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Contrasting Concepts of Competitive State-Anxiety in Sport: Multidimensional Anxiety and Catastrophe Theories.

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ABSTRACT

Originally, it was widely believed that the connection between performance and arousal was an uncomplicated Inverted-U (Yerkes and Dodson, 1908), i.e. best performance could be achieved with an average level of arousal. Moreover, if the level of arousal were too low (or too high) poor performance would ensue. However, the Inverted-U Hypothesis was seen by some as being far too simplistic, and a number of researchers began to question its validity. The Multidimensional Theory of Anxiety (Martens et al., 1990), and the Catastrophe Model (Hardy & Fazey, 1987), are the two foremost theories that have emerged in recent years. Despite offering a much-improved explanation of the 'underlying mechanics' of competitive anxiety, both descriptions are fundamentally in conflict with each other, and are not devoid of their respective critics. The aim of the essay is to firstly underline the foundations and basic principles of each of the theories, and secondly, to examine the criticisms that have been levied upon them. Finally, the essay offers conclusions and recommendations as to the future of the most plausible explanation of competitive anxiety in sport.

Introduction

Competitive state-anxiety usually follows a pattern of subjective feelings of tension and inadequacy, combined with heightened arousal of the autonomic nervous system, (e.g. 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 an uncomplicated Inverted-U (Yerkes and Dodson, 1908), i.e. the best performance could be guaranteed with an average level of arousal (a.). if the level of arousal was too low (b.), or too high (c.), poor performance would result (see fig. 1 below).

However, dissatisfied with the simplistic nature of the Inverted-U Hypothesis (Yerkes and Dodson, 1908), many sport psychologists began to question its validity for a number of conceptual and methodological reasons. Not least of all the question of whether the hypothesis proposes a correlational or causal relationship between arousal and performance (e.g. Neiss, 1980). This paved the way for a number of new theories and models that endeavoured to address the inadequacies of the Inverted-U at measuring and conceptualising competitive anxiety.

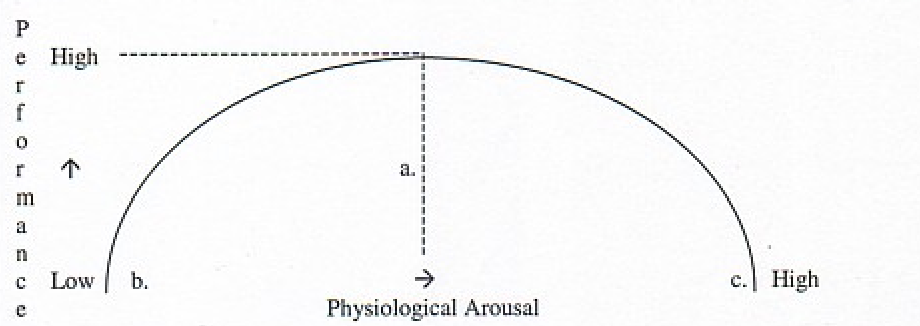

Fig. 1: The Inverted-U (Yerkes & Dodson, 1908) Hypothesis: The early explanation of the relationship between arousal and performance.

The Multidimensional Theory of Anxiety

Primarily, the theory is based on the assumption that competitive anxiety is comprised of two distinct parts; a cognitive component, and a somatic component, both having dissimilar effects on performance. Hence, theoretically, the components can be manipulated 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 palpitations, tense muscles, shortness of breath, clammy hands (Morris, Davis & Hutchings, 1981), and in some cases even nausea (Harris & Rovins, 1981).

The culmination of the recognition of a Multidimensional Theory of Anxiety, in relation to the field of sport psychology, came about through Martens et al.'s (1990) development of the Competitive State Anxiety Inventory-2 (CSAI-2), a multidimensional state-anxiety measure specific to sport. Martens et al. (1990) proposed that somatic anxiety had an Inverted-U shaped relationship with performance, whilst cognitive anxiety had a negative linear relationship with performance. In addition, Martens et al. (1990) utilised a time to event paradigm 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 staid stable before the start, but the somatic component began to increase prior to the onset of the event (see fig. 2 below). Similar results had been found earlier by Parfitt & Hardy (1987). They found a relationship between the two sub-components to such an extent that there were 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 for somatic anxiety for a range of performance related activities shortly before the crucial event when cognitive anxiety was at an elevated level.

