1997). This approach required that repeated observations from different participants be mixed with repeated observations form other participants. Thus we would have a confounding or mixing of within participant observations with between participant observations. An example of this sort of research was reported by Klavora (1978), utilizing male high school basketball players.

To address the problem of mixing within and between participant observations, Sonstroem and Bernardo (1982) introduced the notion of intraindividualizing scores before they are entered into a statistical model. In practice, this was tantamount to converting all raw scores into ipsative z-scores (Cox, 2002, p. 213). Ipsative z-scores have the effect of forcing the means and standard deviations of scores from different participants to be equal to zero and one respectively. The problem with this approach, however, is that it eliminates any and all differences between participants. For example, it removes differences such as gender and skill. Because participants do in fact differ in terms of gender and skill level, this is an unacceptable by product of intraindividaulizing scores.

In the current analysis, a single participant or idiosyncratic approach to data analysis was used. Data were not converted into ipsative z-scores, but neither were observations from one participant mixed with those of another participant.

In this analysis, each golf shot served as the unit of analysis as opposed to the individual subject. In theory, the assumption of independence required in multiple regression analyses was violated because repeated measures were collected from each golfer. It is argued, however, that due to the changing competitive circumstances for each golf shot, such as shot difficulty, weather conditions, increased cognitive anxiety caused by prior performance, or perhaps distractions from other players, that each golf shot is, in reality, an independent measure. This has been supported by other researchers in collecting sport performance data (Gould et at., 1987; Krane et al., 1994; Raedeke & Stein, 1994; Sonstroem & Bernardo, 1982). Hypotheses were tested for each participant separately. This approach allowed the researcher to test the tenants of catastrophe theory for each participant. Differential results would be evidence of the idiosyncratic relationship between activation/anxiety and performance. Results were inspected for apparent differences as a function of skill and gender, but no statistical tests were attempted relative to these two variables.

Polynomial multiple regression. Polynomial multiple regression procedures were used to analyze the collected data. The criterion measure was golf performance as determined by the researcher. In the current investigation it is suggested that the relationship between activation (Act) and golf performance (P) is moderated by worry (Wor). A moderator variable (Holmbeck, 1997) is one that affects the relationship between two variables, so that the nature of the impact of the predictor (activation) on the criterion (golf performance) varies according to the level or value of the moderator (worry). In this case, the test of a moderator is the test of the interaction between activation (X) and worry (Y) and would look like:

$$\text{Performance } (P') = a + b_1X + b_2Y + b_3XY$$

To minimize problematic multicollinearity effects among first-order terms and higher order terms, Aiken and West (1991) have recommended that the independent variable and the moderator be "centered" before testing the significance of the interaction term. To center the variables, scores were put into deviation score form by simply subtracting the participant's sample mean from all individuals' scores on the variable, thus producing a revised sample mean of zero.

The catastrophe model depicted in Figure 1 predicts that the relationship between

---

Insert Figure 1 about here

---

performance and physiological arousal (felt activation) is quadratic in nature. This relationship is moderated, however, by the level of cognitive anxiety (worry). Thus, a low level of worry should yield a smooth inverted-U relationship between felt arousal/activation and golf performance; conversely, a high level of worry should yield a catastrophic but quadratic relationship between felt arousal/activation and golf performance. This predicted relationship was tested using the following polynomial multiple regression equation:

$$\text{Performance } (P') = a + b_1X + b_2Y + b_3X^2 + b_4Y^2 + b_5XY$$

Again, the independent variables were centered to account for multicollinearity among first-order and higher-order terms.

Polynomial multiple regression analyses were calculated and tested for each of the four participants. For example, across four rounds of golf, one golfer took 309 total stokes. Then, for this participant, 309 observations were entered into the polynomial regression model that involved all strokes.

For each polynomial regression analysis, specific steps were adhered to for order of analysis. Step one tested the linear model in which performance was regressed on activation and worry. In step two, the two quadratic terms and their product term were entered into the model in a nonhierarchical fashion to determine if, as a block, they significantly add variance to the linear model (Pedhazur, 1997). In all cases, betas were considered significant if associated p values were $< .05$. Polynomial regression using the general linear model (GLM) tests the significance of partial betas. Partial betas are calculated and tested using Type III sum of squares. A partial beta is an estimate of an effect after all other effects in the model have been removed. Thus a test of significance for a partial beta is a test of significance for unique variance (Pedhazur, 1997). For this reason, it is possible for a beta for a simple linear effect (step 1) to be significant initially, but not be significant in a model that includes powered vectors and product term (interaction).

In order for catastrophe theory to be supported in this investigation, a significant quadratic relationship between activation (Act) and performance must be observed and a significant interaction between Act and Wor must be present. If these two things are true, and the nature of the relationship is such that a catastrophic performance is observed when worry is high, but is not observed in the low worry condition, then catastrophe theory as it has been described in Figure 1 is supported.

Finally, to illustrate the nature of the relationship between activation and worry with golf performance, the predicted values of performance were plotted for each model. Because activation and worry were centered prior to analysis, it was possible to show changes in performance as a function of one standard deviation changes in the prediction variables (Aiken & West, 1991). Plotted predicted performance was illustrated through a figure if a quadratic or interaction term was included in the full model.

<u>Reliability of performance scores</u>. Performance scores were recorded by the researcher following each stroke, independent of the golfer's own assessment of activation and worry.

Performance for a 9-hole practice round and the first round of real data were recorded simultaneously by the researcher and a second rater. Interrater correlation coefficient for participant one (male/high skill) was .90, while for participant two (male, low skill), participant three (female, high skill), and participant four (female, low skill), the correlations were .85, .86, and .78. Since a high correlation was observed in all participants, the main investigators scores were used in all analysis.

Results

The results of the polynomial multiple regression analyses are organized as a function of each participant. For each analysis, results are discussed relative to the stated steps. In addition, for each golfer, Tables and Figures are displayed to clarify the results as well as the nature of the observed relationships.

Participant 1 / Male, High Skill

A significant linear model was obtained when performance (P), was regressed on activation (Act) and worry (Wor), F (2, 306) = 10.19, p < .0001, R^2 = .063 and is illustrated in step one of Table 2. The results of the linear regression analysis resulted in

---

Insert Table 2 about here

---

a significant beta for Wor only. Approximately six percent (R^2 = .063) of golf performance variance was accounted for by Act and Wor; and the zero order correlations among the three variables were -.05 (p = .3595), -.24 (p < .0001), and .49 (p < .0001) for Per with Act, Per with Wor, and Act with Wor respectively. The nature of the linear relationship for this model is illustrated in Figure 3. In the linear model, activation (Act) has a positive effect on performance and worry (Wor) has a negative effect on performance. The linear model unstandardized prediction model is as follows (asterisks indicate significance):

P′ = 2.36 + .06 Act - .17 Wor*

Insert Figure 3 about here

In step two, the two quadratic components and the product term (Act/Wor) were added simultaneously to the linear model. Consequently, all three terms were added to the linear model in what will be referred to as the full test model. Performance (P) was regressed on activation (Act), worry (Wor), Act^2, Wor^2, and Act/Wor in a test of the full model for all golf strokes for participant one (N = 309).

The results of the test of the full model are illustrated in step 2 of Table 2 [F (5,303) = 12.26, p <.0001, R^2 = .168]. From Table 2, step 2, we are able to see that Act, Wor, and Act^2 are significant predictors of golf performances. Powered vectors and product vectors act as suppressor variables allowing activation (Act) to be significant in the full model but not in the linear model (Pedhazur, 1997). Thus, the full model unstandardized prediction model is as follows (asterisks indicate significance):

$P' = 2.097 + .30 \text{ Act*} - .178 \text{ Wor*} + .091 \text{ Act}^2\text{*} + .046 \text{ Wor}^2 + .034 \text{ Act/Wor}$

A F-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test revealed a significant increase (p < .05) in the variance from the linear to the full test model F (3, 302) = 12.73, p < .01, R^2_{inc} = .105.

The nature of the relationship for this model is illustrated in Figure 4. By entering ascending values for Act (standard deviation) and Wor (standard deviation) into the full model unstandardized prediction equation it was possible to calculate a predicted value for performance (a high score is a good score). In Figure 4 (a) activation is on horizontal axis , while in Figure 4 (b) worry is on the horizontal axis. For this model R^2 = .168 and the mean square error (MSE) is equal to .78. By examining Table 2 and Figure 4, for the full model (step 2), we conclude that Wor has a negative effect on performance, while

Act has a quadratic and positive linear effect on performance. From Figure 4, it appears that Wor also had a quadratic effect on performance, but this effect was not significant (p = .066)

Insert Figure 4 about here

In graphic form, Figure 4 illustrates how golf performance is predicted to increase in both a linear and quadratic fashion as activation increases. Regardless of the level of Wor, the best values for performances occur when activation is high. No evidence for a catastrophic relationship is observed between Performance and Act at a high level of worry. Best performance for the male high skilled golfer is predicted when activation is high and worry is low.

Participant 2 / Male, Low Skill

A significant model was obtained when performance (P), on all strokes, was regressed on activation (Act) and worry (Wor), F (2, 338) = 15.52, p < .0001, R^2 = .084 and is illustrated in step one of Table 3. The results of the linear regression analysis

---

Insert Table 3 about here

---

resulted in a significant beta for Wor only. Approximately eight percent (R^2 = .084) of golf performance variance was accounted for by Act and Wor; and the zero order correlations among the three variables were -.26 (p < .0001), -.28 (p < .0001), and .74 (p < .0001) for Per with Act, Per with Wor, and Act with Wor respectively. The nature of the linear relationship for this model is illustrated in Figure 5. In the linear model, worry (Wor) has a significant negative effect on performance. The linear model unstandardized prediction model is as follows (asterisks indicate significance):

P′ = 2.17 - .06 Act - .08 Wor*

Insert Figure 5 about here

In step two, the two quadratic components and the product term (Act/Wor) were added simultaneously to the linear model. Consequently, all three terms were added to the linear model in what will be referred to as the full test model. Performance (P) was regressed on activation (Act), worry (Wor), Act^2, Wor^2, and Act/Wor in a test of the full model for all golf strokes for participant two (N = 341).

The results of the test of the full model are illustrated in step 2 of Table 3 [F (5,335) = 8.65, p <.0001, R^2 = .114]. From Table 3, step 2, we are able to see that Wor^2 is the only significant predictor of golf performances. Thus, the full model unstandardized prediction model is as follows (asterisks indicate significance):

P′ = 1.97 - .059 Act - .073 Wor + .03 Act^2 + .04 Wor^2* - .036 Act/Wor

A F-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test revealed a significant increase (p < .05) in the variance from the linear to the full test model F (3, 334) = 3.77, p < .05, R^2_{inc} = .03.

The nature of the relationship for this model is illustrated in Figure 6. By entering ascending values for Act (standard deviation) and Wor (standard deviation) into the full model unstandardized prediction equation it was possible to calculate a predicted value for performance (a high score is a good score). In Figure 6 (a) activation is on horizontal axis , while in Figure 6 (b) worry is on the horizontal axis. For this model $R^2 = .11$ and the mean square error (MSE) is equal to .86.

Insert Figure 6 about here

By examining Table 3 and Figure 6, for the full model (step 2), we conclude that Wor has a significant quadratic effect on performance. The plotted predicted performance scores in Figure 6 are fairly flat with some evidence of curvilinearity.

In graphic form, it is interesting to notice in Figure 6, that in the highest level of activation, as worry increases, then performance decreases. There is also visual evidence of an interaction, but the interaction term (Act/Wor) was insignificant in the model. There is a slight quadratic relationship between Per and Wor, but generally performance is not improving as a function of Act or Wor.

Participant 3 / Female, High Skill

A significant model was obtained when performance (P) was regressed on activation (Act) and worry (Wor), $F\ (2, 346) = 10.66$, $p < .0001$, $R^2 = .058$ and is illustrated in step one of Table 4. The results of the linear regression analysis resulted in a

---

Insert Table 4 about here

---

significant beta for Wor only. Approximately six percent (R^2 = .058) of golf performance variance was accounted by Act and Wor; and the zero order correlations among the three variables were -.12 (p = .0295), -.24 (p < .0001), and .39 (p < .0001) for Per with Act, Per with Wor, and Act with Wor respectively. The nature of the linear relationship for this model is illustrated in Figure 7. In the linear model, activation (Act) has a slightly negative effect on performance and worry (Wor) has a negative effect on performance. The linear model unstandardized prediction model is as follows (asterisks indicate significance):

P′ = 2.19 - .01 Act - .08 Wor*

Insert Figure 7 about here

In step two, the two quadratic components and the product term (Act/Wor) were added simultaneously to the linear model. Consequently, all three terms were added to the linear model in what will be referred to as the full test model. Performance (P) was regressed on activation (Act), worry (Wor), Act^2, Wor^2, and Act/Wor in a test of the full model for all golf strokes for participant three (N = 349).

The results of the test of the full model are illustrated in step 2 of Table 4 [F (5, 343) = 7.35, p < .0001, R^2 = .0967]. From Table 4, step 2, we are able to see that Wor and Wor^2 are significant predictors of golf performance. Thus, the full model unstandardized prediction model is as follows (asterisks indicate significance):

P′ = 1.92 + .03 Act - .089 Wor* + .01 Act^2 + .034 Wor^2* - .01 Act/Wor

A *F*-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test revealed a significant increase (p < .05) in the variance from the linear to the full test model F (3, 342) = 4.91, $p < .01$, $R^2_{inc} = .039$.

The nature of the relationship for this model is illustrated in Figure 8. By entering ascending values for Wor (standard deviation) and Act (standard deviation) into the full model unstandardized prediction equation it was possible to calculate a predicted value for performance (a high score is a good score). In Figure 8 (a) activation is on horizontal axis , while in Figure 8 (b) worry is on the horizontal axis. For this model $R^2 = .0921$ and the mean square error (MSE) is equal to .82.

Insert Figure 8 about here

By examining Table 4 and Figure 8, for the full model (step 2), we conclude that Wor has a negative linear and quadratic effect upon golf performance. This quadratic effect for Wor is clearly evident in Figure 8.

In graphic form, Figure 8 illustrates how golf performance is predicted to decrease and then increase in a quadratic fashion as worry increases. In the model, Act is having little effect on performance while worry has both a linear and quadratic relationship with performance. Performance decreases with increased worry, but levels off and increases again with higher levels of worry.

Participant 4 / Female, Low Skill

A significant model was obtained when performance (P) was regressed on activation (Act) and worry (Wor), F (2, 346) = 29.04, $p < .0001$, $R^2 = .144$ and is illustrated in step one of Table 5. The results of the linear regression analysis resulted in

---

Insert Table 5 about here

---

a significant beta for Wor only. Approximately fourteen percent ($R^2 = .144$) of golf performance variance was accounted for by Act and Wor; and the zero order correlations among the three variables were -.14 ($p = .0073$), -.37 ($p < .0001$), and .20 ($p = .0002$) for Per with Act, Per with Wor, and Act with Wor respectively. The nature of the linear relationship for this model is illustrated in Figure 9. In the linear model, worry (Wor) has a significant negative effect on performance. The linear model unstandardized prediction model is as follows (asterisks indicate significance):

P′ = 2.18 - .03 Act - .13 Wor*

Insert Figure 9 about here

In step two, the two quadratic components of Act^2 and Wor^2, plus the interaction variable (Act/Wor) were added simultaneously to the linear model. Consequently, Act^2, Wor^2, and Act/Wor were added to the linear model in what will be referred to as the full test model. Performance (P) was regressed on activation (Act), worry (Wor), Act^2, Wor^2 and Act/Wor in a test of the full model for all golf strokes for participant four (N = 349).

The results of the test of the full model are illustrated in step 2 of Table 5 [F (5,343) = 15.09, $p < .0001$, $R^2 = .1803$. From Table 5, step 2, we are able to see that Act/Wor is a significant predictor of golf performances. Thus, the full model unstandardized prediction model is as follows (asterisks indicate significance):

$P' = 2.01 + .059 \text{ Act} - .07 \text{ Wor*} + .016 \text{ Act}^2 + .014 \text{ Wor}^2 - .029 \text{ Act/Wor*}$

A F-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test revealed a significant increase ($p < .05$) in the variance from the linear to the full test model F (3, 342) = 5.00, $p < .01$, $_{inc} = .036$.

The nature of the relationship for this model is illustrated in Figure 10. By entering ascending values for Act (standard deviation) and Wor (standard deviation) into the full model unstandardized prediction equation it was possible to calculate a predicted value for performance (a high score is a good score). For this model $R^2 = .180$ and the mean square error (MSE) is equal to .79. By examining Table 5 and Figure 10, it is possible to conclude that the linear component Wor, as well as the interaction variable (Act/Wor) have a significant effect on performance.

Insert Figure 10 about here

In graphic form, Figure 10 illustrates how golf performance is influenced by worry. In the figure, you see performance decrease as worry increases, except at the highest level of activation. In that case, performance increases slightly as worry increases. An interaction is observed in graphic form.

Discussion

In the linear analyses of all participants, it can be observed that Wor has a significant negative effect on golf performance. This would lead to support of Martens' et al. (1990) multidimensional theory. In multidimensional theory, each type of anxiety (cognitive and somatic) is believed to act independent of the other. Cognitive anxiety (worry) deals with negative concerns with performance and is theorized to have a negative linear effect on performance (Martens' et al., 1990). Also, in the linear analyses, it is noticed that activation has a positive or neutral effect for the higher skilled golfers. Participant 1's (male, high skill) activation score yielded a positive beta and Participant 3's (female, high skill) activation score yielded a very slight negative beta. A better skilled golfer is able to cope with increased activation (Spence, 1956).

No evidence for catastrophe theory was observed in the analyses of the full model of all participants. In order for catastrophe theory to be supported, a significant quadratic relationship between activation (Act) and performance must be observed and a significant interaction between Act and Wor (Act/Wor). In the hypotheses, it was predicted that at conditions of high cognitive anxiety (worry), the relationship between arousal (activation) and performance would be catastrophic and quadratic in nature. The study did not support this hypothesis.

In the hypotheses it was predicted that at low conditions for cognitive anxiety (worry), the relationship between arousal (activation) and performance would take the form of a smooth inverted-U. There is no evidence for this hypothesis in the figures. The closest example to support this hypothesis would be in Figure 4a (male, high skill).

In the plot of lowest conditions for worry (-2 standard deviation), performance increases as activation increases.

In all of the participants, increased worry (Wor) is associated with a decrement in performance and activation is associated with a curvilinear relationship to performance in all participants, except participant 3 (female, high skill). In only one case (female, low skill) was the interaction variable (Act/Wor) significant. In order for the catastrophe theory to be verified the interaction variable must be significant and the quadratic of activation (Act^2) must be significant. In this case, an interaction is observed in Figure 10. But, in Figure 10 you would expect a drop in performance on the high activation line as worry increases. Instead, we see an increase in performance. There is a drop in performance on the low activation line as worry increases, but that is predicted in the multidimensional theory of anxiety (Martens et al., 1990).

In previous research it was noted that the Sport Grid-R is an ideal instrument for testing the catastrophe theory because of its ability to independently measure arousal (activation) and cognitive anxiety (worry) (Ward & Cox, 2001). In their (Ward & Cox, 2001) study, they determined that the correlation of cognitive anxiety to arousal (activation) to be $r = -.07$. In the current study, the following correlations were measured for cognitive anxiety (worry) with arousal (activation), $r = .49$, $r = .74$, $r = .39$, and $r = .20$ for participant 1, 2, 3 and 4 respectively. There is a significantly higher correlation of the two variables in the current study. Durr and Cox (1997) found similar results in their investigation of catastrophe theory on divers. Using the Anxiety Rating Scale (ARS), Durr and Cox (1997) found a correlation of $r = .75$ for cognitive anxiety with somatic anxiety. The reasons for the higher correlations could be in the education of the participants. It would be advantageous to spend extensive time educating the participants on the differences of arousal (activation) and cognitive anxiety (worry) so they could accurately self-report their feelings.

One of the limitations of the current study was the participant's familiarity of the Sport Grid-R and how to accurately use the instrument. As a golfer utilizes the measurement tool more often it would more accurately display the athlete's activation and worry. Thomas et al. (2002) reasoned that there is an element of athlete education involved in utilizing self-report short form assessment inventories for anxiety. Other researchers have indicated that athlete education may result in more accurate understanding, and ability to accurately report their feelings of anxiety (Edwards & Hardy, 1995; Hardy, 1996). In future studies, researchers should have brief review sessions in the time leading up to each competitive situation to educate subjects on anxiety and how to use the self-report forms.

Future research in this area should include more training for the participants on how to use the Sport Grid-R. Better education on the definitions of worry and activation will give the participants better ability to use the self-report form. Possible discussions about how to use the Sport Grid-R while playing in the practice rounds and how their self report matched up with feelings.

The qualitative analysis by Edwards et al. (2002) may be the preferred method for analyzing the relationship of anxiety to performance through the catastrophe theory. They also emphasize understanding the role self-confidence plays in this relationship. The complex nature of cognitive anxiety and arousal may be better understood in one-on-one interviews with the participants. A skilled researcher might be better equipped to determine a participant's true feelings in a personal interview and probe deeper into those feelings.

In the evaluation of shot performance, perhaps a rating of shot difficulty would add to the assessment. In example, a two-foot putt that is relatively flat would be easier than a two-foot putt on a side hill with substantial break. This would change how you rate the performance of the golfer and subsequently how much worry or activation is experienced by the golfer. Also, in the evaluation of shot performance, luck or bad breaks need to be factored into the rating of performance. In some cases, the golfer hit what looked to be a perfect shot and got a bad bounce which put the shot into the poor or average or catastrophic category. Or, the golfer hit a good shot, but the outcome did not meet the standard of performance for that golfer. Future research should address this issue.

This is one of the first attempts at explaining the catastrophe theory in actual competition. Further research is recommended that evaluates catastrophe theory in competition to observe real effects of worry and activation on performance.

References

Aiken, L.S., & West, S.G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.

Baddeley, A., & Idzikowski, C. (1983). Waiting in the wings: Apprehension, public speaking, and performance. *Ergonomics*, *26*, 575-583.

Burton, D. (1988). Do anxious swimmers swim slower? Reexamining the elusive anxiety-performance relationship. *Journal of Sport & Exercise Psychology*, *10*, 45-61.

Cohen, A., Pargman, D., & Tenebaum, G. (2003). Critical elaboration and empirical investigation of the cusp catastrophe model: A lesson for practitioners. *Journal of Applied Sport Psychology, 15*, 144-159.

Cook, D., Gansneder, B., Rotella, R., Malone, C., Bunker, L., & Owens, D. (1983). Relationship among competitive state anxiety, ability, and golf performance. *Journal of Sport Psychology*, *5*, 460-465.

Cox, R.H., Robb, M., & Russell, W.D. (2000). Concurrent validity of the revised anxiety rating scale. *Journal of Sport Behavior*, *23*, 327-334.

Cox, R.H. Robb, M., & Russell, W.D. (2001). Construct validity of the revised anxiety rating scale (ARS-2). *Journal of Sport Behavior*, *24*, 10-18.

Cox, R.H., Russell, W.D., & Robb, M. (1998). Development of a CSAI-2 short form for assessing competitive state anxiety during and immediately prior to competition. *Journal of Sport Behavior, 21*, 30-40.

Cox, R.H., Russell, W.D., & Robb, M. (1999). Comparative concurrent validity of the MRF-L and ARS competitive state anxiety rating scales for volleyball and basketball. *Journal of Sport Behavior*, *22*, 310-320.

Durr, K.R., & Cox, R.H. (1997). *Relationship between state anxiety and performance in high school divers: A test of catastrophe theory*. *Research Quarterly for Exercise and Sport*, *68*, Supplement abstract 102.

Edwards, T.C., & Hardy, L. (1995). Further dimensions of anxiety: Validating a short self-report scale. *Journal of Applied Sport Psychology*, *7*, S59.

Edwards, T., Kingston, K., Hardy, L., & Gould, D. (2002). A qualitative analysis of catastrophic performances and the associated thoughts, feelings, and emotions. *The Sport Psychologist. 16*, 1-19.

Fazey, J.A., & Hardy, L. (1988). *The Inverted-U Hypothesis: A Catastrophe for Sport Psychology*. British Association of Sports Sciences Monograph No. 1 Leeds: National Coaching Foundation.

Gould, D., & Krane, V. (1992). The arousal-athletic performance relationship: Current status and future directions. In T. Horn (Ed.), *Advances in sport psychology* (pp. 119-141). Champaign, IL: Human Kinetics.

Gould, D., Petlichkoff, L., Simons, J., & Vevera, M. (1987). Relationship between competitive state anxiety inventory-2 subscale scores and pistol shooting performance. *Journal of Sport Psychology*, *9*, 33-42.

Gould, D., Petlichkoff, L., & Weinberg, R.S. (1984). Antecedents of, temporal changes in, and relationships between CSAI-2 subcomponents. *Journal of Sport Psychology*, *6*, 289-304.

Hardy, L. (1990). A catastrophe model of performance in sport. In J.G. Jones and L. Hardy (Eds.) *Stress and Performance in Sport* (pp. 81-106). Chichester: John Wiley.

Hardy, L. (1996). A test of catastrophe model of anxiety and sports performance against multidimensional anxiety theory using the methods of dynamic differences. *Anxiety, Stress, and Coping: An International Journal*, *9*, 227-294.

Hardy, L., & Parfitt, G. (1991). A catastrophe model of anxiety and performance. *British Journal of Psychology, 82*, 163-178.

