

# TOWARD AN UNDERSTANDING OF CHALLENGE AND THREAT IN ATHLETES

by

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Thesis submitted for the Degree of Doctor of Philosophy

2014

## ABSTRACT

The aims of this research programme were to a. Further examine and develop an existing self-report measure of Challenge and Threat within a sport context, b. Examine Challenge and Threat self-report with performance in a sport context, c. Further examine the Biopsychosocial Model (BPSM) proposed in relation to Challenge and Threat and sport performance, d. Examine the associations between Challenge, Threat, cortisol response and sport performance, e. Examine self-report of emotions direction and intensity experienced during a sport performance in regard to Challenge and Threat and f. Examine Challenge and Threat in combination with each other in regard to sport performance.

These 6 aims were addressed in 3 different empirical studies. Study 1 used a cross sectional study design to explore the validity and reliability of an existing self-report measure of Challenge and Threat. Participants were gym users (n=200, $M_{age}$=24.91) and asked to complete the self-report measure before a dart-throwing competition. Study 2 comprised of three different stages. Stage 1; a cross sectional study design to examine the content validity of a pool of existing self-report items to measure Challenge and Threat in a range of athletes (n=25, $M_{age}$=22.00). Participants comprised of male and female athletes engaged in various sports (football, n=6, cricket, n=2, swimming, n=5, tennis, n=1, rugby, n=6, netball, n=3, basketball, n=2.). Stage 2, used a cross sectional study design to further examine the construct validity of the remaining items from stage 1. This stage used principle components analysis (PCA) to determine whether Challenge and Threat self-report items were grouped in a particular way (Kline, 1994). Participants were competitive runners (n=197, $M_{age}$=37.11) and asked to complete the self-report measure regarding Challenge and Threat before competition.

Stage 3 used a cross sectional study design to explore the validity and reliability of the self-report measure of Challenge and Threat developed in stages 1-2 in competitive runners (n=147, $M_{age}$ =30.06), using confirmatory factor analysis (CFA) to examine how well the data total fitted the proposed hypothetical model. Finally a quasi-experimental study (study 3) examined the association between Challenge and Threat and shooting performance. This study explored the Challenge and Threat self-report measure and its relationship with performance, emotions and physiological responses. Participants in this study comprised of university student and staff members (n=102, $M_{age}$ =27.11). Results from study 1 suggested that the existing self-report measure of Challenge and Threat utilised was not suitable for use within a sport context. Results from study 2, stage 1, revealed a pool of self-report items that athletes described as applicable and relevant to their sports performance. Results from study 2, stage 2, suggested that items identified in study 2, stage 1 represented a two component solution, one associated with Threat and the other Challenge. Results from study 2, stage 3 suggested that a 12 item self-report measure was suitable for use within a sport context and that Challenge has a positive association with sport performance. Finally, study 3, suggested that the self-report measure of Challenge and Threat developed in study 2 (stages 1-3) was suitable for use within a sport context. Results from study 3 also suggest that a mixture of Challenge and Threat can have implications for performance outcome. Emotions reported were shown to have associations with Challenge and Threat self-report, as suggested by The Theory of Challenge and Threat States in Athletes (TCTSA). The study findings showed that physiological associations with Challenge and Threat were equivocal. Limitations to the present research programme and directions for future research are discussed.

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ACKNOWLEDGEMENTS

There are a few people I would like to thank who have helped me through this journey. First, my thanks go to Dr Mark Uphill for his knowledge, expertise and patience throughout this process and to Dr Damian Coleman and Dr Jon Swain for their advice and guidance. Second, I would like to thank my colleagues and great friends for their support and belief in me to complete this process, Dr Abby Foad, Dr Andy Kirkland and Dr Jamie O'Driscoll. Third, I would like to thank my parents Sharon and Steve, for their support and my best friend and partner Dan who never gave up on motivating and helping me through this process, without you this would not have been possible. Lastly I would like to thank all of the participants who gave up their time to participant within this research programme.

# PREFACE

Research in this thesis has contributed to the following conference presentations:

1) Rossato, C. Uphill, M.A, Coleman, D.A and Swain, J. (2014) Associations between shooting performance and Challenge and Threat. The 5th International Conference in Sport and Exercise Science. Pattaya, July.

2) Rossato, C. J. L. Uphill, M.A, Coleman, D.A and Swain, J. (2013) Towards the Validation of a Measure of Challenge and Threat in Sport. International Society of Sport Psychology 13th World Congress. Beijing, July.

3) Rossato, C. J. L, Uphill, M.A, Coleman, D.A and Swain, J. (2012) The Validity of the Primary and Secondary Appraisal Scale (PASA) for use with Athletes. International Convention on Science, Education & Medicine in Sport. Glasgow, July.

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| | |
|---|---|
| Biospsychosocial Model | BPSM |
| Cardiac Output | CO |
| Challenge and Threat in Sport Scale | CAT |
| Cognitive Appraisal Ratio | CAR |
| Cognitive Appraisal Scale | CAS |
| Confirmatory Factor Analysis | CFA |
| Electrocardiography | ECG |
| Heart Rate | HR |
| Pituitary Adrenal Cortical | PAC |
| Pre-Ejection Period | PEP |
| Principle Components Analysis | PCA |
| Primary Secondary Appraisal Scale | PASA |
| Sympathetic Nervous System | SAM |
| Stroke Volume | SV |
| Theory of Challenge and Threat State in Athletes | TCTSA |
| Total Peripheral Resistance | TPR |

# CHAPTER 1 : INTRODUCTION

## 1.1 Background to Thesis

Thatcher and Day (2008) suggested that identifying and understanding stressors in sport has become an important area in sport psychology. Sport psychology researchers have identified various "sources of stress" that sport performers encounter (Arnold & Fletcher, 2012). Stressors identified include leadership and personal issues, cultural and team issues, logistical and environmental issues and performance issues (Arnold & Fletcher, 2012). In particular organisational stressors have been identified to have an impact upon sporting performance (Woodman & Hardy, 2001). Environmental demands associated primarily and directly with the organisation within which an individual is operating (Fletcher, Hanton & Mellalieu, 2006) are particularly prevalent in performer's lives (Fletcher &Wagstaff, 2009).

Such stressors are not objective stimuli, but rather the degree to which a stimuli is a "stress" is influenced by how it is appraised. Folkman and Lazarus (1985) described a cognitive appraisal as having two components, a. primary appraisal, where the individual assesses whether the situation to hand is important/relevant to them and an assessment of the demands of the situation, and b. secondary appraisal, which represents a judgement about whether or not the individual believes that they have the ability to cope with the task at hand.

Moreover, Neil, Hanton, Mellalieu and Fletcher (2011) suggested that emotional reactions are associated with stressors experienced within sport. Neil et al. (2011) explained, if an individual does not believe that they have the resources to deal with the demands encountered in the competition environment, the individual will likely experience negative emotions, such as anger and possibly suffer from negative behaviour such as physical tension. However negative emotions may not always lead to

negative consequences. Moreover, an individual's appraisals of a stressor may not just influence the stress experienced but also their emotional reaction.

Understanding how an individual responds to stress is important for a number of different reasons. Scneiderman, Ironson and Siegel (2005) suggested that there is a relationship between psychosocial stressors and disease, in particular mental health issues, such as depression and anxiety. Other health issues such as the risk of coronary heart disease are seen to be higher in men who are relatively low in socioeconomic status (Marmot, 2003), due to stress. In addition, Harbuz, Richards, Chover-Gonzalez, Marti-Sistac and Jessop (2005) suggest that autoimmune disease is also shown to have an association with stress.

Recent literature (Wagstaff, Fletcher & Hanton, 2012) suggested that stressors encountered in a sporting situation can have an impact upon performance. In particular, cognitive appraisals and the resources available to cope with the demands of the task.

One model which begins to encapsulate and integrate many of these ideas is the Theory of Challenge and Threat States in Athletes (TCTSA; Jones, Meijen, McCarthy & Sheffield; 2009). The TCTSA suggests that a sports performer could appraise a situation as a Challenge or a Threat dependent on their primary and secondary appraisals. The TCTSA also suggests that these appraisals are accompanied by cardiovascular and neuroendocrine responses (noradrenaline, adrenaline and cortisol release) based upon two specific existing models within the literature (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996; Dienstbier, 1989).

The first model is the Arousal and Physiological Toughness model (Dienstbier, 1989) which suggested that appraising a situation as a Challenge results in an increase

in adrenaline and noradrenaline release, whereas a Threat results in the release of cortisol and adrenaline and noradrenaline.

The second model is the Biopsychosocial model (BPSM; Blascovich & Mendes, 2000). This model suggested that dependent on the appraisal (Challenge or Threat) different cardiovascular reactivity will occur. In particular, an increased cardiac output (CO) is suggested to be associated with Challenge and Threat. No increase or little increase in total peripheral resistance (TPR) is associated with Threat, whereas a decrease in TPR is associated with Challenge.

Furthermore, a Challenge appraisal is said to occur when the individual perceives that they have enough resources to cope with the demands of the task, whereas a Threat appraisal occurs when the individual perceives that they do not have enough resources to cope with the demands of the task (Jones et al., 2009). These appraisals are suggested to lead to a negative performance effect (Threat) and a negative valence of emotions (e.g. anger). A positive performance effect (Challenge) is suggested to be accompanied by a positive valence of emotions (e.g. happiness). However, the model does suggest that emotions such as anxiety can be experienced in both states, but an individual in a Challenged state might perceive this as positive, whereas in a Threat state they might perceive this as negative (section 2.10 within this chapter provides a thorough exploration of the model).

There is an emerging body of research examining Challenge and Threat within sport. However there remain a number of limitations. First, there are only six studies to date that have examined Challenge and Threat in relation to sport performance (Moore, Vine, Wilson & Freeman, 2012; Moore, Wilson, Vine, Coussens & Freeman 2013; Turner, Jones, Sheffield, & Cross, 2012; Turner, Jones, Sheffield, Slater, Barker &

Bell, 2013) or emotional valence (Meijen, Jones, McCarthy, Sheffield & Allen, 2013[a]; Meijen, Jones, Sheffield & McCarthy, 2013[b]). Secondly there is a lack of self-report measures of Challenge and Threat within a sport context. Although there are existing measures (Gaab, Rohleder, Nater & Ehlert 2005; Skinner & Brewer, 2002; McGregor & Elliott, 2000; Tomaka, Blascovich, Kelsey & Leitten, 1993), none have been validated within a sporting context. Thirdly, as Chapter 2 illuminates there are different ways of conceptualising Challenge and Threat (i.e. cognitively, physiologically and experientially), with limited research within the field of sport. In addition there is little to suggest one conceptualisation of Challenge and Threat has advantages over another. Understanding Challenge and Threat in sport is important, empirically, conceptually and ultimately practically. However, as the following chapter suggests much remains to be learned about Challenge and Threat generally, and in sport specifically.

## 1.2 The structure of the present thesis

Chapter 2 presents a thorough and critical review of the Challenge and Threat literature. In particular, research that has examined neuroendocrine, cardiovascular and performance associations and appraisals and social evaluative elements in association with Challenge and Threat. The characteristics of Challenge and Threat and antecedents, precursors and consequence on performance is also examined.

Furthermore, measures of Challenge and Threat and their applicability to sport are also explored. Chapter 3 to 5 report three studies based on the limitations identified in Chapter 2. Chapter 3 reports the results of a factor analysis designed to examine the reliability and validity of an existing self-report measure of Challenge and Threat within a sport and exercise related sample (sports men/women and gym users).

Given the limitations described in Chapter 2, Chapter 4 reports the development of a self-report measure of Challenge and Threat in three stages. The first examined the content validity of a pool of items derived from existing Challenge and Threat self-report measures within a sport related sample. The second examined the components solution of those remaining items and third examines the factor structure and validity of these items in a sport related sample.

Chapter 5 examined the self-report derived in Chapter 4 and its predictive validity in relation to a performance task. Cardiovascular parameters, endocrine response (cortisol) and self-report measures of emotions were recorded in order to provide a holistic examination of the variables associated with Challenge and Threat. Moreover the predictive validity of cardiovascular indices and cortisol response are examined in combination with performance, emotions and Challenge and Threat self-report. Finally in Chapter 6, results of the research programme are summarised and discussed, limitations acknowledged and areas for future research and applications are identified.

# CHAPTER 2 LITERATURE REVIEW

## 2.1 Introduction

The aim of this chapter is to review the extant literature regarding Challenge and Threat and its origins. It is largely presented chronologically. It begins by examining arguably the seminal paper that has stimulated much of the current literature on Challenge and Threat, and traces the evolution of thinking about Challenge and Threat from this point until present. It is recognised however that this linear trajectory is perhaps simplistic; that it does not necessarily convey well the overlap in perspectives at particular time points. This approach however, does confer several advantages. First, it draws attention to the main "moments" that have characterised this body of literature (Blascovich & Mendes, 2000; Dienstbier, 1989; Jones et al., 2009). Second, this retrospective examination illuminates the different conceptualisations of Challenge and Threat (cognitive, experiential and physiological) and the tensions between them.

In particular a critical review of the physiological responses associated with Challenge and Threat and self-report measurements regarding Challenge and Threat will be examined.

## 2.2 The Origins of Literature on Challenge and Threat

Arguably, the seminal paper stimulating much of the contemporary research is Orbrist's (1976) article. This paper examined the suggestion that stressful environmental events can elicit cardiovascular responses. Cardiovascular responses represent adjustments in haemodynamics and its distribution that occurs to meet the metabolic requirements potentially or actually demanded by the task or activity the individual is facing.

Orbrist (1976) suggested that cardiovascular responses have an interaction with behavioural change and coping behaviours. In particular Orbrist (1976) focused on active and passive coping behaviours. Active coping refers to trying to cope with the situation, for example feeling pain in a situation; an individual might try to function despite the pain, whereas passive coping would refer to withdrawing and surrendering control over the pain. In one experiment (Orbrist, 1976) used a task in which participants were exposed to an electric shock. Half of the participants were led to believe they could avoid the shock but were in fact unable to avoid the shock (active coping). The remaining subjects were told that they were helpless recipients of the shock (passive coping). Orbrist (1976) demonstrated that these coping mechanisms are associated with cardiovascular responses. Passive coping was linked to a changes in TPR and active coping was linked to an increase in CO, this is important because these cardiovascular parameters are associated with Challenge and Threat in later research (Blascovich & Mendes, 2000).

To demonstrate the cardiovascular variables associated with stress and coping, Orbrist (1976) used hypertension as an illustration. Where hypertension is caused due to acute stress resulting in labile hypertension (continual fluctuation of blood pressure) CO increases and the cardiovascular system may resemble that of exercise (Brod, 1963). In contrast, essential hypertension (chronic) is associated with an increased TPR and sustained CO.

It may be suggested that labile hypertension is associated with active coping; whereas essential hypertension is associated with passive coping and that the accompanying cardiovascular responses that are associated with these coping strategies are linked with Challenge (active coping) and Threat (passive coping ; Blascovich &

Mendes, 2000). It is this link between coping and Challenge and Threat elaborated upon in this section that provided the starting point for much of contemporary research.

A second article that provided much of the impetus for later research on Challenge and Threat was Dienstbier's (1989) Arousal and Physiological Toughness model. In particular Dienstbier (1989) examined associations between coping and neuroendocrine responses. It is now necessary to examine the neuroendocrine responses that Dienstbier (1989) broadly associates with Challenge and Threat appraisals.

### 2.3 Neuroendocrine responses of Challenge and Threat

Dienstbier (1989) focuses on two physiological responses and associates these with Challenge and stress (Threat) appraisals. Dienstbier (1989) suggeseted that the activation of the sympathetic nervous system (SNS) is related to a Challenge, and this is suggested to cause sympathetic-adreno-medullary activation (SAM). If the SAM is aroused this causes a release of adrenaline and noradrenaline (endocrine response). The stress (Threat) is said to be associated with SAM but also 'pituitary adrenal cortical arousal (PAC)'. Dienstbier (1989) suggested that this interaction features the pituitary gland, which releases adrenocorticotropin (ACTH) into the blood, and the adrenal cortex is stimulated to release cortisol (endocrine response).

Research cited to support Dienstbier's (1989) Arousal and Physiological Toughness model demonstrates an association between coping mechanisms and endocrine responses. For example, Rodin (1980) found that nursing home residents' cortisol response decreased after being taught coping skills. Similar observations were attained in hospitalised children; specifically those who coped effectively had lower cortisol response compared to those who did not (Knight, Atkins Eagle, Finkelstein,

Fukushima, Katz and Weiner, 1979). From this it is suggested that cortisol release is associated with the ability to cope with the situation at hand and supports the notion that a Threat appraisal is associated with cortisol response. An individual who has difficulty in coping has elevated levels of cortisol, compared to that of individuals who are able to cope (Challenge) with the situation at hand.

According to Dienstbier (1989) energy consumption is increased substantially when significant mental activity is undertaken. Therefore it is important to note that improved blood flow to the brain increases blood glucose availability, associated with adrenaline and noradrenaline release (Krotkiewski, Bylund-Fallenius, Holm, Bjoentorp, Grimby & Mandroukas, 1983). Dienstbier (1989) suggested that the release of adrenaline is adaptive, because it increases the blood flow to the brain, which accordingly increases the availability of glucose.

Furthermore, Dienstbier (1989) suggested that the release of noradrenaline helps to regulate free fatty acids and plays a role in blood flow redistribution through vasoconstriction that results in blood pressure increases. Muscle activity can thereby be facilitated because the muscles can utilise the fats as fuel. It is suggested that the release of adrenaline/noradrenaline is associated with higher levels of glucose availability and an increased Heart Rate (HR), improving blood flow to the brain. Vascular resistance therefore decreases in the brain with increased blood flow, as adrenaline/noradrenaline has been associated with Challenge in Dienstbier's model (1989).

In summary, Challenge and Threat are difficult to define. The literature examined thus far suggests that a Challenge appraisal is suggested to be associated with a physiological response related to the 'SAM' activation (physiological component).

However, there are some discrepancies as to whether a Challenge appraisal is that of a stress appraisal and is a process that includes a coping mechanism as discussed later (section 2.4).

A Threat appraisal however, is easier to identify. Both Dienstbier, (1989) and Folkman and Lazarus (1985) agree that this is a stress appraisal and that a coping mechanism is part of the process. The literature reviewed thus far suggests that a Threat appraisal is associated with a 'SAM' response in combination with an increase in cortisol release via the 'PAC' activation (physiological component). However, Dienstbier, (1989) did not elaborate upon appraisal construct; therefore at this stage it would be appropriate to introduce appraisals.

## 2.4 Cognitive Appraisals

There appears to be some tension between the semantics of cognitive appraisal within the extant literature (Dienstbier, 1989 & Folkman and Lazarus, 1985) and these will now be highlighted. A cognitive appraisal defined by Folkman and Lazarus (1985) is a process through which a person evaluates whether a particular encounter with the environment is relevant to his or her well-being, and if so, in what ways. Furthermore, Folkman and Lazarus (1985) suggested that a cognitive appraisal consists of two elements; a primary and a secondary appraisal which are now defined:

1) In primary appraisal the person evaluates whether he or she has anything at stake in this encounter, (a potential stressor)

2) In secondary appraisal the person evaluates what if anything can be done to overcome or prevent harm or to improve the prospects for benefit.

An individual's primary appraisal has been referred to as the motivational relevance of an encounter (Smith & Lazarus, 1990). This appraisal considers the encounters motivational congruence or incongruence, e.g. whether the transaction thwarts or facilitates an individual's goals (Smith & Lazarus, 1990). The secondary appraisal is suggested to focus on available coping options for altering perceived harm, Threat, or Challenge so that a more positive environment is created (Perrewé & Zellars, 1999). This could be associated with active and passive coping as suggested by Orbist (1976) and the cardiovascular indices associated within this coping mechanism as previously discussed in section 2.2. However, thus far there has been no link explicitly that has been elaborated on in reference to coping styles and Challenge and Threat. This is an issue that will be further elaborated on within this chapter, that a clear definition of Challenge and Threat seems very unclear. Orbrist (1976) suggestions seem to link to Blascovich and Mendes (2000) BPSM.

Folkman and Lazarus (1986) suggested that primary and secondary appraisals combine in order to determine whether the person-environment transaction is regarded as significant to their well-being. If it is perceived as significant to well-being this leads to whether it is primarily Threatening (containing the possibility of harm or loss) or Challenging (holding the possibility of mastery or benefit).

Moreover Lazarus (1994) explains that the appraisal process includes three evaluations; firstly one of irrelevant encounter that has no personal significance for the individual and is ignored, secondly, a benign-positive encounter that is one that is considered to be beneficial and/or desirable and the third one that is deemed to be harmful/Threatening or Challenging to the individuals well-being (Lazarus, 1994).

Peacock Wong and Reker (1993) summarise this as the person, event or situation being appraised as irrelevant, benign-positive or stressful. From this it can be suggested that both Challenge and Threat are that of a stress appraisal. The difference between irrelevant and benign appraisal is that the irrelevant encounter hold no personal significance for the individual and is ignored whereas the benign-positive encounter is considered to be of significance but not to be of any significance to the individual well-being. Lastly if it is significant to the individual's well-being Challenge and Threat can be experienced.

In contrast, Dienstbier (1989) suggested that a coping mechanism is activated when an individual is appraising a situation as stressful (Threat and harm/loss appraisals). Furthermore, if stress is associated with a Threat or harm/loss appraisal based upon this semantic a Challenge appraisal would not involve coping as a mechanism as it would be perceived as an opportunity for mastery or benefit rather than a stressor. Lazarus's (1994) explanation does not support Dienstbier's (1989) suggestion that a stress appraisal differs from a Challenge appraisal. Moreover, the comparison could be made that a benign-positive encounter is labelled as a Challenge by Dienstbier (1989), whereas Peacock et al. (1993) suggested that Challenge is part of a stress appraisal.

Dienstbier's (1989) explanation suggested that Orbrist's (1976) physiological components of stress and his explanation of coping (passive and active) would be relevant to only a Threat or harm/loss appraisal. However, Folkman and Lazarus (1985) are associating a Threat /Challenge appraisal as part of the stress appraisal process. Therefore there is a lack of clarity within the extant literature in regard to the semantic of a stress appraisal (i.e. Challenge and Threat). Furthermore, Blascovich and Mendes (2000) propose a model that encompasses Dienstbier's (1989) suggestion that

neuroendocrine responses are associated with Challenge and Threat and utilised Folkman and Lazarus's (1985) approach to examine Challenge and Threat appraisal and their associated cardiovascular indices. This will now be discussed.

## 2.5 Biopsychosocial Model (BPSM)

The BPSM attempts to consolidate this early literature, described in sections 2.3 and 2.4. Specifically, within the BPSM, Challenge is postulated to occur when an individual perceives nearly sufficient resources to meet the situational demands. Threat, on the other hand, occurs when an individual perceives to have insufficient resources to meet the situational demands (Blascovich & Mendes, 2000).

The BPSM is focused on motivational performance situations in which something is at stake. Blascovich and Mendes (2000) suggested that appraisals may involve affective and/or cognitive processes resulting in a physiological response. They also suggested that during performance, interaction with others, and external factors (such as the environment) may influence an appraisal of a situation, creating a dynamic process. For example, a situation may be appraised as a Challenge at the start of a motivational situation and as the event progresses over time may end up as a Threatening situation.

The BPSM used a different approach to the primary/secondary appraisals discussed by Folkman and Lazarus (1985). Within the BPSM there appears to be three processes that lead to a Challenge or Threat appraisal; the first being if the task holds any relevance (similar to that of a primary appraisal, Folkman & Lazarus, 1985); the second, how an individual perceives the demand of the relevant task (Blascovich & Mendes, 2000 label this as the primary appraisal) and thirdly, whether the individual perceives they have enough resource to cope with the demand (similar to that of

secondary appraisal set out by Folkman and Lazarus (1985) and labelled the secondary appraisal by Blascovich & Mendes, 2000). It may be suggested that if an individual appraises the situation as holding no relevance, that it can be labelled as an irrelevant appraisal (Peacock et al., 1993), or a positive benign experience if it is seen as positive to the individual but not relevant to an individual's well-being. An example of this may be having mild weather during a marathon competition is perceived as positive, but it is not significant to the individual's well-being.

Blascovich and Mendes (2000) contend that Challenge and Threat appraisals are grounded in the concepts of demand (primary appraisal) and resources (secondary appraisal). A demand appraisal is described as the 'perception of danger, uncertainty, and required effort inherent in the situation', referring to demands the situation places on the individual. Resource appraisal is the perception of the knowledge and skills applicable to the situational performance. This refers to the secondary appraisal because it reflects perceived available coping resources (Blascovich & Mendes, 2000). To elaborate, if an individual perceives the situation as a Challenge, they will appraise that they have enough resources to cope with the demand of the task. Alternatively, if perceived as a Threat, they will appraise that they do not have enough resources to cope with the demands of the task.

The BPSM suggested that cognitive appraisals of Challenge and Threat occur, but only if the task holds relevance for the individual. This supports Lazarus and Folkman's (1984), primary/secondary appraisal process and Peacock et al. (1993). Ultimately there are varied approaches to understanding appraisals, but no real examination of which conceptualisation is the most appropriate.

Moreover, the BPSM also suggested that affective cues (e.g. hostility) may potentially influence whether an individual appraises a situation as a Challenge or Threat. Therefore it can be suggested that Challenge and Threat appraisal could be manipulated. Blascovich and Mendes (2000) use an example of a hostile voice, explaining that it can lead to an individual appraising the situation at hand as a Threat. Familiarity is also suggested to have an impact upon the demand appraisal. If an individual feels more familiar with a particular set of items to hand (e.g. dressing room), and those items are not available, this may increase uncertainty. Therefore, the individual might perceive this as creating more of a demand on themselves. However, if the set of items are available to hand this may reduce task uncertainty (Blascovich & Mendes, 2000). The BPSM states that affective cues (e.g. familiarity or hostile voices) can have an influence on appraisal, for example familiarity can lead to Challenge whilst hostility can lead to Threat.

The BPSM suggests that there is a physiological component to appraising a situation as a Challenge or a Threat. In particular, cardiovascular responses and endocrine responses (e.g. 'SAM and 'PAC' activation) are suggested to indicate whether an individual has appraised the situation as a Challenge or Threat. Importantly from this perspective, cardiovascular responses are considered to be reliable indices of Challenge and Threat respectively, given that appraisals may occur automatically and outside of individuals' awareness (Blascovich & Mendes, 2000). These suggested cardiovascular responses associated with Challenge and Threat by the BPSM will now be discussed. However, it should be noted that coping styles are not drawn upon within this model, and that there is no suggested link between the endocrine responses discussed and the cardiovascular responses to active and passive coping which was earlier elaborated upon in section 2.2 by Orbrist (1976). This is important because the

cardiovascular indices associated with Challenge and Threat are very similar to those discussed by Orbrist (1976) in conjunction with active and passive coping. Therefore it maybe that active and passive coping are also an important part of Challenge and Threat, however these are not discussed within the BPSM explicitly as important components of Challenge and Threat.

## 2.6 Cardiovascular Responses to Challenge and Threat within the Biopsychosocial model (BPSM)

In addition to the cognitive and neuroendocrine component of the BPSM, cardiovascular responses have also been associated with Challenge and Threat. Moreover, Blascovich and Mendes (2000) suggested that for a Challenge or Threat response to occur the task should be relevant and evaluative. This is suggested to be an elevated HR. If HR increases significantly then it is deemed appropriate to measure whether an individual is appraising a situation as a Challenge or Threat.

Blascovich and Mendes (2000) suggested that a non-invasive way to assess changes in 'PAC' and 'SAM' activation is by measuring cardiovascular responses. Challenge is suggested to be reflected by greater cardiac reactivity (increased CO) and a decrease in systematic vascular resistance (Total Peripheral Resistance, TPR; Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996). In contrast Threat is characterised by no change or an increase in TPR and no change or a small increase in CO. This diagrammatically represented in Figure 2:1.