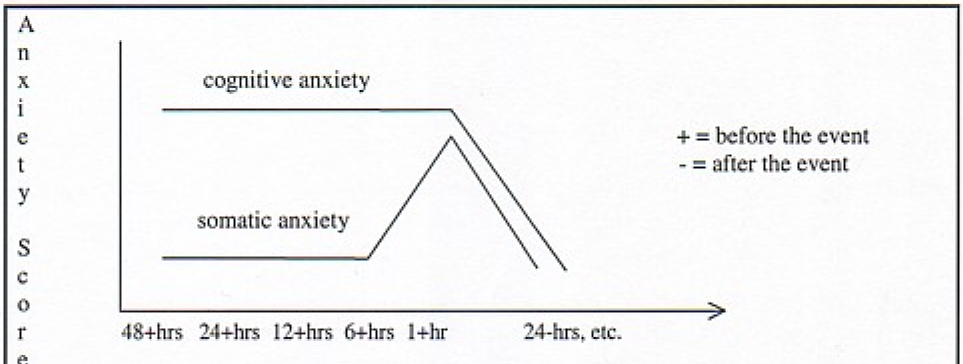

Fig. 2: An approximate representation of the time to event paradigm demonstrated by Martens *et al.* (1990).

Before the recognition of Martens et al. (1990), the principle proponents of multidimensional theory, prior research had acknowledged the presence of the respective sub-components of anxiety, albeit in other areas of human behaviour. For example, through factor analysis, Hamilton (1959), and later Buss (1962), isolated and classified the anxiety-related psychiatric illness sub-components of psychic and somatic anxiety. In addition, clinical psychologists Davidson & Schwartz (1976) suggested that anxiety, in general, was composed of, again, the two factors; somatic and cognitive anxiety. Their supposition was bolstered by their proposal that they could effectively negate either form of anxiety sub-component through selective relaxation therapy, i.e. focusing on one, or both, of the sub-components.

The first attempt to confirm the existence of somatic and cognitive sub-components as separate elements of state-anxiety was by Liebert & Morris (1967). This was accomplished through the utilisation of the Worry-Emotionality Inventory (WEI) they developed (Liebert & Morris, 1967). However, their attempt at illustrating a strong relationship between the two sub-components was not hailed as a complete success, as the high correlations found from six studies demonstrated. Nevertheless, later attempts with a modified WEI achieved lower and more acceptable correlations (e.g. Carron, 1980; Park, 1980; Morris, Davis & Hutchings, 1981).

Hardy & Fazey's (1987) Catastrophe Model

The use of the expression 'Catastrophe Theory' was first conceived by the French mathematician Rene Thom in 1975 to describe a method that could model 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).

A year later Zeeman (1976) took the conceptual framework of catastrophe a step further by drawing attention to it's potential relevance and utilisation within the behavioural sciences. This was not without criticism; based upon the argument that effective testing using experimental methodology would not be possible (e.g. Sussman & Zahler, 1978). Nevertheless, with the aid of a tangible model, Zeeman (1976) demonstrated the effectiveness of the cusp catastrophe, leading the way for others to implement catastrophe models to the appropriate behavioural sciences.

The Hardy & Fazey (1987) model is not unlike the Multidimensional Theory of Anxiety as it presupposes that anxiety is comprised of two sub-components. In contrast however, rather than using somatic anxiety as the asymmetry factor, Hardy & Fazey (1987) chose to use physiological arousal. When measured by heart rate, both follow identical temporal patterns to, for example, a critical competitive event. Nevertheless, there are a number of differences between the two in relation to their effect on performance. It has been reasoned that physiological arousal may have a direct effect upon performance through the suppression of crucial cognitive and physiological resources (e.g. Hardy et al., 1994). Additionally, physiological arousal may also cause an athlete to interpret their physiological state as either negative or positive, inadvertently altering their performance (e.g. Bandura, 1977). Somatic anxiety, on the other hand, is believed to effect performance only if the extent of the somatic response is so large that the athlete becomes excessively concerned and distracted with their perceived physiological state (e.g. Martens et al., 1990).