Hardy, L., Parfitt, G., & Pates, J. (1994). Performance catastrophes in sport: A test of the hysteresis hypothesis. *Journal of Sport Sciences, 12,* 327-334.

Hardy, L., Woodman, T., & Carrington, S. (2004). Is self-confidence a bias factor in higher-order catastrophe models? An exploratory analysis. *Journal of Sport & Exercise Psychology, 26*, 359-368.

Hockey, R., & Hamilton, P. (1983). The cognitive patterning of stress states. In R. Hockey (Ed.) *Stress and Fatigue in Human Performance* (pp. 331-362). Chichester: Wiley.

Holmbeck, G.N. (1997). Toward terminological, conceptual, and statistical clarity in the study of mediators and moderators: Examples from the child-clinical and pediatric psychology literatures. *Journal of Consulting and Clinical Psychology, 65*, 599-610.

Jones, G., Hanton, S., & Swain, A. (1994). Intensity and interpretation of anxiety symptoms in elite and non-elite sports performers. *Personality & Individual Differences, 17*, 657-663.

Jones, G., & Swain, A. (1992). Intensity and direction as dimensions of competitive state anxiety and relationships with competitiveness. *Perceptual and Motor Skills*, *74*, 467-472.

Jones, G., & Swain, A. (1995). Predispositions to experience debilitative and facilitative anxiety in elite and nonelite performers. *The Sport Psychologist*, *9*, 201-211.

Klavora, P. (1978). An attempt to derive inverted-U curves based on the relationship between anxiety and athletic performance. In D. M. Landers & R. W. Christina (Eds.), *Psychology of Motor Behavior and Sport – 1977* (pp. 369-377). Champaign, IL: Human Kinetics.

Krane, V. (1994). The mental readiness form as a measure of competitive state anxiety. *The Sport Psychologist*, *8*, 189-202.

Krane, V., Joyce, D., & Rafeld, J. (1994). Competitive anxiety, situation criticality, and softball performance. *The Sport Psychologist*, *8*, 58-72.

Krane, V., & Williams, J. (1987). Performance and somatic anxiety, cognitive anxiety, and confidence changes prior to competition. *Journal of Sport Behavior*, *10*, 47-56.

Martens, R., Burton, D., Vealey, R.S., Bump, L.A., & Smith, D.E. (1990). Development and validation of the competitive state anxiety inventory-2. In R. Martens, R.S. Vealey, & D. Burton, *Competitive anxiety in sport* (pp. 117-190). Champaign, IL: Human Kinetics.

Murphy, S.M., Greenspan, M., Jowdy, D., & Tammen, V. (1989). Development of a brief rating instrument of competitive anxiety: Comparisons with the competitive state anxiety inventory-2. *Proceedings of the Association for the Advancement of Applied Sport Psychology*. (p. 82). Seattle, WA.

Parfitt, C.G., Jones, G. & Hardy, L. (1990). Multidimensional anxiety and performance. In J.G. Jones and L. Hardy (Eds.) *Stress and Performance in Sport* (pp. 43-80). Chichester: Wiley.

Pedhazur, E. J. (1997). *Multiple regression in behavioral research*. Harcourt Brace: Ft. Worth, TX.

Raedeke, T., & Stein, G. (1994). Felt arousal, thoughts/feelings and ski performance. *The Sport Psychologist*, *8*, 360-375.

Russell, J.A., Weiss, A., & Mendelsohn, G.A. (1989). Affect grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social Psychology*, *57*, 493-502.

Skyzinski, R. (2000, Nov./Dec.). X marks the spot. *Golf World*, *53(9)*, 35-39

Smith, A.M., Malo, S.A., Laskowski, E.R., Sabick, M., Cooney III, W.P., Finnie, S.B., Crews, D.J., Eischen, J.J., Hay, I.D., Detling, N.J., & Kaufman, K. (2000). A multidisciplinary study of the 'yips' phenomenon in golf. *Sports Medicine*, *30*, 423-437.

Sonstroem, R.J., & Bernardo, P. (1982). Intraindividual pregame state anxiety and basketball performance: A re-examination of the inverted-U curve. *Journal of Sport Psychology*, *4*, 235-245.

Spence, K.W. (1956). *Behavior theory and conditioning*. New Haven, CT: Yale University Press.

Thom, R. (1975). *Structural Stability and Morphogenesis* (G.H. Fowler, Trans.). New York: Benjamin-Addison Wesley.

Thomas, O., Hanton, S., & Jones, G. (2002). An alternative approach to short-form self-report assessment of competitive anxiety: A research note. *International Journal of Sport Psychology, 33*, 325-336.

Ward, D.G., & Cox, R.H. (2001). The sport grid-revised as a measure of felt arousal and cognitive anxiety. *Journal of Sport Behavior, 27*, 93-113.

Zeeman, E.C. (1976, April). Catastrophe theory. *Scientific America, 234*, 65-83.

Table1.

Criterion for judging golf shot performance

3 = Excellent	2 = Average	1 = Poor	0 = Catastrophe
Long Drive (+240) in fairway	Short Drive (<240) in fairway	Short Drive in rough	Drive out-of-bounds, in water, deep in trees
	Long Drive (+240) in rough		
Approach on green & close to flag (within 15 ft.)	Approach on green not close to flag (> 15 ft.)	Approach shot within 10 yd of the green	Approach in water or out-of-bounds, shanked.
Made long putt (> 10 feet)	Made short putt (< 10 feet)	Miss short putt (3 – 10 feet)	Miss very short putt (< 3 feet)
	Close long putt within 2 feet	Not close long putt (> 2 feet)	Miss long putt off the green
Shot from rough or trees on green	Shot from rough or trees close to green (within 10 yd)	Shot from rough or trees advanced but not near green	Shot from rough or trees to worse area
Chip shot within 3 feet of hole	Chip shot within 10 feet of hole	Chip shot on green, but not close	Chip shot chunked
Sand shot within 5 feet of flag	Sand shot within 10 feet of flag	Sand shot on green, but not close	Sand shot left in sand trap
Recovery shot near the green	Recovery shot advanced in fairway	Recovery shot in better position, but not in fairway	Recovery shot did not better position

Table 2.

Results of hierarchical polynomial multiple regression analysis for participant 1 (male; high skill).

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	.06	.09	1.35	0.1777	.00559		
	Wor	-.17	-.28	-4.42	<.0001	.05972		
	Model						.063**	.063**
2	Act	.30	.45	4.95	<.0001	.06736		
	Wor	-.18	-.30	-4.49	<.0001	.05530		
	Act^2	.09	.35	3.17	0.0017	.02765		
	Wor^2	.05	.12	1.85	0.0657	.00936		
	Act/Wor	.03	.09	0.67	0.5031	.00123		
	Model						.168**	.105**

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 3.

Results of hierarchical polynomial multiple regression analysis for participant 2 (male; low skill).

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	-.06	-.13	-1.70	0.0894	.00786		
	Wor	-.08	-.18	-2.29	0.0226	.01421		
	Model						.084**	.084**
2	Act	-.06	-.14	-1.48	0.1405	.00577		
	Wor	-.07	-.17	-1.65	0.1009	.00715		
	Act^2	.03	.16	1.47	0.1428	.00570		
	Wor^2	.04	.18	2.03	0.0432	.01089		
	Act/Wor	-.04	-.18	-1.47	0.1418	.00573		
	Model						.114**	.030*

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 4.

Results of hierarchical polynomial multiple regression analysis for participant 3 (female; high skill).

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	-.01	-.03	-0.49	0.6227	.00066		
	Wor	-.08	-.23	-4.04	<.0001	.04446		
	Model						.058**	.058**
2	Act	.005	.01	0.20	0.8386	.000109		
	Wor	-.09	-.25	-4.27	<.0001	.04811		
	Act^2	.01	.05	0.88	0.3791	.00204		
	Wor^2	.04	.21	3.50	0.0005	.03233		
	Act/Wor	-.01	-.07	-1.13	0.2591	.00337		
	Model						.097**	.039**

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 5.

Results of hierarchical polynomial multiple regression analysis for participant 4 (female; low skill).

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	-.03	-.07	-1.41	0.1597	.00491		
	Wor	-.13	-.36	-7.05	<.0001	.12317		
	Model						.144**	.144**
2	Act	.06	.14	1.78	0.0766	.00754		
	Wor	-.07	-.20	-2.66	0.0081	.01695		
	Act^2	.02	.09	0.98	0.3282	.00229		
	Wor^2	.01	.09	1.06	0.2910	.00267		
	Act/Wor	.03	.21	2.54	0.0115	.01542		
	Model						.180**	.036**

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Figure Captions

Figure 1. Catastrophe Model of Cognitive Anxiety and Physiological Arousal Influence on Performance (Fazey and Hardy, 1988).

Figure 2. Sport Grid – Revised (Ward and Cox, 2001).

Figure 3 (legend). Linear prediction of golf performance for participant 1 (male, high skill) while manipulating activation (Act) and worry (Wor). In Figure (a) activation is on horizontal axis, while in Figure (b) worry is on the horizontal axis.

Figure 4 (legend). Curvilinear prediction of golf performance for participant 1 (male, high skill) while manipulating activation (Act) and worry (Wor). In Figure (a) activation is on horizontal axis, while in Figure (b) worry is on the horizontal axis. In the curvilinear prediction equation, significant beta's have asterisk.

Figure 5 (legend). Linear prediction of golf performance for participant 2 (male, low skill) while manipulating activation (Act) and worry (Wor). In Figure (a) activation is on horizontal axis, while in Figure (b) worry is on the horizontal axis.

Figure 6 (legend). Curvilinear prediction of golf performance for participant 2 (male, low skill) while manipulating activation (Act) and worry (Wor). In Figure (a) activation is on horizontal axis, while in Figure (b) worry is on the horizontal axis. In the curvilinear prediction equation, significant beta's have asterisk.

Figure 7 (legend). Linear prediction of golf performance for participant 3 (female, high skill) while manipulating activation (Act) and worry (Wor). In Figure (a) activation is on horizontal axis, while in Figure (b) worry is on the horizontal axis.

Figure 8 (legend). Curvilinear prediction of golf performance for participant 3 (female, high skill) while manipulating activation (Act) and worry (Wor). In Figure (a) activation is on horizontal axis, while in Figure (b) worry is on the horizontal axis. In the curvilinear prediction equation, significant beta's have asterisk.

Figure 9 (legend). Linear prediction of golf performance for participant 4 (female, low skill) while manipulating activation (Act) and worry (Wor). In Figure (a) activation is on horizontal axis, while in Figure (b) worry is on the horizontal axis.

Figure 10 (legend). Curvilinear prediction of golf performance for participant 4 (female, low skill) while manipulating activation (Act) and worry (Wor). In Figure (a) activation is on horizontal axis, while in Figure (b) worry is on the horizontal axis. In the curvilinear prediction equation, significant beta's have asterisk.

Figure 1.

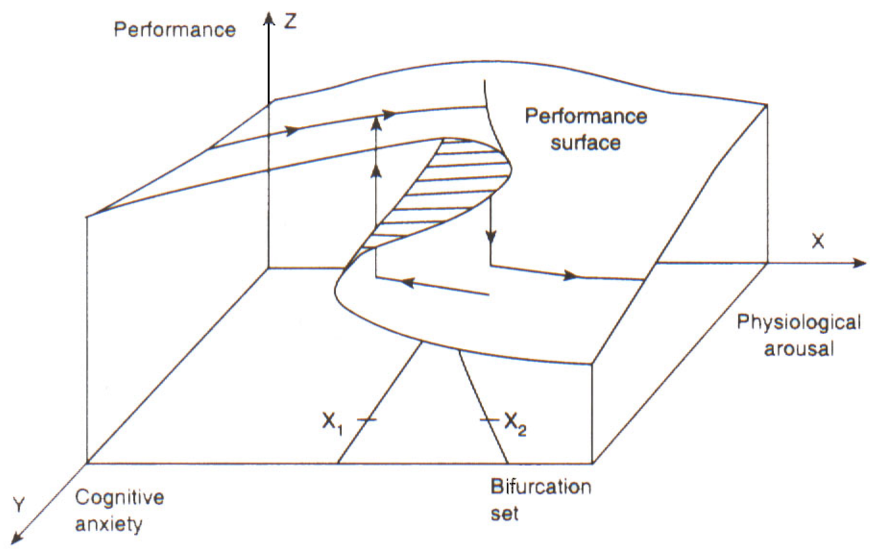
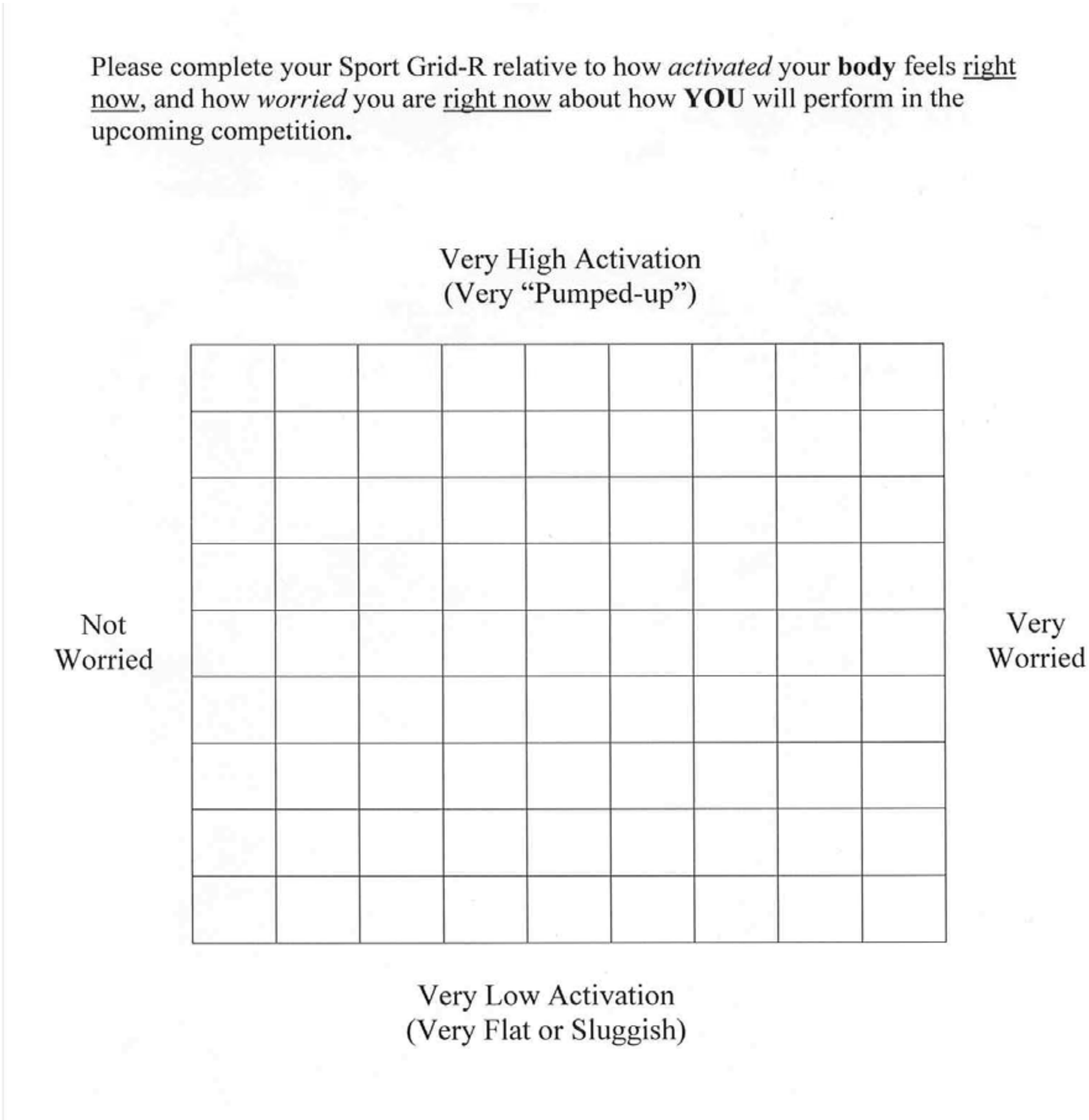

Performance
Z
Performance
surface
X
Physiological
arousal
X1
X2
Y
Cognitive
anxiety
Bifurcation
set

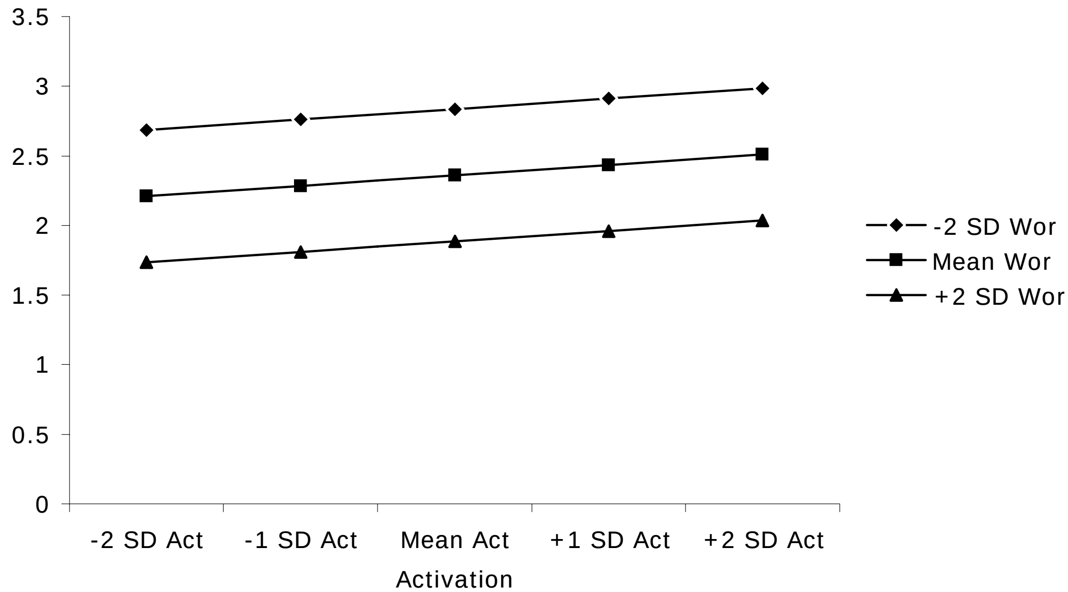
Figure 2.



Please complete your Sport Grid-R relative to how *activated* your **body** feels right now, and how *worried* you are right now about how **YOU** will perform in the upcoming competition.

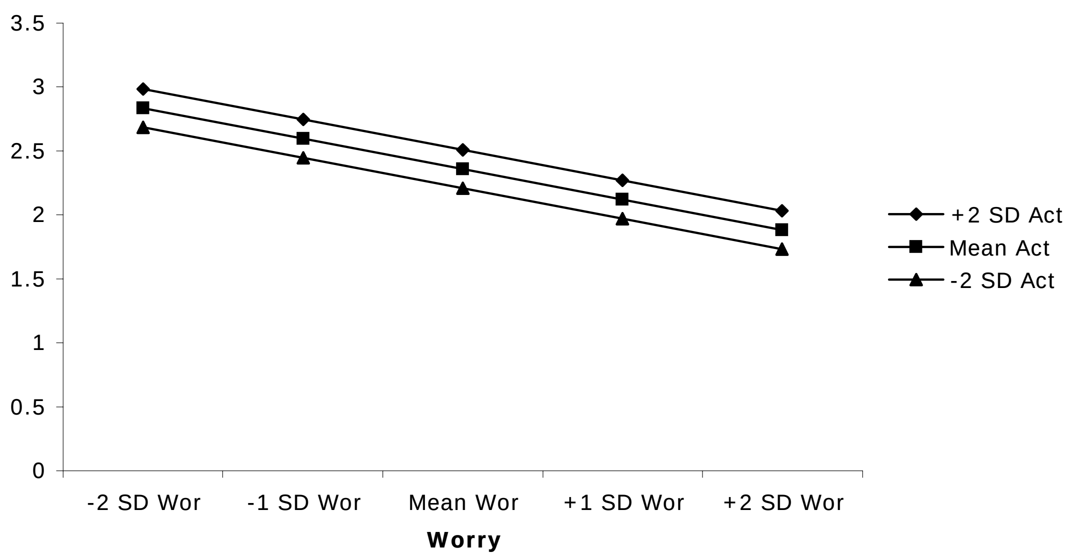
Figure 3.

a.



P′ = 2.36 + .06 Act - .17 Wor*

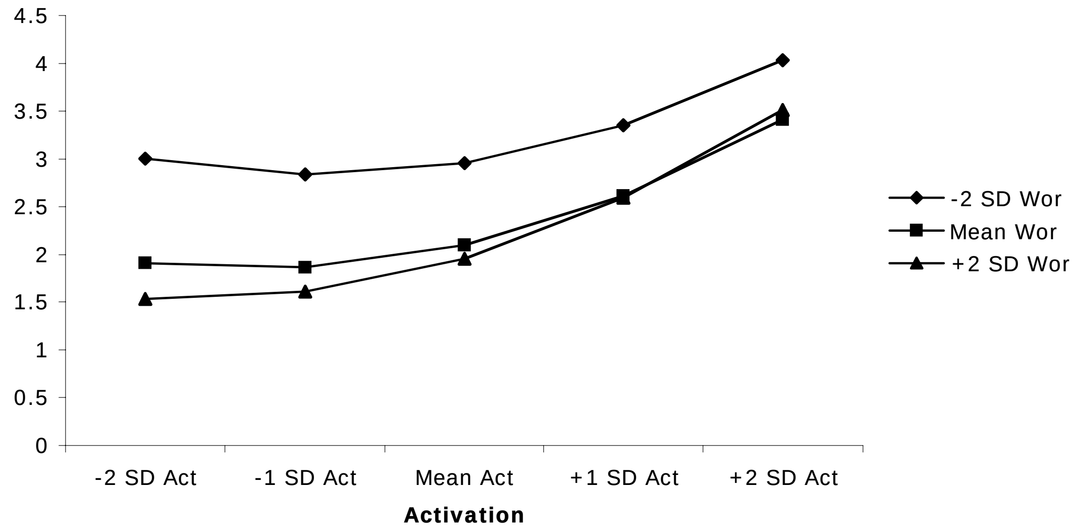
b.



P′ = 2.36 + .06 Act - .17 Wor*

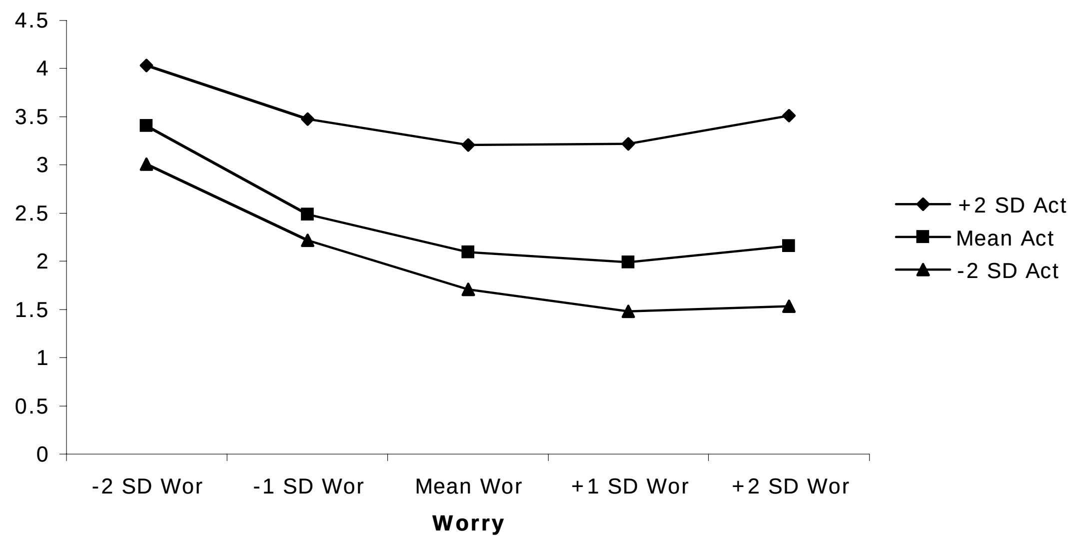
Figure 4.

a.



P′ = 2.097 + .30 Act* - .178 Wor* + .091 Act^2* + .046 Wor^2 + .034 Act/Wor

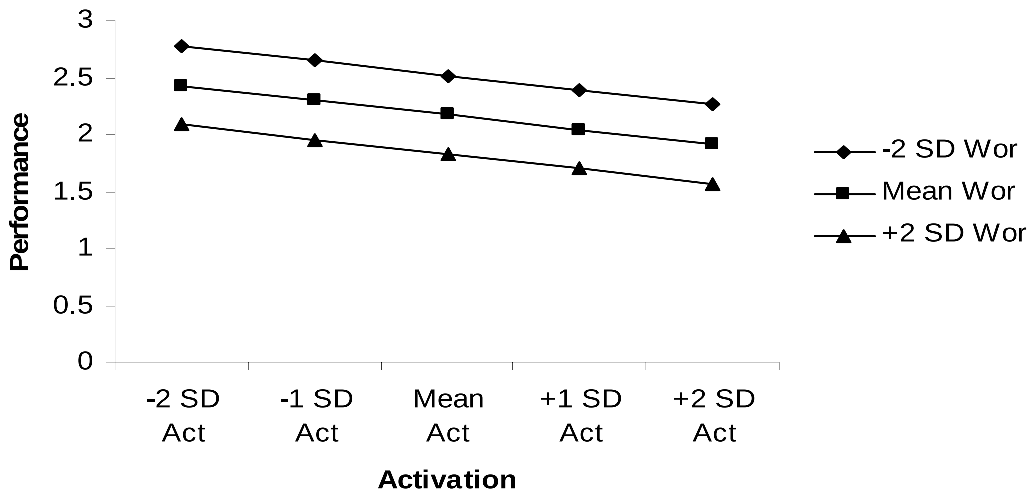
b.