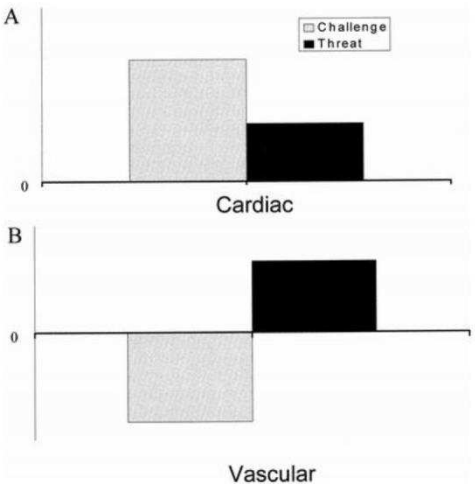


Figure 2:1: Theoretical pattern of cardiac (CO) and vascular (TPR) activity (reprinted from Blascovich, Mendes, Hunter & Salomon, 1999)

The BPSM proposes that an appraisal of resource and demand can result in two different cardiovascular responses. When an individual perceives not having enough resources to cope with the demands of the task, this will lead to a Threat appraisal and specific patterns of cardiovascular responses. In contrast, if the individual perceives that they have enough resources to cope with the demands of the task, this leads to a Challenge appraisal, and a differing cardiovascular response. In particular, TPR is associated with Challenge and Threat, when a Threat appraisal is present, TPR increases or is maintained, whereas in a Challenge it decreases. The suggested cardiovascular markers that define Challenge and Threats are shown in Table 2:1.

Table 2:1: CO and TPR Response Associated with Challenge and Threat within the BPSM (Blascovich & Mendes 2000)

| Measurement | Challenge | Threat |
|---|---|---|
| Cardiac Output (CO) | Strong Increase | No change or increase |
| Total Peripheral Resistance (TPR) | Decrease | No change or small increase |

To clarify, CO is the amount of blood ejected from the left ventricle of the heart each minute, and TPR is the sum of the vascular resistance in the systematic circulation. CO is calculated by Stroke Volume (SV) multiplied by HR. TPR is calculated by the mean arterial pressure minus the mean venous pressure divided by the CO. HR is not seen as a direct measure of Challenge and Threat, but rather a measure to ensure that an individual is engaged within the tasks, this has been utilised in a number of studies (Turner et al., 2013; Meijen et al., 2013[b]).

The BPSM appears to be based upon the work of Orbrist's (1976) and Dienstbier's (1989) Arousal and Physiological Toughness model earlier reviewed within this chapter. The Arousal and Physiological toughness model is focused around the activation of central and peripheral arousal examining the 'SAM' and the 'PAC' response. SAM activation results in release of adrenaline and noradrenaline, and is associated with vasodilation (widening of blood vessels, resulting from relaxation of the muscular wall) suggested by Jones et al. (2009) and a decrease in TPR (Blascovich & Mendes, 2000). This is suggested to result in a Challenge pattern of cardiovascular response producing greater CO via enhanced left-ventricular contractility. Together these changes are suggested to cause an increase in efficiency of energy that can be used for immediate action and also used as a coping resource (Blascovich Mendes, Hunter & Salomon, 1999). Dienstbier (1989) suggested that this energy efficiency occurs because of an increase in blood flow to the brain and skeletal muscles. Also there is an increase in higher blood glucose levels and an increase in free fatty acids that can be used by muscles as fuel, therefore providing more of an energy resource.

As glucose is the main fuel of the brain, it is likely that higher glucose levels will provide the brain with more fuel. Enhanced glucose availability might help to improve cognitive functioning and maintain it for longer durations. This may allow

improved decision making. Improved decision making and cognitive functioning may reduce the resource for self-regulation.

A Threat appraisal is suggested to result in SAM and PAC activation. PAC activation results in the release of the adrenocorticotrophic hormone which is associated with biological stress. This hormonal release is a result of the adrenal cortex secreting corticosteroids into the blood stream, and as a resultant an increase in cortisol. As a result of this activation, although cardiac activity is seen to be stable, vascular resistance increases or stabilises resulting in a less efficient pattern of coping because blood flow is not increased to the brain and muscles. This suggests that there will be less fuel available to the brain compared to being Challenged, therefore less fuel may result in a decrease in cognitive functioning and greater resources devoted to self-regulation as the individual may not have the ability to self-regulate due to impaired cognitive functioning.

The SAM and PAC activation serve different purposes in the context of Challenge and Threat. A Challenge response results in SAM activation, whereas Threat results in SAM and PAC activation of the 'distress system'. Blascovich and Tomaka (1996) suggested that these 'distress systems' are associated with perceptions of actual or physical harm.

In summary, a Challenged state is characterised by an increase in CO and a decrease in TPR due to the vasodilation of the arteries associated with the hormonal release of adrenaline and noradrenaline. Collectively this results in lower TPR and a higher CO compared to that of a Threat. In contrast a Threat appraisal results in cardiac and vascular resistance, an increase in blood pressure due to the release of adrenaline, noradrenaline and cortisol release. It could be suggested that as Threat does not

increase blood flow to the brain compared to Challenge. Cardiovascular responses to Challenge and Threat are identified as predominantly TPR and CO (Blascovich, Brennan, Tomaka, Kelsey, Hughes, Coad & Adlin 1992, Blascovich & Tomaka 1996; Blascovich, Mendes, Tomaka, Salomon & Seery, 2003; Blascovich, Seery, Mugridge, Weisbuch & Norris, 2004).

Although there is a body of work supporting the cardiovascular differences between Challenge and Threat there are some discrepancies that should be highlighted. On the one hand Orbist (1976) and Dienstbier (1989) collectively suggested that Challenge is associated with 'SAM' activation and Threat is associated with'PAC' activation.

On the other hand Obrist (1976) suggests that hypertension is caused due to acute stress (labile hypertension), and elevated arterial blood pressure is a consequence of increased CO, and the cardiovascular system may resemble that of exercise (Brod, 1963). Essential hypertension (chronic) is maintained by increased peripheral resistance with maintained CO. This would suggest that different types of stress (acute and chronic) result in similar cardiovascular indices outlined in the BPSM. However Blascovich and Mendes (2000) have not acknowledged these findings or recognised the coping mechanisms outlined by Orbrist (1976) and have instead attributed the cardiovascular reactivity to endocrine responses alone. It is unclear in the literature thus far whether appraisal is driving these associated physiological responses or whether the physiological responses are driving the appraisals.

Wright and Kirby (2003) also identify areas where there is some uncertainty about the specific cardiac responses related to Challenge and Threat. For example, some research (Blascovich and Mendes, 2000; Tomaka, Blascovich, Kelsey and Leitten,

1993) asserts that a Challenge is associated with an increase in CO and a decrease in TPR, whereas Threat has been seen to increase CO and have a little increase or no change in TPR. The BPSM suggests that HR does not distinguish between Challenge and Threat (Blascovich, Mendes, Hunter, Lickel & Kowai-Bell, 2001). Wright and Kirby (2003) question the measure of CO being associated with Challenge and Threat as this is calculated by HR multiplied by SV, however SV is not seen as an indicator of Challenge and Threat within Blascovich and Mendes (2000) BPSM. Therefore it is necessary to treat the BPSM associations with cardiovascular responses with caution; however there is existing literature to suggest that the cardiovascular indices outlined in the BPSM model are associated with Challenge and Threat states. The following literature will be reviewed.

## 2.7 Evidence supporting the Biopsychosocial model (BPSM)

Early research conducted with Challenge and Threat appraisals and the BPSM focused on assessing physiological responses during tasks such as mental arithmetic or word searching (Tomaka, Blascovich, Kibler & Ernst, 1997; Mendes, Major, McCoy & Blascovich; 2008). For example, Tomaka et al. (1997) investigated Challenge and Threat and the framing of a mental arithmetic task. Challenge and Threat appraisal were assessed using the Cognitive Appraisal Ratio Scale (CAR) developed by (Tomaka et al., 1993). Participants are asked to rate 'How Threatening do you expect the task to be?' and 'How able are you to cope with the task?' From this a ratio is computed of primary to secondary appraisal (demand divided by resource score) which is said to reflect the extent to which environmental demands are appraised as taxing or exceeding perceived resources or ability to cope (Blascovich &Tomaka, 1996). Most of the research surrounding the measurement of cardiovascular responses and Challenge and Threat uses impedance cardiography. Electrodes are used to estimate SV, and assess

systolic time intervals; this method gives an estimate of CO and TPR, alongside other measure such as HR, blood pressure and Pre-Ejection Period (PEP).

Tomaka et al. (1997) carried out several studies examining cognitive appraisal and physiological responses. Within the first study (Tomaka et al., 1997) the performance task utilised was mental arithmetic and the score was calculated by summing the total number of verbal responses and the total number of correct responses. The study protocol began with audio-taped instructions informing the participant that a 5 min rest period was about to begin.

Participants were randomly assigned to hear manipulation instructions emphasising the importance of the task. The instruction labelled Threat explained that the task should be completed as quickly as possible. The Challenge instruction emphasised the task as a Challenge, explaining that the participant was capable of meeting the task demand. The CAR indicated that those in a Threat state had higher ratios compared to that of the Challenge. Based on prior research it was expected that Challenge would exhibit and increase in CO and a decrease in TPR and Threat an increase or stabilised CO and TPR. There was a reported significant difference; Challenge had a greater cardiac response and a lower vascular response compared to Threat. However, there were no differences reported between performance scores. This suggested that there is no association with regarding performance and Challenge and Threat appraisal.

Studies two and three examined the manipulation of physiological responses associated with Challenge and Threat and the impact these manipulations would have on cognitive appraisal. In study two participants were either assigned to an ‘exercise’ condition (pedalled a stationary bicycle) or a stationary condition (sat on the bicycle

without pedalling). Participants cardiovascular measures were taken at rest for 5 minutes and then during their condition. The condition lasted for 5 minutes and in the last minute of the task participants were asked to perform a mental arithmetic task with their cognitive appraisals recorded via the CAR. Although physiological manipulation was achieved (higher cardiac reactivity compared to baseline) in the exercise condition, there was no significant difference between the two conditions in regard to cognitive appraisal.

In study 3, participants were assigned to either one of two conditions; the conditions required the participant to submerge their hand in either cold water or warm water. The same protocol was carried out as in study 2. The manipulation of physiological reactivity was successful however, the analysis revealed no significant difference between cognitive appraisal. Collectively studies two and three suggested that manipulations of physiological responses associated with Challenge and Threat did not correspond with cognitive appraisal.

With reference to study one, it is important to recognise that one individual might perceive the same situation as a Challenge whereas another might perceive it as a Threat. In addition, it is also important to recognise that giving an individual a set of task instructions of Challenge or Threat does not necessarily mean that they will respond in this manner. Studies two and three demonstrate that the submersion of participant's hands in water did not elicit the cognitive appraisals of Challenge and Threat.

Moreover, what an individual is currently experiencing in their life may have an effect on their appraisal (Lazarus, 1991); if an individual is suffering from chronic stress it may also affect the neuroendocrine responses which could have an effect on the

cardiovascular responses (Tomaka et al., 1993). This can be related to early discussions in relation to chronic stress outlined by Orbrist (1976) and its association with cardiac function. Therefore an individual who is classed as being in a Challenge appraisal group may actually be experiencing Threat, due to their current stress levels regardless of any experimental manipulation.

Besides this, applying these research findings to a real world scenario may be presumptuous as it may be unlikely that an individual would be manipulated into a Challenge or Threat state. Moreover, earlier research by Tomaka et al. (1993) has addressed this with a number of studies exploring repetitions of a potential stressful task, and the measurement of Challenge and Threat to double exposure to a task without manipulations. In the first study participants were asked to complete a mental arithmetic task, the primary and secondary appraisals were measured before the task began using the questions 'How stressful do you expect the upcoming task to be?' and 'How able are you to cope with this task?'. These questions are more focused upon the perceived demand of the task and the perceived resources the individual believes they have to cope with the demand of the task.

Skin conductance responses, pulse transit time and HR were recorded throughout the task. From these measures activation of the SAM was recorded; however these measures have not been associated stated with Challenge and Threat and therefore should to be treated with caution for example HR does not distinguish between Challenge and Threat states (Blascovich, Mendes, Hunter & Lickel, 2002). After the initial task, participants were asked to rest for a period of 5 minutes; a second mental arithmetic task was then explained to the participants. Again the cognitive appraisals were measured after the task instructions were given.

Regarding data analysis, groups were separated into Challenge and Threat appraisals groups via their responses to the CAR using a median split. Those reporting Challenge appraisals had higher physiological activation than the Threat group in the first task. The second task revealed no significant differences in the cardiovascular reactivity between the two appraisal groups. This suggests that exposure to a task may dampen the cardiovascular reactivity of an individual.

Within a second study (Tomaka et al., 1993) the same protocol was used, this time impedance cardiography was used to examine the cardiovascular responses of CO, TPR, HR and PEP. Groups were separated in the analysis based on the median split of their CAR. The Challenged group had a heightened cardiac response (CO, HR) and a decrease in TPR compared to the Threat group. These cardiovascular measures fit into the hypothesis of the cardiovascular markers associated with Challenge and Threat within the BPSM. There was no difference between the Challenge and Threat groups within the second task exposure. It may also be important to note that there was no significant difference between Challenge and Threat groups cardiovascular responses in the last minute of the task, which it could be suggested that the first 1-3 minutes of the task is where there is an observed difference within the cardiovascular markers, suggesting that the individual may have only perceived the task as stressor for a short amount of time.

A third study Tomaka et al. (1993) also explored whether there was a difference in the cardiovascular responses with different types of task. Tomaka et al. (1993) investigated both active and passive tasks. Participants were assigned to either a passive group, where they were instructed to look at photos of injured people and the active group were instructed to perform mental arithmetic tasks. Appraisals were measured before the task was carried out using the CAR. With regards to the active

tasks there was a significant difference between cardiovascular responses of the appraisal groups indicative of Challenge and Threat states. Within the passive group there was no significant difference in cardiovascular responses between the appraisal groups. This would indicate that a passive task is not suitable to elicit a Challenge or Threat response; whereas an active coping task such as mental arithmetic would be more suitable.

Quigley, Barrett and Weinstein (2002) examined whether the relation between pre-task appraisals and task-related cardiovascular responses differed. Participants took four mental arithmetic tasks and appraisals were measured. The results suggested that the more Challenged an individual became, the greater their cardiovascular reactivity, consistent with the BPSM. Therefore this demonstrates that appraisals can change and along with cardiovascular responses. However this is not taken into consideration regarding the BPSM.

In summary, there is evidence to support the BPSM (Blascovich & Mendes, 2000; Tomaka et al., 1993), however not all research supports these tenets (Wright & Kirby, 2003). This could be because of three different areas already identified thus far.

Firstly, there are inconsistencies regarding physiological indices used, HR was a determinant of Challenge and Threat, but later research suggested that there was no association (Blascovich et al., 2001). This indicates that there is was some uncertainty regarding the cardiovascular reactivity of Challenge and Threat and the authors position in this domain due to the change in the physiological theoretical under pinning. It could be suggested that because this notion of Challenge and Threat was in its infancy that untested assumptions were made regarding the cardiovascular response to Challenge and Threat. Second, Wright and Kirby (2003) question the measure of CO being

associated with Challenge and Threat as this is calculated by HR multiplied by SV. However SV is not suggested to be an indicator of Challenge and Threat within Blascovich and Mendes (2000) BPSM. Third, relates to the manipulation of individuals into 'Challenged' and 'Threatened' states. As previously discussed Challenge and Threat are seen as dynamic in nature, therefore an individual may perceive a situation differently to another individual regardless of manipulation. It is also important to note that an individual's appraisal may also change over time; therefore the BPSM only gives a 'snapshot' of the cardiovascular indices relating to Challenge and Threat. This also could be another reason to treat the cardiovascular responses of Challenge and Threat with circumspect, due to the fact that cardiovascular changes may cancel each other out due to their dynamic nature, an individual could be experiencing Challenge appraisal for one minute and Threat for another minute, therefore TPR decrease and increase would result in a change that would be equalised. Aside from cardiovascular responses more recent literature suggests that an element of social evaluation is necessary for Challenge and Threat to occur; therefore the next section will examine this in more detail.

## 2.8 Social Evaluative and Loss/Gain Elements of the Challenge and Threat

Seery, Weisbuch & Blascovich, (2009) suggested that factors such as the potential for gain or loss or the person who provides feedback can influence Challenge and Threat. Seery et al. (2009) examined the effects of framing on cardiovascular responses used to obtain measures of Challenge and Threat. Instructions were given to participants focusing on either a potential gain (offering a financial incentive to encourage best performance) or loss (suggesting that if you give incorrect answers, you

will lose money). Those in the potential gain condition had cardiovascular responses indicative of a Challenge response in the BPSM compared to those in the loss condition.

Moreover, Feinberg and Aiello (2010) explored the presence of others upon cognitive performance (mental arithmetic) in regard to Challenge and Threat. In one particular study, participants were given either a Challenge instruction (which focused on ability to perceive the task as a Challenge to be met and overcome) or a Threat instruction (focused upon needing to work as quickly and efficiently as possible). These instruction sets were given to participants during the outline of requirements of a mental arithmetic task. Participants then completed the CAR. The participants were split into those who had an experimenter staying in the room with them and the other in which the experimenter left the room. The participants were also given either a simple task (two digits were summed together) or a more complex task (in which participants were required to sum together three items). Participants were asked if they thought the experimenter was monitoring their performance, 91% answered yes who were in the group with the experimenters in the room, whereas 97% answered no who were in the alone group. All participants completed the simple and complex tasks.

For the Challenge group, having an experimenter present increased the number of correct scores compared to when there was no experimenter present, whereas the Threat group scored lower whilst an experimenter was present. Moreover, Seta and Seta (1995) state the presence of others increases the value of task performance; performing well in front of an audience can lead to praise and recognition; whereas, performing poorly can lead to negative emotions such as embarrassment and shame. Therefore from these findings it could be suggested that Challenge and Threat appraisal might be influenced by an individuals increased value in a task or fear of not performing well in front of an audience.

Similarly, Blascovich et al. (1999) explored social facilitation within Challenge and Threat and the effect that learning a skill might have upon the appraisal of Challenge and Threat. Blascovich et al. (1999) explained that the presence of others increases goal relevance which is necessary to elicit a Challenge and Threat response. In addition Blascovich et al. (1999) suggest that individuals in the presence of an audience should exhibit more arousal. Blascovich et al. (1999) suggest that individuals should experience greater Challenge, when performing well-learned tasks in the presence of others. In contrast Threat is experienced if an individual is performing an unlearned task in the presence of others.

To investigate this Blascovich et al. (1999) recorded cardiovascular measures (PEP, HR, CO and TPR). The participants were then divided into well-learned and unlearned groups and then were further divided into audience or alone groups. All participants were exposed to a task and told that they had to achieve 80% before moving onto the next task. Those in the well-learned group were given the same task as they performed in a familiarisation trial whereas those in the unlearned group were given a different task. The experimenter was present in one of the well-learned and one of the unlearned groups (audience vs. alone conditions)

Within the audience condition participants performing the learned task had higher CO and a decrease TPR, consistent with Challenge. Participants performing an unlearned task with an audience present had cardiovascular responses that would indicate Threat (increase in CO and TPR). It could be suggested that if the task is performed within the presence of others there is more relevance to the task, those who had experienced the task before appraised the task as a Challenge, whilst those who had not performed the task were more likely to appraise this as a Threat. However, those attempting the task alone in the unlearned and well learned groups did not demonstrate

a significant cardiovascular reactivity from baseline. It could be suggested that the presence of an individual in this study elicited a Challenge or Threat; therefore social evaluation may be an important aspect of eliciting a Challenge or Threat response.

Furthermore Harrison, Denning, Easton, Hall, Burns, Ring and Carroll (2001) explored competitiveness and its effects on cardiovascular activity. Participants were asked to take part in a car game task in three different conditions, competing against the experimenter, working alongside the experimenter or alone (without the experimenter present). The participant's level of competitiveness was also measured via self-report. Results suggested that those who were high in competitiveness had a cardiovascular pattern of Threat in line with BPSM research, compared to participants low in competitiveness.

Collectively these studies suggested that various factors such as competitiveness can have an influence over Challenge and Threat appraisals. External factors such as social evaluation and can also play an important part in evoking Challenge and Threat. Indeed for these states to occur a social evaluative element to the task being performed is implicated. This is particularly important within a sport competition context, as nearly all sporting competitions will have a social evaluative element (i.e. an audience, either real or perceived). There is however some weaknesses that should be identified with the studies discussed within this section. Firstly, the studies have been carried out within a laboratory environment, and therefore may lack in ecological validity. It may well be that Challenge and Threat are evoked by social evaluative elements of these study protocols, however caution should be considered as this may not be applicable to a realistic scenario outside of a laboratory environment. Contemporary literature has however examined Challenge and Threat in reference to a sporting domain. The next section will focus upon Challenge and Threat within a sporting context.

## 2.9 Challenge and Threat in Sport

The first study to examine Challenge and Threat in sport was Blascovich et al. (2004). They examined cardiac responses associated with the BPSM in a sporting context using a set of speech tasks. Thirty four baseball and softball players were asked to imagine a sporting situation. They were asked to give a speech regarding that situation. The second part of the study required the participants to give another speech; this was deemed a control condition. Participants were required to give a speech stating if they perceived themselves as good friends and what qualities a good friend has (sport-irrelevant speech).

Cardiovascular responses taken were HR, ventricular contractility, CO and TPR using impedance cardiography and electrocardiography (ECG) during these speech tasks. There were significant differences in HR between the sport irrelevant speech and the sport performance speech, indicating that an examination of Challenge and Threat could take place. Performance statistics of the baseball and softball players were also collected. The performance statistics were calculated through runs created during the baseball and softball season. The results revealed there was a significant relationship between cardiac responses and batting performance in the subsequent season, where cardiovascular response associated with Challenge positively predicted batting performance. Athletes who experienced the cardiovascular reactivity of Challenge during their sports speech performed better than those who experience cardiovascular reactivity of Threat in the sport speech.

Moreover, Blascovich et al. (2004) suggested that these findings indicate that Challenged athletes are potentially more aware of their own abilities and elicit higher levels of confidence. However confidence was not measured within the study. Although this study suggests some support for the BPSM, there should be caution when

interpreting results. Firstly, the comparison of a speech/imagery task and its relationship to batting performance may not be appropriate. This is because talking and imaging a sporting performance does not necessarily have a relationship with subsequent performance. An athlete may image and talk about a sporting event, but this does not mean it will have a significant impact upon performance. Secondly, individuals may not have been able to imagine their sporting situation correctly.

Although Blascovich et al. (2004) study stated that 34 baseball/softball players participated; only 27 players were included in data analysis, of which 17 had played in the previous season. In addition player level was not detailed and this may have varied within the study and impacted performance and therefore results. Self-report of Challenge and Threat was also not adopted within the study; however Blascovich et al. (2004) detail that self-report has limitations, for example an athlete not wanting to admit that they have doubts about their ability to perform. This study was used for further impetus to examine Challenge and Threat in a sporting context.

### 2.10 Theory of Challenge and Threat States in Athletes (Jones et al., 2009)

A recent example of Challenge and Threat in a sporting context is Jones et al. (2009) Theory of Challenge and Threat States in Athletes (TCTSA) model. This theory is an amalgamation and extension of the BPSM. The TCTSA explores other elements of Challenge and Threat that have yet to be discussed within this chapter, for example self-efficacy and emotion. More specifically the TCTSA suggested that athlete's resource and demand appraisal can result in a Challenge or a Threat state, in particular the model suggested that self-efficacy, control and goal approach represent the category of resource appraisals.

Jones et al. (2009) suggested that self-efficacy is an important aspect of the resource appraisal. This is related to Lazarus (1999) suggestion that an athlete's belief that they have the skills/resources required to succeed, contributes to the perception that the athlete can cope with the demands of the situation. This links to the primary and secondary appraisal approach, suggesting that a Challenge appraisal is made when self-efficacy is high. The TCTSA also suggested that an important part of a Challenge appraisal is control and that an athlete is likely to perceive that they have sufficient control alongside self-efficacy. Jones et al. (2009) emphasis that perceived control is associated with self-efficacy because Bandura (1997) suggested that for self-efficacy to develop an individual needs to feel in control.

Control is also seen as a central tenet in the resource appraisal in the TCTSA. Jones et al. (2009) suggested that an athlete's perception of control can have an important influence on resource appraisals (e.g. leading to a Challenge or Threat state). A Threat state is said to occur only when an athlete fixates on those factors which cannot be controlled. It is suggested that this then leads to low levels of perceived control. Whereas a Challenge state is when the athlete focuses on aspects that can be controlled rather than those that cannot be controlled.

Goal type is also a central tenet of the TCTSA, more specifically achievement goals. Jones et al. (2009) suggests that achievement goal theory can play an important part in an athlete's response to a competitive sporting situation. Two distinct goal approaches emerge signifying people's achievement behaviours, and their focus. Dweck (1986) suggested that mastery goals concentrate on developing competence through mastering a task, whereas performance goals focus on demonstrating competence relative to others and develop ego involvement.

Moreover, Jones et al. (2009) suggested that different types of goal focus relate to sports performance and that adopting the model 2x2 achievement goal framework (Elliot & Church, 1997, Elliot & Harackiewicz, 1996) is part of the resource appraisal process. Performance goals are split into approach and avoidance components. Approach goals reflect striving for competence and therefore reflect motivation to be seen as more competent (Jones et al., 2009). Avoidance goals reflect a drive to avoid incompetence and reflect a motivation not to be regarded as incompetent (Jones et al., 2009).

Adie, Duda and Ntoumanis (2008) examined the relationship between achievement goals and Challenge and Threat appraisal of sport competition, in particular mastery (e.g. those that focus on the task) and Ego (focused upon performance outcome) goals. Mastery approach goals (a motivation to appear competent) were positively associated with Challenge appraisal of sport competition; whereas mastery avoidance (a motivation to avoid incompetence) was associated with Threat appraisal. Performance goal approach was positively related to both Challenge and Threat, whereas performance avoidance was not associated with Challenge or Threat appraisal.

Drawing upon this literature, Jones et al. (2009) suggested that individuals with an avoidance goal approach will tend to view an upcoming competition as a Threat while those with approach goals, will tend to view an upcoming competition as a Challenge.

Jones et al. (2009) also suggested that emotions experienced will also have an association with Challenge and Threat states. The adaptive approaches to competition model (Skinner and Brewer, 2004) is suggested to provide support that an athlete's

perception of emotion may differ depending on whether they are in a Challenge or Threatened state (Jones et al., 2009).

The adaptive approaches to the competition model suggested that a Challenge appraisal is associated with positive emotions and if a Challenged appraisal is elicited then these positive emotions are likely to be perceived as beneficial. In contrast, a Threat appraisal is likely to be associated with negative emotions and that these negative emotions are likely to be perceived as harmful to performance (Skinner & Brewer, 2004). Skinner and Brewers (2002) previous research supports this suggestion within an educational context. Participant's response to a stressful event (university exam) indicated that Challenge appraisal was associated with positive emotions and beneficial perceptions of emotions with an increased coping expectancy, whereas Threat was associated with negative emotions and a decrease in coping expectancy. However it is important to note that anxiety can be perceived as facilitative. Jones (1995) suggested this can occur when an athlete perceives they have sufficient coping resource, and that they have control over the environment.

Jones et al. (2009), based on the current literature suggested that control and self-efficacy appear to be associated with an athlete's perception of anxiety and if they deem this facilitative or debilitative to their performance. Therefore the perceptions of other emotions may differ across Challenge and Threat states in athletes. In summary TCTSA suggests that self-efficacy, control, goal approach and emotional valance (positive or negative) and the interpretation of the emotions experienced (helpful or unhelpful) are associated with Challenge and Threat. Based on this hypothesis and the BPSM suggestion that cardiovascular indices will correlate with Challenge or Threat (previously discussed), Jones et al. (2009) suggested that there will be a performance

consequence of being in a Challenged or Threatened state which therefore may affect sporting performance.