Hardy & Fazey (1987) state, in their version, that physiological arousal follows the Inverted-U hypothesis in relation to performance. Nevertheless, that will only occur when the individual is exhibiting low cognitive state anxiety, e.g. they are not worried about their immediate performance, (see back face of fig. 3). 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 expeditious deterioration in the individual's performance, i.e. a catastrophe (see right face fig. 3). Hardy (1990) further proposed that cognitive anxiety behaves as a splitting factor that causes the normal factor's (i.e. physiological arousal) effect on performance to be smooth and small, large and catastrophic, or alternatively falling somewhere within the two extremes. 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 (see left face, fig. 3), (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. This can be demonstrated by bisecting through fig. 3, parallel to the physiological arousal by performance plane.

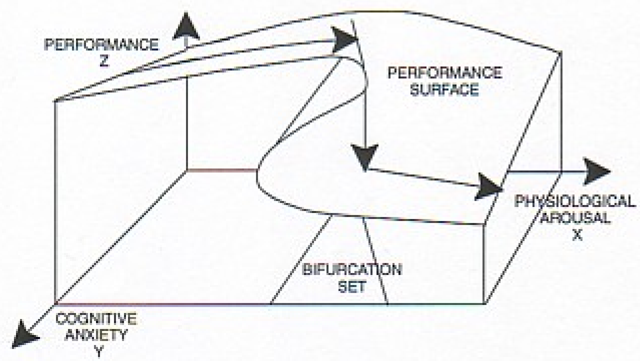

Fig. 3: Hardy & Fazey's (1987) Catastrophe Model demonstrating the association between anxiety and performance.

Fazey & Hardy (1988) suggested four additional proposals based upon their model:

1. Physiological arousal should (for the most part) only be deleterious to athletic performance when there is high cognitive anxiety.
2. Hysteresis will follow when high cognitive anxiety is present, and a bifurcation set will arise, i.e. the association of the same level of physiological arousal with two alternate levels of performance subject to the decrease, or increase, of the physiological arousal. To elucidate, it is predicted that there will be a negative correlation between performance and cognitive anxiety when physiological arousal is high, and a positive correlation when physiological arousal is low.
3. An average level of performance is unlikely to occur when high cognitive anxiety is present. Moreover, performance is likely to follow two distinct modes under conditions of high anxiety, as opposed to being uni-modal when cognitive anxiety is low.
4. Utilising a number of statistical methods (e.g. GEMCAT and the Dynamical Differences Method) it is conceivable that 'real-life data' be applied to cusp catastrophes.

Hardy, Parfitt & Pates (1992) stressed that the surface of the cusp catastrophe is 'tailored' to each individual, insofar as the model can be bent, stretched, rotated and transformed to fit an athlete's ability and experience in relation to their performance. Notably, and central to Thom's (1975) original theorem, the flexible properties of the cusp catastrophe can never be torn, i.e. it should always remain continuous, following the fundamental rule of hysteresis, and the discontinuous changes in performance under certain conditions.

A Critical Analysis of the Two Theories

Initially there was scant research to offer full support for the Multidimensional Theory of Anxiety. In addition to what has been regarded by some as questionable methodology, there were a number of differing conclusions by researchers as to the specific effect that somatic and cognitive anxiety had upon performance. This lack of concordance between researchers was considered the greatest shortcoming within the theory.