P′ = 2.097 + .30 Act* - .178 Wor* + .091 Act^2* + .046 Wor^2 + .034 Act/Wor

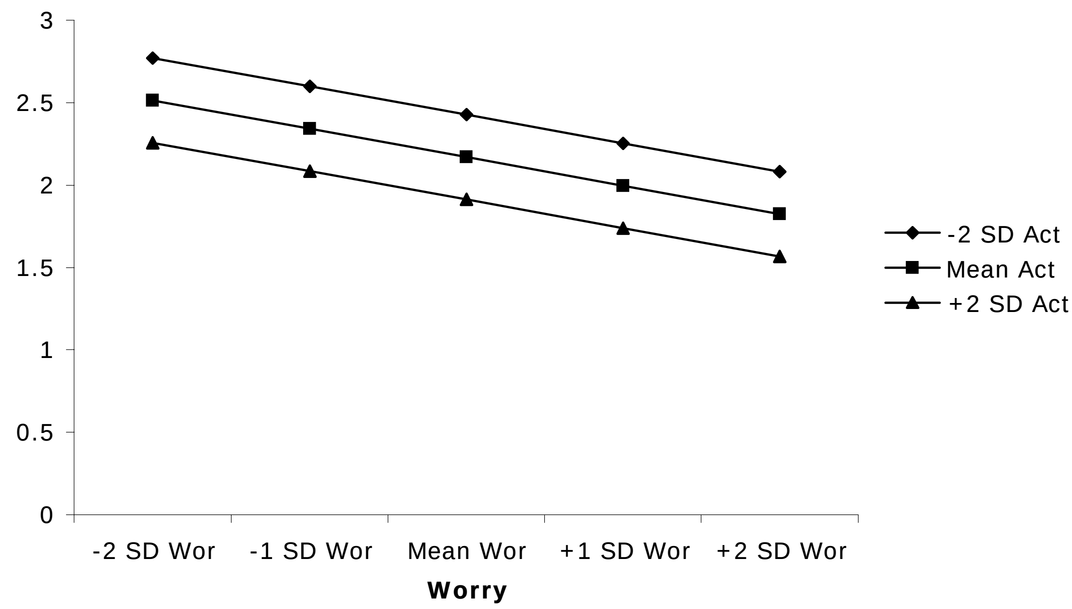
Figure 5.

a.



P′ = 2.17 - .06 Act - .08 Wor*

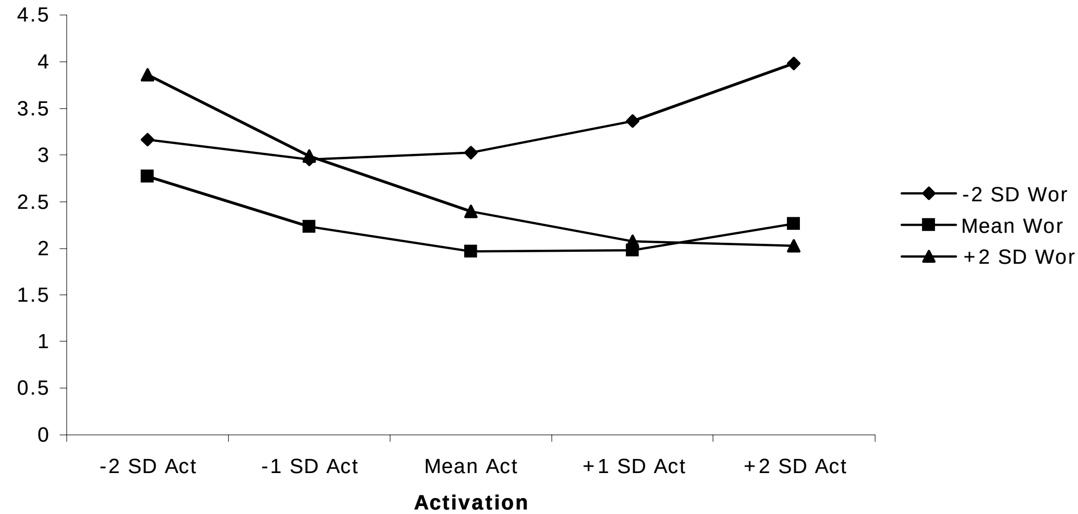
b.



P′ = 2.17 - .06 Act - .08 Wor*

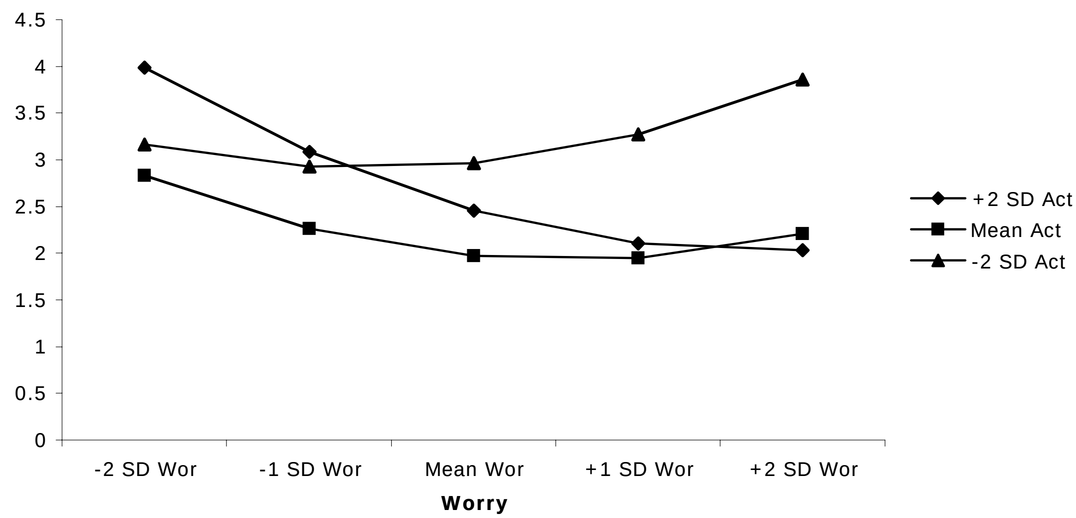
Figure 6.

a.



$P' = 1.97 - .059\ \text{Act} - .073\ \text{Wor} + .03\ \text{Act}^2 + .04\ \text{Wor}^{2*} - .036\ \text{Act/Wor}$

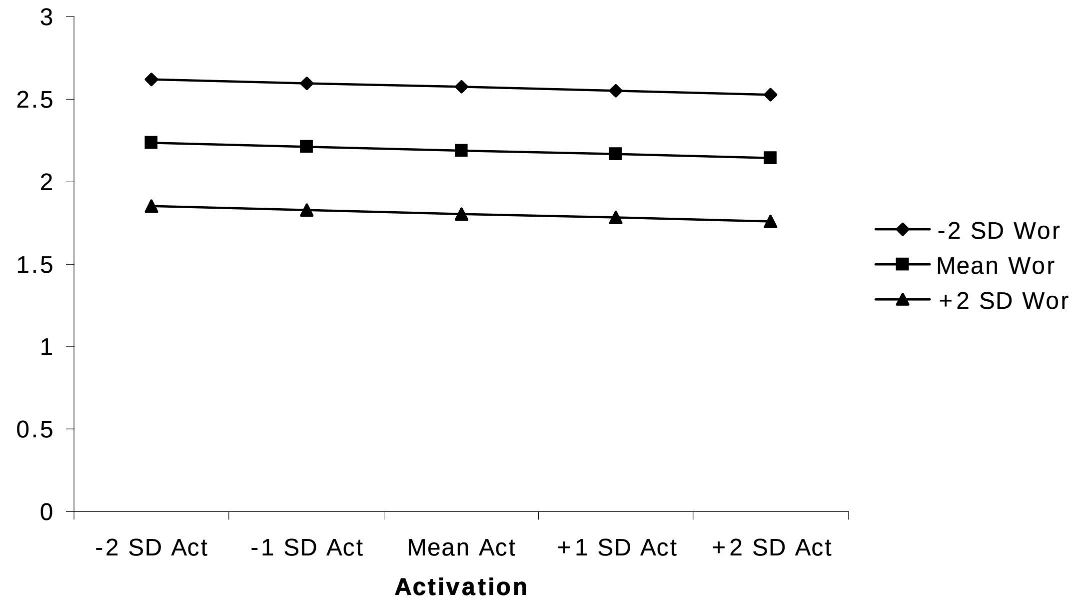
b.



$P' = 1.97 - .059\ \text{Act} - .073\ \text{Wor} + .03\ \text{Act}^2 + .04\ \text{Wor}^{2*} - .036\ \text{Act/Wor}$

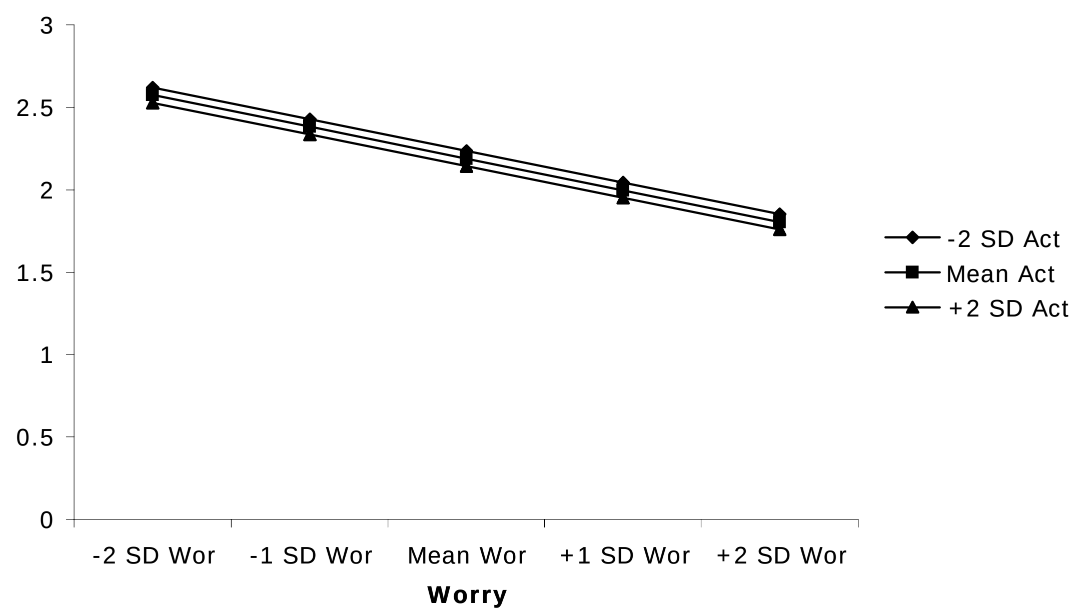
Figure 7.

a.



P′ = 2.19 - .01 Act - .08 Wor*

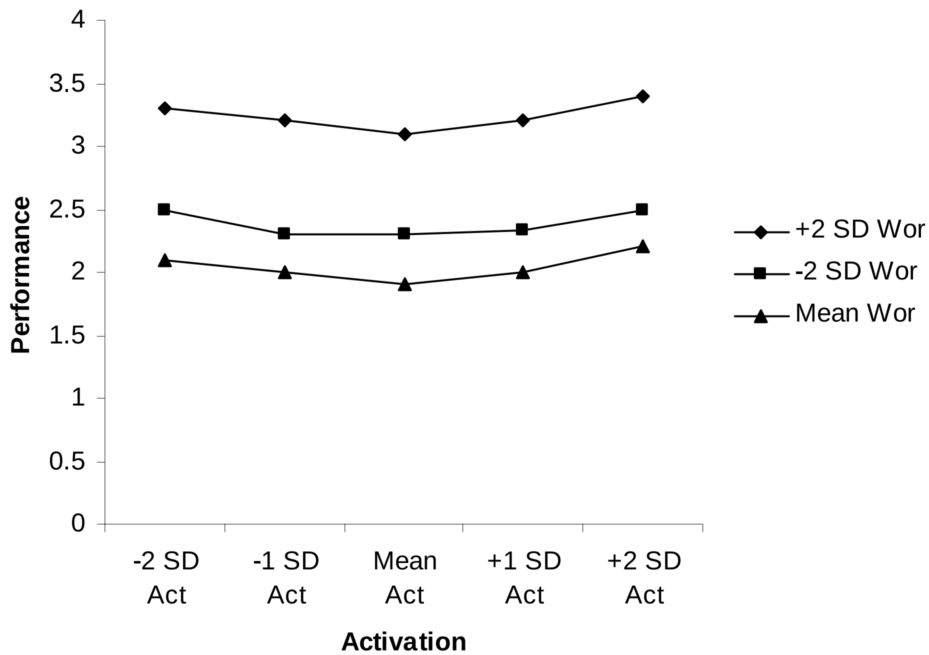
b.



P′ = 2.19 - .01 Act - .08 Wor*

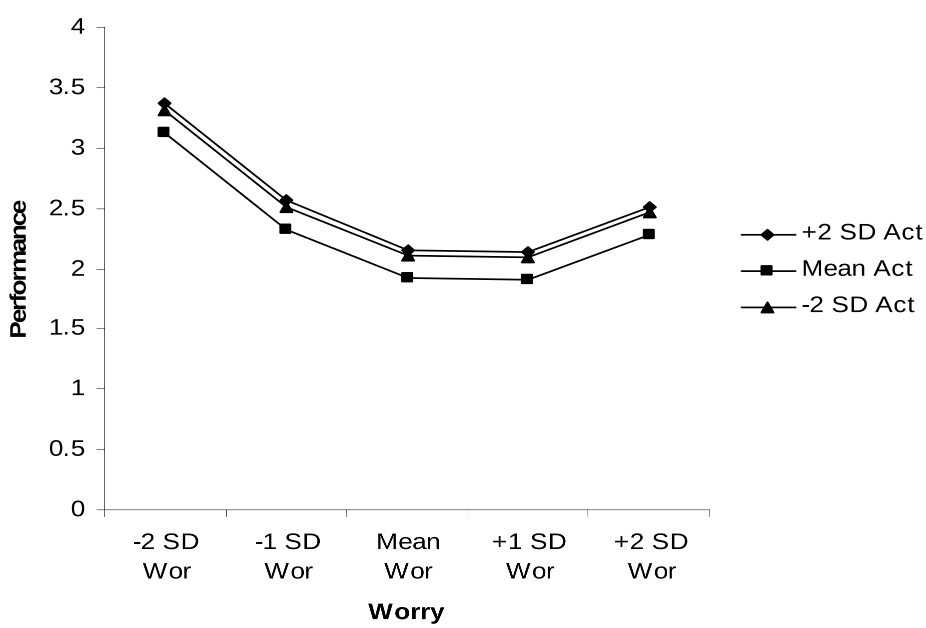
Figure 8.

a.



$P' = 1.92 + .03\ Act - .089\ Wor^{*} + .01\ Act^{2} + .034\ Wor^{2*} - .01\ Act/Wor$

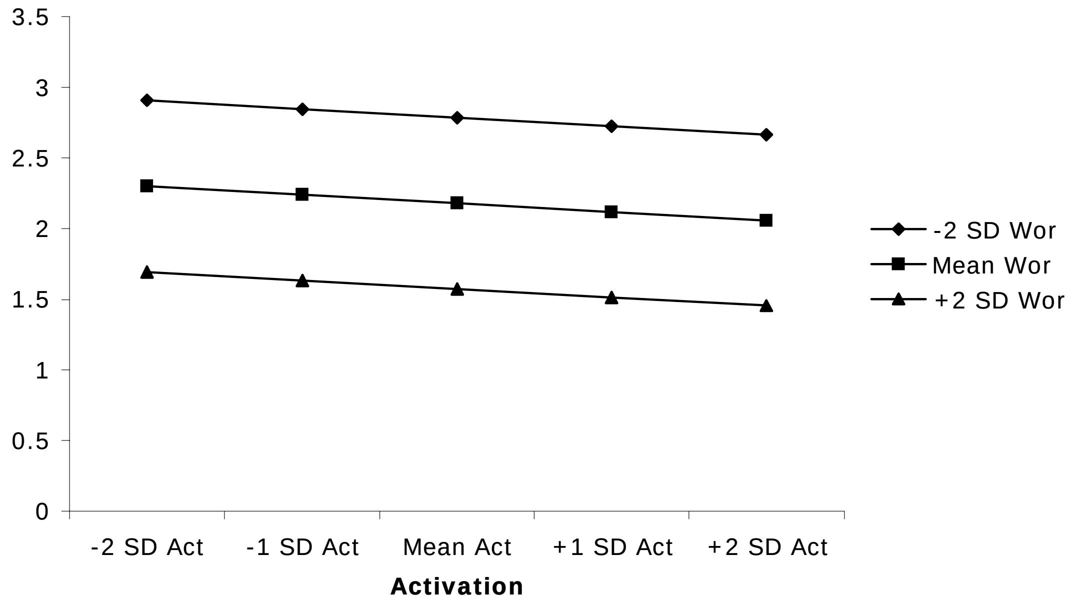
b.



$P' = 1.92 + .03\ Act - .089\ Wor^{*} + .01\ Act^{2} + .034\ Wor^{2*} - .01\ Act/Wor$

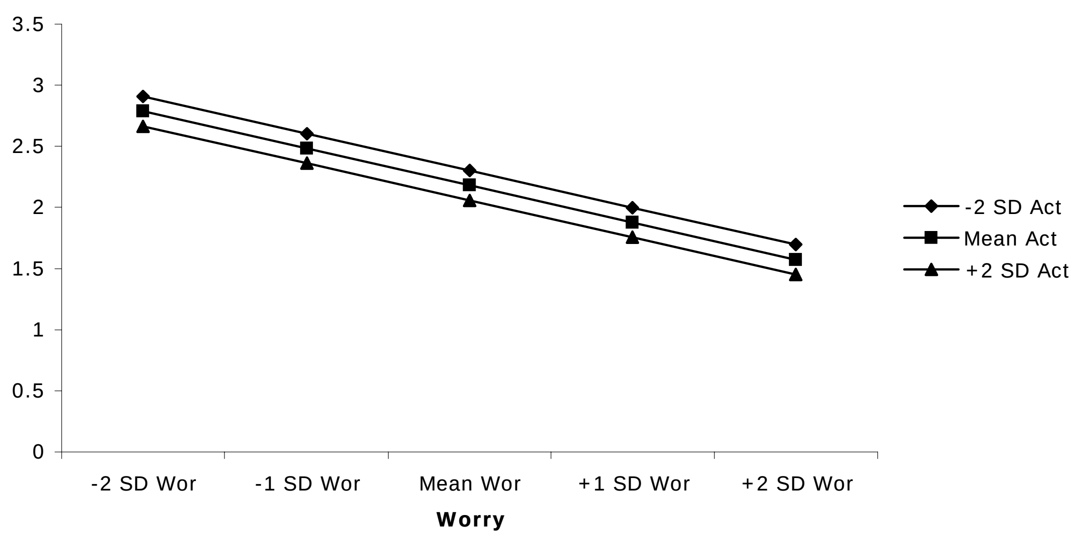
Figure 9.

a.



P′ = 2.18 - .03 Act - .13 Wor*

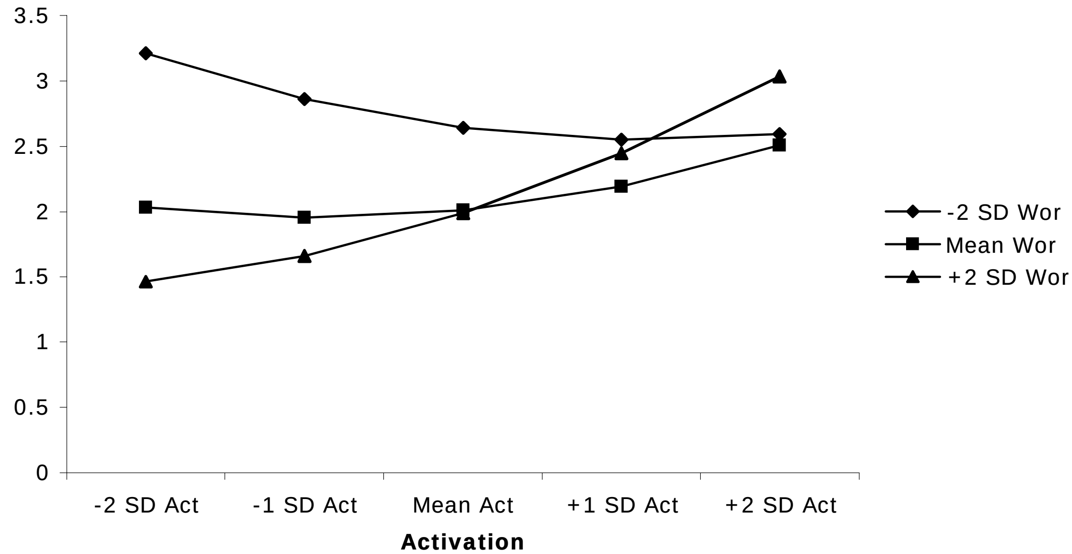
b.



P′ = 2.18 - .03 Act - .13 Wor*

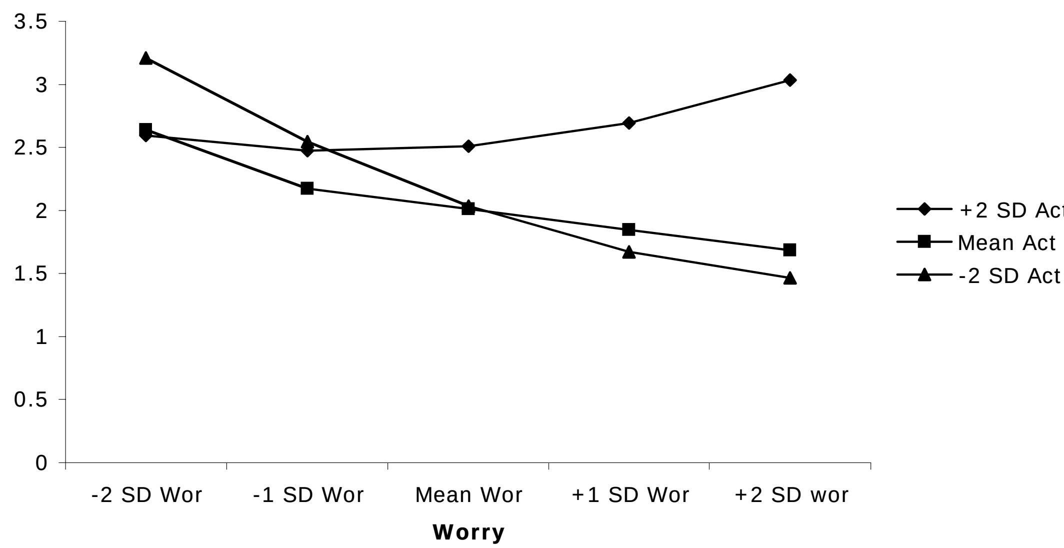
Figure 10.

a.



$P' = 2.01 + .059\ Act - .07\ Wor^* + .016\ Act^2 + .014\ Wor^2 - .029\ Act/Wor^*$

b.



$P' = 2.01 + .059\ Act - .07\ Wor^* + .016\ Act^2 + .014\ Wor^2 - .029\ Act/Wor^*$

Part III

Influences of anxiety on golf performance:
A field test of catastrophe theory

Competitive state-anxiety usually follows a pattern of subjective feelings of tension and inadequacy, combined with heightened arousal of the autonomic nervous system (Hackfort & Schwenkmezger, 1989). The intensity and duration of the anxious state alternates according to; the amount of stressful stimuli the athlete encounters, and the period of subjective threat created by the stimuli (e.g. Hackfort & Schwenkmezger, 1989). Originally, it was thought that the connection between performance and arousal was explained by the Inverted-U hypothesis (Yerkes and Dodson, 1908). The best performance could be guaranteed with an average level of arousal. If the level of arousal was too low, or too high, poor performance would result. Original research by Yerkes and Dodson (1908) was conducted on mice and their response to varying levels of shock as applied to avoidance learning. Yerkes and Dodson's (1908) study actually involved examination of the relationship between task acquisition and stimulus intensity rather than arousal (Raglin, 1992).

Landers and Arent (2001) suggested that to observe a smoother inverted-U shaped function several levels of arousal must be manipulated. It is there recommendation that arousal be manipulated at more than six distinct levels to accurately assess the inverted-U theory. Arent and Landers (2003) have performed more recent examination of the inverted-U theory. In their study, participant reaction time was measured at any one of 8 levels of arousal, as manipulated on a cycle ergometer. The analysis revealed a significant quadratic relationship for arousal and reaction time ($F = 15.10$, $p > .001$). In their study the optimal (or best) performance, as measured by reaction time, was demonstrated at 60-70% of maximum arousal.

Morgan and Ellickson (1989) discussed that there is some support for the inverted-U hypothesis in motor learning tasks, but the results should not be generalized to sport performance. Most of the research that supports inverted-U hypothesis has been conducted with non-athletes or unskilled athletes. Thus, the findings could be applied to learning effects rather than the application of the hypothesis to skilled performers. Previous research has also lacked field experimentation in sport settings (Raglin, 1992).