High self-efficacy and perceived control is positively associated to performance (Bandura, 1997). Furthermore, Elliot, Cury, Fryer and Huguet, (2006) explain that mastery approach and performance approach goals are also positively related to performance. These components are associated with a Challenge state within the TCTSA. Therefore a Challenge state is believed to positively affect performance. More specifically, Jones et al. (2009) suggested that a Challenged state enables improved maintenance of effective cognitive functioning and decreased likelihood of reinvestment. These performance outcomes are based upon Janelle's (2002) suggestion that athletes' cognitive resources available for a task may be reduced and directed to task-irrelevant stimuli when an athlete is anxious. The TCTSA suggested that in a Challenge state appropriate cues are focused upon, whereas in a Threat state attention is also directed to stimuli that are not relevant to the task at hand.

Based on the findings of Masters and Maxwell (2008) and Jones el al (2009), it is suggested that reinvestment is also related to Challenge and Threat states. Masters and Maxwell (2008) suggested that poor performance can be caused by an athlete who focuses on controlling the execution of a motor skill. From this Jones et al. (2009) suggested that a Threat state (low self-efficacy, low perceived control, focusing on avoidance demonstrating incompetence) may lead to the likelihood of reinvestment (conscious effort to enhance control and focus on the mechanics of the skill, in the hope that this will correct skill execution; Jones et al., 2009).

Jones et al. (2009) suggested that Challenge and Threat will also differ in resources devoted to self-regulation and anaerobic power. In a Challenge state, fewer

resources are devoted to self-regulation, and anaerobic power is increased, whereas in a Threat state greater resources are devoted to self-regulation and anaerobic power is reduced in comparison to a Challenge state. TCTSA suggest that self-regulation can deplete a limited pool of resources that are available for controlling emotions, thought and behaviours (Baumeister, Heatherton & Tice, 1994; Baumeister & Heatherton, 1996). Jones et al. (2009) suggests that depletion of these resources can have an impact upon performance, therefore regulating psychological responses with few resources (i.e. perceiving the situation as a Challenge), allows greater resources available for other demands that may arise.

With regard to decision making and anaerobic power, Jones et al. (2009) suggested that the neuroendocrine responses and cardiovascular responses associated with Challenge may be more conducive to athletic performance. The TCTSA suggested that the increases in adrenaline and noradrenaline may have a positive influence on decision making. This is supported by McMorris, Myers, Macgillivary, Sexsmith, Fallowfield, Graydon and Forster (1999) who suggested that adrenaline and noradrenaline help speed up decision making. This is due to their role as a neurotransmitter in the central nervous system. In a Challenge state, blood flow is said to be increased to the brain and skeletal muscles, blood glucose levels increase (fuel for the nervous system) and an increase in free fatty acids that can be used by the muscle as fuel (Dienstbier, 1989) all contribute to mobilising energy for coping. Therefore, Jones et al. (2009) suggested that the physiological responses associated with a Challenge state could be associated with short bursts of energy. These short bursts of energy may enhance performance in sports when anaerobic power is required (e.g. sprinting).

In summary, a Challenge state is said to be associated with positive performance due high self-efficacy, control and an approach focus. Conversely, a Threat state is

associated with negatively affected performance, due to low self-efficacy, low control and avoidance focus. As a consequence, Challenge and Threat states result in different physiological and emotional responses which may affect cognitive function, task reinvestment, self-regulation and anaerobic power.

This model attempted to examine Challenge and Threat in a more detailed manor than the BPSM. The TCTSA draws upon a range of different antecedents that could cause an individual to feel Challenged or Threatened, and for this the authors should be commended as the model extends existing literature. However it is important to note that many of the propositions suggested within this model are not based upon empirical evidence and are merely suggestions regarding the possible antecedents and consequences of Challenge and Threat. This model does however offer a framework in order to examine Challenge and Threat within a sport context. The two states are shown in Figure 2:2 and Figure 2:3.

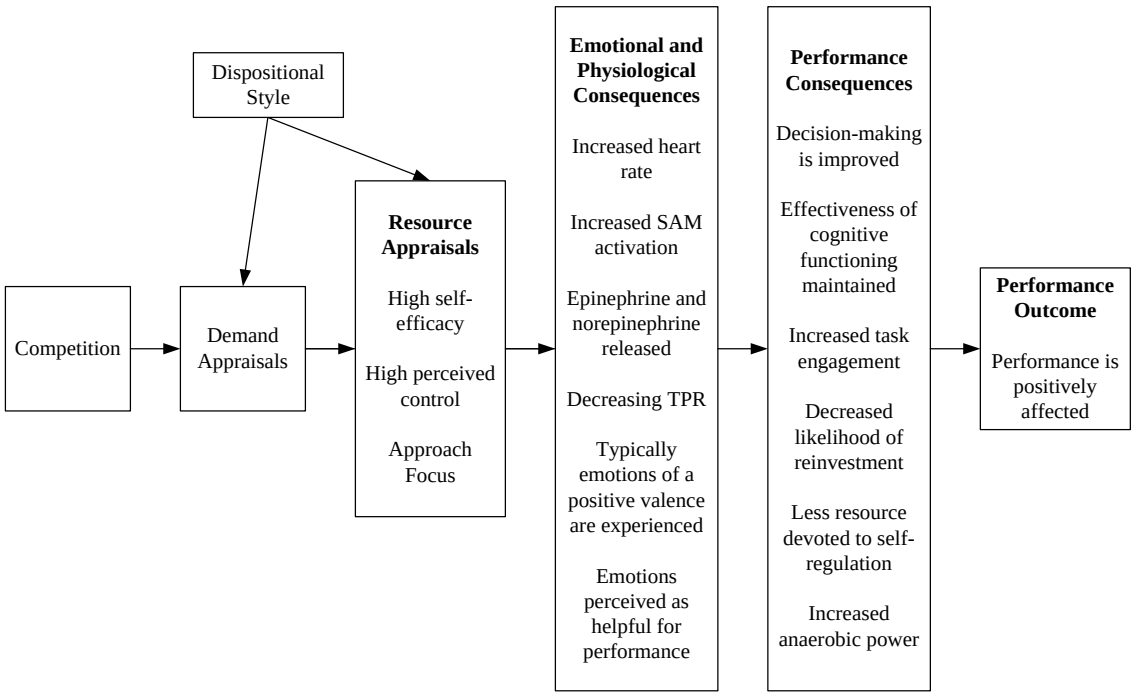


Figure 2:2: Taken from the Theory of Challenge and Threat States in Athletes (TCTSA) Jones et al. (2009) - The Challenge State

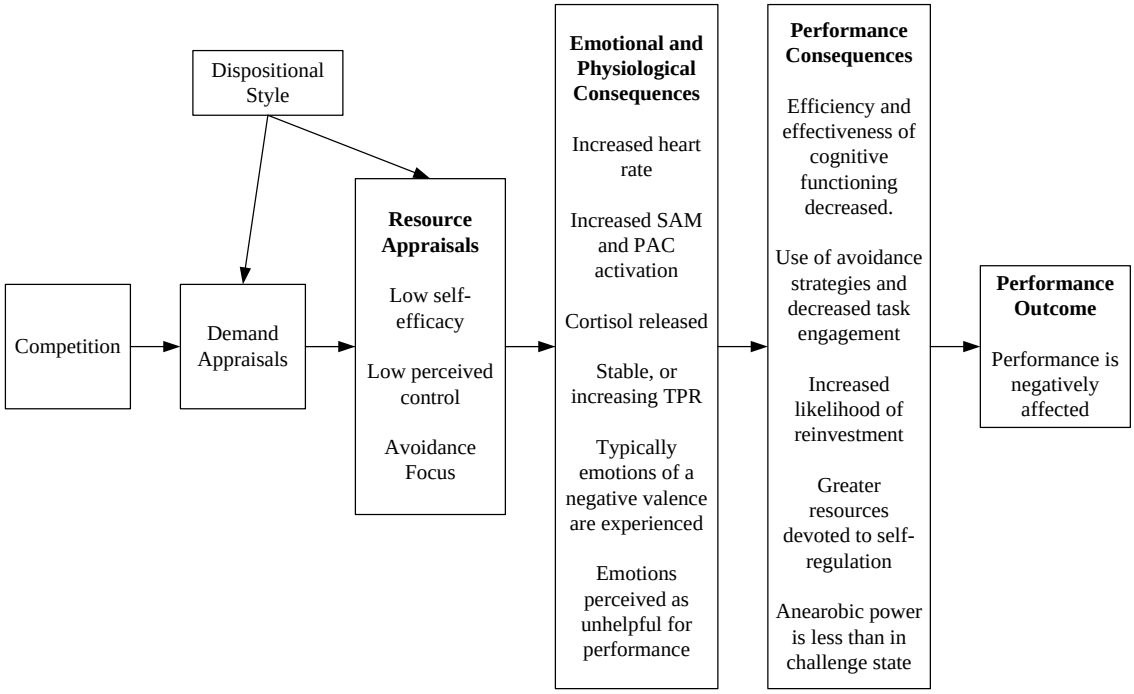


Figure 2:3: Taken from the Theory of Challenge and Threat States in Athletes (TCTSA) Jones et al. (2009) - The Threat State

The TCTSA should be viewed with caution for several reasons. There is an underlying assumption that self-efficacy, control and goal focus will have an association with resource appraisal and in turn a Challenge or Threat state. Indeed self-efficacy has been shown to have an association with positive performance (Bandura, 1997) but not specifically with Challenge and Threat. Although perceived control is seen to have an association with self-efficacy (Bandura, 1997), this again is not within the context of Challenge and Threat. Moreover, there is some support for the effect of Challenge and Threat upon attention elements of performance. Vine, Freeman, Moore, Chandra-Ramanan and Wilson (2013), examined Challenge and Threat and their influences on the attentional processes in relation to the BPSM. They found that when conducting a pressure test, Challenge resulted in the test being completed more quickly. However there was a no association between cardiovascular responses proposed by the BPSM and Challenge and Threat report.

It is suggested that positive emotions will be associated with Challenge and negative emotions with Threat. However there has been no substantial empirical support to demonstrate this, in particular no support with emotions other than anxiety and their possible association with Challenge and Threat.

It is important to note, that within the literature presented thus far, there is support for the BPSM and its suggested cardiovascular associations but there is no examination of a detailed self-report measure to assess Challenge and Threat states alongside measuring the cardiovascular responses. There is also a lack of support within the literature measuring the endocrine responses associated with Challenge and Threat (adrenaline/cortisol), therefore this needs to be addressed to support the suggestions made by TCTSA.

Within the TCTSA there is an assumption that an individual is either in a Challenge or Threat state, this follows the assumption by Blascovich and colleagues that individuals can only be experiencing one or the other. However, research within a sporting context has suggested otherwise. Cerin (2003) found that athletes questioned about their feelings before a competition reported various Challenge and Threat patterns. This experiential notion discussed by Cerin (2003) suggested that athletes' appraisals of a competitive event were most often associated with Challenge and Threat. Some athletes reported a combination of Challenge and Threat patterns, whereas other athletes reported solely Challenge or Threat or neither. The findings from the study are shown in Figure 2:4.

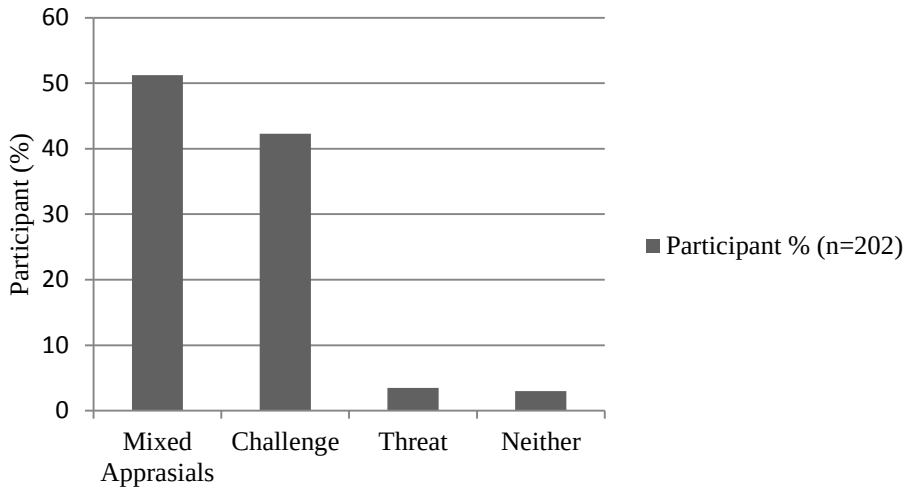


Figure 2:4: Appraisal (%), adapted from Cerin (2003)

Cerin (2003) suggested that appraisals can change over time and are dynamic in nature, therefore although there are a number of components that are part of Challenge and Threat, these components are not pertinent, rather how the individual perceives and what they focus on is.

Furthermore, Cerin (2003) also suggested that that there is a mixture of emotions that neither indicate Challenge and Threat appraisals and the majority of the athletes within the study were both Challenged and Threatened (n=105), Challenged (n=85) or Threatened (n=6) and some were neither (n=6). A more recent study by Meijen et al. (2013) [a] has also examined patterns of Challenge and Threat states, suggested that the dichotomous approach proposed by the TCTSA it too simplistic in a sports setting. The study examined athletes' Challenge and Threat reported patterns alongside emotions, self-efficacy, control and goal focus in relation to imagined upcoming important competition.

Meijen et al. (2013) [a] further explains that Challenge and Threat patterns within the study illustrate that Challenge and Threat do not appear to be opposite ends of a continuum. The research questions the TCTSA, as individual can be both Challenged and Threatened at the same time and it would be impossible to have both a successful and unsuccessful performance simultaneously. An examination of different patterns of Challenge and Threat were explored suggested distinct responses. For example High Challenge/High Threat patterns scored higher on anxiety than the Low Challenge/Low Threat and the High Challenge/Low Threat pattern. In addition the High Challenge/Low Threat pattern reported higher self-efficacy and less avoidance goal approach than the High Challenge/High Threat pattern. However it is important to note that Challenge and Threat appraisals were measured by a single item measure, 'How Challenged/Threatened do you feel by this?

The TCTSA is in its infancy; and several recent studies have tried to encompass some of the suggestions made within the model regarding Challenge and Threat within a sport context. The following literature will now be reviewed.

### 2.11 Recent Challenge and Threat Research in Sport

Recent studies examining Challenge and Threat within a sporting context have utilised a number of different methods including sporting, speech and imagery tasks. Williams, Cummings and Balanos (2010) developed three imagery scripts to induce Challenge and Threat states in a sports setting. The Challenge script emphasised the athlete meeting the demand of the situation, and included feelings of high self-efficacy, control and potential gain. The Threat script emphasised feelings of low self-efficacy, and emphasised a potential loss. The neutral script did not attempt to manipulate the states in anyway.

Participants' cardiovascular measures were recorded throughout the imagery phase and measures included HR, CO and SV. Participants completed the immediate anxiety measurement (Thomas, Hanton & Jones, 2002) which assesses intensity and directional perception of anxiety symptoms and self-confidence.

To assess the cognitive appraisal of imagery scripts, a pool of items were developed to describe how an individual may feel about the upcoming competition that is imaged, with items such as 'I viewed this competition as a Threat'. The Threat script was perceived to be more Threatening than the Challenge or neutral script.

HR, CO and SV within the Challenge and Threat scripts were significantly different from the neutral scripts. However, there were no significant differences between Challenge and Threat and the reported cardiovascular measures. The immediate anxiety measures showed that participants receiving the Threat script had a higher cognitive anxiety score compared to Challenge, but cognitive anxiety was perceived as more facilitative within a Challenged rather than a Threat state.

This research did not support the BPSM within a sporting context; however this may be due to the participant numbers as only twenty athletes were within the sample. The study should however be treated with caution. Using imagery to elicit Challenge and Threat may not have heightened the cardiac responses. The nature of the task also lacked motivational climate and an active coping task which are suggested to be important factors when Challenge and Threat states are experienced (Seery et al., 2009). The protocol design also lacked a social evaluative element which is also considered beneficial when eliciting Challenge and Threat (Feinberg and Aiello, 2010). Collectively the equivocal findings within this study may have been due to the protocol design discussed within this chapter.

Turner et al. (2012) explored the cardiovascular indices of Challenge and Threat states outlined by Blascovich and Mendes (2000) the ability of these indices to predict competitive performance. In the first study participants were asked to perform a 60 second Stroop test (Stroop, 1935) which assesses an individual's attentional flexibility by testing accuracy and speed. This is a reaction speed test in which participants are expected to recall the colour of a written work, for example red written in yellow, the correct answer would be yellow. The participants were given familiarisation trials of the test before being given a standardised audio-taped task instructions designed to induce a motivated performance situation. The instructions given comprised of demand appraisals which informed participants that the test would indicate their cognitive ability and that their final score would be compared to other participants and publically posted in ranking order. Participants were also required to complete several self-report measures which included the Sport Emotion Questionnaire (SEQ) (Jones, Lane, Bray, Uphill & Catlin, 2005), the Achievement Goals questionnaire (Conroy, Elliot & Hofer, 2003), a single item measuring self-efficacy, perceived control and task importance, and Cognitive Appraisal which was measured asking participants to complete a single item indicating 'How Challenged or Threatened they felt prior to the final test'.

Cardiovascular measures were taken 5 minutes before any task instruction (five minute baseline) and then for one minute after instruction had been given. Cardiovascular reactivity scores were calculated by converting each participants CO and TPR score change scores into z-scores and summing them, TPR was assigned a weight of -1 and CO was assigned a weight of +1 so that larger values corresponded with greater Challenge (Seery et al., 2009). Results revealed that cardiovascular reactivity to a psychological stressor (Stroop test) significantly predicted performance accuracy. An increase in TPR was associated with lower accuracy and an increase in CO was

associated with higher accuracy. Challenge and Threat index also significantly predicted performance accuracy, the higher the index the higher the accuracy. Speed of participant response was also examined; however cardiovascular reactivity was not associated with this. Although the study findings are of interest, it could be suggested that manipulation via a task instruction is not an ecological way of examining Challenge and Threat within a sporting context. The study did examine competitiveness but it would be highly unlikely that a sporting individual would be subject to a Threat task instruction before competition. It should also be noted that the cardiovascular responses of Challenge and Threat were taken after task instruction for one minute but before the task took place. Therefore it would be suggested that individuals appraisals could have changed during the task, however their cardiovascular reactivity would not have been captured as part of this study protocol.

Turner et al. (2012) also examined the cognitive and emotional responses through self-report measures. Only avoidance goals were associated with higher levels of cardiovascular reactivity indicative of Challenge (Blascovich et al., 2003) and better performance (higher accuracy and lower speed of response). Although Turner et al. (2012) state that this finding is counterintuitive and contrary to the TCTSA (Jones et al., 2009) and other research such as Chalabaev, Major, Cury & Philippe (2009), it may be a chance finding. Moreover, Turner et al. (2012) suggested to examine self-reported psychological factors and their potential relationship to cardiovascular reactivity or performance a sample of 70 participants is required based upon achieving a power of .8 for significant medium effects ($r=.3$, $p<.05$; Turner et al., 2012).

The second part of this study examined whether Challenge and Threat reactivity can predict performance in netball shooting. Netball players took part in the second study, and were requested to fill out the same self-report measures as in the first study.

Individuals were required to take 12 shots at a netball hoop and performance accuracy was recorded.

The results supported that of study 1, cardiovascular reactivity positively predicted performance. When exploring the association between the psychological, emotional and cardiovascular responses, associations were weak or absent. As previously highlighted cardiovascular reactivity data was taken for 5 minutes before the task and not during, therefore the cardiovascular responses experienced during the task may have changed during the task. This may be the reason for the absence of associations between psychological, emotional response and cardiovascular reactivity.

In regard to task performance, Moore et al. (2012) were the first to examine Challenge and Threats immediate effect upon motor task performance. The study explored Challenge and Threat states impact upon the performance of novice participation in a golf putting task. Participants were required to take six putts from three different locations. Similarly to Turner et al. (2012), physiological measures were taken 5 minutes before any task instruction (five minute baseline) and then for one minute after instruction had been given. In this scenario manipulation instruction was given to induce a Challenge or Threat state. Self-report measures were also taken; these included the Immediate Anxiety Measurement Scales (Thomas, Hanton & Jones, 2002) and the CAR (Tomaka et al., 1993). Within the study quiet eye duration was measured, this is known as the final fixation towards a relevant target prior to movement initiation (Vickers, 2007).

The Challenge group displayed significantly longer quiet eye duration than the Threat group. This supported the suggestion by TCTSA that cognitive functioning is associated with a Challenge state. The Challenge group also reported experiencing

lower levels of cognitive anxiety. Cognitive anxiety was perceived as more positive in the Challenge group compared to the Threat group. This was reflected in putting performance within the Challenge group with the ball on average finishing significantly closer to the hole than for the Threat group. The Challenge group also reported a significantly higher ratio on the CAR (Tomaka et al., 1993) than the Threat group. In regards to cardiovascular reactivity, the Challenge and Threat index was significantly higher in the Challenge group compared to the Threat, therefore showing support for the BPSM. This study however did not measure cardiovascular reactivity during the task; therefore the individual could have been experiencing a mixture of Challenge and Threat at different times during the protocol, however this was not recorded. It should also be highlighted that manipulation instructions were given, similarly to Turner et al, (2012) lacking in ecological validity in regard to a sporting competition environment. It may be presumptuous to assume that within a sporting context a coach would try to elicit Threat, given that previous research suggest that this maybe debilitative to performance.

Meijen et al. (2013)[a] explored the cognitive and affective components of the TCTSA, distributing self-report measures of self-efficacy, perceived control, achievement goals, emotional states and interpretation of emotional states to athletes. Athletes were asked to complete these measures in relation to how they typically felt before a competition. The measures used were Coffee and Rees (2008) sport specific self-report measure, three items based on Bonetti and Johnston's (2008) perceived control measures, the Achievement Goal questionnaire for Sport (Conroy, et al., 2003) and the Sport Emotion questionnaire (Jones et al., 2005). To assess Challenge and Threat, participants were asked to imagine that they were about to take part in the most important competition of the season and to indicate on a five-point Likert scale ranging

from 0 (not at all) to 4 (extremely) on two items, which were "How Threatened do you feel by this?" and "How Challenged to you feel by this?".

The results suggested approach goals significantly predict Challenge in a positive direction whereas avoidance goals significantly predict Challenge in a negative direction negatively. Threat was shown to be significantly (positively) predicted by avoidance goals. Threat was also significantly (negatively) predicted by self-efficacy and approach goals. The authors suggested that for practitioners and researchers there should be a focus on reducing an avoidance orientation. However this should be treated with caution, as the self-report constructs were not examined alongside performance. Therefore similar to other protocols within a sporting context (Williams et al, 2010) this study lacked a performance task and a social evaluative element. The study protocol also asked athletes to recall how they felt typically before competition, which again should be treated with circumspect as individuals are not always able to recall how they have felt previously in regard to past experience (Girotto, Ferrante, Pighin and Gonzalez (2007).

Furthermore, Meijen et al. (2013)[a] examined patterns of Challenge and Threat. For the purpose of this literature review, only significant difference will be highlighted. The High Challenge/Low Threat group scored higher on self-efficacy than the High Challenge/High Threat group. For avoidance goals the High Challenge/Low Threat group scored lower than the High Challenge/High Threat group, for anxiety the High Challenge/High Threat group reported higher scores than the High Challenge/Low Threat group. These findings illustrate that Challenge and Threat do not appear to be at opposite ends of the continuum, as the different patterns appear to elucidate distinct responses (Meijen et al., 2013[a]). The author highlights that using the dichotomous approach proposed by the TCTSA may be too simplistic in a sports setting. Therefore

based on these findings a further examination of Challenge and Threat patterns is required.

Another recent research article (Meijen et al., 2013) [b] examines cardiovascular, affective and cognitive responses to a sports-related speech task. Within this study, collegiate athletes talked about an upcoming competition and a topic of friendship (used a control task), this was a similar study design to that of Blascovich et al. (2004). During this study, cardiovascular responses were recorded (HR, PEP, CO and TPR). Self-report measures of self- efficacy, emotions (SEQ, Jones et al., 2005) and a control measure by rating the statement 'I felt I had control over the situation to demonstrate my skills to the best of my ability' were also completed by the participant. Challenge and Threat were measured by asking participants to rate on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely) in relation to the speech task 'I experienced this situation as a Threat' and 'I experienced this situation as a Challenge'. Stress levels were also measured by the question 'I felt stressful about the important competition' and to what extent they could cope 'I felt that I could cope with the important competition'. The wording 'important competition' was replaced with task for the friend speech task.

The findings of this study suggested that participants experiencing a physiological Threat response report higher levels of self-efficacy and excitement, however none of the self-reported emotions or cognitive appraisals of Challenge and Threat predicted cardiovascular patterns indicative of either Challenge or Threat states. However this study should be treated with circumspect as athletes were asked to talk about an upcoming competition, since Allen, Frings & Hunter (2012) suggested that a speech task is not effective to induce Challenge and Threat responses. It is also important to highlight that this study does not investigate influences of self-report

measures on sporting performance and therefore should be treated with caution in an applied setting.

Furthermore, Moore et al. (2013) examined golfer's evaluations of competition demand and resources before a golf competition. One hundred and ninety nine golfers were asked to complete the CAR before competing in a club championship. Performance was calculated by subtracting the competition standard scratch (difficulty rating of competition) and each participant's handicap from the number of shots taken on the 18 hole competition (golf performance index). A lower index score indicated better performance. The analysis revealed that the demand and resource evaluations made before competition accounted for a significant proportion of variance in golf performance index. This study showed support for the use of self-report measures in regard to Challenge and Threat and performance. However, the self-report measure used (CAR; Tomaka et al, 1993) has some limitations as previously discussed. The experience and antecedents of Challenge and Threat were not examined; therefore this study may be used for impetus in future research. For example it may be informative to examine further how individuals feel whilst experiencing Challenge and Threat and to also measures some of the suggested antecedents and associated variable of Challenge and Threat, for example control, self-efficacy and emotions (Jones et al, 2009). This may help research further understand Challenge and Threat and how it is experienced rather than measure demand and resources in isolation (Tomaka et al, 1993).

A second study by Moore et al. (2013) examined golfer's performance under manipulation of Challenge and Threat states. Sixty golfers were asked to complete a putting task, half of the participants (n=30) were encouraged to perceive the task as a Challenge to be met and overcome, and to think of themselves as someone capable of

meeting the Challenge (Challenge instruction). In contrast the other 30 participants received the Threat instruction which focused on the task's high degree of difficulty and emphasised on how other participants had struggled to perform well. Participants were also required to complete a self-report measure to ascertain cognitive and somatic anxiety, the CAR and a measure to examine conscious processing was also completed. Alongside performance, quiet eye movement and cardiovascular indices (Challenge and Threat index) were also measured.

The analysis revealed that the Challenge group elicited a larger Challenge and Threat index value, reported less anxiety, more facilitative interpretations of anxiety, less conscious processing and displayed longer quiet eye duration and outperformed the Threat group. However, it is important to note that participants were manipulated into Challenge and Threat states and lacked in a social evaluative element to the protocol.

In addition to the work already discussed, Turner et al. (2013) investigated elite academy cricketer's performance using cardiovascular indicators of Challenge and Threat. Participants completed a batting test under pressure, requiring a score of 36 runs with a delivery of 30 bowls within the national academy for cricket 36 is the required score for participants undertaking the batting test which assesses cricketer's ability to perform under pressure. As in other similar studies (Turner et al., 2012; Meijen et al., 2013[a], Meijen et al., 2013[b]) 5 minutes of baseline cardiovascular data was taken and audio taped instructions were given to the participants. This informed participants that they would be required to attain 36 runs to be successful and that their score would be compared with peers. They were also informed that their coaches would be informed of their score and that they would use this information in future decision making for programme selection. They were then informed that they should try very hard to perform well. Alongside this, emotions, achievement goals, self-efficacy,

perceived control, cognitive evaluation and task importance were measured via self-report.