For example, an earlier study by Burton (1988), and later Krane (1990), had found only a tenuous correlation for the negative relationship between cognitive anxiety and performance proposed by Martens et al. (1990). Whereas, Gould et al. (1987), and Burton (1988) had earlier only found a partial relationship for Martens et al.'s (1990) proposed curvilinear relationship between somatic anxiety and performance. Instead, Krane (1990) found that there was a negative correlation between performance and somatic anxiety, while an earlier study by Gould et al. (1987) found no relationship at all between cognitive anxiety and performance. Aside from the previous dissimilar findings, a number of studies have managed to replicate the time to event paradigm of Martens et al. (1990), (e.g. Parfitt & Hardy, 1987; Jones & Cale, 1989). Again, the time to event paradigm has not been without its criticism, notably, Parfitt, Jones & Hardy (1990), who stressed that the time to event paradigm fails to make a distinction between the effects of positive somatic anxiety and positive interactions between cognitive anxiety and practice. Moreover, this positive interaction between cognitive anxiety and practice may cause a significant increase in the athlete's ability before the critical event. It is likely that an occurrence such as this would be credited to somatic anxiety, as opposed to cognitive anxiety and practice.

A number of researchers have also drawn attention to the likelihood that cognitive and somatic anxiety are not entirely the independent sub-components they have been treated as, and in fact actually correlate to some extent with each other (e.g. Petlichkoff & Gould, 1985; Jones, Cale & Kerwin, 1988; Krane, 1990). Martens et al. (1990), by drawing attention to an earlier study by Morris et al. (1981), had already expressed that it was likely that there was some form of relationship between the two sub-components. This study had proposed that the sub-components somatic and cognitive anxiety, should be related, albeit by some degree of covariance (i.e. an overlap in variance between two factors (see fig. 4 below). This assumption is not unreasonable as it should be expected that certain situations that cause a great deal of stress would elicit an effect both somatically and cognitively.

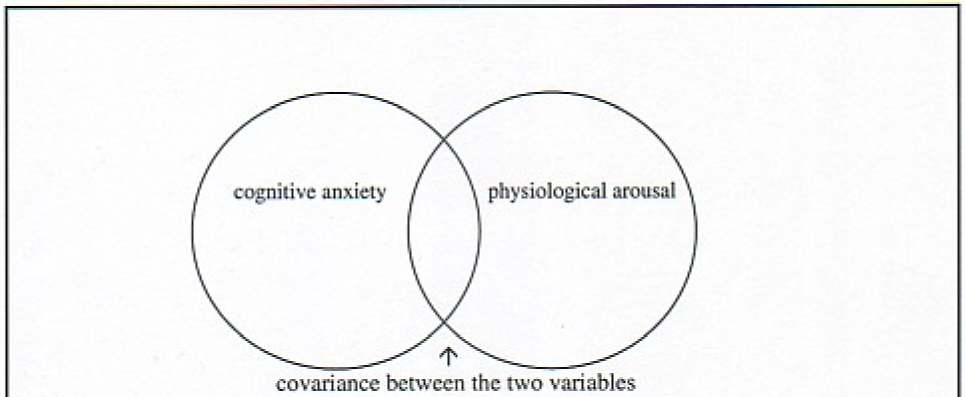

Fig. 4

Another prominent shortcoming of Multidimensional Theory of Anxiety is its continued association with the outmoded Inverted-U hypothesis. Indeed, multidimensional anxiety theory has been criticised as taking a two-dimensional approach to explaining competitive anxiety. To elucidate, the majority of research has made predictions about the interaction between cognitive and somatic anxiety with performance independently, with little or no emphasis on the interaction between the two sub-components. However, in reality a three-dimensional approach that will incorporate both sub-components simultaneously is required. As Krane (1992) indicates in her paper:

...Researchers have continued to examine cognitive and somatic anxiety independently of one an other. That is, the relationship between cognitive anxiety and performance has been examined separately from the relationship between somatic anxiety and performance, disregarding the multivariate nature of the multidimensional anxiety theory, (Krane, 1992, p. 78).