Sonstroem and Bernardo (1982) investigated the basic tenets of an inverted-U relationship between basketball performance and arousal. Varsity female basketball players from eight teams who competed in at least three games of a preseason double elimination tournament were tested in this study. An intra-individualized analysis method was use to assess each subject’s performance. The Sonstroem and Bernardo (1982) investigation supported the notion of an inverted-U relationship between arousal and performance.

Gould, et al. (1987) and Burton (1988) have also confirmed an inverted-U relationship between arousal and performance. Gould, et al. (1987) examined the theory utilizing pistol shooters while Burton (1988) examined the inverted-U theory utilizing swimmers. A quadratic relationship between arousal and performance was observed in both studies. These studies measured arousal as a function of its somatic or physiological properties. An inverted-U relationship was not observed when the cognitive properties of anxiety were tested.

Despite the recognition of the inverted-U hypothesis in the field of sport psychology, several recent studies have questioned its validity (Fazey & Hardy, 1988; Morgan & Ellickson, 1989; Neiss, 1988). Neiss (1988) developed the strongest stand against the inverted-U hypothesis in a review of literature. He states that the hypothesis has not received support due to: a) the general absence of empirical support; b) flaws in the constructs underlying the hypothesis (i.e. global arousal) and; c) the inability to conduct tests of falsification because of the lack of an acceptable index of arousal (Raglin, 1992).

Neiss (1988) argued that it is important to differentiate the terms arousal and anxiety. In many of the research studies involving the inverted-U theory, anxiety would be the manipulated variable (Hockey et al., 1986). Psychological literature though clearly differentiates arousal and anxiety. Arousal is often synonymous with "activation" and refers to body activation (i.e. heart rate, breathing rate, palms sweating) (Sage, 1984). Anxiety is an emotional state often distinguished by unpleasant feelings of intensity and apprehension (Spielberger, 1975). It is important to manipulate arousal in studies that attempt to analyze the inverted-U theory and not anxiety. Even though some experiments do not show inverted-U curves the vast majority of the evidence supports the inverted-U theory as a correlational (not causal) hypothesis that relates arousal to performance. Even the most enthusiastic cynics (Neiss, 1988) have been forced to conclude that arousal is an influencing factor on performance (Landers & Arent, 2001).

Related to the inverted-U relationship between arousal and performance are three other theories: 1) Easterbrook's Cue Utilization Theory (1959), 2) Signal Detection Theory (Cox, 2002), and Information Processing Theory (Welford, 1962; Welford, 1965). In Easterbrook's Cue Utilization Theory (1959) as arousal increases, attention narrows. The narrowing of attention is good to a moderate level, but beyond that moderate level, relevant cues/information is missed and then performance suffers. The signal detection theory is very similar in that at low levels of arousal very few signals in performance are detected. As arousal increases to a moderate level, most of the relevant signals are detected and as arousal continues to increase then too many signals are detected and performance deteriorates. In still another related theory, the information processing theory uses information in the inverted-U profile. As arousal increases, there is a moderate or optimal level to process the related information in a performance. As arousal continues to increase then too much information is processed and performance goes down (Cox, 2002).

Another theory developed that attempted to explain the relationship between arousal and sport performance. The drive theory, as developed by Hull (1943), looked to predict the relationship between arousal and sport performance. Drive theory predicts that there will be an increase in performance, with an increase in arousal (positive linear relationship). The highest performance is reliant on high levels of arousal by the individual (Morgan & Ellickson, 1989).

Spence (1956) researched the drive theory to further explain the arousal/performance relationship. The Hull-Spence theory built on the original theory that the drive (arousal) leads to the dominant response. But, this response can be correct or incorrect depending on skill level. Meaning, if you are a beginner in a sport, the dominant (high arousal) response is not the correct response. The more experienced an athlete becomes in a sport, then the dominant response would be correct. Arguments could also be made for the complexity of the sport. Basketball free throw shooting would require lower levels of arousal for the correct response versus weight lifting requiring high levels of arousal.

Jackson, et al. (1988) examined the drive theory on major level baseball players between the years of 1964 and 1981. The players were baseball players that were traded during that time period and this situation would elicit the elevated arousal levels. When drive was highest (pretrade) the player’s performance was significantly lower than normal levels of drive (3 previous years). The player’s performance returned to there normal level after the trade (lower arousal). This study created problems for the drive theory.

New theories and models have attempted to address the limitations of the inverted-U theory at measuring and conceptualizing competitive anxiety. More recent studies of the anxiety-performance relationship in sport have utilized a multidimensional conceptualization of anxiety. The multidimensional theory of anxiety is based on the assumption that competitive anxiety is comprised of two different parts; a cognitive component, and a somatic component, both having unlike effects on performance. The components can be manipulated, theoretically, independently of one another. The cognitive component has been defined as the negative expectations and concerns about one's ability to perform and the possible consequences of failure. Whereas, the somatic component is the physiological effects of the anxiety experience, such as an increase in autonomic arousal with negative physiological effects, like increased heart rate, tense muscles, shortness of breath, clammy hands, and in some cases, nausea (Jones & Hardy, 1990; Martens, et al., 1990).

Martens et al. (1990) proposed that somatic anxiety had an inverted-U shaped relationship with performance, while cognitive anxiety had a negative linear relationship with performance. In order to examine these effects, Martens et al. (1990) developed the Competitive State Anxiety Inventory (CSAI-2) measurement tool. The CSAI-2 consists of 27 questions with 9 questions devoted to cognitive state anxiety, 9 questions devoted to somatic state anxiety and 9 questions devoted to self-confidence. In addition, Martens et al. (1990) utilized a time to event approach to assist in the demonstration of the dissociation of somatic and cognitive anxiety. Administering their CSAI-2 to a selection of athletes, forty-eight hours, twenty-four hours, two hours, and five minutes before a critical event, they affirmed that the cognitive component remained stable before the start, but the somatic component began to increase prior to the onset of the event. Similar results had been found earlier by Parfitt & Hardy (1987). They found a relationship between the two sub-components that produced positive effects related to cognitive anxiety in the days before a crucial event when somatic anxiety was at a low level. In addition, they found a combination of both negative and positive effects (depending on the nature of the task) for somatic anxiety for a range of performance related activities shortly before the crucial event when cognitive anxiety was at an elevated level (Parfitt, Jones, & Hardy, 1990).

Gould et al. (1984) conducted a study to examine the basic tenets of Martens et al's. (1990) new CSAI-2. Collegiate wrestlers and female high school volleyball players were utilized to see if somatic anxiety displayed substantial increases prior to performance than cognitive anxiety. A limitation of this study was that they examined performance of wrestlers based on winning the match. The athlete may have had an exceptional match performance and still lost. Judging performance on winning alone is not an accurate testing procedure for each individual's performance. In examining the results of the study, the individual subscales shared only 16-29% of the common variance. There was, at best, marginal support for the prediction that cognitive anxiety should be more powerful predictor of performance than somatic anxiety (Durr, 1996).

McAuley (1985) conducted a study of female collegiate golfers to see whether state anxiety affected performance or whether performance affected state anxiety. In contrast to Gould et al's. (1984) study, McAuley (1985) did not find support for the predictive properties of the CSAI-2 subscales. He also stated that the score for the first round (18 holes) might influence cognitive state anxiety and self-confidence in the second round (18 holes). It was McAuley's (1985) conclusion that performance affects anxiety more than anxiety affects performance. Further research in this area is recommended.

Several of the studies have used a rather different standard to explore the relationships between the different subcomponents of anxiety and performance (Jones & Cale, 1989; Parfitt & Hardy, 1987; Parfitt, Jones, & Hardy, 1990). Several studies have engaged polynomial regression analysis to observe the relationship between the different components of competitive state anxiety and performance on the day of an event (Gould, Petlichkoff, & Weinberg, 1984; Burton, 1988). These studies have indicated a negative linear relationship between cognitive anxiety and performance. Also, an inverted-U shaped relationship between somatic anxiety and performance has been shown. Inconsistencies have been indicated in the effects of cognitive anxiety when somatic anxiety was high (Parfitt, Jones, & Hardy, 1990). These inconsistencies could be explained by an interaction between cognitive anxiety and somatic anxiety. This would explain that cognitive anxiety has a harmful effect upon performance when somatic anxiety is high on the day of an important contest, but a positive effect upon performance when somatic anxiety is low during the days prior to an important contest (Hardy, Parfitt, & Pates, 1994).

The major dilemma of the multidimensional theory of anxiety is that it attempts to explain the interaction of cognitive anxiety, somatic anxiety and performance in two separate two-dimensional relationships. Multidimensional theory (Martens et al., 1990) makes predictions only about the separate relationships between cognitive anxiety and performance, and somatic anxiety and performance. What is not understood is an explanation of how cognitive and somatic anxieties interact to influence performance (Hardy et al., 1994).

The multidimensional theory (Martens et al., 1990) and the inverted-U hypothesis have been challenged and expanded in the 1990's and 2000's. The alternative theories are Fazey and Hardy's (1988) Catastrophe Theory, Hanin's (1980) Zone of Optimal Functioning (ZOF) and Apter's (1982) Reversal Theory.

Hardy and associates (Fazey & Hardy, 1988; Hardy, 1990; Hardy & Parfitt, 1991) proposed a three dimensional catastrophe model of anxiety and performance, which attempted to clarify the relationship between cognitive anxiety, physiological arousal, and performance.

Rene Thom (1975) was the first to use the expression 'catastrophe theory' to describe a model of discontinuities in functions that were, as a rule, continuous. As Hardy (1990) explains, "...Thom's central theorem was that, with certain qualifications, all naturally occurring discontinuities could be classified as being of the 'same type' as (i.e. topologically equivalent to) one of seven fundamental catastrophes", (Hardy, 1990, p. 85). Zeeman (1976) popularized catastrophe theory by applying the principles to behavioral sciences. Basically the catastrophe theory supports the multidimensional theory of anxiety. However, instead of analyzing cognitive anxiety and physiological arousal independently, catastrophe theory attempts to explain the interaction of cognitive and physiological arousal and their subsequent effect on performance (Fazey & Hardy, 1988).

The Hardy & Fazey’s (1987) catastrophe model is similar to the multidimensional theory of anxiety as it attempts to explain that anxiety is comprised of two sub-components. It differentiates in the following way, rather than using somatic anxiety as the asymmetry factor, Hardy & Fazey (1987) chose to use physiological arousal. There is disagreement among researchers on the correlation of physiological arousal and somatic anxiety. Studies have attempted to link the relationship of these two parameters and will be discussed later in the review.

Hardy & Fazey (1987) state, in their version, that physiological arousal follows the Inverted-U hypothesis in relation to performance. That will only occur when the individual is exhibiting low cognitive state anxiety, e.g. they are not worried about their immediate performance. Alternatively, a catastrophe will occur if the individual is exhibiting high cognitive anxiety (e.g. concern over their immediate performance). This is typified by an increase in physiological arousal that will reach a threshold point just over the cusp of optimal arousal. Thereafter follows a steep and prompt decline in the individual's performance, i.e. a catastrophe. Fazey and Hardy (1988) selected cognitive anxiety as the splitting factor in their cusp catastrophe model and physiological arousal as the normal factor. They projected that cognitive anxiety determines whether performers interpret their physiological arousal positively or negatively, thereby determining whether the effects of physiological arousal upon performance will be small and continuous, large and catastrophic, or somewhere in between these two extremes. The model allows the likelihood of physiological arousal exerting both direct and indirect effects upon performance (Hardy et al., 1994). The model also predicts that if there is low physiological arousal present in the days leading up to an important event, cognitive anxiety will enhance the athlete's performance in relation to the baseline data that can be taken from his training session (Parfitt, 1988). Additionally, Hardy (1990) goes on to state that the model will predict either positive or negative effects of physiological arousal upon performance when there is an elevation in cognitive anxiety. This depends upon how high the cognitive anxiety is at the time.

Summarizing catastrophe theory, Fazey and Hardy (1988) proposed four hypotheses:

1. Physiological arousal and the associated somatic anxiety are not necessarily detrimental to performance. However, they will be associated with catastrophic effects when cognitive anxiety is high.
2. Hysteresis will occur under conditions of high cognitive anxiety. That is to say, performance will follow a different path when physiological arousal is increasing compared to the path it follows when physiological arousal is decreasing. Hysteresis will not occur under conditions of low cognitive anxiety.
3. Intermediate levels of performance are most unlikely in conditions of high cognitive anxiety. More precisely, performance should be bimodal under

conditions of high cognitive anxiety and unimodal under conditions of low cognitive anxiety.

4. It should be possible to fit precise "cusp catastrophes" to real-life data.

Hardy et al. (1994) using crown green bowlers examined these concepts. Cognitive anxiety was manipulated by testing participant's 2 days before and 2 days after an important tournament. Physiological arousal was used instead of somatic anxiety and was controlled by elevating and lowering the heart rate through exercise. They analyzed their data using a 2 x 2 x 5 repeated-measures ANOVA. The ANOVA revealed the predicted three-way interaction of cognitive anxiety, heart rate, and the direction of change in heart rate upon performance, with follow-up tests indicating that the interaction was due to hysteresis occurring in the high cognitive anxiety condition but not in the low cognitive anxiety condition. However, the results did not provide clear support for the catastrophe model of anxiety and performance.

Hardy and Parfitt (1991) also studied the catastrophe theory using eight female, collegiate basketball players. Physiological arousal was manipulated while the basketball players performed a set shooting task under varying conditions of high and low cognitive anxiety. The data was analyzed using curve-fitting procedures and other tests of significance In general they found support for the catastrophe theory, however, their conclusions did not support the view that cognitive anxiety is the only significant predictor of performance.

A major concern in examining catastrophe theory is the relationship of physiological arousal to somatic anxiety. Can somatic anxiety replace physiological arousal in the model? Physiological arousal has been defined in terms of level or intensity, such as a universal physiological and psychological initiation of the organism that varies on a continuum from deep sleep to intense excitement (Gould & Krane, 1992). The classic ‘fight or flight’ response to threatening environmental stimuli is what is best thought of as physiological arousal. Fazey and Hardy (1988) argued that this response might be partially reflected by somatic anxiety, or other indicators of arousal. However, the peculiarities of different situations, physiological subsystems and task demands could apply to specific deviations from the comprehensive response of any physiological indicators.

As stated before there is disagreement among researchers on the correlation of physiological arousal and somatic anxiety. Studies have attempted to link the relationship of these two parameters. Some studies show that physiological arousal (as measured by heart rate) and somatic anxiety show a similar time course, making physiological arousal a strong indicator of somatic anxiety (Parfitt et al., 1990; Hardy & Parfitt, 1991). Although these studies have shown that physiological arousal follow a similar time course, there are important differences regarding the means by which physiological arousal and somatic anxiety might play a role in performance. Physiological arousal could cause direct effects on performance through the limiting of resources (hormones and blood flow) to performers (Hockey & Hamilton, 1983). Physiological arousal, which is associated with anxiety, has been shown to continue to fluctuate during performance (Baddeley and Idzikowski, 1983). Fazey and Hardy (1988) argued that this response might be partially reflected by somatic anxiety, or other physiological indicators of arousal. This causes a problem in the relationship of physiological arousal and somatic anxiety, in that somatic anxiety is hypothesized to dissipate once performance begins (Martens, et al., 1990). Fazey and Hardy (1988) selected cognitive anxiety as the splitting factor in their cusp catastrophe model and physiological arousal as the normal factor. They projected that cognitive anxiety determines whether performers interpret their physiological arousal positively or negatively, thereby determining whether the effects of physiological arousal upon performance will be small and continuous, large and catastrophic, or somewhere in between these two extremes. The model allows the likelihood of physiological arousal exerting both direct and indirect effects upon performance (Hardy et al., 1994).

A recent study attempted to examine the catastrophe theory using a somatic anxiety inventory to explain physiological arousal and their interactive effect on diving performance. This study had limited success in explaining the relationship of cognitive and somatic anxiety on performance. It is possible that somatic anxiety is too closely related to cognitive anxiety to be able to measure the tenets independently (Durr & Cox, 1997). This brings in another possible problem. For the catastrophe model to be effective, there should be a low correlation between the independent variables (physiological arousal and cognitive anxiety). In the study by Durr and Cox (1997), cognitive anxiety and somatic anxiety were shown to have a high correlation ($r = .745$). This high correlation violates the basic assumption of catastrophe theory that the two constructs in the model that predict performance are independent of each other.

Edwards et al. (2002) used a qualitative analysis approach to investigating the catastrophe model on eight elite performers. The performers were asked structured questions to explore their catastrophic experiences during competition. Both inductive and deductive approaches were utilized in the study. The inductive approach allows for themes and categories to emerge from the interviews. The deductive approach has pre-determined questions in the investigation. From the analysis, two higher order dimensions were identified, "sudden, substantial drop in performance" and " performance continued to deteriorate." This is in direct support of the catastrophe model, in that, performance decrements do not follow a smooth and continuous path.

Hanin's Zone of Optimal Functioning (ZOF) theory relates to the inverted-U theory in that the there is an optimal level of anxiety for peak performance. Hanin's ZOF differs from the inverted-U theory because it suggests that a moderate level of anxiety may not be the optimal level for all athletes. For some athletes the optimal or peak performance may be when anxiety is low and for other athletes high anxiety may elicit peak performance. It is theorized that each athlete has their own "zone" for peak performance (Hanin, 1980, 1986).

The zone of optimal functioning is determined through a systematic calculation of observations of previous performances. The zone can be determined through direct observations of performance or through retrospective recall (Hanin, 1986; Harger & Raglin, 1994). Optimal performance is likely to occur when an athlete's precompetitive anxiety falls within this predetermined anxiety zone (Russell & Cox, 2000). This would create an individual zone of optimal functioning (IZOF) (Hanin, 1989).

Support for the ZOF hypothesis has been demonstrated that with-in zone performances are superior to out-of-zone performances (Hanin, 1986; Morgan, O'Connor, Sparling, & Pate, 1987).

Recent studies have utilized the Modified CSAI-2 (Martens, R., Vealey, R., & Burton, D, 1990; Swain & Jones, 1993) in examining the ZOF theory. The conclusions drawn in these studies have been less favorable for the ZOF theory (Davis & Cox, 2002; Annesi, 1997; Randle & Weinberg, 1997). Davis and Cox (2002) found support for ZOF theory relative to intensity of cognitive anxiety, however, the directional aspect failed to support ZOF theory. Annesi (1997) felt that using the CSAI-2 may not be useful for IZOF research and that the recall method (retrospective) would be the prefer assessment. Randle and Weinberg (1997) found no differences in performances inside and outside the zones when examining collegiate softball players.

Russell and Cox (2000) found limitations with the ZOF theory when examining positive and negative affect as measured with the Positive and Negative Affect Schedules (Watson, Clark, & Tellegen, 1988). Utilizing college male athletes in a basketball shooting drill and football throwing they found low effect sizes, suggesting IZOF limitations. Their study does provide support for the retrospective method of determining peak performance anxiety levels (Russell & Cox, 2000).

Another alternative to the arousal/anxiety relationship with performance is Apter's reversal theory (1982). This theory does not utilize the inverted-U theory and is very much a personality theory. People can be described as either telic or paratelic. Telic individuals are more focused and goal driven versus paratelic being more fun-loving and spontaneous. Apter explains that individuals are not tied to one of the orientations, but can switch (reverse) easily between the two styles. This switching back and forth can be referred to as metamotivational (Apter, 1982).

Apter (1984) identified three factors that interact with each other and help bring about the psychological reversals: 1) contingent events, 2) frustration, and 3) satiation. Contingent events can be described as a change in the atmosphere of a contest. If at the start of a contest you are very tense and focused on the competition (telic) and then your team starts to take control of the game, you shift to a relaxed and fun-natured approach (paratelic) approach to the game. Frustration can be described by a situation during the 1985 World Series involving the St. Louis Cardinals and Kansas City Royals. A controversial call at first base led to the Kansas City Royals winning game 6. The Cardinals let the frustration of that event completely change their orientation to the series. Instead of playing focused, they became lost all composure and eventually lost game 7. Satiation is explained as the longer an individual spends in one metamotivational state (telic or paratelic), the probability of reversal to the other state increases (Kerr, 1993). Having just finished a long practice session (telic state), an athlete would enjoy a reversal to a relaxed diversionary activity (paratelic).

Support for the reversal theory has been found in the sport literature (Kerr and Svebac, 1989; Kerr, 1991). Kerr and Svebac (1989) found that paratelic athletes seek exciting and adventurous sports; where telic individuals prefer safe, low risk sports such as golf and walking. A study by Kerr (1991) found that risk sport participants were more paratelic dominant that safe sport athletes. In a qualitative study with male slalom conoeists, telic orientation led to more situations of hard work, staying focused and following the rules. Paratelic was associated with relaxation, thrill seeking and feelings of pleasure (Males, Kerr & Gerkovich, 1998).

Accurate assessment of an athlete’s anxiety is imperative to investigation of anxiety/performance relationships. Sport psychology anxiety researchers have developed different methods of measurement of sport-specific anxiety. Martens et al (1990) developed the Competitive State Anxiety Inventory-2 (CSAI-2) to assess an athlete’s disposition before performance. The CSAI-2 is a twenty-seven-item inventory that assesses cognitive anxiety, somatic anxiety and self-confidence. Each subscale includes nine questions and the inventory provides reliable measures. The major limitation of the CSAI-2 inventory is amount of time to administer. It can take an athlete from 3 to 10 minutes to complete. Most athletes and coaches would rather not have their sport preparation time interrupted for that amount of time. Researchers suggest that anxiety studies should consider situational facets within the athletic environment related to the measures of anxiety. This is important because, during a competition, situations involving different levels of perceived importance will occur sporadically. One can suspect that the accompanying anxiety levels also will change during the course of the athletic contest. For example, in golf, each hole will present different challenges and each situation will produce varying levels of competitive anxiety (Krane, Joyce, & Rafeld, 1994). In an effort to solve this problem a number of researchers have developed less intrusive measures of competitive state anxiety.

Hardy et al. (2004) proposed that self-confidence might play a role in the relationship with stress and performance. The butterfly catastrophe model (Hardy, 1996a) is an extension of the basic cusp catastrophe model that consists of two other dimensions, a bias factor and a butterfly factor. The bias factor will move the cusp forward in the model and also to the left or to the right. Hardy (1990, 1996a) has considered that self-confidence might be the bias factor in the butterfly catastrophe model. Self-confidence is proposed to shift the cusp to the right in conditions of high self-confidence and to the left in conditions of low self-confidence. Hardy et al. (2004) tested this proposal on eight male golfers prior to teeing off on each golf hole of an 18-

hole golf tournament. The golfers were instructed on how to use the CSAI-2 measurement tool for assessing cognitive state anxiety, somatic state anxiety and self-confidence. During the training session the subjects filled out original CSAI-2's with respect to prior performances. This was performed to teach the subjects to provide a single-integer score for each of the subscales (Likert score 0-27). During the actual testing, subjects would provide a single score on each subscale prior to teeing off on each hole. The single score CSAI-2 and the full CSAI-2 had Pearson correlation coefficients of $r = 0.67$ for cognitive anxiety, $r = 0.72$ for somatic anxiety and $r = 0.80$ for self-confidence. After analysis of the data through a series of two-way (Cognitive Anxiety x Somatic Anxiety) analysis of variance's (ANOVA). The maximum interaction effect was analyzed at varying levels of self-confidence. The ANOVA's supported the moderating role of self-confidence in the butterfly cusp catastrophe model (Hardy et al., 2004). This method of assessing pre-competitive anxiety is an interesting alternative to the field. It is problematic for catastrophe model, in that it still assesses somatic anxiety and not physiological arousal.

Jones and Swain (1995) modified the CSAI-2 to include a direction component of anxiety to accompany the already existing intensity component. Jones (1991) agreed that the intensity (the scores on the somatic, cognitive and self-confidence components) was very important, but also the athlete's perception of those scores. For example, would high cognitive anxiety be interpreted as helpful (facilitative) or harmful (debilitative)? Several studies have found support for the directionality theory (Jones & Hanton, 2001, 1996; Jones & Swain, 1995).

Several studies have found limited support for the directionality theory (Jerome & Williams, 2000; Cunningham & Ashley, 2002). Jerome and Williams studied bowlers and found only limited support. In Cunningham and Ashley (2002) they found no difference in performance in golfers who classified their anxiety as debilitative versus those who classified their anxiety as facilitative.

The Sport Anxiety Scale (SAS) was developed by Smith et al. (1990) to measure the multidimensional nature of competitive anxiety. Included in the SAS are subscales for cognitive and somatic anxiety. Cognitive anxiety is further broken down into as worry and concentration disruption scales. Smith et al. (1990) have correctly developed a measurement tool that assesses the indepentdent, differential effects of cognitive and somatic anxiety on performance (Anshel, 2003). Smth et al. (1990) found that because of the situational demands of sport (states), that the somatic component of SAS was not a great predictor of performance because it was developed to assess trait anxiety. The SAS is a valid assessment tool for trait anxiety, whereas the CSAI-2 measures state anxiety (Anshel, 2003).