The results showed equivocal support for the TCTSA. Of the 42 participants within the study a small subsample (n=5) that exhibited Threat cardiovascular reactivity performed well and also reported greater self-efficacy, than a subsample of 17 participants who had reported greater self-efficacy and performed poorly. Also, a small subsample (n=6) who exhibited Challenge reactivity that performed poorly had higher avoidance goals than a subsample of 14 participants who performed well with Challenge reactivity. However, Challenge and Threat index predicted performance positively. In other words higher cardiovascular reactivity was indicative of Challenge and a higher number of runs scored. However, again it could be suggested that these results are not applicable to a 'real world' scenario as manipulating individuals into a Challenge or Threat state is not transferable to a sporting domain. It would be unlikely that a coach for example would use instruction to manipulate an athlete into a Threat state, if evidence suggested that this would be debilitative to performance.

In addition, there has been some suggestion that personality has an association with Challenge and Threat. Allen et al. (2012) explored the relationship between personality, Challenge and Threat states and sport-related coping ability. Thirty one participants were asked to take part in a speech task regarding an important upcoming competition and a speech task regarding their journey to University in the morning (control task). During this period, their cardiovascular responses were recorded (CO, TPR, HR and PEP). Before completing the speech task they were required to complete a personality measure (NEO-FFI, Costa & McCrae, 1992) assessing five personality dimensions of extraversion, neuroticism, openness, agreeableness and conscientiousness. After the task, participants were asked to complete the Coping

Function questionnaire (Kowalski & Crocker, 2001) in relation to how they usually respond in competitive competition.

The findings indicated that cardiac reactivity was similar across the two speech task scenarios and not effective in inducing Challenge and/or Threat. However lower CO and higher TPR were associated with more problem and emotion focused coping. Higher levels of extraversion and conscientiousness were also associated with CO and higher TPR. This suggested a link in personality and coping in sport and that potentially an assessment of CO and TPR may be sufficient to predict personality and sport-related coping.

The limited research investigating Challenge and Threat states within a sporting context leaves many unanswered questions. The papers reviewed within this section show mixed support for the BPSM and the TCTSA and its associations with motor task and cognitive performance. There is also limited research examining emotions and their associations with Challenge and Threat states. However early research in the area (Moore et al., 2012; Turner et al., 2012; Meijen et al., 2013[a]; Meijen et al., 2013[b], Moore et al., 2013) show some support for the hypothesis made within the TCTSA (Jones et al., 2009), regarding positive emotions being associated with Challenge and negative emotions associated with Threat. In regard to study protocol there have been several weaknesses highlighted in the studies reviewed thus far. Most of the studies have examined Challenge and Threat via manipulation, lacked a social evaluative element and in some cases a performance task. It should also be highlighted that where cardiovascular reactivity was recorded, this was typically before a task performance and therefore only taking a snapshot of cardiovascular reactivity. An individual could be Challenged after task instructions but then once performing the task could be

Threatened. Therefore cardiovascular reactivity recorded may not be a true reflection of what the individual is experiencing during the task.

It is also important to note that there is not a universal way of measuring Challenge and Threat via self-report. Within the BPSM the CAR has been used to determine Challenge or Threat self-report. However as briefly discussed, there are some issues when utilising this measure. Within recent studies of Challenge and Threat in a sport context, measures in regard to emotions, control and self-efficacy have been utilised and examined with reference to Challenge and Threat cardiovascular responses. However no specific measure of Challenge and Threat has been examined in a sporting context. Therefore an examination of self-report measures to capture Challenge and Threat are necessary.

## 2.12 Self-report Measurement of Challenge and Threat

There have been various attempts at assessing Challenge and Threat through self-report measures. Many focused on specifically measuring Challenge and Threat (Cognitive Appraisal Scale (CAS), Skinner & Brewers, 2002; Challenge & Threat Construal; McGregor & Elliot., 2002) whereas other focus on the speculated antecedents of Challenge and Threat (PASA, Gaab et al., 2005; CAR, Tomaka et al., 1993). The following section will review each self-report measure and its current use within the literature.

### 2.12.1 Cognitive Appraisal Scale (CAS) Skinner and Brewer (2002)

Skinner and Brewer (2002) measure Challenge and Threat by using the Cognitive Appraisal Scale (CAS) comprised of 18 items. The items to examine Threat within the CAS address the tendency to focus on possible harm to one's self esteem and social identity. This is posed by the disapproval and negative evaluation of others and

associated with low self-confidence in one's ability to cope with stressful or demanding situations (Skinner & Brewer, 2002). This consists of one item taken from the State-Trait Anxiety Inventory Trait Scale (STAI) (Spielberg, 1983), plus the Self-Presentation Concerns questionnaire (Skinner & Brewer, 2002), which consists of nine items.

The items to assess Challenge concentrate on the anticipation of success and positive outcomes. In addition, confidence in ones capacity to obtain such goals (positive outcomes; Ellsworth & Smith, 1988). This consisted of one item from the Optimism-Pessimism questionnaire (Norem & Cantor, 1986) and the rest developed to reflect conceptual assumptions of Challenge. Collectively this measure has used various different questions to devise the measure, rather than using one instrument alone. These items are listed in Table 2:2.

Table 2:2: Items in included in the CAS

| CAS Item | Measuring Challenge (C) or Threat (T) |
|---|---|
| 1. I tend to focus on the positive aspects of any situation | C |
| 2. I worry that I will say or do the wrong things | T |
| 3. I often think about what it would be like if I do very well | C |
| 4. I believe that most stressful situations contain the potential for positive benefits | C |
| 5. I worry about the kind of impression I will make | T |
| 6. I am concerned that others will find fault with me | T |
| 7. Overall I expect I will achieve success rather than failure | C |
| 8. In general I look forward to the rewards and benefits of success | C |
| 9. Sometimes I think that I am too concerned with what other people think of me | T |
| 10. I feel that difficulties are piling up so that I cannot overcome them | T |
| 11. I lack self-confidence | T |
| 12. A challenging situation motivates me to increase my efforts | C |
| 13. In general I anticipate being successful at my chosen pursuits, rather than expecting to fail | C |
| 14. I worry what other people will think of me even when I know that it doesn't make any difference | T |
| 15. I am concerned that others will not approve of me | T |
| 16. I look forward to opportunities to full test the limits of my skills and abilities | C |
| 17. I worry about what other people may be thinking about me | T |
| 18. I feel like a failure | T |

The CAS has been utilised in an educational context. It has been seen as informative regarding how individuals feel before an exam performance or a high pressured scenario. Challenge reports have a positive association with exam

performance. The measure focuses on some of the suggested components of Challenge and Threat such as, self-efficacy(Jones et al., 2009), social evaluative elements (Seery et al., 2009) and some of the demand/resource appraisal elements regarded as essential to Challenge and Threat appraisal (Blascovich & Mendes, 2000). Although this may be regarded as a useful tool for assessing Challenge and Threat, this has not been utilised within any further research. It also may be worth noting Skinner and Brewer (2002) performed a confirmatory factor analysis (CFA) exploring the construct validity, which demonstrated a moderate fit. No Cronbach alpha values were reported within this paper, therefore no evidence has been provided for the CAS internal consistency.

### 2.12.2 Cognitive Appraisal Ratio (CAR; Tomaka et al., 1993)

Many authors (Feinberg & Aiello 2010, Harvey, Nathens, Bandiera & LeBlanc 2010, Skinner & Brewer 2002, Tomaka et al., 1993) use the CAR to measure Challenge and Threat. Within the measure, primary appraisals are assessed by asking participants 'How stressful do you expect the upcoming task to be?' secondary appraisals 'How able are you to cope with this task?', subjective stress is also measured by asking 'How stressful was the task you just completed?' and all are answered via a 7-point Likert scale. This ratio divides the rating of demand (e.g., on a scale of 1-7) by the rating of resources (e.g., on a scale of 1-7) such that scores greater than 1 are indicative of Threat and scores less than 1 indicative of Challenge. Although this is a measure used in multiple studies examining Challenge and Threat (e.g. Feinberg & Aiello 2010, Harvey, et al., 2010, Skinner & Brewer 2002, Tomaka et al., 1993), it is subject to a number of criticisms.

First, as Blascovich and Mendes (2000) contend, when an individual evaluates sufficient or nearly sufficient resources to meet demands, Challenge may arise as opposed to Threat. Moreover, it could be argued that a score of 1 (1/1) might be

indicative of neither Challenge nor Threat (i.e., low ratings of both demands and resources). Alternatively, athletes who score 1 but rate demands/resources highly (e.g. 7/7) this appraisal might be associated with a quite different physiological state. Although this is a more extensively used measure and is seen to correspond with physiological measures of Challenge and Threat responses (Tomaka et al., 1993), other studies have not found this (Hartley, Ginsburg & Heffner, 1999).

As Skinner and Brewers (2002) research includes many different constructs to explore Challenge and Threat, for example coping, emotional valance and perception, it appears that the CAR lacks an in depth assessment of the states. Wright and Kirby (2003) have criticised its use and suggested that the measure has limited psychometric utility. Other studies have utilised alternative measures to try to understand more Challenge and Threat more extensively (Skinner & Brewer, 2002). Although this tool has been utilised extensively within the Challenge and Threat research to date as previously discussed, focussing upon resource and demand alone may not examine the individual's experience of Challenge and Threat. A measure that relies on two responses to perceived demands and resources could be argued to not capture an adequate range of resources and demands (cf. Wright & Kirby, 1993), or indeed the experience of Challenge or Threat more broadly.

### 2.12.3 Primary and Secondary Appraisal Scale (Gaab et al., 2005)

The PASA (Gaab et al., 2005) assesses control, self-efficacy, Challenge and Threat. The items for this measure are shown in Table 2:3

Table 2:3: Items included in the PASA

| Subscale Items |
|---|
| Self-Efficacy |
| In this situation I know what I can do |
| I have no idea what I should do now |
| In this situation I can think of lots of other alternatives |
| I can think of solutions for solving this task |
| Control Expectancy |
| It mainly depends on me whether the experts judge me positively |
| I can best protect myself against failure in this task through my behaviour |
| I am able to determine a great deal of what happens in this interview myself |
| If the experts judge me positively it will be a consequence of my effort and personal commitment |
| Threat |
| I do not feel Threatened by the situation |
| I find this situation very unpleasant |
| I do not feel worried because the situation does not represent any Threat for me |
| This situation scares me |
| Challenge |
| This situation is important to me |
| I do not care about this situation |
| The situation is not a Challenge for me |
| This Challenges me |

Each items is rated on a Likert scale of 1-6 (1=totally disagree and 6=totally disagree). The subscales included within the PASA examined some of the suggestions made by TCTSA that control and self-efficacy have an association with resource appraisal and therefore have an impact on whether an individual appraises a situation as a Challenge or a Threat. However, this measure has some issues regarding some of the questions included on the Challenge and Threat subscales. Firstly, within the Challenge subscale 'The situation is important to me' and 'I do not care about the situation', is related to primary appraisal, in which an individual decides whether the task holds any relevance to them (Folkman & Lazarus, 1985) before a stress appraisal is made (Challenge and/or Threat), therefore it can be argued that this is not part of a Challenge appraisal process. Secondly in the Threat subscale 'The situation scares me' and 'I find this situation very unpleasant' represent how an individual is feeling. However a

situation may not be very pleasant, but could still be appraised as a Challenge, for example a final year exam may not be perceived by an individual as very pleasant but could still lead to a Challenge. This is the same with 'The situation scares me' since an individual may find something scary but at the same time appraise this as a Challenge. Thirdly, the wording of the questions may need to be treated with caution. For example Challenge and Threat are used explicitly; this may be an issue when trying to ascertain Challenge and Threat self-report in a sporting context as athletes may not relate to the word Challenge and Threat. Within the self-efficacy subscale, there are also some issue within the items, for example 'In this situation I know what I can do' and 'I have no idea what I should do now', effectively these questions are asking the same based on a Likert type scale. If an individual scores low on the statement 'In this situation I know what I can do' it would indicate that they do not know what to do, in turn answering 'I have no idea what I should do now'. It may be that individuals respond to the questions with social desirable answers. For example they may not want to be seen as unable cope with a situation and therefore answer the questions with a false response. Therefore collectively caution should be taken if implementing these questions in future research.

### 2.12.4 Challenge and Threat Construal Measure, McGregor and Elliot (2002)

McGregor and Elliot (2002) devised a Challenge and Threat Construal Measure, rating items on a scale of 1-7 (1=not at all true of me and 7=very true of me). The items consisted of revised items from existing measures (Ptacek, Smith, & Dodge, 1994). The items are listed Table 2:4.

Table 2:4: Items included in the Challenge and Threat Construal

| Challenge | Threat |
|---|---|
| I think this class represents a positive Challenge to me | I think this class represents a Threat to me |
| I view this class as a positive Challenge | I view this class as a Threat |

The Challenge and Threat Construal lacks an in depth assessment of Challenge and Threat in regard to other elements that could have an impact upon a stress appraisal, in particular it does not assess social evaluate elements suggested by Seery et al. (2009). As previously mentioned there maybe issue implementing this self-report measure with athletes, as the items within the Construal are specifically using the terms Challenge and Threat which may not be identifiable to the athletes themselves. Although these items may help to assess Challenge and Threat appraisal, it could be used in combination with other items to further understand how an individual is appraising a situation. Especially taking into consideration that these items do not assess the experience of Challenge and Threat.

Furthermore, Cerin (2003) states there is an absence of a published psychometrically validated inventory measuring Challenge and Threat appraisal in sport. This requires further examination. In summary, all of the existing measures have been utilised within different contexts (such as business and education). Although each of the measures has strengths and weaknesses as discussed above they have not been exposed to a sporting context. The CAS focuses on the social evaluative elements of Challenge and Threat discussed by Seery et al. (2009). This could hold relevance to a sporting competition.

The CAR captures the resource and demand appraisals of Challenge and Threat, but not in great depth. The Challenge and Threat Construal capture simply if an individual feels Challenged or Threatened but does not tap into other elements that could have an impact upon this appraisal process such as social evaluation (Seery et al., 2009). Finally the PASA measures several constructs proposed by the TCTSA that comprises the resource appraisal leading to a Challenge or Threat state but has not been validated within the area of sport. If we are to move forward to examining Challenge and Threat in a sport context, it is pertinent that a tool is validated within this area.

## 2.13 Summary

Challenge and Threat have been conceptualised within the literature using three different approaches as reviewed within this chapter. There appear to be 3 broad ways in which Challenge and Threat are conceptualised, firstly the cognitive approach, espoused by Folkman and Lazarus's (1985) approach that Challenge and Threat are a resultant of cognitive appraisal. Second, the physiological approach advocated by Blascovich and colleagues, that Challenge and Threat have an association with the cardiovascular indices highlighted in the BPSM (Blascovich & Mendes, 2000) and can have an influence upon performance. Third, the experiential elements illuminated by Jones et al. (2009) and Cerin (2003) that Challenge and Threat have elements of emotions and behavioural tenets alongside physiological and cognitive associations as previously highlighted within this chapter. There is not a consensus within the extant literature that one way of conceptualising Challenge and Threat has an advantage over another.

Within this research programme, it is necessary to provide an operational definition of Challenge and Threat based upon the current ways that it has been conceptualised within the literature. Based on the three different conceptualisations,

Challenge is suggested to occur when the individual perceives that they have the resources to cope with the demand of the task, which is suggested to lead to an increase in CO and a decrease in TPR, higher levels of positive emotions, lower levels of negative emotions and adopting an approach tendency compared to a Threat state. However, it may be possible to experience a combination of these facets, with the absence of some of the suggested other facets.

Threat on the other hand is characterised when an individual does not perceive that they have the resource to cope with the demands of the task and, suggested to lead to an increase or maintenance of TPR, a small increase in CO and experience of negative emotional state and adopting an avoidance tendency. These operational definitions are when the individual appraises a situation as purely a Challenge or a Threat.

However, these states can be experienced in combination with one another based on Cerin (2003) experiential conceptualisation of Challenge and Threat. Therefore, although an individual might believe they have enough resource to cope with the demands of the task, they may have concerns about the task at hand, especially if the task demand is dynamic e.g. the demands of the task are likely to change within the environment over a certain time period, i.e. in a snooker match. Simultaneously the individual may be experiencing both negative and positive emotions, approach and avoidance behaviour tendencies based on having concerns about the task demand but still be confident that they have the ability to cope, leading to a mixed pattern of both Challenge and Threat. This mixed pattern of Challenge and Threat may lead to an equivocal set of cardiovascular indices, as the individual would not elicit a Challenge or Threat response in isolation, rather a combination between the two physiological sets of indices defined by Blascovich and colleagues.

In summary Challenge and Threat have previously been measured using self-report (Tomaka et al., 1993; Gaab et al., 2005), cardiovascular responses within the BPSM (Blascovich et al., 2004) and have said to be associated with endocrine responses (Dienstbier, 1989). Challenge is characterised by cardiovascular response of an increase in CO and a decrease in TPR, as a result of the SAM activation within the endocrine response. Threat is characterised by no increase or small increase in TPR as a result of the activation of both the SAM and PAC endocrine response system.

However, this literature although robust should be treated with circumspect. As discussed within the current, chapter Challenge and Threat has been evoked via manipulation, imagery and speech tasks in a selection of studies conducted by Blascovich and colleagues. These methods cannot guarantee induces Challenge and Threat. Furthermore the BPSM has been shown to have equivocal support. It would appear that cardiovascular responses associated with the BPSM provide a secondary outcome of the endocrine responses associated with Challenge and Threat (Dienstbier, 1989), without clear explanation, other than TPR is a measure of systematic vascular function and CO is a measure of cardiac function.

In regard to sport, there is limited research regarding Challenge and Threat, with few studies published to date (Cerin, 2003 ; Jones et al., 2009; Moore et al., 2012; Turner et al., 2012; Meijen et al., 2013[a]; Meijen et al., 2013[b]). The TCTSA (Jones et al., 2009) provides a framework of how cognitive, affective and physiological components amalgamate to form Challenge and Threat states applied to a sport context. However this model needs further examination.

Firstly the evidence reviewed to support the notion that Challenge and Threat will have an impact upon performance was not tested within the model. Moreover,

research since has found that a cardiovascular response of Challenge is associated with improved sporting performance (Turner et al., 2012; Moore et al., 2012).

Secondly, Challenge and Threat are seen as dichotomous within the TCTSA, however other research has suggested that Challenge and Threat can be experienced at the same time (Meijen et al., 2013[a], Cerin, 2003). This needs further examination, although the lack of a self-report to examine Challenge and Threat within a sporting context may be why this has not been expanded any further within current literature. To date there is not a valid and reliable measure that assesses Challenge and Threat within a sports setting.

Thirdly, neuroendocrine responses of Challenge and Threat have yet to be examined within a sporting context since physiological components are a primary outcome of Challenge and Threat, this also requires further attention.

## 2.14 Aim of the Present Thesis

As a result of the literature reviewed, areas for examination regarding Challenge and Threat in sport have been identified. Therefore the current research programme intends to:

a. Further examine and develop existing self-report measures of Challenge and Threat within a sport context
b. Examine Challenge and Threat self-report with performance in a sport context
c. Further examine the Biopsychosocial model (BPSM) prosed in relation to Challenge and Threat and sport performance
d. Examine endocrine response, specifically cortisol outlined in the Arousal and Physiological Toughness model in relation to Challenge and Threat self-report and sport performance

e. Examine self-report of emotion direction and intensity experienced during a sport performance in regard to Challenge and Threat
f. Examine Challenge and Threat in combination with each other in regard to sport performance

The current research programme will encompass the differing way of conceptualising Challenge and Threat taking a holistic approach to the subject area. Chapters 3 and 4 present exploratory study designs to address aim a. Whilst Chapter 5 present the results of a quasi-experimental study that further addresses aims a. through to f.

# CHAPTER 3 –STUDY 1: THE VALIDITY OF THE PRIMARY AND SECONDARY APPRIASAL SCALE (PASA; GAAB ET AL., 2005) IN A SPORT AND EXERCISE SETTING

## 3.1 Introduction

There are several reasons why the development and validation of a self-report measure of Challenge and Threat is desirable. First as Chapter 2 highlights, there are some difficulties when measuring Challenge and Threat via cardiovascular measures. Second, there are a number of reasons to be cautious about the extant self-report measures. Third, a self-report measure may help explore some of the inconsistencies in the literature to date, particularly as it relates to the incongruence between self-report and physiological response. For example, understanding anxiety amongst repressors (individuals who are unable to report negative affect) is arguably facilitated by the combination of both physiological and experiential measures of anxiety (Scwartz, Davidson & Goleman, 1978). Therefore a measure of Challenge and Threat could help facilitative theory development and to further examine suggestions that Challenge and Threat can be experienced simultaneously (Cerin, 2003).

Arguably an existing measure that best reflects a reliable and valid assessment of Challenge and Threat in a sport context is the PASA. The PASA comprises of four subscales (self-efficacy, control expectancy, Challenge and Threat), which are proposed by Jones et al. (2009) as important factors regarding Challenge and Threat states. Although the PASA has received some initial support for its factor structure, there remain at least two limitations that this chapter seeks to address. The first limitation is that the PASA has yet to be subject to a Confirmatory Factor Analysis (CFA); CFA is considered valuable where there is an existing model to test. The second limitation is that it has not been tested in a sport related sample.

Hagger and Chatzisarantis (2009) advocate that some common sense in terms of establishing validity and the subsequent use of such measures is needed, stating that often researchers adopt an existing measure that has been validated without making a careful evaluation of whether the previous validity tests are appropriate and applicable to the context in which they are applying the measure. Hagger and Chatzisarantis (2009) also suggested that unless previous validation tests were conducted in a similar context and in a sample with similar characteristics, it is likely that an assumption of validity cannot be made.

Based upon suggestions that Challenge state leads to a facilitative performance and a Threat state is suggested to lead to a debilitative performance (Jones et al., 2009), a self-report measure could predict sporting performance through a less invasive and cost effective technique compared to ascertaining physiological measures. Measuring these states may give researchers the ability to explore the relationship of the experience of Challenge or Threat and if this has any effect upon performance outcome.

The present study extends the literature by attempting to validate a measure that could be utilised to explore athlete's experiences of Challenge and Threat in regards to an upcoming event or sports competition.

## 3.2 Aim

The aim of this study was to evaluate the factor structure of the PASA (Gaab et al., 2005; Appendix 1) within a sporting context using CFA, therefore addressing aim a. of the current research programme.

## 3.3 Methods

### 3.3.1 Participants

Respondents were 200 attendees of the University gym, 58% male (M age=24.91, SD= 9.43) and 42% female (M age= 24.92, SD =9.43). The gym was used as the location to recruit the participants and this pool of participants were selected on the basis that they took part in competitive sport.

### 3.3.2 Protocol

An initial pool of 16 items were derived from the PASA, the wording of which was subject to some minor modification to suit the task that the participants undertook (e.g. 'I am able to determine a great deal of what happens in this interview myself' was modified to 'I am able to determine a great deal of what happens in this competition myself'. Items were scored on a 6 point Likert type scale ranging from totally disagree (1), disagree to some extent (3) to totally agree (6) to reflect the range of scores on the initial PASA scale.

After obtaining ethical clearance from Canterbury Christ Church University respondents were approached before going into the gym or attending an exercise class at the local University Sport Centre and asked to take part in a task involving throwing darts. It was explained that they achieved the highest score they would win a cash prize of £50.

The financial incentive to take part acts as the relevance to take part in the activity, which is suggested to be a way to elicit a Challenge or a Threat appraisal and has also been adopted in recent studies to elicit Challenge and Threat (Moore et al., 2012).

The participants were recruited via a desk advertising this task, as soon as the individual showed an interest in wanting to take part the task was explained and they were given a written informed consent sheet (Appendix 2). When this was completed participants were given the PASA to complete before taking part in the task. The task was to score as high as possible, three practice darts were thrown and the three 'competition' darts were thrown, the last three would count as the individual's final score. There were several reasons why a dart throwing task was selected. Firstly, because it was a task likely to engage individuals with a competitive element, in which there was also a degree of social evaluation. As the task presented a winner with a cash prize for the top scorer this also provided an incentive to take part as used within previous studies (Moore et al, 2012). Secondly it was practical to set this task up in the gym area. It was also a task that individuals could easily perform and would not necessarily need to have a large amount of practice. The task needed to be relatively quick due to the fact that participants were asked to do this task before their gym workout, and if this was more time consuming participant numbers may have decreased.

### 3.3.3 Sample Size Estimation

Osborne and Costello (2004) conducted a meta-analysis of papers that had adopted factor analysis (n=303). They found that 62 % of the studies used sample size estimation by taking the number of items on a questionnaire and for every one item requiring 10 responses. Everitt (1975) also recommended that it should be at least 10 responses to every item. Therefore the approach taken was to aim to get a 10:1 ratio; the PASA consists of 16 items, therefore 160 respondents were required.

### 3.3.4 Data Analysis

When researching into structural equation modelling, the most widely used piece of software is EQS (Joreskog & Sorbom, 1989). The typical stages of assessment

involve the development of a preliminary model, examining the hypothesised pattern or relationships between variables, the fitting of the specified model to sample data and the modification to the model to improve its structure.

CFA using EQS V5 (Bentler & Wu, 1995; Bentler, 1992) was used to test the 16-item, 4-factor model of the PASA (Gaab et al., 2005). A correlated model (Gross and John, 2003) was specified as the TCTSA proposes that there are correlations between Challenge and Threat appraisal and levels of self-efficacy and control expectancy.

Walling, Duda and Chi (1993) indicate an advantage of using CFA is that it provides information indicating how well the data in total fits the proposed hypothetical model. Following the recommendations of several authors e.g., (Hoyle 1995; Kline, 1998) a range of fit indices were utilised within this study.

Although the study utilised an adequate sample size (Everitt, 1975) a further guard against any influence of sample size was achieved by examining the Robust Comparative Fit Index (RCFI: Bentler, 1992) as it is not overly sensitive to sample size (Fan, Thompson, and Wang, 1999). The Non-Normed Fit Index (NNFI) was also used rather than the Normed Fit Index. This decision was made based on the evidence that the Normed Fit Index has major drawback as it is also sensitive to sample size (Marsh, Balla, McDonald, & Roderick, 1988), and can underestimate fit for samples less than 200 (Mulaik, James, Van Alstine, Bennett, Lind and Stilwell, 1989; Bentler, 1990). Furthermore the literature suggested it should not be solely relied on (Kline, 2005). It was decided that the criterion value of 0.90 or greater would be adopted for this study for RCFI and NNFI (Byrne, 1994). This was is because it is associated with an acceptable model fit (Hu & Bentler, 1999).

The root mean square error of approximation (RMSEA: Steiger, 1990) was also examined for this study as it indicates how well the model fits. A RMSEA value of .08 indicates an acceptable fit (Browne & Cudeck, 1993) whereas values of up to .05 indicate a good fit. Finally, alpha coefficients (Cronbach, 1951) were used. This was in order to assess the internal consistency of each subscale. It is necessary to have alpha reliability of .7 to indicate adequate internal consistency. Factor loadings were also examined.

### 3.3.5 Data Checks

To ensure that multivariate assumptions had been fulfilled, the data was screened. The data suggested that the assumption for multivariate normality had been violated (Mardia's coefficient, $p<.01$). To compensate for non-normality the Sartora-Bentler $\chi^2$ value was utilised, similar to that of Terry, Lane, and Fogarty (2003). The Satorra-Bentler $\chi^2$is a statistic that includes a downward correction for degree of observed kurtosis (Satorra & Bentler, 1994). The variance of the factor was fixed at 1, and the model specified that items were related to the factors hypothesised.

## 3.4 Results

The CFA revealed a poor fit for the hypothesised four-factor model (see Table 3:1). Factor loadings and error variances are shown for each item below (see Table 3:2). As levels of fit were poor, an uncorrelated model was tested to see if the fit improved, however the values obtained were also poor[1]. A model of this is shown in Figure 3:1.