Further criticisms arise not from the rationale of multidimensional anxiety theory itself, but rather from the way researchers continue to measure it (Hardy, 1990). For example Parfitt, Jones and Hardy (1990) indicated that much of the previous research has relied upon between-subject, cross-sectional designs when, in their opinion, they should have been within-subjects, longitudinal designs. They go on to state that, "...it is the effect of changing anxiety levels upon an individual's actual performance that is important, not how scores vary between individuals with different (relative) anxiety levels", (p. 54). Jones (1995) goes on to argue that some researchers (e.g. Gould et al., 1987) have shown a tendency to concentrate on linear rather than curvilinear relationships, "...thus precluding the possibility of support for the predicted somatic anxiety performance relationship", (Jones, 1994, p.461). In addition, he states that the measures used to record individual performance, e.g. nominal data entry based on either winning or losing, etc. have been too comprehensive and lacking the sensitivity to successfully measure small but significant fluctuations in overall anxiety. In support, Hardy (1990) stresses that the Inverted-U shaped somatic anxiety performance demonstrated by Burton (1988), could not have been illustrated by Morris et al.'s (1975) method of linear correlational analysis. Hardy (1990) goes on to explain that similarly the within-subjects analysis of group performance by Parfitt & Hardy (1987), conveys information more qualitatively diverse than the between subjects curvilinear regression analysis of Burton (1988).

However, Martens et al.'s (1990) predictions of performance have been reproached as inaccurate due to the generalisation of findings from one diverse scenario to the other, i.e. academic testing associated with competitive sport. Further, Martens et al. (1990) claim that cognitive anxiety is the principle factor that influences performance, i.e. high levels will cause a debilitative effect. However, evidence to support this is meagre, save for some early research on examination anxiety (Morris, Davis & Hutchings, 1981), and data collated from what Hardy (1992) criticised as an inappropriate retrospective self-report sports related questionnaire (Martens et al., 1990). Such self-report measures have previously shown consistently poor correlations with performance (e.g. Thayer, 1970). Nevertheless, partial corroboration from Jones & Cale (1989) demonstrated the importance of cognitive anxiety, insofar as low levels of the sub-component immediately prior to a competitive event predicted a positive outcome, while the opposite effect, i.e. a poor outcome, was found with high levels of cognitive anxiety.

Hardy & Fazey (1988) have attempted to address the inherent problems associated with multidimensional theory by using three dimensions in the shape of the catastrophe model. Even so, this interpretation is not without its weaknesses.

Some doubt has been raised as to the full efficacy of Hardy & Fazey's (1988) model serving as a faithful account of the effect high cognitive anxiety has upon performance. For example Hardy, Parfitt & Pates (1992) were unable to offer complete support to Hardy & Fazey's (1988) prediction that performance should be high when cognitive anxiety is high and physiological arousal is low. However, Hardy, Parfitt & Pates (1992) went on to mention that, upon careful consideration, they realised that there were a number of flaws within their methodology (e.g. small sample size), and that these may have caused the contrary and unexpected outcome.

In addition, the model fails to explain how the effects of cognitive anxiety and physiological arousal on performance occur. Speculation has focused mainly upon interference (e.g. Hamilton, 1975), described by Hackfort & Schwenkmezger (1989) as, "...a cognitive component, which at a high level of state anxiety leads to persons being ...preoccupied with considerations irrelevant/extraneous to the solution of their task instead of concentrating on the solution of their task", (p. 331). Motivational effects (e.g. Eysenck, 1979, 82) have also been proposed as an alternative explanation, i.e. athletes exhibiting high anxiety could be thought of as having a greater variance between their present aspirations and their previous achievements. Eysenck (1979, 82) further predicts that, providing there is at least a reasonable chance of success, a greater goal discrepancy could be expected to improve motivation and effort in athletes with high anxiety. On the other hand, if the event is too demanding on the athlete and success is unlikely, the greater goal discrepancy of the highly anxious could be expected to decrease their motivation significantly. Additional empirical support for Eysenck's (1979, 82) proposal has been put forward by Erez & Zidon (1984) and Hardy, Maiden & Sherry (1986).

Another possibility, put forward by Hardy & Parfitt, (1991) states that when individuals are cognitively anxious they continue in their attempts to deal with the demands of the task. However, the amount of physiological arousal they experience could interfere with their performance, either by distraction, reducing their capacity to process cognitive information, or by causing them to consciously divert cognitive resources to maintaining effort, rather than to their performance on the task at hand.