Murphy, Greenspan, Jowdy, and Tammen (1989) developed the Mental Readiness Form (MRF) as an alternative to the CSAI-2 for measuring competitive state anxiety. The MRF assessed competitive state anxiety (cognitive and somatic) in single inventories. The original MRF consisted of a bipolar continuous scale defined with a 10-centimeter line on which subjects marked their level of affect. The athlete is to place a mark on the ruled line as to how he or she is thinking (worried --- calm), physically feeling (tense --- relaxed), or as to his or her confidence (confident --- scared). Each of the three questions corresponds with the cognitive anxiety, somatic anxiety, and self-confidence subscales of Martens et al's. (1990) CSAI-2. In Krane (1994), the MRF was modified to an 11-point Likert scale, thus providing a more systematic and accurate method for scoring cognitive anxiety, somatic anxiety and self-confidence. The same root words were used in the MRF-Likert as in the original MRF. A third version was created, MRF-3, which contained true bipolar terms (worried --- not worried; tense --- not tense; confident --- not confident). Results from Murphy et al's. (1989) study revealed that all three MRF versions exhibited concurrent validity to the CSAI-2, but the MRF-Likert or MRF-3 are preferred because of their clarity in Likert scales. The MRF-Likert and MRF-3 are considered sufficient options for the investigation of competitive state anxiety with minimal imposition of the sport situation.

In a study of collegiate softball players, Krane et al. (1994) tested the catastrophe prediction that somatic anxiety would differentially relate to performance depending upon the level of cognitive anxiety with the use of the MRF-Likert. Softball players were assessed their state anxiety every time they reached the "on deck" status using Krane's (1994) MRF-Likert. Results showed that athlete anxiety changes during performance and that somatic anxiety differentially relates to performance depending on the degree of cognitive anxiety. Somatic anxiety was found to differentially relate to performance under conditions of situation criticality lending some support to Fazey and Hardy's (1988) catastrophe theory. The relationship of somatic anxiety and performance when cognitive anxiety was extremely high, however, was not fully explored in this study. Therefore Krane et al. (1994) did not observe a catastrophe between the anxiety measures and performance. They concluded that further research was needed on the relationship of cognitive state anxiety, somatic state anxiety, and athletic performance.

Cohen et al. (2003) employed the MRF-Likert to assess cognitive anxiety and somatic anxiety in 16 male dart throwers. Participants would throw darts after having somatic anxiety manipulated on a treadmill (hr adjustment via speed on treadmill). Utilizing a RM MANOVA to assess 18 somatic and cognitive anxiety values, the results of the study failed to support the catastrophe model.

Cox, Russell and Robb (1998, 1999) developed the Anxiety Rating Scale (ARS) as a short form for assessing competitive state anxiety during and immediately prior to competition. The ARS is meant to be a short version of the CSAI-2. The ARS was developed directly from the CSAI-2 and contains brief statements obtained from the CSAI-2 to measure cognitive state anxiety, somatic state anxiety and self-confidence. College intramural athletes were administered the CSAI-2 approximately 15 minutes prior to a game. Using the appropriate subscale score as the dependent variable and the appropriate item scores as independent variables, stepwise multiple regression was utilized to determine the best three variable predictive models. From this analysis, two independent anxiety rating scales were developed, the somatic state anxiety component (ARS-S) and the cognitive state anxiety component (ARS-C). The results of the study suggest that the ARS-somatic and ARS-cognitive are reliable predictors of competitive state anxiety and may be used as an alternative for the CSAI-2 when time is a consideration. A revision to the ARS was later make in order to improve athlete's interpretation of the items (Cox, Robb, & Russell, 2000)

In a study by Durr and Cox (1997), swimming divers were tested using the anxiety rating scale (ARS) during several diving competitions. Divers rated their somatic and cognitive state anxiety prior to each dive during each competition. Raw scores and standardized ipsative z-scores were tested in regression models. Linear and quadratic relationships were observed between somatic anxiety and performance. The inverted-U relationship between somatic anxiety and performance was not observed. The performance results did not offer support for the catastrophe theory. The relationship of somatic anxiety and physiological arousal needs to be addressed when assessing participants' feelings. It has already been determined that somatic anxiety and arousal produce dissimilar results on performance (Hardy et al., 1994). The catastrophe model proposed by Fazey and Hardy (1988) requires using physiological arousal as the normal factor. A key component of testing the catastrophe theory would consist of a measurement tool that accurately assessed participant physiological arousal as well as cognitive anxiety independently.

The inability of the MRF and ARS to accurately measure arousal is problematic. Hardy and associates repeated stress the importance of the distinction between physiological arousal and somatic anxiety (Hardy, 1996; Hardy & Parfitt, 1991; Hardy et al., 1994).

The Sport Grid, as developed by Raedeke and Stein (1994), is a modified version of Russell, Weiss, and Mendelsohn's (1989) affect grid. The Sport Grid is a 9 x 9 grid (see Figure 2). The participant places an X in the box that best describes how they feel at the moment. The vertical component measures perceived arousal level, and the horizontal component measures thoughts/feelings (cognitive anxiety). In order to place a score on the self-measurement, the scores are given by counting boxes from the bottom for the arousal score and from the left for the thoughts/feelings score. In Raedeke and Stein's (1994) study, the Sport Grid has demonstrated construct and criterion validity based on responses of 72 undergraduate athletes. In the study, the participants completed several instruments including the CSAI-2, three Likert scales measuring arousal levels, and a subjective performance rating. Sport Grid and CSAI-2 correlation were in the expected direction and range of values, thus further supporting the sport grid's construct validity ($r = .40$ and $-.47$; $p < .001$). Arousal on the Sport Grid moderately correlated ($r = .40$) with somatic anxiety. The correlation makes sense because, although somatic anxiety and arousal are both based on arousal perceptions, arousal is more inclusive than somatic anxiety. Arousal includes perceptions of arousal independent of whether those perceptions are associated with positive or negative affective states, whereas somatic anxiety refers only to the perceptions of arousal associated with negative affect. Furthermore, the Sport Grid exhibits independence between the two constructs that it measures ($r = .11$), making it potentially ideal for testing the catastrophe model (Raedeke & Stein, 1994).

The Sport Grid (Raedeke & Stein, 1994) has problems when it comes to testing the catastrophe theory, specifically the Sport Grid's inability to measure cognitive anxiety independent of self-confidence. The Sport Grid measures both cognitive anxiety and self-confidence through the "thoughts and feelings" segment. The dimension range of "extremely negative thoughts and feelings" measures cognitive anxiety and "extremely positive thoughts and feelings" measures self-confidence. Having these two diverse constructs on the same measurement makes it difficult to determine exactly what is being measured (Ward & Cox, 2001). To address the shortcoming of the Sport Grid, Ward and Cox (2001) developed a revised version of the Sport Grid (Sport Grid-R). The measurement of felt arousal was maintained on the vertical axis with the anchors being adjusted from “extremely high arousal” and “extremely low arousal” to “extremely high activation (extremely pumped-up) and “extremely low activation (extremely flat or sluggish). The reason for this change was to use more familiar terminology for athletes. The horizontal measurement now indicates cognitive anxiety rather than positive or negative thoughts/feelings. The cognitive anxiety is measured through the continuum of “not worried” to “very worried”. Intramural athletes in volleyball and basketball were assessed the Sport Grid, the Sport Grid-R, and the Competitive State Anxiety Inventory-2 approximately 10 minutes before competition. Results indicated that felt arousal as measured by the Sport Grid and Sport Grid-R was not related to somatic anxiety as measured by the CSAI-2 ($r = .06$ and $r = .04$, respectively). The Sport Grid-R’s measure of cognitive anxiety (worry) had a larger correlation with cognitive anxiety as measured by the CSAI-2 than did the Sport Grid’s measure of thoughts/feelings ($r = .43$ versus $r = -.25$) and also in the same desired positive direction. Also, the correlation between cognitive anxiety and felt arousal for the Sport Grid-R was smaller, and thus less dependent, than the correlation between thoughts/feelings and felt arousal as measured by the Sport Grid ($r = -.07$ versus $r = .13$) (Ward & Cox, 2001).

The relationship between anxiety, arousal and sport is very interesting and complex. Early research examining the inverted-U theory has lead to multidimensional models, which has lead to the catastrophe model. Developing the best possible instrument to accurately assess an individual’s current anxiety/arousal status is also a complex situation. Other factors to be investigated should be task difficulty and environmental factors on performance. Further research is needed in these areas.

References

Annesi, J.J. (1997). Three-dimensional state anxiety recall implications for individual zone of optimal functioning research and application. *The Sport Psychologist*, *11*, 43-52.

Anshel, M.H. (2003). *Sport Psychology*. Benjamin Cummings: San Francisco.

Apter, M.J. (1982). *The Experience of Motivation: The Theory of Psychological Reversals.* London: Academic Press.

Apter, M.J. (1984). Reversal theory and personality: A review. *Journal of Research in Personality*, *18*, 265-288.

Arent, S.M. & Landers, D.M. (2003). Arousal, anxiety, and performance: A reexamination of the inverted-U hypothesis. *Research Quarterly for Exercise and Sport*, *74*, p. 436-444.

Baddeley, A. & Idzikowski, C. (1983). Waiting in the wings: Apprehension, public speaking, and performance. *Ergonomics*, *26*, 575-583.

Burton, D. (1988). Do anxious swimmers swim slower? Reexamining the elusive anxiety-performance relationship. *Journal of Sport & Exercise Psychology*, *10*, 45-61.

Cohen, A., Pargman, D., & Tenebaum, G. (2003). Critical elaboration and empirical investigation of the cusp catastrophe model: A lesson for practitioners. *Journal of Applied Sport Psychology*, *15*, 144-159.

Cox, R.H. (2002). *Sport Psychology: Concepts and Applications* (5^{th} ed.). Boston: McGraw-Hill.

Cox, R.H., Robb, M., & Russell, W.D. (2000). Concurrent validity of the revised anxiety rating scale. *Journal of Sport Behavior*, *23*, 327-334.

Cox, R.H., Russell, W.D., & Robb, M. (1998). Development of a CSAI-2 short form for assessing competitive state anxiety during and immediately prior to competition. *Journal of Sport Behavior*, *21*, 30-40.

Cox, R.H., Russell, W.D., & Robb, M. (1999). Comparative concurrent validity of the MRF-L and ARS competitive state anxiety rating scales for volleyball and basketball. *Journal of Sport Behavior, 22*, 310-320.

Cunningham, G.B. & Ashley, F.B. (2002). Debilitative and facilitative perceptions of trait anxiety among students in a college golf class. *Perceptual and Motor Skills*, *94*, 739-742.

Davis, J.E. & Cox, R.H. (2002). Interpreting Direction of Anxiety Within Hanin's Individual Zone of Optimal Functioning. *Journal of Applied Sport Psychology*, *14*, 43-52.

Durr, K.R. & Cox, R.H. (1997). Relationship between state anxiety and performance in high school divers: A test of catastrophe theory. *Research Quarterly for Exercise and Sport, 68*, Supplement abstract 102.

Easterbrook, J.A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review, 66*, 183-201.

Edwards, T., Kingston, K., Hardy, L., & Gould, D. (2002). A qualitative analysis of catastrophic performances and the associated thoughts, feelings, and emotions. *The Sport Psychologist. 16*, 1-19.

Fazey, J.A., & Hardy, L. (1988). *The Inverted-U Hypothesis: A Catastrophe for Sport Psychology*. British Association of Sports Sciences Monograph No. 1 Leeds: National Coaching Foundation.

Gould, D., & Krane, V. (1992). The arousal-athletic performance relationship: Current status and future directions. In T. Horn (Ed.), *Advances in sport psychology* (pp. 119-141). Champaign, IL: Human Kinetics.

Gould, D., Petlichkoff, L., Simons, J., & Vevera, M. (1987). Relationship between competitive state anxiety inventory-2 subscale scores and pistol shooting performance. *Journal of Sport Psychology*, *9*, 33-42.

Gould, D., Petlichkoff, L., & Weinberg, R. S. (1984). Antecedents of, temporal changes in, and relationships between CSAI-2 subcomponents. *Journal of Sport Psychology*, 6, 289-304.

Hackfort, D., & Schwenkmezger, P. (1989). Measuring Anxiety in Sports: Perspectives and Problems. In D. Hackfort & C. D. Speilberger (Eds.), *Anxiety in Sports: An International Perspective* (pp. 55-74). Washington, DC: Hemisphere.

Hanin, Y.L. (1980). A study of anxiety in sports. In W.E. Straub (Ed.), Sport Psychology: *An Analysis of Athlete Behavior* (pp. 236-249). New York: Movement Publications.

Hanin, Y.L. (1986). State-trait anxiety research on sports in the U.S.S.R. In C.D. Spielberger & R. Dias-Guerrero (Eds.), *Cross Cultural Anxiety* (pp. 45-64). Washington D.C.: Hemisphere.

Hanin, Y.L. (1989). Interpersonal and intragroup anxiety: Conceptual and methodological issues. In D. Hackfort & C.D. Spielberger (Eds.), *Anxiety in Sports: An International Perspective* (pp. 19-28). Washington, DC: Hemisphere.

Hardy, L. (1990). A catastrophe model of performance in sport. In J.G. Jones and L. Hardy (Eds.) *Stress and Performance in Sport* (pp. 81-106). Chichester: John Wiley

Hardy, L. (1996a). A test of catastrophe models of anxiety and sports performance against multidimensional anxiety theory models using the method of dynamic differences. *Anxiety, Stress, and Coping, 9*, 69-86.

Hardy, L. (1996b). Testing the predictions of the cusp catastrophe model of anxiety and performance. *The Sport Psychologist, 10,* 140-156.

Hardy, L., & Fazey, J. (1987). *The inverted-U hypothesis: A catastrophe for sport psychology?* Paper presented at the Annual Conference of the North American Society For the Psychology of Sport and Physical Activity. Vancouver.

Hardy, L., & Parfitt, G. (1991). A catastrophe model of anxiety and performance. *British Journal of Psychology, 82*, 163-178.

Hardy, L., Parfitt, C.G., & Pates, J. (1994). Performance catastrophes in sport: A test of the hysteresis hypothesis. *Journal of Sports Sciences, 12,* 327-324.

Hardy, L., Woodman, T., & Carrington, S. (2004). Is self-confidence a bias factor in higher-order catastrophe models? An exploratory analysis. *Journal of Sport & Exercise Psychology, 26,* 359-368.

Hockey, G.R.J., Coles, M.G.H., & Gaillard, A.W.K. (1986). Energetical issues in research on human information processing. In G.R.J. Hockey, A.W.K. Gaillard, & M.G. H. Coles (eds.), *Energetics and Human Information Processing* (pp. 3-21). Dordrecht, The Netherlands: Martinus Nijhoff.

Hockey, R., & Hamilton, P. (1983). The cognitive patterning of stress states. In R. Hockey (Ed.) *Stress and Fatigue in Human Performance* (pp. 331-362). Chichester: Wiley.

Hull, C.L. (1943). *Principles of Behavior*. New York: A;;leton-Century-Crofts, Inc.

Jackson, J.M., Bulione, S.A., & Glenwick, D.S. (1988). Major league baseball performance as a function of being traded: A drive theory analysis. *Personality and Social Psychology Bulletin*, *14,* 46-56.

Jerome, G.J., & Williams, J.M. (2000). Intensity and interpretation of competitive state anxiety: Relationship to performance and repressive coping. *Journal of Applied Sport Psychology*, *12*, 236-250.

Jones, G. (1991). Recent developments and current issues in competitive state anxiety research. *The Psychologist: Bulletin of the British Psychological Society*, *4*, 152-155.

Jones, G. & Hanton, S. (2001). Pre-competitive feeling states and directional anxiety interpretations. *Journal of Sport Sciences*, *19,* 385-395.

Jones, G. & Hanton, S. (1996). Interpretation of competitive anxiety symptoms and goal attainment expectancies. *Journal of Sport & Exercise Psychology*, *18,* 144-157.

Jones, G., & Swain, A. (1992). Intensity and direction as dimensions of competitive state anxiety and relationships with competitiveness. *Perceptual and Motor Skills*, *74*, 467-472.

Jones, G. & Swain, A. (1995). Predispositions to experience debilitative and facilitative anxiety in elite and nonelite performers. *The Sport Psychologist*, *9*, 201-211.

Jones, J.G., & Cale, A. (1989). Pre-competition temporal patterning of anxiety and self-confidence in males and females. *Journal of Sport Behavior, 12*, 183-195.

Jones, J.G., & Hardy, L. (1990). *Stress and Performance in Sport*. John Wiley & Sons Ltd.

Kerr, J.H. (1991). Arousal-seeking in risk sport participants. *Personality Individual and Differences*, *12*, 613-616.

Kerr, J.H. (1993). An eclectic approach to psychological interventions in sport: Reversal theory. *The Sport Psychologist*, *7*, 400-418.

Kerr, J.H., & Svebac, S. (1989). Motivational aspects of preference for, and participation in 'risk' and 'safe' sports. *Personality and Individual Differences*, *10*, 797-800.

Krane, V. (1994). The mental readiness form as a measure of competitive state anxiety. *The Sport Psychologist, 8*, 189-202.

Krane, V., Joyce, D., & Rafeld, J. (1994). Competitive anxiety, situation criticality, and softball performance. *The Sport Psychologist*, *8*, 58-72.

Landers, D.M., & Arent, S.M. (2001). Arousal-performance relationships. In J.M. Williams (Ed.), *Applied Sport Psychology: Personal Growth to Peak Performance* (4th ed., pp. 206-228). Mountain View, CA: Mayfield).

Males, J.R., Kerr, J.H., & Gerkovich, M. (1998). Metamotivational states during canoe slalom competition: A qualitative analysis using reversal theory. *Journal of Applied Sport Psychology*, *10*, 185-200.

Martens, R., Burton, D., Vealey, R.S., Bump, L.A., & Smith, D.E. (1990). Development and validation of the competitive state anxiety inventory-2. In R. Martens, R.S. Vealey, & D. Burton, *Competitive anxiety in sport* (pp. 117-190). Champaign, IL: Human Kinetics.

McAuley, E. (1985). State anxiety: Antecedent or result of sport performance. *Journal of Sport Behavior, 8*, 71-77.

Morgan, W.P., & Ellickson, K.A. (1989). Health, Anxiety, and Physical Exercise. In D. Hackfort and C.D. Spielberger (Eds.), *Anxiety in Sports: An International Perspective*. Hemisphere Publishing Corporation, NY., pp. 165-182.

Morgan, W.P., O'Connor, P.J., Sparling, P.B., & Pate, R.R. (1987). Psychological characterization of the elite female runner. *International Journal of Sports Medicine*, *8*, 124-131.

Murphy, S.M., Greenspan, M., Jowdy, D., & Tammen, V. (1989). Development of a brief rating instrument of competitive anxiety: Comparisons with the competitive state anxiety inventory-2. *Proceedings of the Association for the Advancement of Applied Sport Psychology*. (p. 82). Seattle, WA.

Neiss, R. (1988). Reconceptualizing arousal: Psychobiological states in motor performance. *Psychological Bulletin*, *103*, 345-366.

Parfitt, C.G. (1988). *Interactions Between Models of Stress and Modes of Motor Control*. Unpublished Phd Thesis. University of Wales, Bangor.

Parfitt, C.G., & Hardy, L. (1987). Further evidence for the differential effects of competitive anxiety upon a number of cognitive and motor sub-components. *Journal of Sports Science,* 5, 62-72.

Parfitt, C.G., Jones, G., & Hardy, L. (1990). Multidimensional anxiety and performance. In J.G. Jones and L. Hardy (Eds.) *Stress and Performance in Sport* (pp. 43-80). Chichester: Wiley.

Raedeke, T. & Stein, G. (1994). Felt arousal, thoughts/feelings and ski performance. *The Sport Psychologist*, *8*, 360-375.

Raglin, J.S. (1992). Anxiety and sport performance. *Exercise and Sports Sciences Reviews*, ACSM Series, Williams & Wilkins, Baltimore, Vol. 20, pp. 243-274.

Randle, S., & Weinberg, R. (1997). Multidimensional anxiety and performance: An exploratory examination of the zone of optimal functioning hypothesis. *The Sport Psychologist*, *11*, 160-174.

Russell, W.D. & Cox, R.H. (2000). A laboratory investigation of positive and negative affect within individual zones of optimal functioning theory. *Journal of Sport Behavior*, *23*, 160-174.

Russell, J.A., Weiss, A., & Mendelsohn, G.A. (1989). Affect grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social Psychology*, *57*, 493-502.

Sage, G. (1984). *Motor Learning and Control*. Dubuque, IA: Brown

Smith, R.E., Smoll, F.L., & Schutz, R.W. (1990). Measurement and correlates of sport-specific cognitive and somatic trait anxiety: The sport anxiety scale. *Anxiety Research*, *2*, 263-280.

Sonstroem, R.J., & Bernardo, P. (1982). Intraindividual pregame state anxiety and basketball performance: A re-examination of the inverted-U curve. *Journal of Sport Psychology*, *4*, 235-245.

Spence, K.W. (1956). *Behavior Theory and Conditioning*. New Haven, CT: Yale University Press.

Spielberger, C.D. (1975). Anxiety: State-trait process. In C.D. Spielberger & I.G. Sarason (Eds.), *Stress and Anxiety* (Vol. 1, pp. 115-143). New York: Hemisphere.

Thom, R. (1975). *Structural Stability and Morphogenesis* (G.H. Fowler, Trans.). New York: Benjamin-Addison Wesley.

Ward, D.G. & Cox, R.H. (2001). The sport grid-revised as a measure of felt arousal and cognitive anxiety. *Journal of Sport Behavior*, *27*, 93-113.

Watson, D., Clark, L.A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063-1070.

Welford, A.T. (1962). Arousal, channel-capacity, and decision. *Nature*, *194*, 365-366.

Welford, A.T. (1965). Stress and achievement. *Australian Journal of Psychology*, *17*, 1-9.

Yerkes, R.M., & Dodson, J.D. (1908). The relation of strength of stimulus to rapidity of habit formation. *Journal of Comparative and Neurological Psychology*, *18*, 459-482.

Zeeman, E.C. (1976). Catastrophe theory. *Scientific American*, *234*, 65-82.

Informed Consent

Investigator's Name: Marshall Robb **Investigator's Phone #:** 573-445-9388
Project #: #1024584
Project Approval Date: April 2003

Study Title: Influences of Anxiety on Golf Performance: A Field Test of Catastrophe Theory

Introduction:
This consent may contain words that you do not understand. Please ask the investigator to explain any words or information that you do not clearly understand.

This is a research study. Research studies include only subjects who choose to participate. As a study participant you have the right to know about the procedures that will be used in this research study so that you can make the decision whether or not to participate. The information presented here is simply an effort to make you better informed so that you may give or withhold consent to participate in this research study.

In order to participate in this study, it will be necessary to give your written consent.

Why Is This Study Being Done?
The purpose of this study is to understand the basic tenets of the catastrophe theory. How state anxiety and arousal influence golf performance will specifically be investigated.

How Many People Will Take Part In The Study?
Four people will take part in this study. You must be 18 years or older to participate.

What Is Involved In The Study?
If you take part in this study you will have the following tests and procedures:

- You will play 4 competitive rounds of golf and provide self-report measurements of state anxiety and arousal (using the Sport Grid-R) prior to every golf shot taken.

How Long Will I Be In The Study?
Four competitive rounds of golf.

Total time for each session will be approximately 4 to 4 ½ hours.

The investigator may decide to take you off this study if he thinks it is in your best interest.

You can stop participating at any time. Your decision to withdraw from the study will not affect in any way any care and/or benefits to which you are entitled.

What Are The Risks Of The Study?
There are no risks involved in participation of this study.

What Are The Benefits To Taking Part In The Study?
If you agree to take part in this study, there may or may not be direct medical benefit to you. You may expect to benefit from taking part in this research to the extent that you are contributing to sport psychology knowledge. What other options are there? An alternative is to not participate in this research study.

What are the costs?
Taking part in this study will not lead to added costs to you.

Will I receive any payments for participating in this study?
You will receive no payment for taking part in this study.

What about confidentiality?
Information produced by this study will be stored in the investigator's file and identified by a code number only. The code key connecting your name to specific information about you will be kept in a separate, secure location. Information contained in your records may not be given to anyone affiliated with the study in a form that could identify you without your written consent, except as described in this consent form or as required by law.

The results of this study may be published in a medical book or journal or used for teaching purposes. However, your name or other identifiers will not be used in any publication or teaching materials without your specific permission.

What are my rights as a participant?
Participation in this study is voluntary. You do not have to participate in this study. Your present or future care will not be affected should you choose not to participate.

Whom Do I Call If I Have Questions Or Problems?
If you have any questions regarding your rights as a subject in this research and/or concerns about the study, or if you feel under any pressure to enroll or to continue to participate in this study, you may contact the University of Missouri Institutional Review Board (which is a group of people who review the research studies to protect participants' rights) at (573) 882-9585 or the William Woods University Human Subjects Committee at (573) 592-4354 (Betsy Tutt, Academic Dean).

- If you have any questions or concerns, please ask the investigator.

- **If at any point during the study you change your mind about the procedures or feel uncomfortable with the procedures, you are free to withdraw from this study without negative consequences at all.**

I confirm that the purpose of the research, the study procedures, the possible risks and discomforts as well as potential benefits that I may experience have been explained to me. Alternatives to my participation in the study also have been discussed. I have read this consent form and my questions have been answered. My signature below indicates my willingness to participate in this study.

Subject Printed Name_______________________________________ Age __________

Signature____

Witness____

Signature of Study Representative

I have explained the purpose of the research, the study procedures, identifying those that are investigational, the possible risks and discomforts as well as potential benefits and have answered questions regarding the study to the best of my ability.

____ Date________________

Study Representative***

***Study Representative is a person authorized to obtain consent. Per the policies of the University of Missouri Health Care, for any 'significant risk/treatment' study, the study representative must be a physician who is either the Principal or Co-Investigator. If the study is deemed either 'significant risk/non-treatment' or 'minimal risk', the study representative may be a non-physician study investigator.