[1] A uncorrelated model was also run, however these results did not yield a better fit, Satorra- Bentler $X^2$= 255.74, NNFI=0.59, RCFI=0.64, RMSEA=0.086

Table 3:1: Confirmatory Factor Analysis of the PASA (Gaab et al., 2005)

| Confirmatory Factor Analysis of the PASA (Gaab et al., 2005)<br>Sample (n=200) | |
|---|---|
| Fit-Index | Correlated |
| Satorra-Bentler $\chi^2$ | 197.36 |
| Non-Normed Fit Index (NNFI) | 0.71 |
| Robust Comparative Fit Index (RCFI) | 0.76 |
| Root Mean Square Error of Approximation (RMSEA) | 0.071 |

Table 3:2: Factor Loadings and Error Variances for the 16 Item PASA (Gaab et al., 2005)[2]

| Subscale Items | Factor Loading | Error Variance |
|---|---|---|
| Self-Efficacy | | |
| In this situation I know what I can do | .763 | .125 |
| I have no idea what I should do now | .498 | .107 |
| In this situation I can think of lots of alternatives activities* | .171 | .114 |
| I can think of lots of solutions for solving this task | .581 | .106 |
| Control Expectancy | | |
| It mainly depends on me whether my performance is successful* | .535 | .094 |
| I can best protect myself against failure in this competition through my performance* | .581 | .106 |
| I am able to determine a great deal of what happens in this competition myself* | .753 | .097 |
| If the outcome of the competition is positive it will be a consequence of my effort and personal commitment* | .648 | .112 |
| Threat | | |
| I do not feel Threatened by the situation | .512 | .108 |
| I find this situation very unpleasant | .680 | .064 |
| I do not feel worried because the situation does not represent any Threat to me* | .589 | .099 |
| This situation scares me | .760 | .076 |
| Challenge | | |
| This situation is important to me | .421 | .104 |
| I do not care about this situation | .254 | .105 |
| The situation is not a Challenge for me | .843 | .126 |
| This task Challenges me* | .706 | .144 |

## Internal Reliability

In addition results suggested that the internal reliability of the subscales of the PASA were also poor (Threat; α=.630, Challenge; α=.593, Self-Efficacy; α=.360, Control; α=.594).

[2] *Please note items were reworded to reflect the competition task

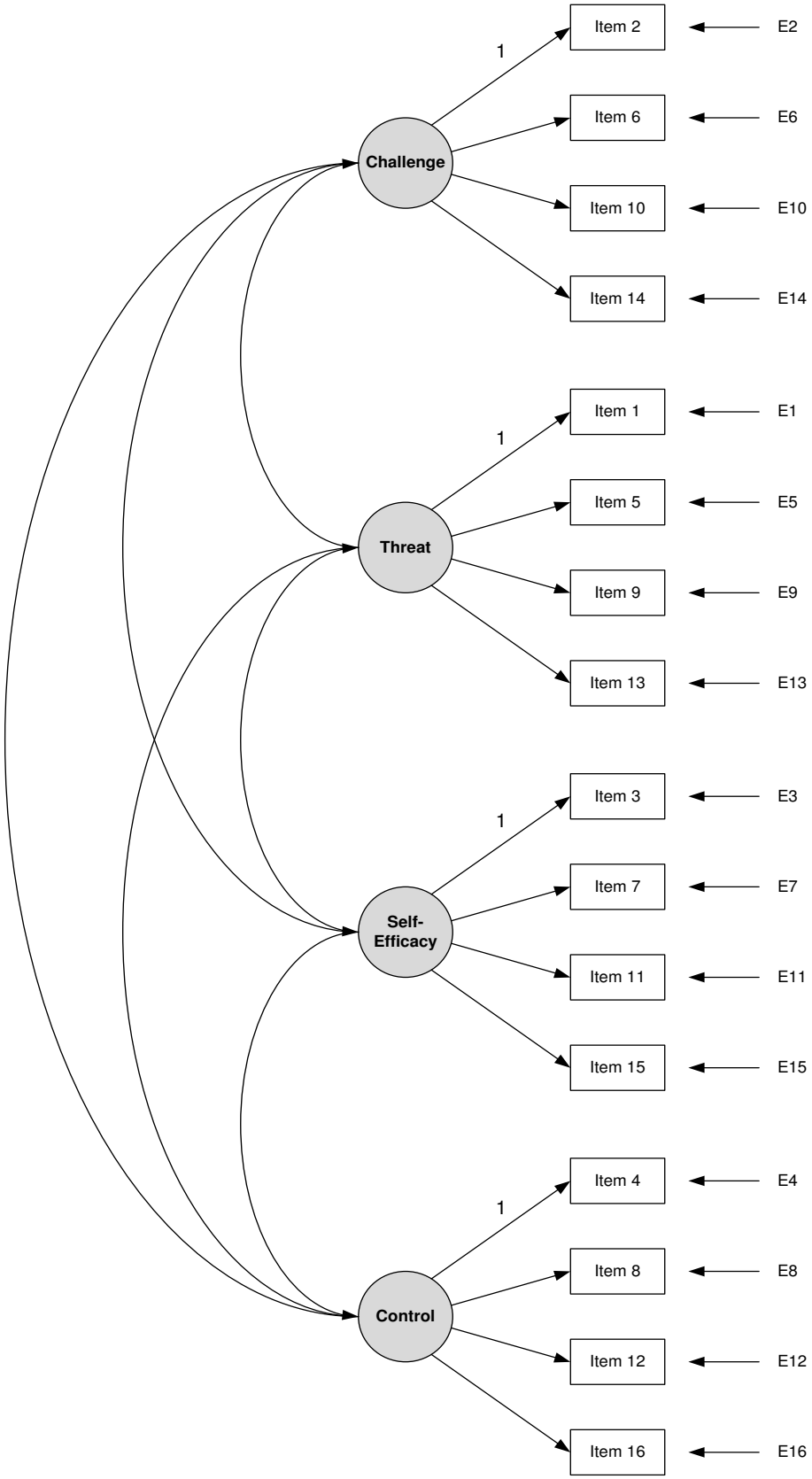


Figure 3:1: The PASA model tested within the Confirmatory Factor Analysis (Correlated)

## 3.5 Discussion

The aim of this Chapter was to examine the factor structure of the PASA in a sports sample. The results of this study suggested that the hypothesised structure of the PASA was poor and that the internal reliabilities for each subscale were also low. Although there are some discrepancies regarding sample size when adopting a CFA analysis, in some cases a suggested minimum sample of 200 is required (Kline, 2013), it was decided that the PASA was not a suitable tool for the assessment of Challenge and Threat within a sporting context based on a number of reasons.

First the items were not originally derived from an athlete population and therefore may not have been an appropriate to utilise within a sport context. Second, values obtained within the analysis for both the correlated and uncorrelated models yielded results that were substantially removed from the cut off values desired. Third, Cronbach's alpha values suggested that this measure had weak internal reliability and fourth, the factor loading for a number of items included across the subscales yielded low values. Trying to validate this measure has affirmed some of the suggestions previously discussed by Hagger and Chatzisarantis (2009) as collectively, the results suggested that the fit indices of the factor structure is inappropriate to use within a sport setting. This could have been for a number of reasons, firstly the wording of the subscales, statements were very similar, and secondly may have not been examining what the subscale was labelled as. For example the Self-Efficacy subscale focuses on knowing what to do within a situation and thinking of solutions. These statements are repetitive, for example 'In this situation I know what I can do' and 'I have no idea what I should do now', these items also may not be examining Self-Efficacy as it could be possible that an individual might not know what they should do but still might be confident in their ability to find out what they need to do.

Similarly in the Threat subscale the statement 'I find this situation very unpleasant' does not necessarily mean that if the individual was finding the situation unpleasant that they would be experiencing Threat. For example an individual might find a situation unpleasant but may find this Challenging to try and overcome it. The TCTSA suggested that individuals might experience different emotions in regard to Challenge and Threat; however anxiety is said to be experienced within both states. Similarly an individual might be finding a situation unpleasant; they may find experiencing anxiety unpleasant but it is how the individual perceives this that may differ. For example Jones et al (2009) suggested that anxiety maybe perceived as more facilitative in a Challenge compared to that of a Threat state. Collectively the PASA lacks the ability to assess the four different specified subscales; it may be prudent to conclude that an examination of another set of existing items measuring Challenge and Threat would help in the development of a self-report measure within a sport domain.

Alongside the limitations associated with existing measures identified in section 2.12, the development of a tool to assess the experience of Challenge and Threat in a sport setting is the necessary logical progression. In particular, limitations associated with the PASA (Gaab et al., 2005) are used as an impetus for development of a self-report measure of Challenge and Threat in the subsequent chapters. We describe the development and validation of an instrument across three stages, within Chapter 4.

# CHAPTER 4 : STUDY 2: THE DEVELOPMENT OF THE CHALLENGE AND THREAT IN SPORT SCALE (CAT)

## 4.1 Introduction

Based on the results of Chapter 3 and the limitation identified in Chapter 2, the aim of this chapter is to present three stages in the initial development and validation of a self-report measure of Challenge and Threat in sport. Specifically the three stages are firstly to develop an item pool and assess the content validity of these items; second subject these items to further analysis adopting principle components analysis (PCA); third to test the emerging factor structure using a CFA.When developing a questionnaire it is important to consider several elements. Firstly, Bowling (1997) suggested that to avoid misinterpretation and reduce measurement error questionnaire should not rely upon a single-item response and that a multi-item scale would be more appropriate. Secondly, Rattray and Jones (2007) suggested that the type of question, language used and order of items may all bias a recipient response and that a mixture of both positively and negatively worded items may minimise the tendency for the respondents to agree with a statement, or respond in the same way. Bowling (1997) also suggested that leading questions including double negatives or double-barrelled questions should be avoided. Although it might be useful to include open ended questions to gain more information for respondents regarding Challenge and Threat experience, it was decided that this was not be included in the questionnaire development at this stage. This was because such data can be difficult to analyse and interpret (Polgar and Thomas, 1995).

Thirdly, the range of the scale is an important element to consider when designing a questionnaire. Likert-type scales are most commonly used with questionnaires and are usually fixed choice response formats designed to measure attitudes or opinions (Burns & Grove, 1997). These methods of using Likert-type scale

make the assumption that attitudes can be measured. Burns and Grove (1997) also have suggested that to avoid respondent irritation and increase non-response bias a neutral point in a scale should be avoided.

Another important aspect of questionnaire development is face validity. Weiss (1976) suggested that although researchers often take sophisticated analysis aimed at testing the validity of a measure, little attention is paid to face validity. Hagger and Chatzisarantis (2009) refer to face validity as researchers and 'experts' judgements or ratings that the content of a self-report measure or item captures aspects of the psychological construct of interest. Furthermore they suggested that face validity is extremely important in the early stages of developing a self-report tool and emphasise that the meaning to respondents is imperative. This is important regarding the initial development of a self-report measure and is addressed in stage one of this chapter.

A PCA was adopted in order to reduce the amount of variables within the self-report measure (Kim and Mueller, 1978) in stage 2 of this chapter. Tabachnick and Fidell (2007) suggested that the PCA is a statistical technique applied to a single set of variables when the researcher is interested in discovering which variables group together and are relatively independent of one another. Variables that are correlated with one another but largely independent of other subsets of variables are organised into combined factors.

Davies, Lane, Devonport and Scott (2010) suggested that researchers involved in questionnaire development should adopt confirmatory procedures to establish factorial validity. Furthermore, Byrne (2013) suggested that CFA is the best known statistical procedure for testing a hypothesised factor structure. Therefore this was utilised to examine the construct validity of the items retained from the PCA, in stage 3 of this chapter.

## 4.2 Stage 1- Content Validity

The aims of this stage were to firstly generate a pool of items and second to examine the content validity of these items with the input from two expert groups, student athletes and academics. This helps to address aim a. of the current research programme.

## 4.3 Method

### 4.3.1 Participants

Twenty five student athletes 64% male (M age= 22.48, SD =6.12) and 36% female (M age=21.50, SD= 1.79), competed in various sports including football (n=6), cricket (n=2), swimming (n=5), tennis (n=1), rugby (n=6), netball (n=3), basketball (n=2), all sports were reported at University level.

### 4.3.2 Protocol and Data Analysis

Initially items were generated from the PASA, CAS and Challenge and Threat Construal measures see Chapter 2 (Sections 2.12.1, 2.12.3, 2.12.4) for item detail. Two academics (Senior Lecturers in Sport and Exercise Psychology with particular interest in Challenge and Threat) then examined the items for face validity. A number of factors guided this decision. First, the items were derived from existing measures that other academics had already considered appropriate for assessing Challenge and Threat. Therefore, the main task was to identify which items were clearly not assessing Challenge and Threat. Second, although it is suggested that using a large number of expert judgement is of benefit to avoid bias (Rowe & Wright, 2001), with increasing numbers of expert judgements, decisions about the "degree of consensus" is a matter for debate.

The discussions were centred on applicability to a sports setting, and in particular with reference to how an athlete feels before a sporting competition. Based upon these discussions it was decided which items should be included within the final set of items given to the sample of student athletes.

After obtaining ethical clearance from Canterbury Christ Church University all retained items were presented to a random selection of student athletes. These athletes were divided into four focus groups; three groups of six and one group of seven. The focus groups were asked to read through the items and think carefully about whether the item was applicable to their experience of evaluating a forthcoming sporting situation as a Challenge and/or a Threat. In particular, they were asked to consider whether each item captures the types of thoughts and feelings experienced when they are Challenged and/or Threatened before taking part in a sporting competition (Appendix 3).

It was stated that if the participant was "in two minds" or uncertain about the applicability of an item to them personally, but believe it could be applicable to others' experience of Challenge or Threat, they were asked to rate this as applicable.

Participants were also welcomed to write their own comments on the list of questions, i.e. if they did not understand the wording, or if certain wording was deemed incorrect or could be changed. This is similar to Bartholomew Ntoumanis and Thogersen-Ntoumanin (2010), method of the development and initial validation of the Controlling Coach Behaviour Scale.

Following discussions and applicability rating a simple frequency test was run on the data collected via SPSS (Version 19.0). Similar to Jones et al. (2005), those items that had lower than 50% applicability rating (less than 13 rating based upon the

sample size of this study) were eliminated from the pool of items as these items were deemed not relevant to Challenge and Threat.

## 4.4 Results

During the expert discussions some of the items were reworded to reflect a sporting task. Seventeen items of the 18 were included in the final items presented to the student athletes from the CAS. The item 'I feel like a failure' was extracted, as this was not deemed to be an appropriate measure. It was considered that this item reflected an evaluation of one 'self' (Mullen, Markland & Ingledew, 1997), and although might be related to Challenge or Threat, was not representative of Challenge and/or Threat specifically.

Two of the four questions included in the pool of items derived from McGregor and Elliott (2000) Challenge and Threat Construal were also excluded, these items were, 'I think this class represents a positive Challenge to me' and 'I think this class represents a Threat to me', as these items were very similar to the items retained for analysis from the same measure ('I feel like this task is a Threat' and 'I feel like this task is a Challenge'). From the PASA is was decided that only items from the Challenge and Threat subscale would be utilised, six items were retained and two items ('I find this situation very unpleasant' and 'I do not feel worried because the situation does not represent any Threat for me') were removed as there were considered very similar to the items included from the CAS. This left a total of 25 items for examination, all of these initial items included are shown in Table 4:1. After the student athlete focus groups discussed the items and their applicability, five items were eliminated due to falling below the 50% applicability criterion. Some items were revised to reflect a sporting competition.

Table 4:1: Items included for analysis in Stage 1 [3]

| Item | Applicable (n) | Non-Applicable (n) |
|---|---|---|
| 1. I do not feel Threatened by the situation | 17 (68%) | 8 (32%) |
| 2. The situation is not a Challenge for me | 14 (56%) | 11 (44%) |
| 3. This situation Challenges me* | 22 (88%) | 3 (12%) |
| 4. This situation scares me | 15 (60%) | 10 (40%) |
| 5. The situation is important to me | 2 (8%) | 23 (92%) |
| 6. I do not care about this situation | 5 (20%) | 20 (80%) |
| 7. I am focusing on the positive aspects of this situation* | 19 (76%) | 6 (24%) |
| 8. I worry that I will say or do the wrong thing | 17 (68%) | 8 (32%) |
| 9. I am thinking about what it would be like if I do well* | 5 (20%) | 20 (80%) |
| 10. I am worrying about the kind of impression I will make | 17 (68%) | 8 (32%) |
| 11. I am concerned that others will find fault with me | 15 (60%) | 10 (40%) |
| 12. I expect that I will achieve success rather than experience failure* | 18 (72%) | 7 (28%) |
| 13. I am looking forward to the rewards and benefits of success* | 21 (84%) | 4 (16%) |
| 14. I am concerned what other people will think of me* | 15 (60%) | 10 (40%) |
| 15. I feel I cannot overcome the difficulties in this task* | 12 (48%) | 13 (52%) |
| 16. I lack self-confidence | 8 (32%) | 17 (68%) |
| 17. A Challenge situation motivates me to increase my efforts* | 22 (88%) | 3 (12%) |
| 18. I am thinking about being successful in this task rather than expecting to fail* | 20 (80%) | 5 (20%) |
| 19. I worry what other people will think of me, even though it won't make any difference* | 14 (56%) | 11 (44%) |
| 20. I am concerned that others will not approve of me | 13 (52%) | 10 (40%) |
| 21. I am looking forward to the opportunity to test my skills and abilities* | 23 (92%) | 2 (8%) |
| 22. I believe that most stressful situations contain the potential for positive benefits | 4 (16%) | 21 (84%) |
| 23. I worry what other people are thinking of me | 16 (64%) | 9 (36%) |
| 24. I feel like this task is a Threat* | 14 (56%) | 11 (44%) |
| 25. I feel like this task is a Challenge* | 21 (84%) | 4 (16%) |

[3] Please note items 1-6 are taken from the Primary Secondary Appraisal Scale (PASA; Gaab et al, 2005), items 7-23 are taken from the Cognitive Appraisal Scale (Skinner and Brewer, 2002); and items 24-25 are taken from the Challenge and Threat Construal (Ptacek et al, 1994). *Some items were revised to make them more applicable to a sports setting.

The five items eliminated were item 5 ‘This task is important to me’, item 6 ‘I do not care about this situation’, item 9, ‘I am thinking about what it would be like if I do well’, item 16, ‘I lack self-confidence’ and item 22 ‘I believe that most stressful situations contain the potential for positive benefits’. It was considered by the student participants that the item ‘This situation scares me’ (item 4) was too extreme to apply to a situation but the consensus was that it could be seen as relevant. The two academics within this study were asked to discuss this. It was deemed that the item would be retained within the questionnaire but another item would be added to address this area being ‘I find this situation daunting’.

The questionnaire was then left with 21 items (See Table 4:2), consisting of four from the PASA, 14 items from the CAS, two items from the Challenge and Threat Construal and the added item of ‘I find this situation daunting’. These items were collectively named the Challenge and Threat in Sport Scale (CAT).

Table 4:2: Items retained for further analysis (CAT) [4]

| Items | |
|---|---|
| 1. | I do not feel Threatened by the situation |
| 2. | The situation is not a Challenge for me |
| 3. | This situation Challenges me |
| 4. | This situation scares me |
| 5. | I am focusing on the positive aspects of this situation |
| 6. | I worry that I will say or do the wrong things |
| 7. | I am worrying about the kind of impression I will make |
| 8. | I am concerned that others will find fault with me |
| 9. | I expect that I will achieve success rather than experience failure |
| 10. | I am looking forward to the rewards and benefits of success |
| 11. | I am concerned what other people will think of me |
| 12. | I feel I cannot overcome the difficulties in this task |
| 13. | A challenging situation motivates me to increase my efforts |
| 14. | I am thinking about being successful in this task rather than expecting to fail |
| 15. | I worry what other people will think of me, even though it won't make any difference |
| 16. | I am concerned that others will not approve of me |
| 17. | I am looking forward to the opportunity to test my skill and abilities |
| 18. | I worry about what other people are thinking of me |
| 19. | I feel like this task is a Threat |
| 20. | I feel like this task is a Challenge |
| 21. | I find this situation daunting |

## 4.5 Discussion

The aims of this study were to generate an initial item pool and assess the content validity of these items based on athlete rating and academic judgement. Results of the study suggested that a provisional 21 item questionnaire possesses adequate face validity when assessing athlete's experiences of Challenge and/or Threat.

Collectively this left a pool of items which focussed upon social evaluative element in line with suggestions by Feinberg and Aiello (2010) that this element is

[4] *Please note items 1-4 are taken from the PASA (Gaab et al., 2005); items 5-18 are taken from the Cognitive Appraisal Scale (Skinner & Brewer, 2002); items 19-20 are taken from the Challenge and Threat Construal (Ptacek et al., 1994) and item 21 was developed specifically as an outcome of this study

necessary to induce Challenge and Threat. Other items left in the pool concentrated on looking forward to opportunities to test skills and abilities and achieving success. These areas are highlighted within the TCTSA in regard to potentially an individual taking an approach rather than avoidance goals.

The approach taken within this study was based upon the use of common sense when attempting to establish validity and the use of a measure (Hagger and Chatzisarantis, 2009). A pool of items were taken from existing measures (PASA, CAS and Challenge and Threat Construal) in order to evaluate their ability to measure Challenge and Threat. A group of student athletes and academics were selected as this approach seemed logical in order to ascertain if the pool of items were suitable. Although this was a relatively small number of individuals, too many individuals input may cause a consensus but not enhance accuracy of assessing items, therefore this number was deemed appropriate. The sample also included different ranges of athletes and therefore gained a varied understanding of what Challenge and Threat meant to the athletes collectively. The items retained are an important step in ascertaining a self-report measure of Challenge and Threat in a sporting domain. If individuals are able to self-report their Challenge and Threat levels, then a further exploration of these judgements and how they may potentially impact performance can be examined in more detail. The potential to also examine Challenge and Threat independently would allow the examination of the notion that Challenge and Threat cannot be viewed as bipolar approach, rather this is too simplistic to apply to a sporting context (Cerin, 2003; Meijen et al, 2013[a]). This method of assessing Challenge and Threat would also allow a quicker and less invasive way to ascertain Challenge and Threat rather than measuring cardiovascular activity or endocrine response.

In conclusion, a further examination of the items retained from stage 1 is required. In particular it would be prudent to examine whether any subsets of variable can be organised into combined factors as discussed in the introduction to this chapter.

## 4.6 Stage 2- Principle Components Analysis of the Challenge and Threat in Sport Scale (CAT)

## 4.7 Aim

The aim of this stage was to test for a components solution for the pool of items selected to assess Challenge and Threat using PCA with the items retained from stage 1 (CAT). This helps to address aim a. of the research programme.

## 4.8 Method

### 4.8.1 Participants

Respondents were 197 runners, 69% male (M age=38.36, SD=10.48) and 29% female (M age= 35.86, SD =13.94) and, 2% (M age=37.21, SD= 12.50) did not report their gender. All participants routinely took part (once a month) in long distance running events. Participant race runners were selected because it was an opportunity to collect data in an event that was well attended in order to ascertain a high number of responses. The race also had a social evaluative element which is suggested to elicit Challenge and Threat (Blascovich et al, 1999). The social evaluative element required was provided by the race times being posted online after the competition by the race organisers. This pool of participants also were selected because it was an ecologically valid environment in which they were performing the task, other research regarding Challenge and Threat and sport performance have predominately been laboratory based (Turner et al, 2012; Moore et al, 2013) or lacked a sport performance task (Meijen et al, 2013 [a]; Meijen et al, 2013 [b] ). Therefore it was deemed more realistic and appropriate to select athletes who were about to take part in a sporting competition for this study design.

### 4.8.2 Protocol

After obtaining ethical clearance from Canterbury Christ Church University the race organisers of two competitive long distance running events were contacted and asked if it was possible to distribute the CAT at the events. Upon agreement a copy of the informed consent (Appendix 4) and questionnaire was sent to the race organisers so that they were aware of what questions would be asked of the runners. On race day of the events a total of two researchers over two different long distance races attended in order to request runners to complete the questionnaire. After informed consent was obtained runners were asked to complete the questionnaire before the race (Appendix 5).

### 4.8.3 Sample Size Estimation

Everitt (1975) recommended that it should be at least 10 respondents to every question included on the questionnaire. Therefore the approach taken was to aim to get a 10:1 ratio; as in study 1 (section 3.3.3).

### 4.8.4 Data Analysis

A PCA was chosen because the purpose of this analysis was to identify which variables accounted for the most of the observed variance. The PCA was also selected as it reduces the number of observed variables to a smaller number of principle components.

The 21 items CAT was subjected to PCA using SPSS version 19. This was to determine whether items of Challenge and Threat are grouped in a particular way (Kline, 1998). Any items that were cross loaded were excluded from further analysis (Costello and Osborne, 2005).

Criteria for components extraction was utilised using Guadagnoli & Velicer (1988) suggestions. These values included:

1. Eigenvalues greater than 1.0 to indicate that a component explains more variance than any single item
2. A minimum of around 5% explained variance per component
3. Components loading of .4 and above

Oblimin rotations (correlated) were utilised over orthogonal rotation (non-correlated), as based upon existing literature examining Challenge and Threat within a sporting context, it is suggested that Challenge and Threat are correlated with each other. It is suggested that if you are appraising a situation as a Threat, you are not appraising the situation as a Challenge (Blascovich & Mendes, 2000); therefore levels of Challenge will be low if Threat is high. Alpha coefficients (Cronbach, 1951) were also examined to assess the internal consistency of each subscale. It is desirable to have alpha reliability of .7 to indicate adequate internal consistency, as within study 1.

### 4.8.5 Data Checks

Before performing the PCA, suitability of the data for factor analysis was assessed using the Kaiser-Meyer-Oklin value (Kaiser, 1974) and Barlett's Test of Sphericity (Bartlett, 1954). The Kaiser-Meyer-Oklin value indicates the proportion of variance of the variables that are potentially caused by underlying factors and whether factor analysis is appropriate for the data. Data obtaining values above 0.5 indicate suitability. Bartlett's Test of Sphericity indicates if variables are unrelated or related, values below 0.05 indicate that values are related and therefore factor analysis is appropriate.

## 4.9 Results

A PCA was conducted on the data using SPSS version 19.0. A high level of sampling adequacy was achieved as the Kaiser-Meyer-Oklin value was .87 (Kaiser, 1974) and Barlett's Test of Sphericity (Bartlett, 1954) reached statistical significance ($p<0.01$). PCA analysis revealed a presence of a four component solution with eigenvalues exceeding 1, explaining 62% of the variance, 33%, 15%, 9 %, and 5% respectively, with components loadings of .4 and above. A further inspection of the scree plot was examined. This revealed a clear break after the third component; however items in the third component were cross loaded consisting of only three items which indicate that the component is unsuitable for further analysis (Costello & Osborne, 2005). Based on these results it was decided to retain a two component solution for a subsequent PCA, with nine items (see Table 4:3) excluded from further analysis due to cross loading.

Table 4:3: Items excluded after initial PCA

| Items excluded after initial PCA |
|---|
| 1. I do not feel Threatened by the situation |
| 2. The situation is not a Challenge for me |
| 3.This situation Challenges me |
| 4.This situation scares me |
| 5.I am focusing on the positive aspects of this situation |
| 12. I feel I cannot overcome difficulties in this task |
| 16. I am concerned that others will not approve of me |
| 20. I feel like this task is a Challenge |
| 21. I find this situation daunting |

A subsequent PCA with performed with Oblimin rotations yielding a two component solution explaining a total of 66% of the variance, with eigenvalues above 1.0 and components loading of .4 and above; Component 1 (Threat) contributing to 44.5% and Component 2 (Challenge) contributing to 21.5%. This revealed that both components showed a number of strong loading values and all variables loading substantially onto the two components. Items related to Threat loaded onto component 1, and items relating to Challenge loading onto factor 2.

Items all had loadings greater than .63 and did not cross load; in addition their communalities ($h^2$) were examined in order ascertain the proportion of variance each item accounts for in regard to the common factor it is associated with. This examination showed that $h^2$ were high (>0.7; Costello and Osborne, 2005) therefore indicating the proportion of variance accounted by the components was adequate. The results of this analysis suggested that there are two different components to assess Challenge and Threat. These are shown in Table 4:4.