Conclusions

Essentially, Hardy & Fazey's (1988) catastrophe model is still in its 'infancy'. Moreover, it has yet to evolve from its conceptual framework stage to a fully established and accepted theory. This, however, may not occur for some time as there is still very little current or on-going research involving the model to sufficiently validate its proposed explanation of A-state competitive anxiety. Additionally, this situation has been exasperated by the difficulty in testing the model. At present there are four alternative methods that can be utilised to measure data relating to catastrophes: Oliva et al.'s (1987) GEMCAT, or general multivariate methodology for estimating catastrophe models; non-linear regression analysis; Cobb's (1981) parameter estimation model; and Guastello's (1987) dynamical differences method. However, following her unsuccessful application of the GEMCAT method, and criticism over the lack of research using Cobb's (1981) parameter estimation model, Krane (1990) postulated that the preferred method for analysing catastrophes should be either the non-linear regression method, or Guastello's (1987) dynamical differences method.

Additionally, it should also be noted that the majority of the research has been conducted by the same small number of behavioural scientists, thus adding to the questionable validity of the model and its role in sport and exercise psychology. Clearly, the encouragement of 'fresh' researchers with novel methods of measurement is required to bolster the model's position in the solution to the competitive anxiety phenomenon.

Finally, despite it's shortcomings, Hardy & Fazey's (1987) approach has been regarded by many as a plausible 'up to date' alternative to the outmoded multidimensional theory (e.g. Jones, 1995). Nevertheless, the multidimensional theory has been invaluable in leading the way towards the identification and establishment of cognitive and somatic anxiety/physiological arousal as two distinct sub-components of A-state.

References

Bandura, A. (1977). Self-Efficacy: Toward a Unifying Theory of Behavioural Change. Psychological Review, 84, 1475-1482.

Burton, D. (1988). Do Anxious Swimmers Swim Slower? Re-examining the Elusive Anxiety-Performance Relationship. Journal of Sport and Exercise Psychology, 10, 45-61.

Buss, A. H. (1962). Critique and Notes: Two Anxiety Factors in Psychiatric Patients. Journal of Abnormal and Social Psychology, 65, 426-427.

Carron, A. V. (1980). Social Psychology of Sport. Ithaca, NY: Mouvement.

Cobb, L. (1981). Parameter Estimation for the Cusp Catastrophe Model. Behavioural Science, 26, 75-78.

Davidson, R. J. & Schwartz, G. E. (1976). The Psychobiology of Relaxation and Related States: A Multiprocess Theory, In D. I. Motofsky (Ed.). Behaviour Control and Modification of Psychological Activity. Englewood Cliffs, NJ: Prentice Hall.

Deffenbacher, J. L. (1980). Worry and Emotionality in Test Anxiety, in I. G. Sarason (Ed.), Test Anxiety: Theory, Research and Applications. Hillsdale, NJ: Erlbaum.

Erez, M. & Zidon, I. (1984). Effect of Goal Acceptance on the Relationship of Goal Difficulty to Performance. Journal of Applied Psychology, 69, 69-78.

Eysenck, M. W. (1979). Anxiety, Learning and Memory: A Reconceptualization. Journal of Research in Personality, 3, 363-385.

Eysenck, M. W. (1982). Attention and Arousal: Cognition and Performance. Berlin: Springer-Verlag.

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

Gould, D., Petlichkoff, L., Simons, H. & Vevera, M. (1987). The Relationship Between Competitive State Anxiety Inventory-2 Subscale Scores and Pistol Shooting Performance. Journal of Sport and Exercise Psychology, 9, 33-42.

Guastello, S. (1987). A Butterfly Catastrophe Model of Motivation in Organisations: Academic Performance. Journal of Applied Psychology, 72, 161-182.

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.

Hamilton, M. (1959). The Assessment of Anxiety States by Rating. British Journal of Medical Psychology, 32, 50-55.

Hamilton, V. (1975). Socialisation Anxiety and Information Processing: A Capacity Model of Anxiety-Induced Deficits. In I. Sarason & C. D. Spielberger (Eds.), Stress and Anxiety, Vol. 2. London: Academic Press.