Participant Information Form

Study Title: Influences of Anxiety on Golf Performance: A Field Test of Catastrophe Theory

Name:____

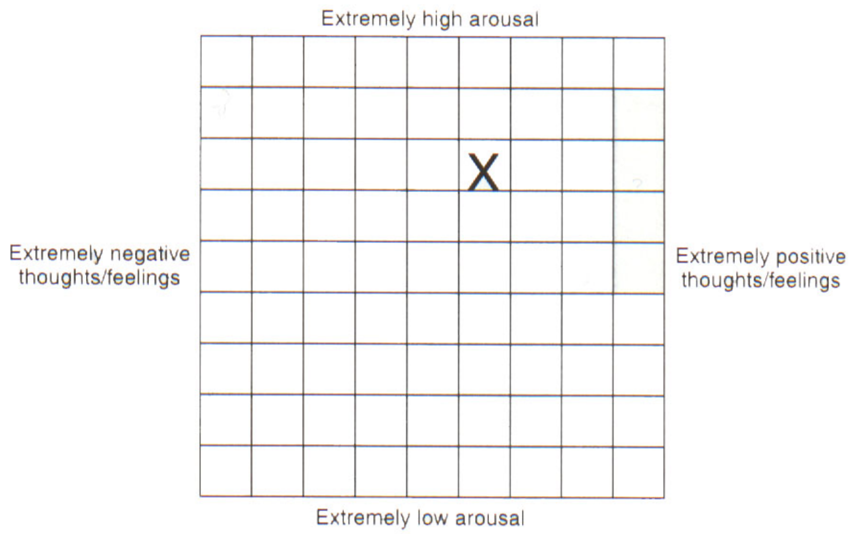
Age:____________________________ Yrs. Playing Golf _________________________

USGA
Handicap:____

Anti-Social Desirability Instructions

The effects of highly competitive sports can be powerful and very different among athletes. The inventory you are about to complete measures how you generally fell about competition. Please complete this inventory as honestly as you can. Sometimes athletes feel they should not admit any nervousness, anxiety, or worry about competition because this is undesirable. Actually, these feelings are quite common, and to help us understand them we want you to share your feelings with us candidly. If you are worried about the competition or have butterflies or other feelings that you know are signs of anxiety, please indicate these feelings accurately on the inventory. Similarly, if you feel calm and relaxed, indicate these feelings as accurately as you can. Your answers will not be shared with anyone.

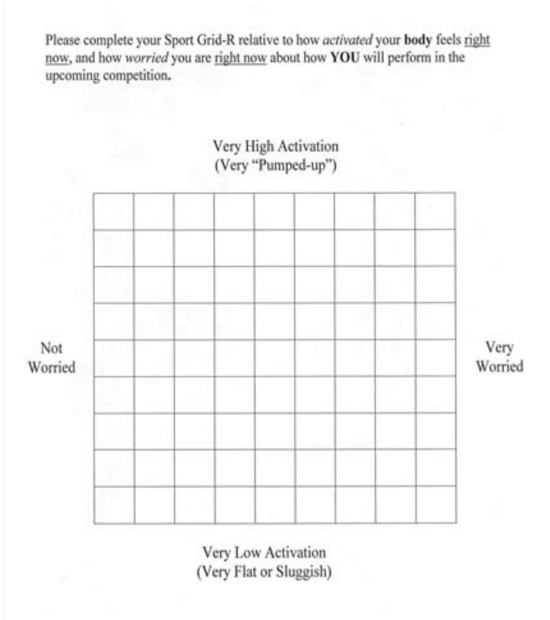
Sport Grid (Raedeke & Stein, 1994).



Data Collection Form

Hole #________________

Shot #________________


Please complete your Sport Grid-R relative to how *activated* your **body** feels right now, and how *worried* you are right now about how **YOU** will perform in the upcoming competition.

Very High Activation
(Very "Pumped-up")

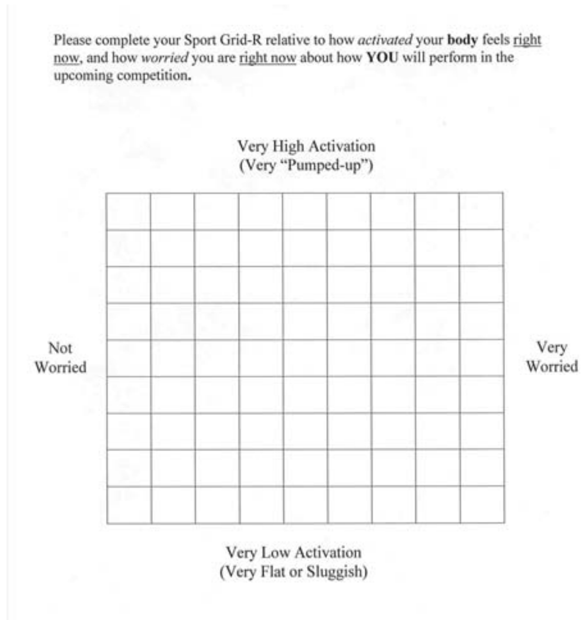
Not Worried

Very Worried

Very Low Activation
(Very Flat or Sluggish)

Hole#________________

Shot #________________


Please complete your Sport Grid-R relative to how *activated* your **body** feels right now, and how *worried* you are right now about how **YOU** will perform in the upcoming competition.

Very High Activation
(Very "Pumped-up")

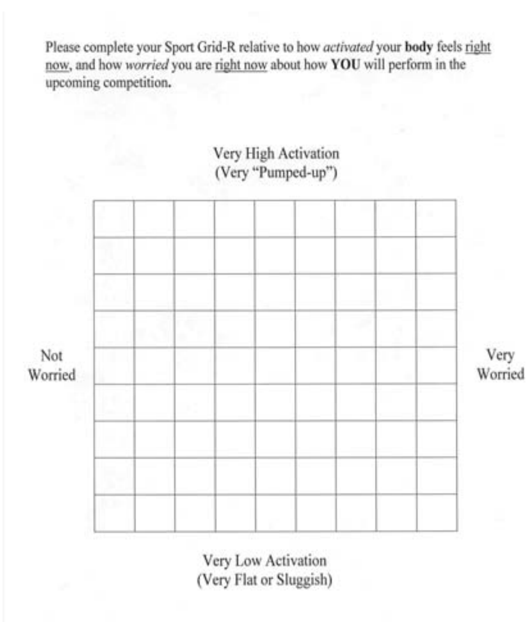
Not Worried

Very Worried

Very Low Activation
(Very Flat or Sluggish)

Hole #________________

Shot #________________


Please complete your Sport Grid-R relative to how *activated* your **body** feels right now, and how *worried* you are right now about how **YOU** will perform in the upcoming competition.

Very High Activation
(Very "Pumped-up")

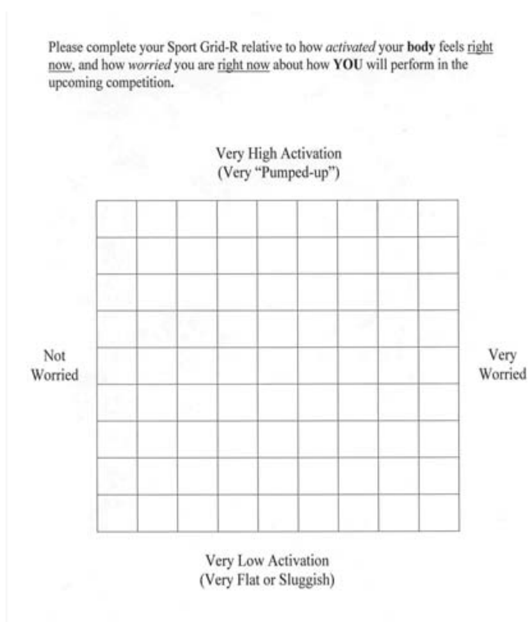
Not Worried

Very Worried

Very Low Activation
(Very Flat or Sluggish)

Hole #________________

Shot #________________


Please complete your Sport Grid-R relative to how *activated* your **body** feels right now, and how *worried* you are right now about how **YOU** will perform in the upcoming competition.

Very High Activation
(Very "Pumped-up")

Not Worried

Very Worried

Very Low Activation
(Very Flat or Sluggish)

Rating of Performance Round # _____ Golfer's Name____________

Shot #1_____	Shot #21_____	Shot #41_____	Shot #61_____	Shot #81_____
Shot #2_____	Shot #22_____	Shot #42_____	Shot #62_____	Shot #82_____
Shot #3_____	Shot #23_____	Shot #43_____	Shot #63_____	Shot #83_____
Shot #4_____	Shot #24_____	Shot #44_____	Shot #64_____	Shot #84_____
Shot #5_____	Shot #25_____	Shot #45_____	Shot #65_____	Shot #85_____
Shot #6_____	Shot #26_____	Shot #46_____	Shot #66_____	Shot #86_____
Shot #7_____	Shot #27_____	Shot #47_____	Shot #67_____	Shot #87_____
Shot #8_____	Shot #28_____	Shot #48_____	Shot #68_____	Shot #88_____
Shot #9_____	Shot #29_____	Shot #49_____	Shot #69_____	Shot #89_____
Shot #10____	Shot #30_____	Shot #50_____	Shot #70_____	Shot #90_____
Shot #11____	Shot #31_____	Shot #51_____	Shot #71_____	Shot #91_____
Shot #12____	Shot #32_____	Shot #52_____	Shot #72_____	Shot #92_____
Shot #13____	Shot #33_____	Shot #53_____	Shot #73_____	Shot #93_____
Shot #14____	Shot #34_____	Shot #54_____	Shot #74_____	Shot #94_____
Shot #15____	Shot #35_____	Shot #55_____	Shot #75_____	Shot #95_____
Shot #16____	Shot #36_____	Shot #56_____	Shot #76_____	Shot #96_____
Shot #17____	Shot #37_____	Shot #57_____	Shot #77_____	Shot #97_____
Shot #18____	Shot #38_____	Shot #58_____	Shot #78_____	Shot #98_____
Shot #19____	Shot #39_____	Shot #59_____	Shot #79_____	Shot #99_____
Shot #20____	Shot #40_____	Shot #60_____	Shot #80_____	Shot #100_____

Additional Analyses

Four additional polynomial multiple regression analyses were calculated and tested for each of the four participants. An analysis was run for drive shots only, one for approach or fairway shots only, one for chip shots only, and one for putts only.

The results of the polynomial multiple regression analyses are organized as a function of each participant. For each analysis, results are discussed relative to the stated steps. In addition, for each golfer, Tables and Figures are displayed to clarify the results as well as the nature of the observed relationships.

Participant 1 / Male, High Skill

Tee shot analysis. The data were analyzed by tee shot type (N = 72). Tee shot type resulted in a significant linear regression model [$F(2, 69) = 4.52$, $p = 0.0143$, $R^2 = .1158$] as is illustrated in step 1 of Table 6. The results of the linear regression analysis resulted in significant betas for both Act and Wor. Golf tee shot performance variance accounted for in the linear model was $R^2 = .1158$ and the zero order correlations among the three variables were .21 ($p = .07$), -.20 ($p = .08$), and .24 ($p = .04$) for Per with Act, Per with Wor, and Act with Wor respectively. In step 2, the higher order terms (Act^2, Wor^2, and Act/Wor) were added simultaneously to the tee shot type linear model. The full unstandardized prediction model was significant [$F(5,66) = 2.50$, $p = .04$, $R^2 = .1593$], but the addition of the higher order terms did not result in a significant increase in variance to the linear model. The data are presented in step 2 of Table 6.

A F-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test did not reveal a significant increase (p < .05) in the variance from the linear to the full test model F (3, 65) = 1.12, p > .05, R^2_{inc} = .043.

<u>Approach shot analysis</u>. The data were then analyzed by approach shot type (N = 75). Approach shot type had a significant linear regression model [F(2, 72) = 7.08, p = 0.0016, R^2 = .1643] and is illustrated in step 1 of Table 7. The results of the linear regression analysis resulted in significant betas for both Act and Wor. Golf approach shot performance variance accounted for in the linear model was R^2 = .1643 and the zero order correlations among the three variables were .31 (p = .007), -.19 (p = .10), and .21 (p = .07) for Per with Act, Per with Wor, and Act with Wor respectively. In step 2 the higher order terms (Act^2, Wor^2, and Act/Wor) were added simultaneously to the approach shot type linear model. The full unstandardized prediction model was significant [F(5,69) = 3.19, p = .01, R^2 = .1879], but the addition of the higher order terms did not result in a significant increase in variance to the linear model. The data are presented in step 2 of Table 7.

A F-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test did not reveal a significant increase (p < .05) in the variance from the linear to the full test model F (3, 68) = 0.66, p > .05, R^2_{inc} = .024.

<u>Chip shot analysis</u>. The data were analyzed by chip shot type (N = 28). Chip shot type had a significant linear regression model [F(2, 25) = 6.68, p = 0.0048, R^2 = .3481] and is illustrated in step 1 of Table 8. The results of the linear regression analysis resulted in significant betas for both Act and Wor. Golf chip shot performance variance accounted for in the linear model was R^2 = .3481 and the zero order correlations among

the three variables were .41 (p = .03), -.30 (p = .12), and .25 (p = .20) for Per with Act, Per with Wor, and Act with Wor respectively. The higher order terms (Act^2, Wor^2, and Act/Wor) were added simultaneously to the chip shot type linear model. The full unstandardized prediction model was significant [$F(5,22) = 2.88$, $p = .04$, $R^2 = .3954$], but the addition of the higher order terms did not result in a significant increase in variance to the linear model. The data are presented in step 2 of Table 8.

A F-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test did not reveal a significant increase ($p < .05$) in the variance from the linear to the full test model $F(3, 21) = 0.55$, $p > .05$, $R^2_{inc} = .047$.

<u>Putting shot analysis</u>. The data were then analyzed by putting shot type (N = 134). A significant model was obtained when performance (P), on all putting shot type strokes, was regressed on activation (Act) and worry (Wor), $F(2, 131) = 9.38$, $p = .0002$, $R^2 = .1253$ and is illustrated in step 1 of Table 9. The results of linear regression analysis resulted in significant betas for Wor only. Golf performance variance accounted for in the linear model was $R^2 = .1253$ and the zero order correlations among the three variables were -.23 (p = .008), -.35 (p < .0001), and .69 (p < .0001) for Per with Act, Per with Wor, and Act with Wor respectively. In step two, the two quadratic components and the product term (Act/Wor) were added simultaneously to the linear model. Consequently, all three terms were added to the linear model in what will be referred to as the full test model. Performance (P) was regressed on activation (Act), worry (Wor), Act^2, Wor^2, and Act/Wor in a test of the full model for all golf strokes for participant one (N = 134).

The results of the test of the full model are illustrated in step 2 of Table 9 [F(5,128) = 5.77, $p < .0001$, $R^2 = .1838$]. From Table 9 we are able to see that Act is a positive significant predictor and Wor is a negative significant predictor of golf performances, but none of the quadratic or interaction terms add significance to the model.

A *F*-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test revealed a significant increase ($p < .05$) in the variance from the linear to the full test model F (3, 127) = 3.08, $p < .05$, $R^2_{inc} = .059$.

Participant 2 / Male, Low Skill

Tee shot analysis. The data were analyzed by tee shot type (N = 72). Tee shot type did not have a significant linear regression model [F(2, 69) = 1.15, p = 0.3229, R^2 = .0322]. The higher order terms (Act^2, Wor^2, and Act/Wor) were added to the tee shot type linear model simultaneously and the full unstandardized prediction model was insignificant [F(5, 66) = 1.04, p = 0.4031, R^2 = .0729].

Approach shot analysis. The data were then analyzed by approach shot type (N = 75). Approach shot type did not have a significant linear regression model [F(2, 72) = 1.72, p = 0.1868, R^2 = .0455]. The higher order terms (Act^2, Wor^2, and Act/Wor) were added to the approach shot type linear model simultaneously and the full unstandardized prediction model was insignificant [F(5, 69) = 1.06, p = 0.3891, R^2 = .0715].

Chip shot analysis. The data were analyzed by chip shot type (N = 52). Chip shot type did not have a significant linear regression model [F(2, 49) = 0.01, p = 0.9865, R^2 = .0006]. The higher order terms (Act^2, Wor^2, and Act/Wor) were added to the chip shot type linear model simultaneously and the full model was insignificant [$F(5, 46) = 0.50$, $p = 0.7709$, $R^2 = .0520$].

Putting shot analysis. The data were then analyzed by putting shot type (N = 142). A significant model was obtained when performance (P), on all putting shot type strokes, was regressed on activation (Act) and worry (Wor), $F(2, 139) = 8.32$, $p = .0004$, $R^2 = .1069$ and is illustrated in step 1 of Table 10. The results of linear regression analysis resulted in significant betas for Wor only. Golf performance variance accounted for in the linear model was $R^2 = .1069$ and the zero order correlations among the three variables were -.23 ($p = .0056$), -.33 ($p < .0001$), and .78 ($p < .0001$) for Per with Act, Per with Wor, and Act with Wor respectively. In step two, the two quadratic components and the product term (Act/Wor) were added simultaneously to the linear model. Consequently, all three terms were added to the linear model in what will be referred to as the full test model. In step two, performance (P) was regressed on activation (Act), worry (Wor), Act^2, Wor^2, and Act/Wor in a test of the full model for all putting strokes for participant two.

The results of the test of the full model are illustrated in step 2 of Table 10 [$F(5,136) = 9.45$, $p < .0001$, $R^2 = .2579$]. By examining Table 10, it is possible to conclude that the quadratic components for Act (Act^2) and Wor (Wor^2) significantly predict golf performances.

A *F*-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test revealed a significant increase ($p < .05$) in the variance from the linear to the full test model $F(3, 135) = 9.15$, $p < .01$, $R^2_{inc} = .151$.

Participant 3 / Female, High Skill

Tee shot analysis. The data were analyzed by tee shot type (N = 72). Tee shot type did not have a significant linear regression model [F(2, 69) = 1.46, p = 0.2384, R^2 = .0407]. The higher order terms (Act^2, Wor^2, and Act/Wor) were added to the tee shot type linear model simultaneously and the full model was insignificant [F(5, 66) = 0.70, p = 0.6272, R^2 = .0502].

Approach shot analysis. The data were then analyzed by approach shot type (N = 75). Approach shot type had a significant linear regression model [F(2, 70) = 4.44, p = 0.0153, R^2 = .1126] and is illustrated in step 1 of Table 11. The results of the linear regression analysis resulted in a significant beta for Wor only. Golf approach shot performance variance accounted for in the linear model was R^2 = .1126 and the zero order correlations among the three variables were -.12 (p = .3248), -.33 (p = .0038), and .28 (p = .0180) for Per with Act, Per with Wor, and Act with Wor respectively. The higher order terms (Act^2, Wor^2, and Act/Wor) were added simultaneously to the approach shot type linear model. The full unstandardized prediction model was significant [F(5,67) = 2.72, p = .0269, R^2 = .1687], but the addition of the higher order terms did not result in a significant increase in variance to the linear model. The data are presented in step 2 of Table 11.

A F-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test did not reveal a significant increase ($p < .05$) in the variance from the linear to the full test model F (3, 68) = 1.53, $p > .05$, R^2_{inc} = ..057.

Chip shot analysis. The data were analyzed by chip shot type (N = 55). Chip shot type did not have a significant linear regression model [$F(2, 52) = 0.25$, $p = 0.7772$, $R^2 = .0096$]. The higher order terms (Act^2, Wor^2, and Act/Wor) were added to the chip shot type linear model simultaneously and the full model was insignificant [$F(5, 49) = 0.53$, $p = 0.7534$, $R^2 = .0512$].

Putting shot analysis. The data were then analyzed by putting shot type (N = 149). A significant model was obtained when performance (P), on all putting shot type strokes, was regressed on activation (Act) and worry (Wor), $F(2, 146) = 3.88$, $p = .0227$, $R^2 = .0505$ and is illustrated in step one of Table 12. The results of linear regression analysis did not result in a significant beta for Act or Wor. Golf performance variance accounted for in the linear model was $R^2 = .0505$ and the zero order correlations among the three variables were -.17 ($p = .0354$), -.21 ($p = .0085$), and .55 ($p < .0001$) for Per with Act, Per with Wor, and Act with Wor respectively. In step two, the two quadratic components and the product term (Act/Wor) were added simultaneously to the linear model. Consequently, all three terms were added to the linear model in what will be referred to as the full test model. In step two, performance (P) was regressed on activation (Act), worry (Wor), Act^2, and Wor^2 in a test of the full model for all putting strokes for participant three.

The results of the test of the full model are illustrated in step 2 of Table 12 [$F(4, 144) = 6.10$, $p = .0001$, $R^2 = .1448$]. From Table 12 we are able to see that only Wor^2 is a significant predictor of golf performance.

A *F*-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test revealed a significant increase ($p < .05$) in the variance from the linear to the full test model F (3, 142) = 5.63, $p < .01$, $R^2_{inc} = .102$.

Participant 4 / Female, Low Skill

Tee shot analysis. The data were analyzed by tee shot type (N = 72). Tee shot type did not have a significant linear regression model [F(2, 69) = 2.70, $p = 0.0744$, R^2 = .0725]. The higher order terms (Act^2, Wor^2, and Act/Wor) were added to the tee shot type linear model simultaneously. Golf performance variance accounted for in the linear model was $R^2 = .0725$ and the zero order correlations among the three variables were .25 ($p = .0326$), -.21 ($p = .0730$), and -.52 ($p < .0001$) for Per with Act, Per with Wor, and Act with Wor respectively.

The results of the test of the full model are illustrated in step 2 of Table 13 [F(5,66) = 3.01, $p = .0165$, $R^2 = .1858$]. From Table 13 we are able to see that Act^2 is a significant predictor of golf tee shot performances for participant 4.

A F-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test did not reveal a significant increase ($p < .05$) in the variance from the linear to the full test model F (3, 65) = 3.02, $p > .05$, $R^2_{inc} = .113$.

Approach shot analysis. The data were then analyzed by approach shot type (N = 80). Approach shot type did not have a significant linear regression model [F(2, 77) = 2.16, $p = 0.1218$, $R^2 = .0532$]. The higher order terms (Act^2, Wor^2, and Act/Wor) were added to the approach shot type linear model simultaneously and the full model was not significant [F(5, 74) = 0.92, $p = 0.4734$, $R^2 = .0585$].

Chip shot analysis. The data were analyzed by chip shot type (N = 43). Chip shot type did not have a significant linear regression model [$F(2, 40) = 0.40$, $p = 0.6703$, $R^2 = .0198$]. The higher order terms (Act^2, Wor^2, and Act/Wor) were added to the chip shot type linear model simultaneously and the full model was not significant [$F(5, 37) = 1.14$, $p = 0.3592$, $R^2 = .1330$].

Putting shot analysis. The data were then analyzed by putting shot type (N = 154). A significant model was obtained when performance (P), on all putting shot type strokes, was regressed on activation (Act) and worry (Wor), F (2, 151) = 31.32, $p < .0001$, $R^2 = .2932$ and is illustrated in step 1 of Table 14. The results of linear regression analysis resulted in significant betas for both Act and Wor. Golf performance variance accounted for in the linear model was $R^2 = .2932$ and the zero order correlations among the three variables were -.44 ($p < .0001$), -.51 ($p < .0001$), and .59 ($p < .0001$) for Per with Act, Per with Wor, and Act with Wor respectively. In step two, the two quadratic components and the product term (Act/Wor) were added simultaneously to the linear model. Consequently, all three terms were added to the linear model in what will be referred to as the full test model. In step two, performance (P) was regressed on activation (Act), worry (Wor), and Act/Wor in a test of the full model for all putting strokes for participant four.

The results of the test of the full model are illustrated in step 2 of Table 14 [$F(5,148) = 14.28$, $p < .0001$, $R^2 = .3254$. From Table 14 we are able to see that only Act/Wor is a significant predictor of golf performance.

A F-test was performed on the R^2 increase to see if there was a significant increase in variance from the linear model to the full test model (Pedhazur, 1997). This test did not reveal a significant increase ($p < .05$) in the variance from the linear to the full test model F (3, 147) = 2.33, $p > .05$, $R^2_{inc} = .032$.

Table 6.

Results of hierarchical polynomial multiple regression analysis for participant 1 (male; high skill) tee shots.

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	.42	.28	2.40	0.0191	.0738		
	Wor	-.27	-.27	-2.34	0.0224	.06995		
	Model						.116*	.116*
2	Act	.22	.15	0.81	0.4193	.00841		
	Wor	-.30	-.30	-2.24	0.0288	.06363		
	Act^2	.21	.20	1.10	0.2754	.01541		
	Wor^2	.04	.05	0.40	0.6911	.00203		
	Act/Wor	.15	.11	0.77	0.4454	.00751		
	Model						.159*	.043

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 7.

Results of hierarchical polynomial multiple regression analysis for participant 1 (male; high skill) approach shots.

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	.39	.36	3.31	0.0015	.12698		
	Wor	-.20	-.27	-2.45	0.0167	.06966		
	Model						.164**	.164**
2	Act	.42	.39	2.65	0.0100	.08270		
	Wor	-.22	-.31	-2.20	0.0312	.05691		
	Act^2	.08	.09	0.74	0.4598	.00650		
	Wor^2	.05	.08	0.74	0.4613	.00646		
	Act/Wor	.07	.09	0.60	0.5491	.00427		
	Model						.188*	.024

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 8.

Results of hierarchical polynomial multiple regression analysis for participant 1 (male; high skill) chip shots.