Table 4:4: Items Retained for the CAT

| Items | | | | |
|---|---|---|---|---|
| Component 1 (Threat) | Mean | SD | Skewness | Kurtosis |
| 6. I worry that I will say or do the wrong things | 2.04 | 1.35 | 1.30 | .903 |
| 7. I am worrying about the kind of impression I will make | 2.11 | 1.29 | 1.12 | .440 |
| 8. I am concerned that others will find fault with me | 1.94 | 1.28 | 1.39 | 1.18 |
| 11. I am concerned what other people will think of me | 2.29 | 1.39 | .80 | -.484 |
| 15. I worry what other people will think of me, even though it won't make any difference | 2.35 | 1.51 | .897 | -.288 |
| 18. I worry about what other people are thinking of me | 1.93 | 1.17 | 1.24 | .705 |
| 19. I feel like this task is a Threat | 1.92 | 1.25 | 1.46 | 1.48 |
| Component 2 (Challenge) | | | | |
| 9. I expect that I will achieve success rather than experience failure | 4.71 | 1.19 | -1.06 | 1.35 |
| 10. I am looking forward to the rewards and benefits of success | 4.95 | 1.11 | -1.35 | 2.16 |
| 13. A challenging situation motivates me to increase my efforts | 5.05 | 1.09 | -1.58 | 2.98 |
| 14. I am thinking about being successful in this task rather than expecting to fail | 5.14 | 1.04 | -1.61 | 3.02 |
| 17. I am looking forward to the opportunity to test my skill and abilities | 5.22 | .97 | -1.58 | 1.58 |

### Component 1 (Threat)

Seven items (6, 7, 8, 11, 15, 18 and 19) loaded on to Component 1 accounting for 44.5% of the total variance. This component is representative of the construct of Threat and reflects how an individual feels about the upcoming event. It consists of items such as, experiencing feelings of apprehension, concern and failure about the event as well as evaluation of ones performance by others.

### Component 2 (Challenge)

Five items (9, 10, 13, 14, and 17) loaded on to component 2 accounting for 21.5% of the total variance. This component is representative of the construct of Challenge and includes items such as feelings of success, ability to test skills and increasing efforts.

### Internal Reliability

Cronbach's alpha coefficient analysis was conducted revealing that the CAT has adequate internal consistency with a Cronbach's alpha coefficient of $\alpha$=.71, and component 1 (Threat), $\alpha$=.92 and component 2 (Challenge), $\alpha$=.84 respectively.

## 4.10 Discussion

The aims of this study were to examine the factor structure of the items retained from stage 1. The results suggested a two component solution comprising 12 of the initial 21 items that seem to capture athletes' experience of Challenge and Threat (CAT).

The CAT can potentially measure an athlete's experience of Challenge and Threat in relation to an event (e.g. sporting competition). A PCA revealed that there are two components that were clearly identified in the solution with high loading factors, potentially one Challenge and one Threat component. The 12 items remaining on the

CAT are derived from the CAS (11 items) and the Challenge and Threat Construal measure (1 item; item 19).

This study supports a two component solution that arguably reflects athletes' thoughts and feelings when experiencing Challenge or Threat. Interestingly, items whose content explicitly reflected Challenge or Threat were removed in this analysis, suggesting that athletes' experience of these states are rarely expressed in such explicit terms, similar to the Sport Anxiety Scale-2 (Smith, Smoll, Cumming & Grossbard, 2006) which does not explicitly use the term anxiety within any of the items included. However, it is argued that the items remaining reflect athletes' experience of Challenge and Threat and the length of the instrument is appropriate for administering briefly and efficiently, given appraisals of situations may fluctuate rapidly (Lazarus, 2000).

As previously mentioned within this chapter, ascertaining levels of Challenge and Threat via a self-report measure would be a less invasive way than measuring cardiovascular or endocrine responses. The pool of items remaining were both positively and negatively worded, following suggestions that this may minimise the tendency for the respondents to agree with a statement or respond in the same way (Rattray & Jones, 2007). The items that remained also avoided double negatives (Bowling, 1997) and were derived from athletes suggested experiences of Challenge and Threat, therefore should be easily understood by the recipients. Furthermore, this self-report measure construct provides a multiple-item scale rather than a single-item response as previously used within the sport domain literature (Blascovich et al, 2004). Single item response design is not suitable as this can cause misinterpretation and increase error measurement. Therefore this measure could provide a more robust examination of participants' self-report of Challenge and Threat compared to existing measures (Cerin, 2003).

It should be noted that although the sample size was relatively small within this study, loading factors were high and internal consistency was also high, therefore it was decided that a further examination of the CAT was necessary, this could be achieved by further examining the CAT with a CFA to examine the construct validity of the items. If we are to derive a valid and reliable measure of Challenge and Threat a distribution of this revised questionnaire to another sample is required in order to perform a CFA on the remaining items.

## 4.11 Stage 3 -Confirmatory Factor Analysis of the Challenge and Threat in Sport Scale (CAT)

## 4.12 Aim

The aims of this study were twofold, first to examine the construct validity of the CAT and second to examine the criterion validity of the CAT in regard to running performance. This helps to address aim a. of the research programme.

## 4.13 Method

### 4.13.1 Participants

Respondents were 147 runners, 59% male (M age=39.28, SD= 12.25) and 41% female (M age= 40.48, SD =10.49) and, 6% (M age= 41.20, SD= 9.50) did not report their gender, who took part in long distance running events. All participants routinely took part (once a month) took part in long distance running events. Again participants were selected for reasons previously discussed in section 4.8.1 of this chapter.

### 4.13.2 Protocol

After obtaining ethical clearance from Canterbury Christ Church University the race organisers of the two competitive long distance running events were contacted and asked if it was possible to distribute the CAT at the events. Upon agreement a copy of the informed consent (Appendix 6) and questionnaire (Appendix 7) was sent to the race organisers so that they were aware of what questions would be asked of the runners. On race day of the events a total of two researchers over two different long distance races attended in order to distribute the questionnaires. Runners were asked if they would like to complete the questionnaire. After informed consent was obtained runners were left with the questionnaires to complete and return to the researchers before the start of the race.

### 4.13.3 Sample Size Estimation

Everitt (1975) recommended that it should be at least 10 respondents to every question included on the questionnaire. Therefore the approach taken was to aim to get a 10:1 ratio; as in study 1.

### 4.13.4 Data Analysis

Regarding the CFA the same steps were taken as in Chapter 3, section 3.3.4 and 3.3.5. A two-factor (Challenge, Threat) correlated model was tested. The self-report measure presented the questions in random order. The Threat scale compromised of items 1, 2, 3, 6, 9, 11 and 12 and the Challenge scale compromised of items 4, 5, 7, 8 and 10 (see Table 4:5). The criterion validity was also examined in regard to the CAT. Running times from the current study were standardised by calculating running speed over time (km/h) and a correlation analysis was utilised to examine any association between performance and Challenge and Threat.

### 4.13.5 Data Checks

Regarding the CFA the same steps were taken as in Chapter 3, section 3.3.5. The data suggested that the assumption for multivariate normality has been violated (Mardia's coefficient, $p<.01$). To compensate for non-normality the Sartora-Bentler $\chi^2$ value was utilised

## 4.14 Results

The CFA of the two factor correlated model revealed adequate levels of fit; Satorra-Bentler $\chi^2$ scaled 115.09 ($p<0.01$); NNFI =0.90, RMSEA =0.09, RCFI =0.91, factor loadings and error variances are displayed in Table 4:5. Alongside the correlated

structure, analysis was also run on the uncorrelated and single structure, but this did not show a better model of fit[5]. The correlated model is shown in Figure 4:1.

Table 4:5: Factor Loadings and Error Variances for the 12 Item CAT

| Subscale Items | Factor Loading | Error Variance |
|---|---|---|
| Threat | | |
| Item 1.I am worrying that I will say or do the wrong things | .749 | .087 |
| Item 2.I am worrying about the kind of impression I will make | .714 | .090 |
| Item 3.I am concerned that others will find fault with me | .605 | .089 |
| Item 6.I am concerned what other people will think of me | .645 | .109 |
| Item 9.I worry what other people will think of me, even though it won't make a difference | .719 | .093 |
| Item 11. I am worrying about what other people are thinking of me | .441 | .102 |
| Item 12.I feel like this task is a Threat | .514 | .090 |
| Challenge | | |
| Item 4.I expect that I will achieve success rather than experience failure | .873 | .101 |
| Item 5.I am looking forward to the rewards and benefits of success | .665 | .093 |
| Item 7.A challenging situation motivates me to increase my efforts | .762 | .077 |
| Item 8.I am thinking about being successful in this task rather than expecting to fail | .860 | .073 |
| Item 10.I am looking forward to the opportunity to test my skills and abilities | .535 | .083 |

[5] Uncorrelated model, Satorra- Bentler $\chi^2$= 120.27, NNFI=0.79, RCFI=0.85, RMSEA=0.13. Single model, Satorra- Bentler $\chi^2$= 287.55, NNFI=0.62, RCFI=0.55, RMSEA=0.23

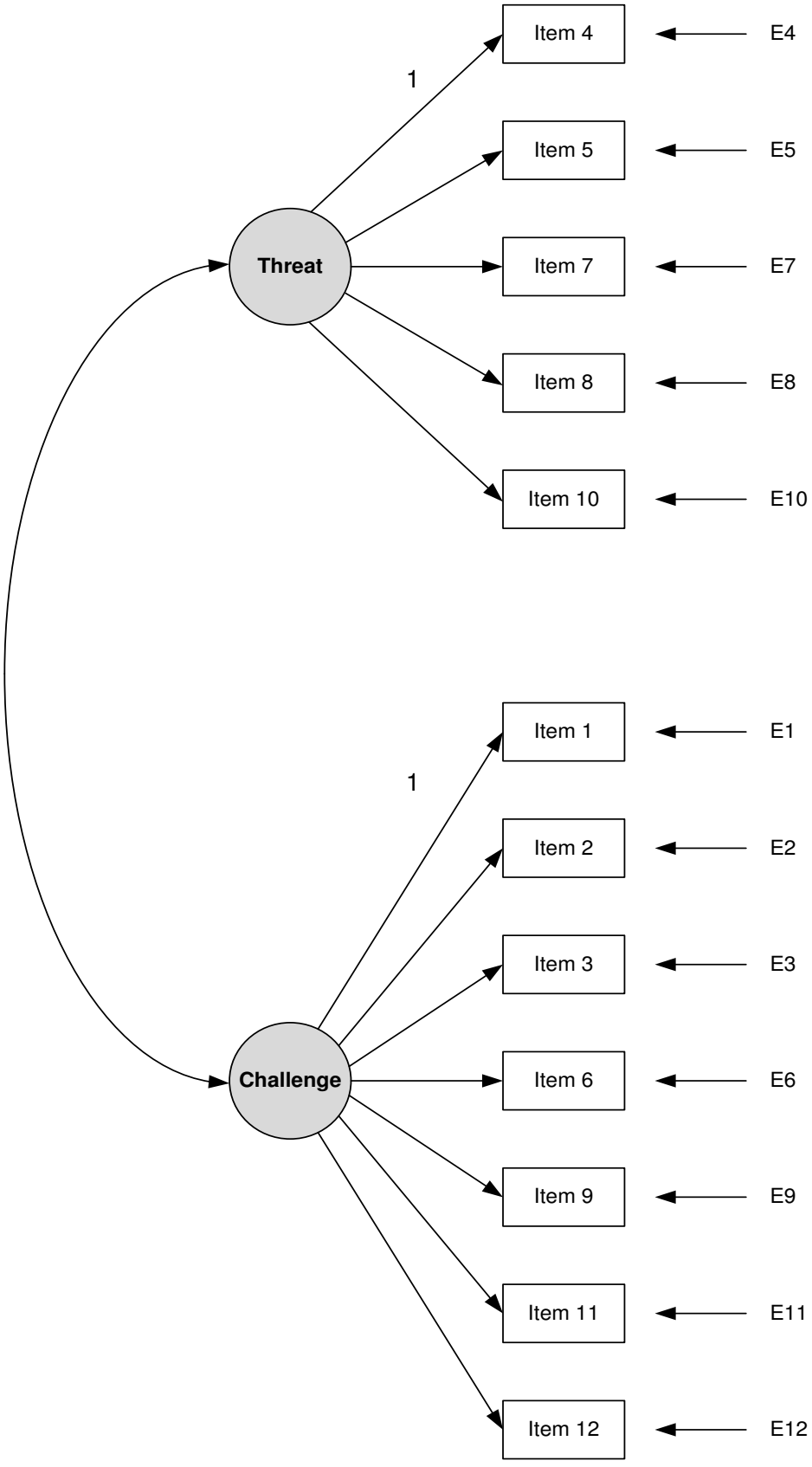


Figure 4:1: Challenge and Threat Components Yielded in the CFA model for the CAT

### Internal Reliability and Criterion Validity

The CAT showed relatively high scores of reliability with Cronbach's Alpha values for Threat (α=.84) and Challenge (α=.80). A significant positive association was observed between Challenge and running speed (km/h) with all the distances combined, ($r = .173$, $p < 0.01$).

## 4.15 Discussion

The aims of this study were twofold, first to examine the construct validity of the CAT and second to examine the criterion validity of the CAT in regard to running performance. The results suggested that the CAT yielded an adequate model fit and that Challenge was positively associated with running performance.

The sample size was not particularly high (n=147) although it does meet the guidelines that for every question, 10 participants are needed recommended (Everitt, 1973). However, to further guard against sample size the RCFI and NNFI were assessed. The values of >.90 in regard to the RCFI and NNFI are considered representative of an adequate model (Bentler, 1992), therefore the above analysis suffices this assumptions. Regarding the RMSEA, MacCallum, Browne and Sugawara (1996) have suggested that the cut-off point ranging from .08-.10 indicate a mediocre fit. Within this model a RMSEA of 0.09 is yielded and thus indicative of a mediocre fit.

It is important to identify limitations when using CFA; the analysis cannot provide unequivocal evaluation that the items provide a valid measure of the construct (Hagger & Chatzisatantis, 2009). Recognition of face validity is also pertinent; as previously discussed as addressed in stage 1 within this chapter. There are four reasons, as to why this measure was deemed as an appropriate model fit, first the construct

validity satisfied the recommended cut off values, second the internal reliability of the measures was good, third, the factor loading of the items were sufficient and fourth the measure demonstrated criterion validity.

As previous literature has linked successful performance to a Challenge state (Blascovich et al., 2004) the Challenge component of the CAT supports this suggestion as Challenge increase correlated with faster running performance. However there was no association between Threat and performance. This may have been because the participants reported low levels of Threat scores, this may have been because all of the participants within this study were used to competition and therefore may not have found the race very threatening. Further investigation of the use of the CAT in a different context to examine Challenge and Threat and performance may help to extend the current suggestions within the extant literature. Again the sample size for this study was relatively small for CFA, the internal consistency was high and the report of Challenge had an association with running speed. Therefore these various findings indicate that this may be a useful tool for examining Challenge and Threat in regard to sport performance.

Although this suggested an adequate model fit, it would be prudent to test the predictive validity of the CAT in a further sample for a number of reasons. For example all of the participants that completed the questionnaire were runners, therefore the present finding are based upon a homogenous sample. Concluding on the stages discussed within this chapter, it is necessary to subject the CAT to a further group of athletes to examine its use in a different sports setting. This will be examined alongside a performance task in Chapter 5.

## 4.16 Summary

Chapter 4 reports the initial stages of the development and validation of the CAT. Firstly in order to examine content validity, a pool of items to assess Challenge and Threat were used; specifically the CAS and the Challenge and Threat Construal alongside some items retained from the PASA and were subject to further analysis. Previously the use of the CAS and Challenge and Threat Construal were successfully used to measure Challenge and Threat appraisals amongst students and their approaches to academic achievement and exam performance. Although this is not sport based, there is similarity between a situation when something is at stake (exam grade; outcome of sporting competition) which is dependent on the athlete or sports team. Therefore these measures were utilised to examine whether they were suitable to measure Challenge and Threat within a sports setting.

Stage 2 and 3 within this chapter provided support that the CAT could be utilised in order to assess both Challenge and Threat experience within a sport setting. The CAT is a unique measure as it attempts to measure the experience of Challenge and Threat states in a sport setting whereas previously discussed; other measures have tried to use a single measure to assess Challenge and Threat, suggesting that an individual is either Challenged or Threatened, but not experiencing both at the same time.

From a compositional perspective the CAT attempts to cover both Challenge and Threat experiences by combining a series of questions taken from various Challenge and Threat measures. This measure has then been subject to a several samples of athletes to examine its validity within a sports setting. The range of athletes used to develop the measure aided in the design of the questionnaire as the athletes were required to think about how certain items related to their experience of Challenge and

Threat. This content validity aspect is important when developing a measure, as meaning of the items maybe not be transferable from one context to another.

Future research is needed to examine this self-report measure within different sporting contexts and examine the predictive validity of the measure. Relationships between Challenge and Threat report on the CAT and cardiovascular reactivity of Challenge and Threat could also be examined, alongside emotions experienced to investigate whether there are any associations outlined within the TCTSA.

This chapter provides impetus for the examination of performance and Challenge and Threat report, to further support the self-report measure and its use within a sports setting. Although there are existing measures to assess Challenge and Threat, there are no specific measures that have been developed within a sport domain. Within the existing literature to measure Challenge and Threat among athletic population is the CAR (Tomaka et al., 1993), however this item has been previously discussed by Wright and Kirby (2003) drawing concerns about it uses as the items are very limited in detail, basing appraisal only on the ability to cope and the demand of the task on the individual. Therefore the CAT addresses those issues with a more detailed assessment of the experience of Challenge and Threat, and allows for the simultaneous measurement of both Challenge and Threat. The offer of this self-report measure could help to reconcile some areas of weakness within the literature; firstly it offers a more in depth assessment of Challenge and Threat with multi-item subscales and secondly it allows for the examination of both Challenge and Threat in combination and/or independently of one another.

# CHAPTER 5 : STUDY 3: AN EXAMINATION OF CHALLENGE AND THREAT IN SHOOTING PERFORMANCE

## 5.1 Introduction

The aim of this chapter is to present a quasi-experimental examination of the influence of Challenge and Threat on shooting performance. In particular, this study extends Chapters 2 to 4 in several ways. Firstly, although Chapter 4 provides some preliminary support for the use of the CAT, it is important to cross-validate self-report measures in an independent sample. Accordingly, this study provides an additional CFA and based on propositions of the TCTSA, examines the predictive validity of the CAT on indices of performance, emotion, endocrine and cardiovascular response.

The second way in which this study extends the current literature is by redressing conceptual and methodological limitations. With regards to the former, conceptually, the TCTSA is predicated on the assumption that athletes experience either Challenge or Threat. However it might be as Cerin (2003) and Meijen et al. (2013) [a] have suggested, some athletes experience both Challenge and Threat simultaneously. Furthermore, based on cardiovascular indices alone, support for the TCTSA has been mixed.

With regards to the latter, there are methodological decisions which may be problematic. First the measurement of cardiovascular reactivity has been questioned (Wright and Kirby, 2000). Moreover, a group of athletes may exhibit a mean increase in TPR compared to baseline (indicative of Threat), but the variation in data could mean that some individuals' TPR increases compared to baseline, whereas others remain the same or even decrease. Therefore it could be suggested that when an individual is manipulated into Threat they might experience cardiovascular reactivity of Challenge or vice versa. Second, there are also limitations with the induction of Challenge and Threat

typically employed within the extant literature. Imagery for instance should be treated circumspectly as participants are often asked to imagine how they would feel before a competition (Meijen et al., 2013[a]), or imagine being placed in a Challenge or Threatened state with differing imagery scripts (Williams et al., 2010). Although collectively the studies have given useful insight into Challenge and Threat, they may not be representing an accurate understanding of Challenge and Threat. Asking an athlete to recall how they might feel before a competition may not capture how an athlete actually felt at the time of competition. Similarly, Girotto et al, (2007) suggested that individual's predictions of how they might act during a situation are often not a true reflection of how they actually act when placed in the same situation.

Third, there are a number of current 'gaps' regarding the associations between different variables associated with Challenge and Threat. For instance, there is limited research examining Dienstbier's (1989) suggestion that Challenge and Threat are associated with neuroendocrine responses. Therefore this chapter attempts to examine cortisol as measure of Threat. To measure adrenaline accurately an invasive procedure would be required. However cannulation or venepuncture may have an impact upon psychophysiological responses and potentially induce a stress response (Hamilton, 1995). This potential response would not be desirable for this research programme.

A further gap within the extant literature is the examination of emotions when experiencing Challenge and Threat. Jones et al. (2009) states within the TCTSA more positive emotions will be experienced when the athlete is in a Challenged state, whereas a more Threatened state is characterised by negative emotions. In addition to the valence of emotions, it could be that the direction of emotion also differs between Challenge and Threat.

Finally based upon the conceptual and methodological limitation outlined above, and research by Cerin, (2003) and Meijen et al. (2013)[a] , this study adopts an exploratory examination of the interaction of Challenge and Threat upon performance, emotions and physiological responses.

In summary, to address these multi-faceted aims participants were exposed to a motivational competitive environment, with minimal influence on the individuals approach to the event. To allow the examination of Challenge and Threat it is important to create a situational environment where social evaluation is present (Mendes et al., 2008). Designing a sporting task that has limited movement to allow decrease noise in the cardiovascular measure would be the most appropriate. A shooting task was selected as this skill was discrete and did not require a high intensity of physical exertion, thus minimising the impact upon recording cardiovascular indices. Specifically, motor performance is examined as Turner et al. (2012) identify motor performance has not be explored in great depth in relation to cardiovascular indicators of Challenge and Threat. Using a shooting task, with a competitive element in a social evaluative situation with a cash incentive is a suitable task to assess Challenge and Threat similar to that of Moore et al. (2012). Self and other comparison has been identified by Thatcher and Day (2008) as a property of stress appraisal; therefore a score board was also implemented to create an element of social evaluation similar to Turner et al. (2013).

## 5.2 Aim

In summary, the aims of the present study were to:

1. Further examine the CAT (Challenge and Threat) in an independent sample to test its predictive validity in regard to performance, emotion intensity and direction

2. To examine the physiological responses associated with Challenge and Threat and its ability to predict performance and emotion intensity and direction
3. To examine the interaction of Challenge and Threat upon performance, physiological responses, emotion intensity and emotion direction
4. To examine the interaction of Challenge and Threat (Based on Lundqvist, Kenttä and Raglin (2011) recommendations) the combination of emotion direction and intensity

Collectively the aims of the present study address aims a. to f. of the research programme.

## 5.3 Method

### 5.3.1 Participants

One hundred and eighty university student and staff members volunteered to take part in the study. Due to drop out rate 110 participants completed the task. Eight respondents were removed due to noise in the data as a result of blood pressure measurements that were lost during the testing phase or visual acuity problems. The final data set included 102 participants, 75% male (Mean age=27.39, SD=10.38) and 25% Female (Mean age=25.15, SD=8.80). None of the participants reported previous shooting experience.

### 5.3.2 Protocol

A shooting task was selected to try and elicit a stress in the form of Challenge and/or Threat. A shooting task was selected for several reasons, firstly it has been stated within the literature that there has been seldom examination of motor performance in relation to cardiovascular indicators of Challenge and Threat (Turner et al, 2012), secondly the shooting task provided a skill with a number of parameters that

could be analysed and thirdly the task did not involve a large amount of movement. This is important whilst trying to record cardiovascular indices because the potential 'noise' picked up whilst recording the cardiovascular parameters because of excess movement would make it difficult to interpret whether the cardiovascular changes recorded are due to the inducement of Challenge and/or Threat or because of the movement of the participant. Lastly, and more specifically shooting in a prone position was selected as this requires a high level of accurate control and mobilisation of motor movement (Crocker & Hadd, 2005). As Turner et al. (2012) states in the TCTSA (Jones et al., 2009) it is predicted that the likelihood for reinvestment, known to disrupt motor performance will increase in a Threat state, which is suggested to have a decrement on performance. Conversely, a reduced reinvestment is associated with a Challenged state, and has facilitative effects upon performance.

The gun utilised within this study was a replica rifle (Figure 5:1) with an infrared firing sensor attached, which was triggered via vibration of the gun trigger. The target that participants were asked to shoot at was scaled to represent a 50 metre rifle target. This was set five metres in front of the participant. Accuracy of the task was recorded via the SCATT shooter training system (Diverse Trading Ltd, Surrey UK). The SCATT system is designed to help beginners shorten the time needed to learn shooting skills as this can be used in an indoor environment and there is no live fire. The gun is connected to a computer via USB and linked to the SCATT software. As there is no live fire, the SCATT software records a variety of performance measures via infrared. Each shot taken can score a maximum of 10.9 as in line with professional shooting competitions. Using the SCATT software also provided a novel element to the task due to the lack of feedback. The researcher could see what the participant was scoring during the task on the computer screen, but the participant was unable to see

this and was unable to ascertain how they were performing due to the lack of live fire within the research protocol. Within the literature examining Challenge and Threat thus far there is no examination of Challenge and Threat in regard to a sporting task without immediate feedback, other studies have used golf putting (Moore et al, 2013) and netball shooting (Turner et al, 2012) in which immediate feedback can be ascertained by the participant.

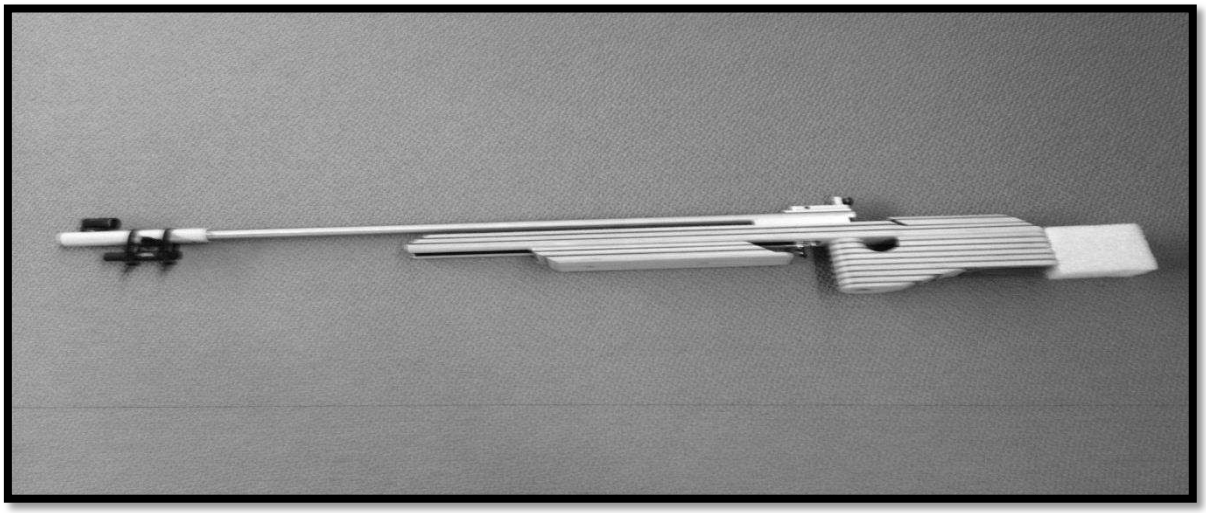

Figure 5:1: SCATT Training Gun

Shooting Performance measures

Within the analysis, various performance measures were recorded via the SCATT software (Appendix 8). These are listed with the definitions of the performance measures recorded in Table 5:1.