Hardy, L. (1990). A Catastrophe Model of Performance in Sport. In J. G. Jones & L. Hardy (Eds.), Stress and Performance in Sport (pp. 81-106). Chichester, England: Wiley.

Hardy, L. & Parfitt, G. (1991). A Catastrophe Model of Anxiety and Performance. British Journal of Psychology, 82, 163-178.

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. June.

Hardy, L., Maiden, D. S. & Sherry, K. (1986). Goal-setting and Performance: The Effects of Performance Anxiety. Journal of Sports Sciences, 4, 233-234.

Hardy, L., Parfitt, G. & Pates, J. (1992). Performance Catastrophes in Sport: A Test of the Hysteresis Hypothesis. Journal of Sports Sciences, 12, 327-334.

Holroyd, K. A., Westbrook, T., Wolf, M. & Bradhorn. (1978). Performance, Cognition and Physiological Responding in Test Anxiety. Journal of Abnormal Psychology, 87, 442-457.

Jones, G. (1995). More than Just a Game: Research Developments and Issues in Competitive Anxiety in Sport. British Journal of Psychology, 86, 449-478.

Jones, J. G., Cale, A. & Kerwin, D. G. (1988). Multidimensional Competitive State Anxiety and Psychomotor Performance. Australian Journal of Science and Medicine, 20, 3-7.

Jones, J. G. & Cale, A. (1989a). Pre-competition Temporal Patterning of Anxiety and Self-Confidence in Males and Females. Journal of Sport Behaviour, 12, 183-195.

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

Krane, V. (1990). Anxiety and Athletic Performance: A Test of the Multidimensional Anxiety and Catastrophe Theories. Unpublished Doctoral Dissertation. University of North Carolina at Greensboro.

Krane, V. (1992). Conceptual and Methodological Considerations in Sport Anxiety Research: From the Inverted-U Hypothesis to Catastrophe Theory. Quest, 44, 72-87.

Liebert, R. M. & Morris, L. W. (1967). Cognitive and Emotional Components of Test Anxiety: A Distinction and Some Initial data. Psychological Reports, 20, 975-978.

Martens, R., Burton, D., Vealey, R. Bump, L. & Smith, D. (1990). The Development of the Competitive State Anxiety Inventory-2 (CSAI-2). In R. Martens, R. S. Vealey & D. Burton (Eds.). Competitive Anxiety in Sport (pp. 117-190). Champaign, IL: Human Kinetics.

Morris, L., Davis, D. & Hutchings, C. (1981). Cognitive and Emotional Components of Anxiety: Literature Review and Revised Worry-Emotionality Scale. Journal of Educational Psychology, 73, 541-555.

Morris, L., Harris, & Rovins, D. S. (1981). Interactive Effects of Generalised and Situational Expectancies on Cognitive and Emotional Components of Anxiety. Journal of Research in Personality, 15, 302-311.

Neiss, R. (1988). Reconceptualising Arousal: Psychobiological States in Motor Performance. Psychological Bulletin, 103, 345-366.

Oliva, T. A., Descarbo, W. S., Day, D. L. & Jedidi, K. (1987). GEMCAT: A General Multivariate Methodology for Estimating Catastrophe Models. Behavioural Science, 32, 121-137.

Parfitt, C. G. (1988). Interactions Between Models of Stress and Models 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.

Park, R. J. (1980). Citius Altius Fortius. The Academy Papers. Reston, VA: American Academy of Physical Education, No. 14.

Petlichkoff, L. & Gould, D. (1985). Interrelationships Between Pre- and Mismatch Competitive State Anxiety Measures. Paper Presented at the AAHPERD National Conference, Atlanta, Georgia.

Sussman, H. & Zahler, R. (1978). A Critique of Applied Catastrophe Theory in the Behavioural Sciences. Behavioural Science, 23, 28-39.

Thayer, R. E. (1970). Activation States as Assessed by Verbal Report and Four Psycho-Physiological Variables. Psychophysiology, 7, 86-94.

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

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.