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	.42	.52	3.14	0.0043	.25649		
	Wor	-.29	-.43	-2.60	0.0154	.17643		
	Model						.348**	.348**
2	Act	.45	.56	2.80	0.0103	.21616		
	Wor	-.26	-.39	-2.02	0.0556	.11230		
	Act^2	.17	.23	1.29	0.2118	.04545		
	Wor^2	.01	.02	0.10	0.9174	.00030		
	Act/Wor	-.03	-.02	-0.12	0.9078	.00038		
	Model						.395*	.047

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 9.

Results of hierarchical polynomial multiple regression analysis for participant 1 (male; high skill) putting shots.

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	.01	.03	0.27	0.7876	.00049		
	Wor	-.16	-.37	-3.30	0.0012	.07291		
	Model						.125**	.125**
2	Act	.22	.49	2.56	0.0115	.04192		
	Wor	-.17	-.42	-3.42	0.0008	.07455		
	Act^2	.06	.37	1.54	0.1253	.01518		
	Wor^2	.02	.08	0.67	0.5061	.00283		
	Act/Wor	.02	.10	0.39	0.6973	.00097		
	Model						.184**	.059*

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 10.

Results of hierarchical polynomial multiple regression analysis for participant 2 (male; low skill) putting shots.

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	.02	.05	0.42	0.6735	.00115		
	Wor	-.14	-.37	-2.88	0.0046	.05343		
	Model						.107**	.107**
2	Act	.006	.02	0.10	0.9222	.00005		
	Wor	-.06	-.15	-0.93	0.3531	.00474		
	Act^2	.06	.44	2.43	0.0163	.03231		
	Wor^2	.07	.38	2.80	0.0059	.04266		
	Act/Wor	-.06	-.41	-1.63	0.1051	.01453		
	Model						.258**	.151**

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 11.

Results of hierarchical polynomial multiple regression analysis for participant 3 (female; high skill) approach shots.

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	-.01	-.03	-0.23	0.8220	.00065		
	Wor	-.12	-.33	-2.79	0.0067	.099		
	Model						.112*	.112*
2	Act	.03	.07	0.51	0.6137	.00319		
	Wor	-.14	-.39	-3.19	0.0021	.12649		
	Act^2	.02	.09	0.67	0.5060	.00555		
	Wor^2	.04	.20	1.57	0.1202	.03075		
	Act/Wor	-.05	-.27	-1.93	0.0576	.04632		
	Model						.169*	.057

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 12.

Results of hierarchical polynomial multiple regression analysis for participant 3 (female; high skill) putting shots.

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	-.03	-.08	-0.82	0.4139	.00437		
	Wor	-.05	-.17	-1.79	0.0760	.02077		
	Model						.050*	.050*
2	Act	-.02	-.05	-0.49	0.6215	.00145		
	Wor	-.04	-.14	-1.37	0.1723	.01116		
	Act^2	.03	.14	1.63	0.1053	.01576		
	Wor^2	.05	.30	3.19	0.0018	.06035		
	Act/Wor	-.02	-.10	-1.08	0.2806	.00696		
	Model						.152**	.102**

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 13.

Results of hierarchical polynomial multiple regression analysis for participant 4 (female; low skill) tee shots.

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	.11	.19	1.43	0.1581	.02737		
	Wor	-.05	-.11	-0.82	0.4172	.00896		
	Model						.073	.073
2	Act	-.14	-.25	-1.26	0.2128	.01952		
	Wor	-.09	-.21	-1.25	0.2146	.01937		
	Act^2	.14	.59	2.97	0.0041	.10890		
	Wor^2	-.02	-.08	-0.66	0.5093	.00543		
	Act/Wor	.06	.24	1.53	0.1317	.02874		
	Model						.186*	.113

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

* significant at .05 level

** significant at .01 level

Table 14.

Results of hierarchical polynomial multiple regression analysis for participant 4 (female; low skill) putting shots.

Step	Variable	*b*	*B*	*T*	*p*	r^2_p	R^2	R^2_{inc}
1	Act	-.10	-.22	-2.60	0.0102	.03166		
	Wor	-.13	-.38	-4.51	<.0001	.09528		
	Model						.293**	.293**
2	Act	-.04	-.08	-0.64	0.5228	.00187		
	Wor	-.09	-.28	-2.05	0.0417	.01923		
	Act^2	-.04	-.25	-1.19	0.2357	.00646		
	Wor^2	.02	.15	1.19	0.2351	.00648		
	Act/Wor	.04	.37	2.20	0.0294	.02204		
	Model						.325**	.032

b = unstandardized beta

B = standardized beta

r^2_p = squared semi-partial correlation (unique variance)

- significant at .05 level

** significant at .01 level

Participant 1 (male, high skill)

```
001 1 01 1 0 9 5
002 1 01 2 0 9 3
003 1 01 2 1 8 7
004 1 01 4 0 8 7
005 1 02 1 1 6 6
006 1 02 2 0 7 7
007 1 02 4 0 8 8
008 1 03 1 0 7 5
009 1 03 2 1 7 4
010 1 03 4 1 8 6
011 1 03 4 0 8 5
012 1 04 1 0 6 4
013 1 04 2 0 6 4
014 1 04 4 1 7 6
015 1 04 4 0 5 2
016 1 05 1 1 7 5
017 1 05 4 1 7 6
018 1 05 4 1 7 6
019 1 05 4 0 6 2
020 1 06 1 1 7 5
021 1 06 2 0 8 7
022 1 06 4 1 7 6
023 1 06 4 0 7 7
024 1 07 1 0 7 4
025 1 07 4 1 8 6
026 1 07 4 0 5 2
027 1 08 1 0 7 5
028 1 08 2 1 7 6
029 1 08 2 0 7 4
030 1 08 4 0 7 6
031 1 08 4 0 4 2
032 1 09 1 1 7 7
033 1 09 2 1 7 6
034 1 09 4 0 7 4
035 1 09 4 0 8 5
036 1 10 1 1 7 4
037 1 10 2 0 7 3
038 1 10 4 0 8 5
039 1 11 1 0 8 6
040 1 11 2 2 5 3
041 1 11 3 2 5 4
042 1 11 4 1 7 5
043 1 11 4 3 7 7
044 1 11 4 0 7 6
045 1 12 1 1 6 5
046 1 12 2 0 8 6
047 1 12 4 0 8 5
048 1 12 4 0 3 2
049 1 13 1 1 7 4
050 1 13 2 1 6 4
051 1 13 2 0 8 6
052 1 13 3 2 7 5
053 1 13 4 1 7 6
054 1 13 4 0 3 2
055 1 14 1 0 6 4
```

056	1	14	2	0	7	4
057	1	14	4	1	7	3
058	1	14	4	0	7	7
059	1	15	1	0	7	4
060	1	15	4	1	7	4
061	1	15	4	0	7	7
062	1	16	1	0	8	5
063	1	16	2	2	7	4
064	1	16	3	2	7	6
065	1	16	3	2	7	7
066	1	16	4	1	3	3
067	1	16	4	0	6	4
068	1	17	1	0	7	4
069	1	17	4	0	7	3
070	1	17	4	0	4	2
071	1	18	1	3	7	4
072	1	18	2	1	7	3
073	1	18	2	0	7	4
074	1	18	3	1	7	4
075	1	18	4	0	8	4
076	1	18	4	0	3	3
077	2	01	1	0	6	3
078	2	01	2	0	6	3
079	2	01	2	1	6	4
080	2	01	4	1	6	4
081	2	01	4	0	7	6
082	2	02	1	3	7	4
083	2	02	2	1	7	6
084	2	02	3	1	6	4
085	2	02	4	1	6	4
086	2	02	4	0	7	8
087	2	03	1	0	7	6
088	2	03	2	0	7	6
089	2	03	4	0	7	6
090	2	03	4	0	3	3
091	2	04	1	0	7	4
092	2	04	2	2	7	3
093	2	04	3	1	7	6
094	2	04	4	2	6	5
095	2	04	4	0	4	3
096	2	05	1	2	7	5
097	2	05	3	0	8	4
098	2	05	4	0	7	8
099	2	06	1	0	8	3
100	2	06	2	0	8	5
101	2	06	4	1	7	4
102	2	06	4	0	7	7
103	2	07	1	0	8	6
104	2	07	4	0	8	7
105	2	08	1	3	7	5
106	2	08	2	2	8	6
107	2	08	2	1	7	5
108	2	08	4	1	7	5
109	2	08	4	0	7	7
110	2	09	1	0	7	4
111	2	09	2	0	8	5
112	2	09	4	1	7	6

113	2	09	4	0	4	3
114	2	10	1	0	8	5
115	2	10	2	0	8	4
116	2	10	4	1	7	7
117	2	10	4	0	4	3
118	2	11	1	0	7	6
119	2	11	2	2	7	6
120	2	11	3	1	7	4
121	2	11	4	0	7	4
122	2	12	1	0	6	3
123	2	12	2	1	6	4
124	2	12	4	2	6	6
125	2	12	4	0	7	5
126	2	13	1	1	7	5
127	2	13	2	0	7	3
128	2	13	2	0	7	3
129	2	13	4	1	7	3
130	2	13	4	0	7	6
131	2	14	1	0	7	4
132	2	14	2	0	7	4
133	2	14	4	0	7	3
134	2	14	4	0	6	4
135	2	15	1	1	7	5
136	2	15	3	1	7	6
137	2	15	4	0	7	4
138	2	16	1	0	7	4
139	2	16	2	2	7	3
140	2	16	3	0	7	6
141	2	16	4	0	7	7
142	2	17	1	1	7	3
143	2	17	4	1	7	5
144	2	17	4	0	7	6
145	2	18	1	0	7	4
146	2	18	2	0	7	4
147	2	18	2	1	7	7
148	2	18	4	2	7	7
149	2	18	4	2	7	6
150	2	18	4	0	4	3
151	3	01	1	0	7	4
152	3	01	2	0	7	2
153	3	01	2	1	7	4
154	3	01	3	1	7	5
155	3	01	4	1	7	6
156	3	01	4	3	7	6
157	3	01	4	0	3	3
158	3	02	1	0	7	4
159	3	02	2	1	6	3
160	3	02	4	0	7	4
161	3	02	4	0	3	3
162	3	03	1	1	7	4
163	3	03	2	2	7	6
164	3	03	3	1	6	3
165	3	03	4	1	7	5
166	3	03	4	0	7	6
167	3	04	1	1	7	3
168	3	04	2	0	8	4
169	3	04	4	0	8	3

170	3	05	1	0	7	5
171	3	05	4	1	7	6
172	3	05	4	0	7	6
173	3	06	1	2	7	5
174	3	06	2	3	7	6
175	3	06	2	2	5	4
176	3	06	3	1	5	5
177	3	06	4	0	3	3
178	3	07	1	0	7	4
179	3	07	4	1	7	6
180	3	07	4	0	7	6
181	3	08	1	2	7	5
182	3	08	2	3	7	6
183	3	08	2	2	6	3
184	3	08	2	0	5	4
185	3	08	4	0	7	4
186	3	08	4	0	6	5
187	3	09	1	0	7	5
188	3	09	2	2	6	5
189	3	09	3	1	5	4
190	3	09	4	1	5	3
191	3	09	4	0	4	3
192	3	10	1	0	8	5
193	3	10	2	2	8	5
194	3	10	3	0	8	6
195	3	10	4	2	8	7
196	3	10	4	0	6	3
197	3	11	1	2	8	6
198	3	11	2	0	7	4
199	3	11	3	1	7	6
200	3	11	4	1	7	7
201	3	11	4	0	7	7
202	3	12	1	1	7	6
203	3	12	2	0	7	5
204	3	12	4	0	7	6
205	3	12	4	0	7	7
206	3	13	1	1	7	6
207	3	13	2	0	8	4
208	3	13	2	0	8	4
209	3	13	4	0	8	3
210	3	14	1	0	8	6
211	3	14	2	0	8	4
212	3	14	4	0	8	5
213	3	14	4	0	4	2
214	3	15	1	2	8	5
215	3	15	3	0	8	4
216	3	15	4	0	8	8
217	3	16	1	3	7	6
218	3	16	2	0	6	4
219	3	16	3	0	8	4
220	3	16	4	1	7	5
221	3	16	4	0	7	6
222	3	17	1	2	7	4
223	3	17	3	0	8	5
224	3	17	4	1	7	5
225	3	17	4	0	4	3
226	3	18	1	0	8	6

227	3	18	2	2	7	4
228	3	18	2	2	7	4
229	3	18	3	1	6	4
230	3	18	4	1	6	4
231	3	18	4	0	4	3
232	4	01	1	0	8	5
233	4	01	2	2	6	3
234	4	01	2	1	7	5
235	4	01	4	1	7	5
236	4	01	4	0	7	6
237	4	02	1	1	7	6
238	4	02	2	2	6	4
239	4	02	3	0	6	4
240	4	02	4	0	7	4
241	4	03	1	2	6	5
242	4	03	2	1	7	7
243	4	03	3	0	7	4
244	4	03	4	0	4	3
245	4	04	1	0	8	5
246	4	04	2	0	8	3
247	4	04	4	0	8	7
248	4	05	1	0	8	4
249	4	05	4	1	7	5
250	4	05	4	0	4	3
251	4	06	1	2	7	5
252	4	06	2	3	6	6
253	4	06	2	1	7	6
254	4	06	4	1	7	7
255	4	06	4	0	3	4
256	4	07	1	0	7	4
257	4	07	4	1	7	7
258	4	07	4	0	7	7
259	4	08	1	2	7	5
260	4	08	2	0	7	7
261	4	08	2	1	8	4
262	4	08	3	1	7	6
263	4	08	4	2	7	7
264	4	08	4	0	4	3
265	4	09	1	0	7	4
266	4	09	2	2	7	5
267	4	09	3	2	7	5
268	4	09	4	0	8	5
269	4	09	4	0	4	3
270	4	10	1	0	8	4
271	4	10	2	0	8	4
272	4	10	4	0	8	5
273	4	11	1	0	8	5
274	4	11	2	1	8	6
275	4	11	4	0	8	5
276	4	11	4	0	8	6
277	4	12	1	0	6	2
278	4	12	2	0	8	4
279	4	12	4	1	7	5
280	4	12	4	2	7	7
281	4	12	4	0	3	3
282	4	13	1	2	7	4
283	4	13	2	0	5	3

284	4	13	2	0	8	3
285	4	13	4	1	7	5
286	4	13	4	3	7	7
287	4	13	4	0	2	2
288	4	14	1	0	7	5
289	4	14	2	2	6	5
290	4	14	3	0	7	3
291	4	14	4	1	6	5
292	4	14	4	0	3	2
293	4	15	1	2	6	5
294	4	15	3	1	6	4
295	4	15	4	0	6	4
296	4	15	4	0	6	4
297	4	16	1	2	7	6
298	4	16	2	0	6	4
299	4	16	3	1	6	5
300	4	16	4	1	6	6
301	4	16	4	0	3	3
302	4	17	1	0	8	4
303	4	17	4	0	8	4
304	4	18	1	0	8	4
305	4	18	2	0	7	3
306	4	18	2	0	8	4
307	4	18	4	1	7	6
308	4	18	4	2	7	8
309	4	18	4	0	3	2

Participant 2 (male, low skill)

```
001 1 01 1 1 7 7
002 1 01 2 0 5 3
003 1 01 2 0 6 8
004 1 01 4 1 4 2
005 1 01 4 0 5 1
006 1 02 1 1 5 7
007 1 02 2 2 6 8
008 1 02 3 0 7 8
009 1 02 4 0 8 6
010 1 03 1 0 7 6
011 1 03 2 1 5 3
012 1 03 4 1 7 7
013 1 03 4 0 8 8
014 1 04 1 2 7 5
015 1 04 2 1 6 7
016 1 04 4 1 6 7
017 1 04 4 0 8 7
018 1 05 1 2 5 5
019 1 05 3 0 8 6
020 1 05 4 1 4 4
021 1 05 4 0 2 1
022 1 06 1 3 8 8
023 1 06 2 2 7 5
024 1 06 3 0 8 7
025 1 06 4 1 7 5
026 1 06 4 0 5 1
027 1 07 1 1 5 6
028 1 07 3 1 9 8
029 1 07 4 2 6 5
030 1 07 4 1 6 5
031 1 07 4 0 1 1
032 1 08 1 1 5 3
033 1 08 2 0 4 6
034 1 08 2 0 6 7
035 1 08 4 0 5 6
036 1 08 4 0 6 1
037 1 09 1 0 7 6
038 1 09 2 0 7 4
039 1 09 4 2 5 5
040 1 09 4 2 8 7
041 1 09 4 0 5 1
042 1 10 1 1 8 7
043 1 10 2 2 7 7
044 1 10 3 1 8 8
045 1 10 4 1 3 5
046 1 10 4 0 1 1
047 1 11 1 3 8 8
048 1 11 2 2 5 5
049 1 11 3 0 4 5
050 1 11 4 2 7 6
051 1 11 4 0 1 1
052 1 12 1 1 7 6
053 1 12 2 1 7 7
054 1 12 3 1 3 5
055 1 12 4 2 7 7
```

056	1	12	4	0	1	1
057	1	13	1	0	8	8
058	1	13	2	1	4	3
059	1	13	2	2	7	3
060	1	13	3	0	6	3
061	1	13	4	2	7	5
062	1	13	4	0	1	1
063	1	14	1	0	8	8
064	1	14	2	1	6	6
065	1	14	3	1	6	6
066	1	14	4	0	5	3
067	1	15	1	1	6	7
068	1	15	3	0	5	7
069	1	15	4	0	4	4
070	1	16	1	0	7	7
071	1	16	2	2	5	5
072	1	16	3	1	7	7
073	1	16	4	1	6	4
074	1	16	4	0	1	1
075	1	17	1	1	7	4
076	1	17	4	1	5	2
077	1	17	4	0	7	2
078	1	18	1	1	8	2
079	1	18	2	0	6	5
080	1	18	2	3	6	7
081	1	18	3	1	5	3
082	1	18	4	0	5	3
083	1	18	4	0	1	1
084	2	01	1	3	7	7
085	2	01	2	0	4	4
086	2	01	2	2	6	7
087	2	01	4	0	4	2
088	2	01	4	0	1	1
089	2	02	1	1	7	7
090	2	02	2	0	6	6
091	2	02	4	0	7	2
092	2	03	1	0	5	5
093	2	03	2	1	7	3
094	2	03	4	0	7	3
095	2	03	4	0	7	3
096	2	04	1	0	5	3
097	2	04	2	2	7	4
098	2	04	3	1	5	3
099	2	04	3	1	3	3
100	2	04	4	3	2	2
101	2	04	4	0	1	1
102	2	05	1	1	6	7
103	2	05	4	0	7	7
104	2	05	4	0	5	4
105	2	06	1	0	7	3
106	2	06	2	3	5	7
107	2	06	2	1	4	3
108	2	06	3	2	4	3
109	2	06	4	2	5	4
110	2	06	4	0	1	1
111	2	07	1	0	6	5
112	2	07	4	1	4	3

113	2	07	4	0	1	1
114	2	08	1	0	5	4
115	2	08	2	0	4	7
116	2	08	2	1	6	8
117	2	08	4	1	4	3
118	2	08	4	2	6	5
119	2	08	4	0	1	1
120	2	09	1	0	4	5
121	2	09	2	1	7	3
122	2	09	3	1	7	3
123	2	09	4	1	6	7
124	2	09	4	0	1	1
125	2	10	1	2	7	3
126	2	10	2	2	4	4
127	2	10	3	2	5	3
128	2	10	4	1	4	3
129	2	10	4	0	1	1
130	2	11	1	1	4	6
131	2	11	2	2	3	5
132	2	11	3	0	4	3
133	2	11	4	0	7	3
134	2	12	1	0	7	7
135	2	12	2	0	6	5
136	2	12	4	1	5	3
137	2	12	4	0	1	1
138	2	13	1	3	7	6
139	2	13	2	2	3	3
140	2	13	2	1	3	2
141	2	13	2	2	5	4
142	2	13	3	1	5	5
143	2	13	4	2	5	5
144	2	13	4	2	3	3
145	2	13	4	0	3	3
146	2	14	1	2	7	7
147	2	14	2	1	5	5
148	2	14	3	2	3	3
149	2	14	3	1	4	3
150	2	14	4	0	2	2
151	2	14	4	0	2	2
152	2	15	1	2	6	6
153	2	15	3	0	7	7
154	2	15	4	0	8	7
155	2	16	1	0	6	3
156	2	16	2	3	7	5
157	2	16	3	0	7	8
158	2	16	4	0	4	3
159	2	17	1	2	5	5
160	2	17	3	2	7	7
161	2	17	3	1	7	3
162	2	17	4	1	1	1
163	2	17	4	0	1	1
164	2	18	1	2	6	6
165	2	18	2	0	7	3
166	2	18	2	0	7	7
167	2	18	4	1	5	5
168	2	18	4	2	3	2
169	2	18	4	0	1	1

170	3	01	1	0	5	5
171	3	01	2	2	5	4
172	3	01	2	1	3	3
173	3	01	4	1	5	7
174	3	01	4	0	6	3
175	3	02	1	0	4	4
176	3	02	2	1	6	6
177	3	02	3	0	4	3
178	3	02	4	2	5	3
179	3	02	4	0	1	1
180	3	03	1	3	7	7
181	3	03	2	1	3	3
182	3	03	3	0	5	7
183	3	03	4	0	3	3
184	3	03	4	0	1	1
185	3	04	1	0	6	6
186	3	04	2	2	7	7
187	3	04	3	1	7	8
188	3	04	4	1	3	3
189	3	04	4	0	1	1
190	3	05	1	2	6	6
191	3	05	3	1	3	3
192	3	05	4	1	3	3
193	3	05	4	0	1	1
194	3	06	1	0	7	7
195	3	06	2	2	7	7
196	3	06	3	1	4	3
197	3	06	4	1	6	3
198	3	06	4	0	3	3
199	3	07	1	1	6	6
200	3	07	3	2	3	3
201	3	07	4	1	2	2
202	3	07	4	0	1	1
203	3	08	1	0	7	7
204	3	08	2	1	4	3
205	3	08	2	1	7	7
206	3	08	4	0	5	3
207	3	08	4	0	1	1
208	3	09	1	0	4	4
209	3	09	2	1	6	7
210	3	09	3	1	4	4
211	3	09	4	1	3	3
212	3	09	4	0	9	3
213	3	10	1	0	6	6
214	3	10	2	0	7	2
215	3	10	4	1	7	5
216	3	10	4	0	8	3
217	3	11	1	3	7	5
218	3	11	2	0	3	2
219	3	11	3	1	7	4
220	3	11	4	1	7	4
221	3	11	4	0	1	1
222	3	12	1	3	7	7
223	3	12	2	0	3	3
224	3	12	3	0	3	3
225	3	12	4	1	4	7
226	3	12	4	0	6	5

227	3	13	1	0	6	6
228	3	13	2	0	4	3
229	3	13	2	2	7	5
230	3	13	3	3	4	7
231	3	13	3	1	4	3
232	3	13	4	0	3	3
233	3	13	4	0	1	1
234	3	14	1	3	8	8
235	3	14	2	2	4	2
236	3	14	3	2	4	2
237	3	14	4	1	3	3
238	3	14	4	0	2	2
239	3	15	1	1	3	3
240	3	15	3	1	3	7
241	3	15	4	1	3	2
242	3	15	4	0	2	2
243	3	16	1	0	5	4
244	3	16	2	2	7	7
245	3	16	3	2	3	3
246	3	16	3	1	3	3
247	3	16	4	1	3	3
248	3	16	4	0	1	1
249	3	17	1	0	6	6
250	3	17	4	0	3	3
251	3	17	4	0	1	1
252	3	18	1	0	7	7
253	3	18	2	1	5	4
254	3	18	2	0	6	3
255	3	18	4	0	4	4
256	3	18	4	0	1	1
257	4	01	1	0	7	4
258	4	01	2	1	7	7
259	4	01	2	0	5	5
260	4	01	4	0	7	3
261	4	01	4	0	1	1
262	4	02	1	0	5	5
263	4	02	2	1	7	3
264	4	02	4	0	7	7
265	4	02	4	0	7	7
266	4	03	1	3	7	4
267	4	03	2	3	6	3
268	4	03	2	1	2	2
269	4	03	3	1	3	2
270	4	03	4	2	3	2
271	4	03	4	3	3	2
272	4	03	4	0	1	1
273	4	04	1	2	3	3
274	4	04	2	1	3	3
275	4	04	3	0	3	3
276	4	04	4	2	3	3
277	4	04	4	0	1	1
278	4	05	1	2	3	3
279	4	05	4	0	3	3
280	4	05	4	0	1	1
281	4	06	1	1	4	5
282	4	06	2	1	6	7
283	4	06	3	1	4	3