Table 5:1: Shooting Terminology

| Shooting Terminology | Definitions | Unit Measurement |
|---|---|---|
| Group Size | A centre to centre distance measurement between two most distant shots | mm |
| Length | Average length of trace made on the target from breach to point of shot execution | mm |
| Performance Accuracy | Result for the shot group in relation to the to the centre of the target (average over 18 shots) | |
| Snatch | Average length of the trace made in the last 0.5s before shot execution | mm |
| Stability of Aiming | Average points of the tracing are taken for a given interval of time before the shot, and the diametral dispersion of these points is calculated | mm |
| Stability of Time Interval | Stability of Time Interval between shots (if all shots are equally spread the stability is 100%) | % |
| Steady 10 | The amount of time the aiming trace was within the 10.0 expressed as a percentage | % |
| Steady 10a | The amount of time the aiming trace was within the 10.5 expressed as a percentage | % |
| Time Taken | Average Time Taken per shot | s |
| Total Shooting Time | An interval from the beginning of first shot to the end of last shot | min:s |

Finometer ™ and Electrocardiogram (ECG) (cardiovascular recording equipment)

The cardiovascular measures recorded were CO and TPR. These variables were chosen based on previous research (Blascovich et al., 2004; Williams et al., 2010). All

of these variables were measured continuously at baseline and throughout the task using a Finometer™ (Finapres™ Medical Systems, Paasheuvelweg, The Netherlands). The Finometer™ is a non-invasive haemodynamic monitoring system and deemed suitable for use within this study as it is non-invasive. The Finometer™ uses a finger and arm cuff to estimate haemodynamic measures and could be positioned on the arm that the participant was not pulling the trigger with.

Finger pressure is monitored with a finger cuff (Figure 5:2) to check for arterial diameter changes. Reconstructed pressures are obtained by momentarily calibrating systolic finger cuff pressures with a typical upper arm cuff.

Finger pulse pressure was measured continuously for the whole duration of the performance task using a Finometer™. Recordings were transferred onto Lab Chart software (ADInstruments, Oxford, UK), which allow channels of data to be viewed simultaneously whilst recording. This data was later exported into excel and SPSS for further analysis.

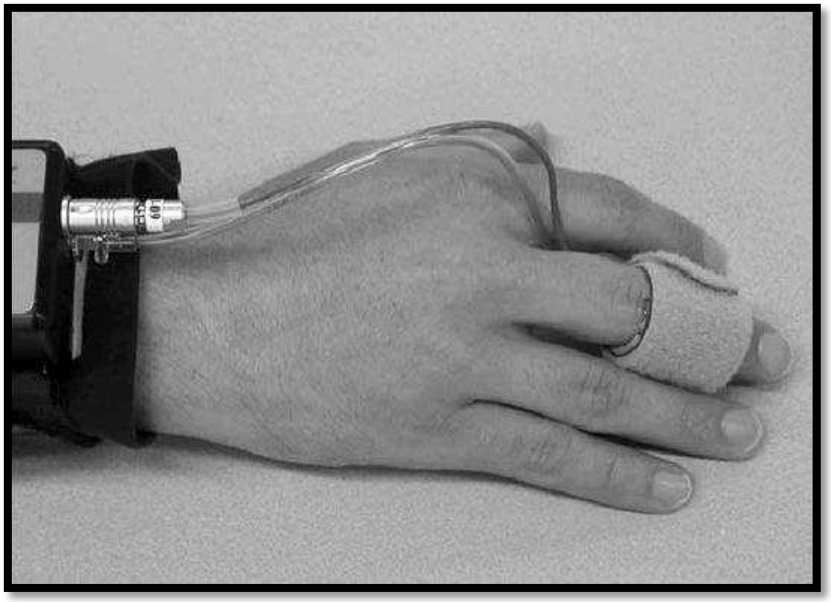

Figure 5:2: Finger Cuff of Finometer™

HR was recorded using a PowerLab/16SP (model no.ML795). A standard three lead bipolar ECG arrangement was used as recommended by ADInstruments Castle Hill, (Australia). Electrodes were placed at the mid-clavicular point of each clavicle (right-negative electrode and left-ground/earth, Figure 5**:**3) with a third electrode (positive electrode) placed on the posterior median line of the participant centred with the spine (Figure 5:4). Measurements were recorded continuously for the duration of the test with the participant in a prone position.

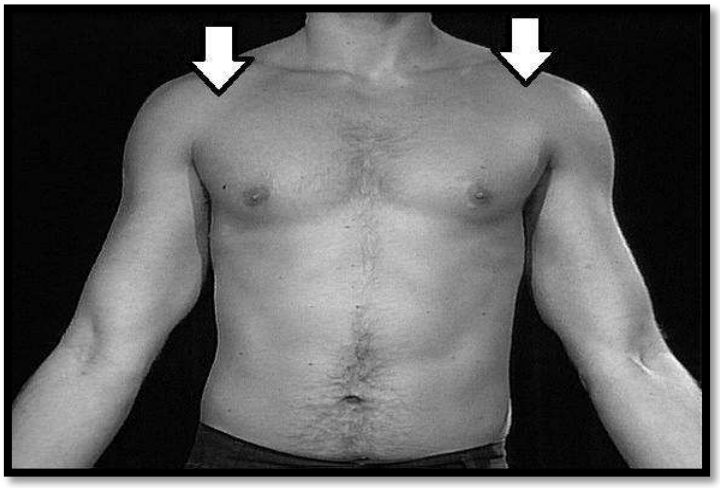

Figure 5:3: Mid Clavicular EGG Points

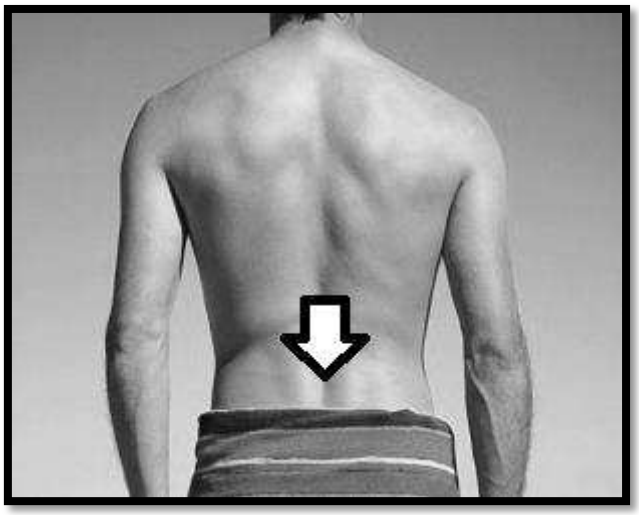

Figure 5:4: Posterior Median ECG Point

Cortisol Lab Consumables

The endocrine response of cortisol was measured by collecting saliva samples using a Salivette® (Sardest Ltd, Leicester, UK) (Figure 5:5).


Figure 5:5: Salivette® Sarstedt Tube

This method was utilised as it is a simple way to collect saliva for cortisol analysis. Due to the nature of the task and the prone position this was a favourable option to the drooling method or blood analysis. It has also been shown that this method of sampling offer results almost identical to the drooling methods with very similar coefficient of variations (Reck, Boob, Schwartz & Jewell, 2008). Due to the endocrine responses that occur when a Challenge or Threat state is elicited, saliva was collected to detect a change in cortisol as this has been associated with a Threat state (Gaab et al., 2005; Jones et al., 2009).

Dickerson and Kemeny's (2004) meta-analysis of acute stressors and cortisol response suggested that this experimental set up with social evaluative stress will elicit more of a stress response compared to passive tasks. This is similar to the findings of Mendes et al. (2008) and Blascovich and Tomaka (1996), in which social evaluative

elements are suggested to elicit a stress response. Dickerson and Kemeny's (2004) meta-analysis also suggested that the length of the stressor time is not important in regards to eliciting a cortisol response; therefore the three minute task adopted in this study is sufficient to achieve a stress response. The cortisol sample within this study was taken five minutes after the three minute task. Dickerson and Kemeny (2004) suggested that between 0-20 minutes post stressor (for social-evaluative and performance tasks) is a suitable time to ascertain a significant cortisol response. However, these responses are seen to dampen after this time window (e.g. 21-60 minutes post stressor). Therefore eight minutes post stressor is a suitable time to ascertain the cortisol response.

With regards to cortisol analysis, samples were sent to Salimetrics (Newmarket, UK) for analysis as there was no appropriate method of analysis available within Canterbury Christ Church University. The enzyme-linked immunosorbent assay (ELISA) Salimetrics commercial kit was used for analysis with an assay coefficient of variation 7.47%. All samples were analysed twice and the mean result of the two analyses used in data analysis.

After obtaining ethical clearance from Canterbury Christ Church University participants were recruited via student email, website, leaflets, posters (Appendix 9) and promotion in lectures, where participants were asked to take part in a shooting competition. It was advertised that this was a competition and that the top scorer would win £100. Once participants had signed up to the competition they were offered time slots either face to face or over email. After agreeing to these, participants were given an information sheet if recruited face to face or sent an email containing the information sheet (Appendix 10).

The exclusion criteria for the study were extreme visual impairment, which included those who are blind or partially blind and/or those unable to lie in a prone position for a long period of time; such as disabled individuals. Participants with corrected vision via contact lenses or glasses were included within the study.

The study was a quasi-experimental design (one visit), assessing shooting performance alongside self-reports of Challenge and Threat, cardiovascular responses of Challenge and Threat and emotions via the SEQ. The researcher did not try to manipulate participants into either a Challenge or Threat state, in an attempt to gain ecological validity.

Testing took place in a movement analysis laboratory within Canterbury Christ Church University, where only the experimenter and the participant were present. Displayed in Figure 5:6 is a diagrammatic representation of the data collection for this study.

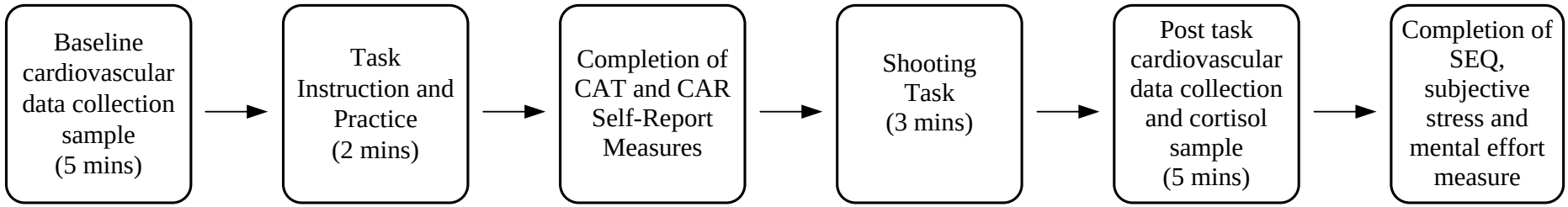


Figure 5:6: Diagrammatic Representation of Data Collection Protocols for Study

The participant was first asked to sit comfortably in a chair in an upright position and reminded of the information sheet that they had been sent via email or physically given before providing informed consent and requesting that participants refrained from caffeine intake or alcohol for at least 12 hours before taking part. This process was completed on a computer. The participants were then tested for eye dominance, as this is an important variable within shooting performance. This was done by an individual fixating on an object and bringing a sheet of card towards their face with a viewing hole. If they bring the card towards the left eye then they are left eye dominate and the same for the right, this is regardless of left of right handed individuals. Participants then completed a short eye test, where they were asked to cover their dominant eye and complete a vision acuity test. This is estimated by the Snellen chart (Figure 5:7) and is used as one of the methods to assess long sightedness by the National Health Trust (NHS, 2013). If participants were unable to read to 20/25 vision, the test was still carried out however they were not included within the final data set as their performance score may have been based upon their inability to see the target rather than their performance. Ambient temperature was also recorded alongside participant age and gender.

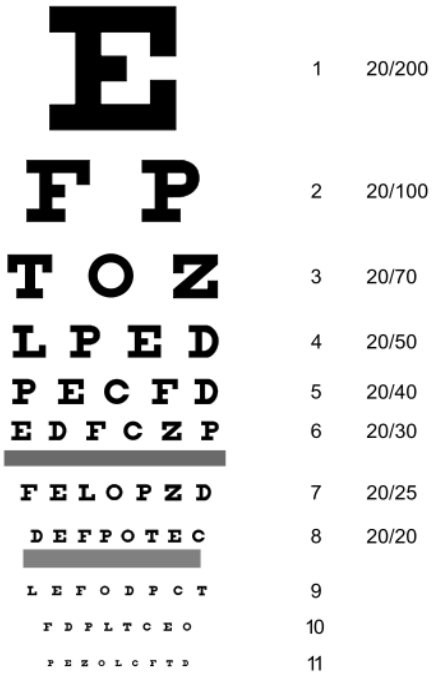


Figure 5:7: The Snellen Chart (Image redrawn from NHS, 2013)

Once eye dominance and visual acuity test had been determined the individual's height, sex and weight were recorded and then the cuffs of the Finometer™ were attached to the individual non-dominant arm. The participants were then asked to sit in the chair upright for 2 minutes whilst the Finometer™ calibrates the measures.

During this time participants were asked to chew a Salivette® to collect saliva to gain a baseline of cortisol before the task, they were asked to chew this for 2 minutes. Participants were then asked to lie in a prone position for a further 5 minutes to record baseline data of the cardiovascular measures. The task was then explained to the participant after the five minutes had elapsed. They were told that it was a competition and that their score would be entered into the score board immediately and peers could access this online. Participants were reminded that they would be in with a chance to win £100 in cash if they were the highest scorer overall. The participants were also informed at this stage that there would be no feedback during the task, so they would

not know until the protocol had ended what their final score was or how they did in relation to the online leader board (Appendix 11). As the gun was attached to a computer, this was facing away from the participant so that only the experimenter could see what the participant was scoring.

The task was explained to participants in the prone shooting position. During a three minute time period each participant would take 18 shots, with a shot taken every 10 seconds. Participants were told that they should take the shot after hearing a third bleep sound which signalled the start of the 10 seconds, but must take the shot before hearing the next set of bleeps which signalled the next 10 seconds. There was a TV screen ahead of the participants displaying how many shots they had taken at any time during the task. It was explained that each shot was worth 10.9, and they could score a total of 196.2 if they scored 10.9 for each shot. A demo of the bleep and shot display was then shown. A photo of the setup is shown in Figure 5:8.

Figure 5:8: Set up of protocol

Participants were then asked to perform five practice shots at the target to familiarise themselves with the kit. The practice of the task was not extensive as previous research has demonstrated that the amount of practice or exposure to a task dampens cardiovascular responses (Quigley et al., 2002). As one of the aims of the

thesis is to examine cardiovascular responses of Challenge and Threat, dampening the reactivity of these cardiovascular responses would not have been beneficial for this study. The practice scores were not included in the analysis, as all of the participants were novice shooters and similar to Moore et al. (2012), participants were asked to perform the task as a one off performance. Participants were then asked to complete the CAT and the CAR (Tomaka et al., 1993) on a laptop computer as this allowed them to stay in the prone position (Appendix 12).

Participants were then informed that during the task there would be no interaction between themselves and the researcher unless there was a malfunction with the kit. It was then requested that participants get into a shooting position that they felt comfortable and listen out for the bleeps to signal when to take the shots. Participants then took 18 shots at the target over a time period of three minutes. A photo of this set up is shown in Figure 5:9.

Figure 5:9: A picture of the task protocol during the task phase

After this was completed participants were asked to stay in the prone position for a further 5 minutes to gain post baseline cardiovascular measures. After this time had passed they were asked to sit upright on a chair for a further five minutes, this gives

a total time of 13 minutes from the beginning of the testing protocol and a total of 8 minutes from the stressor, as this is an adequate time to capture cortisol levels after a mental stressor (Dickerson & Kemeny, 2004). During this time the arm and finger cuff were removed from the participants and they were requested to give another saliva sample via the Salivette®, which was chewed by the participant for a further two minutes.

Participants were then required to complete the SEQ, subjective stress and mental effort self-report measure which was given to them via a computer. They were asked to rate the intensity of emotion experienced during the task and whether or not that was facilitative, debilitative or neither to their performance (Appendix 13). They were then given their final result and their final score was posted on the online leader board. Participants were then debriefed and were free to leave the laboratory. All cortisol samples were placed into a freezer at -80°C immediately after the participant protocol had finished.

### 5.3.3 Self-Report Measures

All of the self-report measures were presented to the subjects' via a laptop computer screen and the questionnaires were answered using a button click. All of the self-report measures used within the study are now listed.

#### Challenge and Threat in Sport Scale (CAT)

The final version CAT was administered to assess participants Challenge and Threat states. This consisted of 12 questions that were rated on a Likert scale of 1-6 from totally disagree to totally agree with reference to the upcoming task. The scores of the subscales Challenge and Threat were then calculated based on the total of the scores summed, divided by the number of items within each subscale.

Cognitive Appraisal Ratio (CAR; Tomaka et al., 1993)

Participants were also required to complete CAR questions (Tomaka et al., 1993) in order to assess their primary and secondary appraisals. This was presented to the participants with the question 'how stressful do you expect the upcoming task to be? and 'how able are you to cope with the upcoming task?'. These items were measured on a 7 point Likert type scale, from 1 being not at all to 7 being very much so. This was then calculated using primary appraisal/secondary appraisal with those scoring high classed as Threat relative to those scoring low classed as Challenged.

Sport Emotion Questionnaire (SEQ; Jones et al., 2005)

To examine emotions in regard to sport performance the Sport Emotion questionnaire (SEQ; Jones et al., 2005) was utilised in this study. This measure has also been utilised to measure emotion and its association with Challenge and Threat in recent research (Meijen et al., 2013[b]). The measures examines anxiety, anger, dejection, excitement and happiness, and has been widely used within a sport context (Meijen., et al[a]) and is shown to be a reliable and valid measure (Jones et al.,2005, Meijen et al., 2013[a]).

After the task, participants were asked to complete the SEQ (Jones et al., 1995) in which they were asked to indicate whether they had experienced certain emotions during the task and whether they found them to be debilitative of facilitative on a scale of -3 (debilitative) to 3 (facilitative). It was deemed those scores in the negative were indicative of debilitative and those in the positive were facilitative, and zero was neutral (neither debilitative nor facilitative). The following subscales were then calculated for anxiety, anger, dejection, excitement and happiness and scores for direction of emotions.

Subjective Stress (Tomaka et al., 1997)

The participants were also asked to rate how stressful they found the task. This was on a scale of 1 being not at all to 7 very much so and is taken from Tomaka et al. (1993) measure of subjective stress. It is suggested that subjective stress will have a negative association with Challenge and a positive association with Threat (Tomaka et al.,1993).

Mental Effort (Zijlstra, 1993)

The amount of mental effort was also assessed using the Rating Scale Mental Effort (RSME, Zijlstra, 1993). Participants were required to indicate on a vertical axis scale with a range of 0 to 150, 0 being 'no mental effort, 75 'moderate mental effort and 150 'a lot of mental effort. The RSME (Zijlstra, 1993) is regarded as an adequate estimation of the mental costs. Veltman and Gaillard (2008) state that compared to other existing measures the RSME appears to be more sensitive to variations in mental load. This measure was included as the TCTSA suggested that mental effort will decrease within a Challenge state (Jones et al., 2009).

5.3.4 Sample Size Estimation

A sample size of between 70-84 participants was sufficient for this study following Cohen (1992) and Turner et al. (2012) recommendations. This is similar to other study designs (Blascovich et al., 2004, Mendes et al., 2003, Williams et al., 2010, Turner et al., 2012; Meijen et al,. 2013[a] & Meijen et al., 2013[b]) where a sample size of around 48 is adopted regarding physiological data (e.g. cardiovascular determinants of Challenge and Threat). To explore self-reported psychological factors and their potential relationship to cardiovascular reactivity or performance a sample of 70 participants is required based upon achieving a power of 0.8 for significant medium

effects (r=.3, p<.05; Turner et al., 2012). Although these studies are not based upon the same study design as the current research programme, there is limited research to base sample size estimation upon, therefore Turner et al. (2012) research paper was selected as the researcher examines cardiovascular indices in combination with self-report and a sporting performance.

### 5.3.5 Data Analysis & Manipulation Checks

All statistical tests were performed using specialised statistical software (SPSS version 19.) apart from the CFA in which EQS V5 (Bentler & Wu, 1995; Bentler, 1992) was used. All data was subject to Shapiro Wilks or Kolmogorov-Smirnov normality tests and screened for outliers. If data violated the assumption of normality a non-parametric alternative was used.

To ensure the effects of ambient temperature did not impact performance, a Pearson's correlation test was conducted. There was no significant correlation between ambient temperature and performance accuracy ($p>0.05$). Eye dominance was also accounted for. An independent samples t-test was carried out on eye dominance and performance and there was no significant differences ($p>0.05$).

### Cardiovascular Reactivity Data Checks

HR reactivity is an important pre-requisite for the analysis of Challenge and Threat cardiovascular reactivity (Turner et al., 2012). In line with previous research using a paired t- test (Mendes, Reis, Seery & Blascovich, 2003) HR averaged across a three minute time period, in this case the task, was compared with the last minute of the baseline to determine if the task represented a motivational state for the participant. A paired samples t-test was conducted to compare the last minute of the baseline HR with the averaged HR across the three minute task cardiovascular data collection phase for

all participants. There was a significant increase from the last minute of the baseline HR (70.65 ± 11.89 to 78.23 ± 16.36 $b \cdot min^{-1}$), t (101) =-5.45, $p<0.01$). This indicated that participants engaged with the competitive task and that Challenge and Threat states could be examined.

In addition, to ensure any between-group differences were not due to differences in gender, a series of independent t-tests were carried out on the self-report measures included with the protocol, the performance scores and also the cardiovascular reactivity. No significant difference were revealed ($p>0.05$).

### Cardiovascular reactivity calculations

As in similar research (Mendes et al, 2003), reactivity of CO and TPR were calculated by subtracting the raw cardiovascular score for the last minute of the task from the average raw cardiovascular response across the three minute task period.

A Challenge and Threat index was also calculated where CO and TPR reactivity across the three minutes of the task were combined into a single Challenge and Threat index. Cardiovascular reactivity was calculated by subtracting the raw cardiovascular responses for the last minute of the baseline from the raw cardiovascular responses across the three minute task period. The index was calculated by converting the CO and TPR reactivity values into Z-Scores and summing them. CO was assigned a weight of +1 and TPR was assigned a weight of -1 so that larger values reflected Challenge reactivity. Following previous research (Blascovich et al., 2004; Seery et al., 2009; Moore et al., 2012; Turner et al., 2012) this index allow the examination of the combined cardiovascular reactivity and performance via linear regression.

### Cortisol response

The baseline measure of cortisol was subtracted from the post task measure to give the change for cortisol. Only 40 participants' samples were analysed as this was an exploratory analysis and one of the first studies to examine cortisol response and Challenge and Threat self-report in regard to a sport performance.

SEQ (Jones et al., 2005)

Cronbach's alpha for the SEQ subscales from the current sample was as follows: anxiety α=.86, dejection α=.53, excitement α=.78, anger α=.76 and happiness α=.83. Variables anger (Mean=.28, SD=.46) and dejection (Mean=.18, SD=.27) were excluded from further analyses due to low scores.

Inferential Statistical Analyses

To address aim one of the study, a CFA was used to assess the construct validity of the CAT and Cronbach Alphas analyses were used to examine internal reliabilities of the subscales. To address the second aim of this chapter, in line with previous literature three stages of regression analyses were used (Blascovich, et al., 2001; Turner et al., 2012, Meijen et al., 2013[b]). The third examined the predictive validity of Challenge and Threat self-report on performance, emotions (intensity and direction), cardiovascular reactivity and endocrine response. The second examined the predictive validity of cardiovascular reactivity on performance, emotions (intensity and direction), Challenge self-report, Threat self-report and endocrine response. The third regression examined cortisol response on performance, Challenge and Threat self-report, emotion (direction and intensity) and cardiovascular reactivity. A multiple step-wise regression method was utilised because this was an exploratory analysis, therefore it was important to identify any significant predictors either alone or in combination with one another to gain an understanding of any significant relationships that were present.

To address aim three of this chapter, a 2 Group (Challenge, Threat ) x 2 Level (Low; High) multivariate analysis of variance (MANOVA) was performed to examine how Challenge and Threat patterns relate to performance, cardiovascular reactivity, and reported emotions experienced (intensity and direction). A separate one-way analysis of variance (ANOVA) was conducted for the interpretation of cortisol as fewer participants were included in the sample used for analysis. Levene's "F statistic" was used to examine if any of the data violated the assumptions. However all data was deemed appropriate for parametric analysis ($p<0.05$).

### Challenge and Threat Groups

Analysis for the Challenge and Threat groups included the third split of the groups (highest and lowest) 33% of the sample size. This approach was adopted as very few participants reported high levels of Threat and/or low levels of Challenge within the sample. The labels were assigned based upon the mean scores on the CAT (Challenge and Threat) and were coded as follows; 1-2.9 was classed as Low, 3-4.9 Moderate and 5-6 High. This left 4 groups labelled Moderate Challenge/Low Threat, Moderate Challenge/Moderate Threat, High Challenge/Low Threat and High Challenge/Moderate Threat. This allowed exploration of the data combining both levels of Challenge and Threat. Ten male participants were selected from each appraisal group in order to examine cortisol response in regards to Challenge and Threat reports in combination with each other. Female participant were not selected, due to hormonal responses associated with the menstrual cycle.

To address aim four of this chapter three steps were taken. First, a median split was conducted on the Challenge and Threat subscales of the CAT. Second, the interaction of emotion intensity and direction was assessed using the same procedures as Lundqvist et al. (2011). Specifically the scores on the SEQ; 0-1 was coded as Low

intensity and 2-4 was coded Moderate to High Intensity. For the direction +1 to+3 was coded as facilitative and -1 to -3 was coded as debilitative, where 0 was coded as neutral. These were combined to yield six groups. These groups were labelled 'Moderate to High/Debilitative', 'Moderate to High/Facilitative', 'High to Moderate/Neutral', 'Low and Debilitative', 'Low and Facilitative' and 'Low and Neutral' for emotions. Finally, the frequencies of the occurrences of each of these groups within the median splits were compared using a series of Cross-Tabs and Chi-Square analyses for each emotion.

## 5.4 Analysis 1- Descriptive Statistics and Correlations

In order to examine any relationships between the indices of Challenge and Threat and outcome measures, a series of statistical analyses were adopted. Full descriptive statistics and correlations for performance variables, Challenge and Threat self-report and their associations with cardiovascular reactivity, cortisol response, emotions, mental effort and subjective stress were examined (Appendix 14). The key findings from this analysis are highlighted in the following sections under sub-headings.

### Challenge (CAT)

In regard to performance parameters the report of Challenge on the CAT had a significant correlation with performance accuracy ($r=-.21$, $p<0.05$), alongside length trace ($r=.20$, $p<0.05$), Steady 10a movement ($r=-.23$, $p<0.05$) and group size ($r=.21$, $p<0.05$). Moreover, an examination of Challenge scores on the CAT with subjective stress showed a significant positive relationship ($r=.22$, $p<0.01$). With regards to emotion intensity, Challenge had a significant positive correlation with excitement intensity ($r=.20$, $p<0.05$) and a significant negative correlation with anxiety ($r=-0.14$, $p<0.05$). There was also an observed positive relationship with excitement and

happiness direction. The more Challenge experienced the more facilitative excitement ($r=.22$, $p<0.05$) and happiness($r=.25$, $p<0.05$) were reported.

Threat (CAT)

The self-report of Threat on the CAT had a significant correlation with length trace ($r=.26$, $p<0.05$), and stability of time intervals between shots ($r=-.20$, $p<0.05$) and a significant correlation with the CAR ($r=.59$, $p<0.01$). Subjective stress significantly increases when Threat report increases ($r=.36$, $p<0.01$) and anxiety increases as Threat report increases ($r=0.38$, $p<0.05$).

CAR (Tomaka et al., 1997)

The CAR had a significant positive correlation with subjective stress report ($r=.52$, $p<0.01$) and anxiety ($r=.43$, $p<0.01$).

Cortisol response

There was a significant correlation observed between report on the CAR and cortisol delta ($r=.38$, $p<0.05$) and mental effort ($r=-.40$, $p<0.05$).

Cardiovascular Reactivity

There were no significant correlations observed between cardiovascular reactivity of CO and TPR and self-report measures of Challenge and Threat on the CAT, CAR or subjective stress or mental effort ($p>0.05$).