284	4	06	4	2	3	3
285	4	06	4	0	1	1
286	4	07	1	2	3	3
287	4	07	3	0	4	4
288	4	07	4	0	1	1
289	4	08	1	0	4	5
290	4	08	2	0	7	4
291	4	08	2	0	5	5
292	4	08	4	1	3	3
293	4	08	4	0	1	1
294	4	09	1	1	3	2
295	4	09	2	0	3	3
296	4	09	4	0	5	5
297	4	10	1	2	7	5
298	4	10	2	1	3	3
299	4	10	3	0	7	7
300	4	10	4	1	3	3
301	4	10	4	0	6	7
302	4	11	1	0	7	7
303	4	11	2	1	5	4
304	4	11	3	3	7	7
305	4	11	3	1	3	3
306	4	11	4	1	2	2
307	4	11	4	0	1	1
308	4	12	1	3	6	3
309	4	12	2	1	5	3
310	4	12	3	1	3	3
311	4	12	4	1	3	3
312	4	12	4	1	3	3
313	4	12	4	0	1	1
314	4	13	1	2	6	4
315	4	13	2	1	3	7
316	4	13	2	1	6	7
317	4	13	4	0	4	4
318	4	13	4	0	1	1
319	4	14	1	0	7	7
320	4	14	2	1	4	6
321	4	14	3	3	9	8
322	4	14	3	1	6	7
323	4	14	4	1	3	3
324	4	14	4	0	1	1
325	4	15	1	1	6	6
326	4	15	4	1	6	7
327	4	15	4	0	6	6
328	4	16	1	1	6	6
329	4	16	2	0	5	3
330	4	16	4	1	3	3
331	4	16	4	0	1	1
332	4	17	1	3	6	3
333	4	17	3	0	3	3
334	4	17	4	1	2	2
335	4	17	4	0	1	1
336	4	18	1	2	7	7
337	4	18	2	3	7	7
338	4	18	2	1	4	4
339	4	18	3	1	4	3
340	4	18	4	0	3	3

341 4 18 4 0 1 1

Participant 3 (female, high skill)

```
001 1 01 1 0 5 6
002 1 01 2 1 7 7
003 1 01 3 0 8 4
004 1 01 4 1 8 7
005 1 01 4 0 1 1
006 1 02 1 1 7 4
007 1 02 2 0 6 3
008 1 02 2 1 6 6
009 1 02 3 1 4 7
010 1 02 4 0 5 8
011 1 02 4 0 8 7
012 1 03 1 0 6 5
013 1 03 2 0 6 7
014 1 03 3 0 4 8
015 1 03 4 1 6 8
016 1 03 4 1 6 8
017 1 03 4 0 3 1
018 1 04 1 0 7 2
019 1 04 2 1 5 7
020 1 04 3 2 5 8
021 1 04 4 0 7 1
022 1 04 4 0 3 1
023 1 05 1 1 5 8
024 1 05 3 2 5 7
025 1 05 4 2 6 8
026 1 05 4 0 6 4
027 1 05 4 0 3 1
028 1 06 1 0 7 3
029 1 06 2 1 6 7
030 1 06 4 0 6 6
031 1 06 4 0 8 2
032 1 07 1 1 8 3
033 1 07 2 1 8 4
034 1 07 2 0 5 8
035 1 07 4 0 6 4
036 1 07 4 0 6 6
037 1 08 1 1 7 7
038 1 08 4 0 6 8
039 1 08 4 0 7 2
040 1 09 1 0 7 5
041 1 09 2 0 6 7
042 1 09 4 0 5 8
043 1 09 4 0 6 8
044 1 10 1 0 2 2
045 1 10 2 2 6 5
046 1 10 3 1 2 6
047 1 10 4 1 1 7
048 1 10 4 0 1 1
049 1 11 1 1 7 2
050 1 11 2 0 8 4
051 1 11 2 1 3 7
052 1 11 4 1 2 3
053 1 11 4 0 3 7
054 1 12 1 2 5 5
055 1 12 2 0 1 7
```

```
056 1 12 3 0 2 4
057 1 12 4 1 7 7
058 1 12 4 0 1 1
059 1 13 1 0 7 7
060 1 13 2 1 4 2
061 1 13 4 1 2 7
062 1 13 4 0 2 3
063 1 14 1 0 6 6
064 1 14 4 0 5 4
065 1 14 4 0 1 1
066 1 15 1 1 5 4
067 1 15 2 0 1 3
068 1 15 4 0 6 6
069 1 15 4 0 1 1
070 1 16 1 1 3 2
071 1 16 2 0 6 4
072 1 16 2 2 5 6
073 1 16 3 1 3 7
074 1 16 4 1 7 7
075 1 16 4 0 1 1
076 1 17 1 0 4 3
077 1 17 4 0 3 6
078 1 17 4 0 1 1
079 1 18 1 0 6 4
080 1 18 2 2 6 7
081 1 18 3 0 2 8
082 1 18 4 0 1 4
083 2 01 1 1 3 5
084 2 01 2 0 4 3
085 2 01 2 2 2 7
086 2 01 3 0 4 8
087 2 01 4 2 2 2
088 2 01 4 0 1 2
089 2 02 1 2 7 6
090 2 02 3 3 5 5
091 2 02 3 2 5 3
092 2 02 4 2 3 2
093 2 02 4 0 6 6
094 2 03 1 0 1 3
095 2 03 2 1 7 6
096 2 03 4 0 6 7
097 2 03 4 0 2 7
098 2 04 1 3 3 8
099 2 04 2 0 2 2
100 2 04 2 0 2 3
101 2 04 4 1 6 5
102 2 04 4 0 2 2
103 2 05 1 2 8 7
104 2 05 3 2 1 8
105 2 05 3 2 4 6
106 2 05 4 1 4 7
107 2 05 4 0 2 2
108 2 06 1 0 3 2
109 2 06 2 1 5 3
110 2 06 4 1 4 3
111 2 06 4 0 6 3
112 2 07 1 0 1 2
```

```
113 2 07 2 0 2 5
114 2 07 4 2 5 4
115 2 07 4 2 3 2
116 2 07 4 0 1 1
117 2 08 1 1 7 7
118 2 08 2 0 5 2
119 2 08 3 1 2 7
120 2 08 4 1 2 2
121 2 08 4 0 1 1
122 2 09 1 2 7 6
123 2 09 2 2 4 7
124 2 09 3 3 3 3
125 2 09 3 1 4 6
126 2 09 4 1 1 7
127 2 09 4 0 1 1
128 2 10 1 2 2 7
129 2 10 3 0 3 5
130 2 10 4 2 7 7
131 2 10 4 0 1 1
132 2 11 1 1 6 7
133 2 11 2 1 2 3
134 2 11 3 1 2 3
135 2 11 4 1 2 2
136 2 11 4 0 1 3
137 2 12 1 1 2 8
138 2 12 2 1 4 3
139 2 12 2 3 2 5
140 2 12 3 2 1 2
141 2 12 4 1 6 6
142 2 12 4 0 8 8
143 2 13 1 2 6 5
144 2 13 3 0 4 2
145 2 13 4 1 8 6
146 2 13 4 0 4 4
147 2 14 1 0 8 5
148 2 14 2 0 3 6
149 2 14 4 1 2 7
150 2 14 4 0 1 2
151 2 15 1 1 6 2
152 2 15 2 1 3 3
153 2 15 3 0 1 2
154 2 15 4 0 4 7
155 2 16 1 0 2 7
156 2 16 2 1 7 7
157 2 16 4 1 1 8
158 2 16 4 0 1 1
159 2 17 1 0 4 8
160 2 17 2 1 1 2
161 2 17 4 1 7 8
162 2 17 4 2 4 4
163 2 17 4 0 1 1
164 2 18 1 2 1 7
165 2 18 2 0 3 7
166 2 18 4 1 1 8
167 2 18 4 2 6 7
168 2 18 4 0 1 1
169 3 01 1 1 2 7
```

170	3	01	2	0	3	2
171	3	01	3	1	1	2
172	3	01	4	0	4	4
173	3	02	1	1	4	5
174	3	02	2	1	4	2
175	3	02	2	1	3	8
176	3	02	3	1	2	2
177	3	02	4	1	2	5
178	3	02	4	0	1	1
179	3	03	1	1	6	5
180	3	03	2	2	1	5
181	3	03	2	0	3	2
182	3	03	4	0	4	6
183	3	03	4	0	1	1
184	3	04	1	1	2	6
185	3	04	2	1	3	5
186	3	04	3	3	1	7
187	3	04	3	3	1	7
188	3	04	4	1	2	5
189	3	04	4	0	1	1
190	3	05	1	1	6	7
191	3	05	3	3	1	3
192	3	05	4	1	1	5
193	3	05	4	0	1	7
194	3	06	1	1	4	3
195	3	06	2	0	2	2
196	3	06	4	0	1	5
197	3	06	4	0	1	1
198	3	07	1	1	1	4
199	3	07	2	1	3	7
200	3	07	2	0	2	7
201	3	07	2	1	2	2
202	3	07	4	2	5	7
203	3	07	4	2	7	7
204	3	07	4	0	1	1
205	3	08	1	1	3	4
206	3	08	4	1	2	5
207	3	08	4	0	1	1
208	3	09	1	0	4	3
209	3	09	2	1	3	3
210	3	09	3	2	3	7
211	3	09	4	2	2	7
212	3	09	4	0	1	5
213	3	10	1	0	6	6
214	3	10	2	1	3	1
215	3	10	3	1	2	2
216	3	10	4	1	1	3
217	3	10	4	0	1	1
218	3	11	1	0	8	3
219	3	11	2	1	4	5
220	3	11	3	1	7	3
221	3	11	4	2	5	6
222	3	11	4	2	4	2
223	3	11	4	0	1	1
224	3	12	1	1	6	5
225	3	12	2	0	2	7
226	3	12	4	1	6	7

227	3	12	4	2	2	2
228	3	12	4	0	1	1
229	3	13	1	0	2	6
230	3	13	2	1	4	7
231	3	13	3	1	3	8
232	3	13	4	1	3	3
233	3	13	4	0	1	1
234	3	14	1	1	8	8
235	3	14	3	0	3	3
236	3	14	4	2	2	2
237	3	14	4	0	1	1
238	3	15	1	0	2	6
239	3	15	2	1	5	5
240	3	15	3	1	1	7
241	3	15	4	0	1	8
242	3	16	1	1	3	2
243	3	16	2	0	4	3
244	3	16	2	1	2	4
245	3	16	3	1	1	2
246	3	16	4	1	5	7
247	3	16	4	0	1	1
248	3	17	1	0	8	8
249	3	17	4	1	5	3
250	3	17	4	0	2	2
251	3	18	1	2	7	2
252	3	18	2	1	6	6
253	3	18	3	1	5	5
254	3	18	4	1	2	5
255	3	18	4	2	6	7
256	3	18	4	0	1	1
257	4	01	1	1	7	2
258	4	01	2	1	1	4
259	4	01	3	1	6	6
260	4	01	4	2	1	7
261	4	01	4	2	1	2
262	4	01	4	0	1	1
263	4	02	1	1	1	2
264	4	02	2	2	1	6
265	4	02	2	3	5	7
266	4	02	2	2	5	8
267	4	02	2	1	7	7
268	4	02	3	1	7	6
269	4	02	4	1	2	2
270	4	02	4	0	1	1
271	4	03	1	1	2	8
272	4	03	2	1	5	7
273	4	03	3	0	2	6
274	4	03	4	0	1	8
275	4	04	1	2	7	6
276	4	04	2	1	7	8
277	4	04	3	1	2	5
278	4	04	4	2	1	3
279	4	04	4	3	1	2
280	4	04	4	0	1	1
281	4	05	1	2	3	8
282	4	05	3	0	2	3
283	4	05	4	2	4	4

284	4	05	4	0	1	1
285	4	06	1	0	4	3
286	4	06	2	1	4	6
287	4	06	4	3	1	2
288	4	06	4	2	6	5
289	4	06	4	0	1	1
290	4	07	1	0	2	2
291	4	07	2	0	2	1
292	4	07	2	2	7	8
293	4	07	3	3	7	7
294	4	07	3	3	7	6
295	4	07	3	3	7	7
296	4	07	3	0	7	7
297	4	07	4	0	2	7
298	4	08	1	0	1	9
299	4	08	4	1	3	3
300	4	08	4	0	1	1
301	4	09	1	2	6	3
302	4	09	2	1	5	5
303	4	09	3	1	2	2
304	4	09	4	2	6	6
305	4	09	4	0	1	4
306	4	10	1	1	6	3
307	4	10	2	0	4	3
308	4	10	3	1	1	2
309	4	10	4	0	1	6
310	4	11	1	1	6	7
311	4	11	2	2	7	7
312	4	11	3	2	1	2
313	4	11	3	2	5	3
314	4	11	4	1	5	5
315	4	11	4	0	1	1
316	4	12	1	0	7	8
317	4	12	4	1	2	8
318	4	12	4	0	1	1
319	4	13	1	0	7	4
320	4	13	2	1	2	7
321	4	13	2	0	7	5
322	4	13	4	1	2	3
323	4	13	4	0	7	7
324	4	14	1	0	6	3
325	4	14	2	0	3	2
326	4	14	3	1	1	6
327	4	14	4	1	2	1
328	4	14	4	0	1	1
329	4	15	1	1	1	2
330	4	15	2	1	1	7
331	4	15	3	3	1	3
332	4	15	3	3	3	7
333	4	15	3	1	2	3
334	4	15	4	1	1	2
335	4	15	4	3	2	3
336	4	15	4	0	1	1
337	4	16	1	2	7	7
338	4	16	3	1	1	6
339	4	16	3	1	5	2
340	4	16	4	0	1	2

```
341 4 17 1 1 3 3
342 4 17 2 1 5 5
343 4 17 3 1 6 7
344 4 17 4 0 1 7
345 4 17 4 0 1 1
346 4 18 1 1 3 5
347 4 18 2 0 1 7
348 4 18 4 2 1 2
349 4 18 4 0 4 7
```

Participant 4 (female, low skill)

```
001 1 01 1 0 7 6
002 1 01 2 1 6 4
003 1 01 3 1 5 5
004 1 01 4 1 4 3
005 1 01 4 0 1 2
006 1 02 1 3 6 3
007 1 02 2 1 5 4
008 1 02 2 1 6 5
009 1 02 2 2 4 7
010 1 02 3 1 7 7
011 1 02 3 1 5 5
012 1 02 4 1 3 5
013 1 02 4 0 1 2
014 1 03 1 1 7 6
015 1 03 2 0 6 5
016 1 03 3 2 3 5
017 1 03 4 1 6 5
018 1 03 4 0 1 2
019 1 04 1 1 6 7
020 1 04 2 0 2 8
021 1 04 4 1 5 7
022 1 04 4 0 1 2
023 1 05 1 1 8 8
024 1 05 3 1 4 4
025 1 05 4 1 4 6
026 1 05 4 0 1 2
027 1 06 1 0 4 3
028 1 06 2 1 4 5
029 1 06 4 1 3 4
030 1 06 4 0 1 2
031 1 07 1 2 5 5
032 1 07 2 0 4 3
033 1 07 2 1 4 7
034 1 07 4 1 7 5
035 1 07 4 0 1 2
036 1 08 1 1 7 7
037 1 08 3 1 4 4
038 1 08 4 1 4 4
039 1 08 4 0 1 2
040 1 09 1 0 3 3
041 1 09 2 2 8 6
042 1 09 3 1 8 6
043 1 09 4 2 8 6
044 1 09 4 0 1 2
045 1 10 1 0 3 8
046 1 10 2 1 5 8
047 1 10 3 0 6 6
048 1 10 4 0 4 7
049 1 11 1 1 7 4
050 1 11 2 1 7 4
051 1 11 2 2 3 7
052 1 11 2 2 7 5
053 1 11 3 2 5 8
054 1 11 4 2 3 8
055 1 11 4 3 6 4
```

056	1	11	4	0	7	2
057	1	12	1	1	6	5
058	1	12	2	2	4	7
059	1	12	3	1	6	7
060	1	12	4	0	6	7
061	1	13	1	0	7	4
062	1	13	2	2	5	8
063	1	13	2	2	4	8
064	1	13	4	2	3	8
065	1	13	4	0	4	8
066	1	14	1	1	4	7
067	1	14	4	2	3	7
068	1	14	4	2	4	5
069	1	14	4	2	6	7
070	1	14	4	0	1	1
071	1	15	1	1	7	3
072	1	15	2	0	7	4
073	1	15	4	1	6	5
074	1	15	4	0	2	2
075	1	16	1	1	6	5
076	1	16	2	3	4	8
077	1	16	2	2	5	5
078	1	16	2	1	3	8
079	1	16	2	0	4	8
080	1	16	4	0	4	9
081	1	17	1	0	6	8
082	1	17	4	0	5	6
083	1	17	4	3	7	2
084	1	17	4	0	1	1
085	1	18	1	0	7	3
086	1	18	2	1	5	7
087	1	18	3	0	7	4
088	1	18	4	0	5	5
089	2	01	1	0	6	7
090	2	01	2	1	8	3
091	2	01	2	1	5	7
092	2	01	4	1	5	5
093	2	01	4	0	6	7
094	2	02	1	1	5	5
095	2	02	4	1	8	3
096	2	02	4	0	3	8
097	2	03	1	1	7	3
098	2	03	2	0	6	5
099	2	03	4	2	6	3
100	2	03	4	1	4	8
101	2	03	4	0	2	1
102	2	04	1	0	7	5
103	2	04	2	0	6	6
104	2	04	4	1	6	6
105	2	04	4	0	5	3
106	2	05	1	1	6	5
107	2	05	3	0	5	6
108	2	05	4	0	5	5
109	2	06	1	2	5	7
110	2	06	2	0	8	4
111	2	06	3	2	7	5
112	2	06	4	2	5	7

113	2	06	4	2	4	8
114	2	06	4	0	1	2
115	2	07	1	0	7	4
116	2	07	2	3	6	7
117	2	07	3	1	5	5
118	2	07	4	1	5	6
119	2	07	4	0	4	7
120	2	08	1	2	4	7
121	2	08	2	1	3	8
122	2	08	3	1	6	4
123	2	08	4	1	4	8
124	2	08	4	2	6	5
125	2	08	4	0	7	2
126	2	09	1	0	7	4
127	2	09	2	0	7	3
128	2	09	4	0	4	8
129	2	09	4	0	6	2
130	2	10	1	0	7	7
131	2	10	4	2	5	7
132	2	10	4	3	4	8
133	2	10	4	0	2	2
134	2	11	1	1	8	3
135	2	11	2	1	7	6
136	2	11	3	0	6	4
137	2	11	4	2	5	8
138	2	11	4	0	2	2
139	2	12	1	1	6	6
140	2	12	2	0	4	8
141	2	12	2	0	6	6
142	2	12	4	0	5	8
143	2	13	1	1	7	4
144	2	13	2	1	5	7
145	2	13	4	1	4	8
146	2	13	4	0	1	1
147	2	14	1	0	7	6
148	2	14	2	0	7	7
149	2	14	4	1	4	9
150	2	14	4	2	4	8
151	2	14	4	0	1	1
152	2	15	1	0	7	3
153	2	15	2	0	6	7
154	2	15	4	3	5	8
155	2	15	4	1	5	6
156	2	15	4	0	1	1
157	2	16	1	2	4	8
158	2	16	2	1	6	4
159	2	16	4	1	4	8
160	2	16	4	3	6	6
161	2	16	4	0	1	1
162	2	17	1	0	5	7
163	2	17	2	2	7	4
164	2	17	3	2	6	4
165	2	17	4	1	6	7
166	2	17	4	0	7	4
167	2	18	1	0	8	2
168	2	18	2	0	7	3
169	2	18	4	2	5	7

170	2	18	4	0	6	7
171	3	01	1	0	7	5
172	3	01	2	0	5	7
173	3	01	4	1	6	6
174	3	01	4	2	6	5
175	3	01	4	0	1	1
176	3	02	1	1	8	3
177	3	02	2	0	5	7
178	3	02	2	1	5	8
179	3	02	4	3	4	8
180	3	02	4	2	7	5
181	3	02	4	0	6	7
182	3	03	1	0	8	3
183	3	03	2	1	7	7
184	3	03	3	2	4	8
185	3	03	4	1	4	8
186	3	03	4	0	1	1
187	3	04	1	0	8	3
188	3	04	2	2	5	8
189	3	04	3	3	3	8
190	3	04	3	2	4	8
191	3	04	4	0	5	8
192	3	04	4	0	1	1
193	3	05	1	1	4	8
194	3	05	4	2	4	8
195	3	05	4	1	6	7
196	3	05	4	0	1	1
197	3	06	1	1	8	3
198	3	06	2	2	6	5
199	3	06	3	0	4	8
200	3	06	4	1	5	6
201	3	06	4	0	1	1
202	3	07	1	0	7	4
203	3	07	2	0	8	3
204	3	07	2	2	5	7
205	3	07	3	1	3	8
206	3	07	4	1	5	7
207	3	07	4	0	1	1
208	3	08	1	0	3	7
209	3	08	4	0	4	7
210	3	09	1	0	8	3
211	3	09	2	2	4	8
212	3	09	3	1	6	6
213	3	09	4	2	3	7
214	3	09	4	0	6	6
215	3	10	1	1	5	5
216	3	10	2	0	5	8
217	3	10	3	0	6	2
218	3	10	4	0	4	6
219	3	11	1	1	7	3
220	3	11	2	1	7	2
221	3	11	3	0	4	8
222	3	11	4	0	4	7
223	3	11	4	0	1	1
224	3	12	1	1	7	5
225	3	12	2	1	7	3
226	3	12	3	2	5	5

227	3	12	4	1	6	8
228	3	12	4	0	1	1
229	3	13	1	1	7	5
230	3	13	2	0	5	7
231	3	13	4	0	4	8
232	3	13	4	3	5	8
233	3	13	4	2	2	8
234	3	13	4	0	1	1
235	3	14	1	1	7	8
236	3	14	3	0	8	4
237	3	14	4	0	4	8
238	3	15	1	0	8	4
239	3	15	2	2	5	7
240	3	15	3	2	8	3
241	3	15	4	0	5	8
242	3	16	1	1	8	3
243	3	16	2	1	5	6
244	3	16	2	0	7	6
245	3	16	3	1	4	8
246	3	16	3	2	7	2
247	3	16	4	2	5	7
248	3	16	4	1	6	3
249	3	16	4	0	1	1
250	3	17	1	0	4	7
251	3	17	4	1	5	6
252	3	17	4	0	1	1
253	3	18	1	2	7	3
254	3	18	2	0	6	8
255	3	18	2	1	6	8
256	3	18	3	1	5	8
257	3	18	4	1	3	6
258	3	18	4	3	3	7
259	3	18	4	2	4	7
260	3	18	4	0	1	1
261	4	01	1	2	5	6
262	4	01	2	0	6	6
263	4	01	2	1	6	4
264	4	01	3	1	4	8
265	4	01	4	2	5	5
266	4	01	4	3	6	4
267	4	01	4	0	1	1
268	4	02	1	1	7	4
269	4	02	2	1	4	7
270	4	02	2	1	4	7
271	4	02	3	1	5	8
272	4	02	3	0	5	8
273	4	02	4	0	1	1
274	4	03	1	0	7	4
275	4	03	2	1	6	4
276	4	03	3	0	6	4
277	4	03	4	0	5	5
278	4	04	1	0	8	4
279	4	04	2	0	6	7
280	4	04	4	2	3	8
281	4	04	4	2	3	8
282	4	04	4	0	1	1
283	4	05	1	3	5	8

284	4	05	3	0	6	7
285	4	05	4	2	6	8
286	4	05	4	0	1	1
287	4	06	1	1	6	4
288	4	06	2	0	6	3
289	4	06	4	1	4	6
290	4	06	4	0	7	4
291	4	07	1	0	7	3
292	4	07	2	1	7	4
293	4	07	2	1	5	6
294	4	07	3	1	4	9
295	4	07	4	1	5	5
296	4	07	4	0	1	1
297	4	08	1	2	5	7
298	4	08	3	1	5	7
299	4	08	4	1	5	7
300	4	08	4	0	1	1
301	4	09	1	0	8	3
302	4	09	2	0	7	3
303	4	09	4	1	5	8
304	4	09	4	0	6	2
305	4	10	1	1	6	5
306	4	10	2	0	7	4
307	4	10	3	0	5	6
308	4	10	4	1	4	8
309	4	10	4	0	1	1
310	4	11	1	0	8	5
311	4	11	2	0	5	8
312	4	11	4	1	7	7
313	4	11	4	0	1	1
314	4	12	1	0	7	8
315	4	12	4	1	6	8
316	4	12	4	0	1	1
317	4	13	1	0	6	2
318	4	13	2	2	8	4
319	4	13	2	2	6	8
320	4	13	2	2	7	7
321	4	13	2	1	6	3
322	4	13	3	2	7	5
323	4	13	4	1	4	8
324	4	13	4	0	1	1
325	4	14	1	1	8	4
326	4	14	2	0	8	3
327	4	14	2	0	6	7
328	4	14	4	1	6	8
329	4	14	4	0	1	1
330	4	15	1	0	8	4
331	4	15	2	1	7	6
332	4	15	3	1	7	3
333	4	15	4	2	4	7
334	4	15	4	0	1	1
335	4	16	1	2	4	8
336	4	16	3	1	4	5
337	4	16	4	2	4	7
338	4	16	4	0	5	6
339	4	17	1	2	7	4
340	4	17	2	0	7	4

```
341 4 17 2 0 7 4
342 4 17 3 1 7 4
343 4 17 4 1 5 7
344 4 17 4 2 7 5
345 4 17 4 0 1 1
346 4 18 1 0 5 6
347 4 18 2 0 7 7
348 4 18 4 1 3 8
349 4 18 4 0 1 1
```

VITA

Stuart Marshall Robb was born September 16, 1960, in Springfield, Missouri. After attending public school in Mt. Vernon, Missouri, he received the following degrees: B.S. in Recreation & Leisure Studies from Southwest Missouri State University at Springfield, Missouri (1983); M.A. in Recreation Administration at University of Tulsa in Tulsa, Oklahoma (1985); Ph.D. in Health & Physical Education from the University of Missouri-Columbia (2005). He is married to the former Cynthia S. Meade of Easton, Missouri, and he is presently a member of the Human Performance Division at William Woods University, Fulton, Missouri.