5.4.1 Analysis 1- Discussion

Threat is associated with longer trace length and a decrease in time intervals between shots. Although it is suggested that increased shooting accuracy is associated with minimal movement around the target and longer time intervals between shots (Causer, Bennett, Holmes, Janelle & Williams, 2010), overall accuracy was not shown to have an association with Threat report. Tentatively, Threat then, seemed to have an

impact on co-ordination and control of movement, but this did not translate to changes in performance outcome in this sample of shooters. In contrast, Challenge has a negative correlation with performance accuracy and a positive correlation with group size (smaller group size is indicative of accurate aiming). This intimates that Challenge has a negative impact upon performance, and is contradictory to the TCTSA suggestion that Challenge is associated with facilitative performance.

A possible explanation lies within the neuroendocrine responses markers shown to be associated with a Challenge state. As Ball, Russell, Best and Wrigley (2003) explain shooting is an Olympic sport, with over 15 categories and rifle shooting is one of the most technical of these requiring extreme precision for success. Lakie (2010) suggested that factors which affect physiological tremor size inversely correlate with shooting ability. If adrenaline markedly increases tremor size (Lakie, 2010) and adrenaline release is associated with SAM activation and a Challenged state, then it may be logical to assume that a Challenged state may not be facilitative to shooting performance within this study.

Furthermore, Challenge, Threat and the CAR have a positive relationship with subjective stress. These findings support the notion that Challenge and Threat are stress appraisals (Lazarus, 2000). Threat yielded a stronger association with subjective stress than Challenge and the CAR. This supports previous findings that subjective stress is experienced more so in individuals experiencing Threat in isolation compared to those experiencing Challenge (Tomaka et al., 1993).

The results also suggested that Challenge is positively associated with excitement and this supports Jones et al's. (2009) suggestion that positive valence emotions are associated with Challenge. The CAR and Threat were positively

associated with anxiety, whereas Challenge was negatively associated with anxiety. The TCTSA suggested that anxiety can be associated with both Challenge and Threat, but how the individual perceives anxiety (facilitative or debilitative) may differ depending on if the individual is more Challenged (more likely to perceive anxiety as facilitative) or Threatened (more likely to perceive anxiety as debilitative). Furthermore, excitement and happiness were reported as more facilitative as Challenge report increased.

The examination of cortisol response and its positive association with Threat report on the CAR showed support for the suggestions that cortisol response is heightened when an athlete is experiencing a Threatened state. This shows support for the suggestion by Dienstbier (1989) than neuroendocrine responses such as the PAC activation are associated with a Threat appraisal.

Cortisol response was also shown to have a negative correlation with mental effort measured. This finding differs from Jones et al. (2009) suggestion that mental effort will increase in a Threatened state and will lead to reinvestment in the task performance. Alternatively, Peters, Godaert, Ballieux, van Vliet, Willemsen, Sweep and Heijnen (1998) found that high mental effort leads to greater increases in HR, blood pressure and noradrenaline levels. Peters et al. (1998) suggested that when endocrine responses related to Challenge are activated (such as noradrenaline); there is an increase in mental effort.

Therefore if an increased mental effort is associated with endocrine responses of Challenge, endocrine response associated with Threat (cortisol) are less likely to occur if mental effort is high. Therefore decreased mental effort is potentially associated with Threat based upon endocrine responses.

The cardiovascular reactivity was shown to have no associations with Challenge and Threat report or any of the other measures included within this analysis. This is similar to other recent findings, indicating that Challenge and Threat self-report and performance measures in a sport context have little or no association with cardiovascular measures (Meijen et al., 2013[b]; Turner et al., 2012).

## 5.5 Analysis 2-Confirmatory Factor Analysis

In order to address the first aim of this study, a further examination of the CAT with another sport related sample was conducted using CFA. The same procedure for analysis was carried out as in Chapter 3 and 4 regarding the CFA. This was to examine the factor structure of the CAT in an independent sample from the previous chapters. The examination of internal consistency was also examined using Cronbach's alpha. Further exploration of the data using CFA yielded a good fit model, with all constructs of acceptable fit, see Table 5:2.

Table 5:2: CFA for the CAT

| Fit Index<br>Sample (n=147) | Correlated |
|---|---|
| Satorra-Bentler $\chi^2$ | 83.59* |
| Robust Comparative Fit Index (RCFI) | 0.93 |
| Goodness of Fit (GFI) | 0.94 |
| Root Mean Square Error of Approximation (RMSEA) | 0.07 |

*$p < 0.05$

Cronbach's alpha for the CAT subscales from the current sample was as follows: Challenge $\alpha = .80$, Threat $\alpha = .89$ indicating high internal consistency.

### 5.5.1 Analysis 2-Discussion

The values obtained in the CFA of the CAT suggested that the model fit are sufficient with high internal consistency. Based upon this analysis and previous results

from Chapter 3 and 4, the CAT is shown to be a suitable tool to examine Challenge and Threat. Therefore the predictive validity of the CAT will now be examined in analysis 5.6, alongside the predictive validity of physiological responses associated with Challenge and Threat to address the second aim of this chapter.

## 5.6 Analysis 3-Predictive Validity

### 5.6.1 Analysis 3a- Predictive Validity of Challenge and Threat Self-Report

To examine the predictive validity of Challenge and Threat self-report, performance accuracy was entered as an outcome variable. No significant proportion of variance was accounted for by Threat report (CAT) and CAR regarding performance ($p>0.05$) and they were therefore removed from the model. However, there was a significant proportion of variance accounted for by Challenge report on the CAT ($R^2=.043$, $p<0.05$) and performance; as Challenge report increased performance decreased (ß=-.206, $p<0.05$), see Table 5:3.

Table 5:3: Summary Regression Analysis for Performance Accuracy, Challenge (CAT), Threat (CAT) and CAR

| | Performance Accuracy | | |
|---|---|---|---|
| | b | SE b | ß |
| Challenge (CAT) | -7.13 | 3.42 | -.206* |

*$p<0.05$, Performance Accuracy; Challenge $R^2=.043$

Furthermore the predictive validity of the self-report measure of Challenge and Threat were examined in relation to emotions. Anxiety, excitement and happiness were entered as the outcome variable in three separate regression analyses, there was no significant proportion accounted for regarding excitement and happiness ($p>0.05$). There was a significant proportion of variance accounted for regarding the self-report measures of Challenge, Threat and anxiety which accounted for 16% of variance

($R^2$=.168). Challenge report was associated with a decrease in anxiety report (ß=-.233, $p<0.05$), Threat report was associated with an increase in anxiety report (ß=.346, $p<0.05$) and as the CAR scored increased so did anxiety report (ß=.418, $p<0.05$).

A further seven regression analyses were conducted to examine the predictive validity of Challenge, Threat and CAR and the direction of emotion (anxiety, excitement and happiness), cardiovascular reactivity (CO, TPR and Challenge and Threat Index) and cortisol response as outcome variables. However, none of self-report measures were shown to have any significant variances accounted for within these variables ($p>0.05$).

### 5.6.2 Analysis 3b- Predictive Validity of the Cardiovascular Measures

To examine the predictive validity of cardiovascular measures on performance, emotion intensity and direction and cortisol, 11 regression analyses were conducted with performance, emotion intensity (anxiety, excitement and happiness), emotion direction (anxiety, excitement and happiness), cortisol reactivity and Challenge, Threat and CAR as outcome variables. No significant proportion of variance was accounted for by CO reactivity, TPR reactivity or Challenge and Threat Index regarding performance, Challenge, Threat, CAR, emotion intensity, emotion direction or cortisol response ($p>0.05$).

### 5.6.3 Analysis 3c- Predictive validity of Cortisol

An examination of the predictive validity of cortisol response was examined with 13 multiple regression analyses cardiovascular reactivity (CO, TPR and Challenge and Threat Index), emotional intensity (anxiety, excitement and happiness), direction (anxiety, excitement and happiness), Challenge, Threat, CAR and performance. However, there was no significant variance accounted for ($p>0.05$).

### 5.6.4 Analysis 3-Discussion

The examination of performance and self-reports of Challenge and Threat via the CAT and the CAR, were similar to associations within Analysis 1. Challenge was shown to predict shooting performance negatively. As Challenge report increased shooting performance decreased. As previously discussed in Analysis 1 this could be due to an increase in adrenaline, causing an increase in tremor size which is associated with a decrement to shooting performance (Lakie, 2010).

The examination of self-reports of intensity of emotion showed some support for the TCTSA (Jones et al., 2009). Within this study, Challenge negatively predicted anxiety, whereas Threat and CAR positively predicted anxiety. This suggested that anxiety is experienced at a higher intensity in a Threat state compared to that of a Challenge.

Collectively within this section of the analysis the examination of cardiovascular reactivity in regards to self-report of Challenge and Threat, emotion direction and intensity, cortisol response and performance yielded limited support for the BPSM and the cardiovascular measures indicative of Challenge and Threat. These further support the findings of that in Analysis 1. There may be several explanations for these finding collectively. Firstly, recent studies examining Challenge and Threat have tried to elicit these responses via manipulation and the present study did not. Therefore the reactivity recorded within the study may not have been as heightened to the extent they might have been if manipulated.

Secondly, Turner et al. (2012) explain that when approaching a motivated performance situation increased muscular tension, as part of an anxiety response, may inhibit vessel dilation and thus a TPR increase. Understanding the complexity of

Challenge and Threat states is important because, as Jones et al. (2009) reports, in the TCTSA it may be possible to experience anxiety but still perceive the situation as a Challenge or a Threat. Therefore, if anxiety is associated with an increase in TPR (Turner et al., 2012), then decrease in TPR to be indicative for a Challenged state is questionable. Thirdly, repressors (Eysenck & Derakshan, 1997) and individuals unable to detect their own physiological responses (Wiens, Mezzacappa and Katkin, 2000) will be elaborated on within section 5.9 of this chapter.

Thirdly, there have been seldom studies that have included social evaluative elements of Challenge and Threat, a performance task and examination of cardiovascular indices during the performance task. Therefore the study may have shown some equivocal results due to the novel design of the protocol.

Collectively these results show mixed support for the TCTSA and limited support regarding the cardiovascular responses ability to predict outcome variable. Further to this, in analysis 4 and to address aim three of the study, an examination of a combination of Challenge and Threat was conducted, advocated by suggestions that Challenge and Threat can be experienced in combination with one another (Cerin, 2003; Meijen et al., 2013[a]).

## 5.7 Analysis 4-Challenge and Threat in Combination

To allow an examination of the suggestion that Challenge and Threat can be experienced in combination with one another (Cerin 2003; Meijen et al., 2013 [a]), the Challenge and Threat groups were formed using top and bottom 33% of the sample as described in section 5.3.5 of this chapter. The final sample included Moderate Challenge/Low Threat (11 participants), Moderate Challenge/Moderate Threat (13 participants), High Challenge/Low Threat (15 participants) and High Challenge/Moderate Threat (18 participants). See Table 5:4 for the descriptive.

Table 5:4: Challenge and Threat Group Descriptive Statistics

| Challenge and Threat Group | Mean Ages (Years) and SD Males | Number of Males | Mean Ages (Years) and SD Females | Number of Females | Total Participants |
|---|---|---|---|---|---|
| Moderate Challenge/Low Threat | 33.4 (10.11) | 10 | - | 1 | 11 |
| Moderate Challenge/Moderate Threat | 25.57 (11.37) | 10 | 28.16 (13.95) | 3 | 13 |
| High Challenge/Low Threat | 33.36 (15.57) | 11 | 25 (8.52) | 4 | 15 |
| High Challenge/Moderate Threat | 21.14 (4.55) | 14 | 27.5 (5.8) | 4 | 18 |

The results for the MANOVA showed a main effect for group (Challenge/Threat pattern), Wilks $\Lambda$=.650, F (11, 42) =2.05, $p<0.05$, $\eta^2_p$=0.83. Univariate Bonferroni corrections showed that there was a significant difference between Challenge and Threat patterns in terms of performance accuracy, F (3, 53) =4.33, p<0,01, $\eta^2_p$=0.84, aiming time, F (3, 53) =4.49, $p<0.01$, $\eta^2_p$=0.85, snatch, F (3, 53) =4.05, $p<0.05$, $\eta^2_p$=0.81, steady 10a, F (3, 53) =3.86, $p<0.05$, $\eta^2_p$=0.79, trace length, F (3, 53) =3.73, $p<0.05$, $\eta^2_p$=0.77, CO reactivity (between reactivity from the last minute of the baseline to mean reactivity across the three minutes of the task), F (3, 53) =3.04, $p<0.05$,

$\eta^2_p$=0.68, anxiety intensity, F (3, 53) =3.35, p<0.05, $\eta^2_p$=0.72, happiness intensity, F (3, 53) =3.46, p<0.01, $\eta^2_p$=0.95 and excitement intensity, F (3, 53) =3.40, p<0.01, $\eta^2_p$=0.88. These findings will now be examined in further detail in sections 5.7.1. to 5.7.3. Each section illuminates where the significance findings lie with regard to performance, physiological data and emotions respectively.

### 5.7.1 Analysis 4a- Challenge and Threat (CAT) Combined Analysis: Accuracy of Performance

For accuracy of performance, Moderate Challenge/Low Threat scored higher on the shooting task (Mean=7.96, SD=1.49) than Moderate Challenge/Moderate Threat (Mean=6.23, SD=1.16, p=0.03), High Challenge/Low Threat (Mean=6.40, SD=1.19, p<0.001) and High Challenge/Moderate Threat (Mean=6.75, SD=1.30, p=0.01).

For aiming time, Moderate Challenge/Low Threat spent the most time aiming at the target before taking the shot (Mean=4.47seconds, SD=1.18seconds) compared to Moderate Challenge/Moderate Threat (Mean=2.77 seconds, SD=1.09 seconds, p<0.001), High Challenge/Moderate Threat (Mean=2.66 seconds, SD=1.30 seconds, p=0.02) and High Challenge/Low Threat, Mean=3.23 seconds, SD=1.50 seconds, p<0.001).

For the snatch, Moderate Challenge/Low Threat had the lowest snatch (Mean=16.86, SD=6.69) and was significantly different compared to Moderate Challenge/Moderate Threat (Mean=31.29, SD=12.37, p<0.001 and High Challenge/Moderate Threat (Mean=29.98, SD=14.25, p<0.001).

For the amount of movement in the Steady 10a of the target Moderate Challenge/Low Threat had the most movement in the 10a of the target (Mean=37.99mm, SD=18.04mm) and was significantly different compared to Moderate Challenge/Moderate Threat (Mean=17.75mm, SD=14.10mm, p<0.001), High

Challenge/Low Threat (Mean=18.74mm, SD=12.03mm, $p<0.001$) and High Challenge/Moderate Threat (Mean=19.61, SD=20.68, $p<0.001$).

In regard to length, Moderate Challenge/Low Threat had a significantly shorter trace length (Mean=155.73mm, SD=51.29mm) compared to Moderate Challenge/Moderate Threat (Mean=257.94mm, SD=120.32mm, $p=0.01$) and High Challenge/Moderate Threat (Mean=270.34mm, SD=144.21mm, $p<0.001$).

This analysis suggested a Moderate Challenge/Low Threat produces better performance compared to the other groups for the performance variables overall accuracy, length, snatch and also the amount of movement made in the centre of the target (Table 5:5).

Table 5:5: Means and Standard Deviations (SD) for Performance Variables between Challenge and Threat Groups

| | Performance Variables (Means and SD) | | | | |
|---|---|---|---|---|---|
| Challenge and Threat Groups | Performance Accuracy | Aiming Time(s) | Snatch (mm) | Steady 10a (mm) | Length (mm) |
| Moderate Challenge/Low Threat | 7.96 (1.49)* | 4.47 (1.18)** | 16.86 (6.69)** | 37.99 (18.04)* | 155.73 (51.29)** |
| High Challenge/Low Threat | 6.40 (1.19) | 3.23 (1.50) | 24.83 (9.03) | 18.74 (12.03) | 270.34 (144.21) |
| Moderate Challenge/Moderate Threat | 6.23 (1.16) | 2.77 (1.09) | 31.29 (12.37) | 17.75 (14.10) | 257.94 (120.32) |
| High Challenge/Moderate Threat | 6.75 (1.30) | 2.66 (1.30) | 29.98 (14.25) | 19.61 (20.68) | 228.60 (120.43) |

*$p < 0.05$, **$p < 0.01$

### 5.7.2 Analysis 4b- Challenge and Threat Combined Analysis: Cardiovascular Reactivity and Cortisol Delta

For CO reactivity across the whole 3 minutes of the task, High Challenge/Moderate Threat (Mean= .65, SD= .55) had higher reactivity than High Challenge/Low Threat (Mean=.21, SD=.24, $p<0.001$).

No significant differences were observed between the groups and TPR reactivity, F (3, 53) =.55, p=.064, $\eta^2_p$=0.15, Challenge and Threat Index, F (3, 53) =1.66, p=.18, $\eta^2_p$=0.41 or cortisol response, F (3, 35) =1.91, p=.14, $\eta^2_p$=0.45). However, the largest delta within the groups was the Moderate Challenge/Moderate Threat group. This suggested that in line with the literature higher levels of cortisol are associated with higher levels of Threat report and lower levels of Challenge report (Dienstbier; 1989; Jones et al., 2009). The descriptives are shown in Table 5:6.

Table 5:6: Mean and Standard Deviations (SD) for Cardiovascular Reactivity and Cortisol Delta

| | Cardiovascular reactivity and Cortisol Delta Mean and (SD) | | | |
|---|---|---|---|---|
| Challenge and Threat Group | CO (L/min) | TPR (dyn·s/cm5) | Challenge and Threat Index | Cortisol (nmol/L)** |
| Moderate Challenge/Low Threat | .21 (.24) | 46.09 (165.36) | .25 (2.13) | .17 (.16) |
| High Challenge/Low Threat | .22 (.06) | 53.18 (68.49) | -1.00 (1.64) | .12 (.16) |
| Moderate Challenge/Moderate Threat | .38 (.09) | 64.46 (128.70) | .25 (.99) | .27 (.14) |
| High Challenge/Moderate Threat | .65 (.55)* | 13.61 (108.60) | -1.00 (1.94) | .12 (.16) |

*p< 0.01, **Note cortisol analysis only included 39 participants

### 5.7.3 Analysis 4c-Challenge and Threat (CAT) Combined Analysis: Emotion Intensity and Direction

Moderate Challenge/Moderate Threat reported significantly higher anxiety (Mean=1.62, SD=.73) compared to Moderate Challenge/Low Threat (Mean=.76,

SD=.73, p=0.09) and High Challenge/Low Threat (Mean=.84, SD=.80, p=0.01). Other comparisons did not reach statistical significance (p>0.05), see Table 5:7.

Table 5:7: Means and Standard Deviations (SD) for Emotion Intensity (SEQ) between Challenge and Threat Groups

| Emotion Intensity Mean and SD | | | |
|---|---|---|---|
| Challenge and Threat Group | Excitement | Happiness | Anxiety |
| Moderate Challenge/Low Threat | 1.42 (.68)* | 1.32 (.88)** | .76 (.73) |
| High Challenge/Low Threat | 2.58 (72) | 2.58 (.73) | .84 (.80) |
| Moderate Challenge/Moderate Threat | 2.05 (.69) | 2.05 (.69) | 1.62 (.73)* |
| High Challenge/Moderate Threat | 2.11 (.98) | 2.00 (.7) | 1.18 (.18) |

*p< 0.05, **p< 0.01

Moderate Challenge/Low Threat reported experiencing less excitement (Mean=1.42, SD=.68) than Moderate Challenge/Moderate Threat (Mean=2.05, SD=.69, p=0.03), High Challenge/Low Threat (Mean=2.58 SD=.72, p=0.00) and High Challenge/Moderate Threat (Mean=2.11, SD=.98, p=0.01).

Moderate Challenge/Low Threat reported experiencing significantly less happiness (Mean=1.32, SD=.88) than Moderate Challenge/Low Threat (Mean=2.58, SD=.73, p=0.00), Moderate Challenge/Moderate Threat (Mean=2.05 SD=.69, p<0.001) and High Challenge/Moderate Threat (Mean=2.00, SD=.70, p<0.001).

There was no significant difference between the group emotion direction in regard to excitement F (3, 53) =.44, p>0.05, $\eta^2_p$=0.11, happiness, F (3, 53) =1.27, p>0.05, $\eta^2_p$=0.61 or anxiety F (3, 53) =.36, p>0.05, $\eta^2_p$=0.11 see Table 5:8.

Table 5:8: Means and Standard Deviations (SD) for Emotion Direction (SEQ) between Challenge and Threat Groups

| | Emotion Direction Mean and SD | | |
|---|---|---|---|
| Challenge and Threat Groups | Excitement | Happiness | Anxiety |
| Moderate Challenge/Low Threat | 1.61 (.88) | 1.57 (.96) | -.036 (.97) |
| High Challenge/Low Threat | 1.93 (.93) | 1.60 (.89) | .37 (.1.15) |
| Moderate Challenge/Moderate Threat | 1.82 (.1.14) | 1.94 (1.24) | .57 (.1.33) |
| High Challenge/Moderate Threat | 1.68 (1.01) | 1.61 (.92) | .20 (.73) |

### 5.7.4 Analysis 4-Discussion

This analysis examined the interaction of Challenge and Threat on performance, cardiovascular reactivity, cortisol response, emotion direction and intensity. In regard to cardiovascular reactivity, High Challenge/Moderate Threat had significantly higher CO reactivity than High Challenge/Low Threat. According to Blascovich et al. (2004) CO increases in Challenge and Threat states; it is proposed to increase more so in Challenge compared to that of Threat. However, there is no quantifiable amount to which an individual can be based in either a Challenge or Threatened state without examining the TPR. As noted before, TPR is affected by anxiety and anxiety experienced can be perceived positively or negatively whilst experiencing a Challenged or Threatened state. Therefore this can lead to problems when using cardiovascular reactivity to examine Challenge and Threat. It is possible that anxiety can be experienced simultaneously with Challenge and/or Threat, therefore compromising TPR as a measure of Challenge and/or Threat.

Furthermore, Turner et al. (2012) states that it is not known exactly how Challenge cardiovascular reactivity facilitates performance, or how Threat cardiovascular reactivity disrupts performance if at all. Therefore it could be concluded

from this study that the examination of cardiovascular reactivity may not help to further our understanding of Challenge and Threat in a sports setting.

Based upon further results within this study there may be a more complex mechanism to examine Challenge and Threat using a bivariate rather than bipolar perspective. In regards to performance the findings in this study suggested that Moderate Challenge/Low Threat had the highest performance accuracy, the highest 10a movement and the lowest length compared to the other groups. Therefore Moderate Challenge/Low Threat yielded the highest performance attributes. These findings further support earlier suggestions that a high Challenged state may not be facilitative to shooting performance in Analysis 1 and 3a, and in fact a pattern of both Challenge and Threat further help to understand which are associated with facilitative performance.

In regards to emotions, Moderate Challenge/Low Threat experienced significantly lower intensity of happiness and excitement compared to the other groups. Jones et al. (2009) suggested that positive valence of emotions is associated with a Challenged state; therefore, a Moderate Challenge state combined with low Threat may not be expected to be associated with high levels of positive valence emotions.

Anxiety is associated with Challenge and Threat according to Jones et al. (2009). The Moderate Challenge/Moderate Threat group reported significantly higher levels of anxiety intensity than Moderate Challenge/Low Threat and High Challenge/Low Threat. This requires further exploration as to whether experiencing positive and negative emotional valence is perceived as facilitative or debilitative to performance when examining combinations of both Challenge and Threat. Therefore, an analysis of Emotion Direction and Intensity is examined in Analysis 5.

## 5.8 Analysis 5-A further examination of Emotion Direction and Intensity Combined

There was no significant difference between Challenge and Threat median splits on the CAT regarding any of the emotion direction and intensity combinations ($p>0.05$).

### 5.8.1 Analysis 5-Discussion

An examination of these crosstabs collectively suggested that experiencing excitement and happiness whether it is at high or low intensity level is reported as facilitative regardless of whether or not the individual is perceiving the situation as a Challenge, Threat or a mixture of both. However, these findings were not significant in the Chi-Square analysis ($p>0.05$). This may have been due to the lack of participants reporting high Threat and low Challenge and a very limited number of individuals reporting any of the emotion intensities as neutral. However this showed support for the notion that positive emotions are seen as facilitative to an individual performance. This also gives an insight into the TCTSA suggestion that positive emotions are more likely to occur in a Challenge state, however these finding suggest that positive emotions are likely to occur in a Challenge or Threat state and that rather than being perceived as debilitative in a Threat state they are perceived as being facilitative regardless of Challenge or Threat.

## 5.9 Summary

The aims of the present study were to 1. Further examine the CAT in an independent sample to test its predictive validity in regard to performance, emotion intensity and direction; 2. To examine the physiological responses associated with Challenge and Threat and its ability to predict performance and emotion intensity and direction; 3. To examine the interaction of Challenge and Threat upon performance, physiological responses, emotion intensity and emotion direction and 4. Based on

Lundqvist, et al. (2011) recommendations to examine the interaction of Challenge and Threat on the combination of emotion direction and intensity.

Firstly, the present study showed further support for the use of the CAT within sport related samples, yielding a good model of fit and acceptable internal consistency values. Furthermore, regarding the examination of Challenge and Threat report, result suggested that higher levels of Challenge were not ideal when completing a motor skill task, such as shooting. This data does not support previous suggestions that a Challenge state can induce a facilitative performance (Jones et al., 2009). However this may be due to the impact adrenaline response may have upon physiological tremor, impacting performance in a negative way (Lakie, 2010). Previously in Chapter 4, Challenge is shown to have a positive impact upon running performance in half-marathon runners; therefore this demonstrates the complexity of examining Challenge within a sporting context.

Within this study, cardiovascular reactivity yielded limited support for the use of the BPSM within a sport setting. There may be a number of reasons for these findings as previously discussed within the aims of this Chapter. Firstly, those who dissociate their somatic reactions from their perceptions of stress may inhibit individual reports of Challenge and Threat, therefore causing some discrepancies between these two constructs. Secondly, individual's inability to perceive their own physiological responses may also elicit some discrepancies between self-report and cardiovascular measures. Within this study, cardiovascular measures did not have an association with performance measures; this again might be because individuals' cardiovascular reactivity is not always shown to have a direct association with performance. For example Turner et al. (2012) as previously discussed detailed that individuals

experiencing similar levels of Threat cardiovascular reactivity can performance very well and in contrast very poorly.

To highlight some of the discrepancies, none of the TPR reactivity had any association with any of the variables examined. In Figure 5:10 and Figure 5:11 are the direction of TPR outlined in the BPSM and the TPR reactivity patterns for the Challenge and Threat groups within this current research programme.

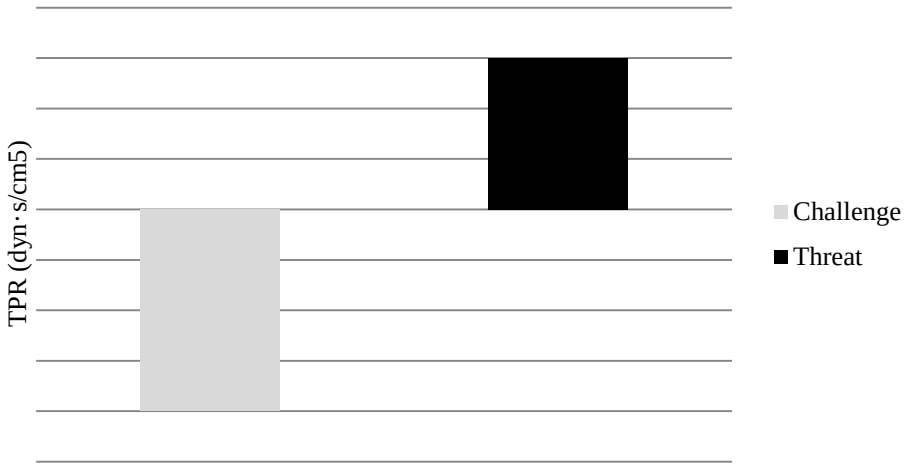


Figure 5:10: TPR Reactivity Values based on BPSM

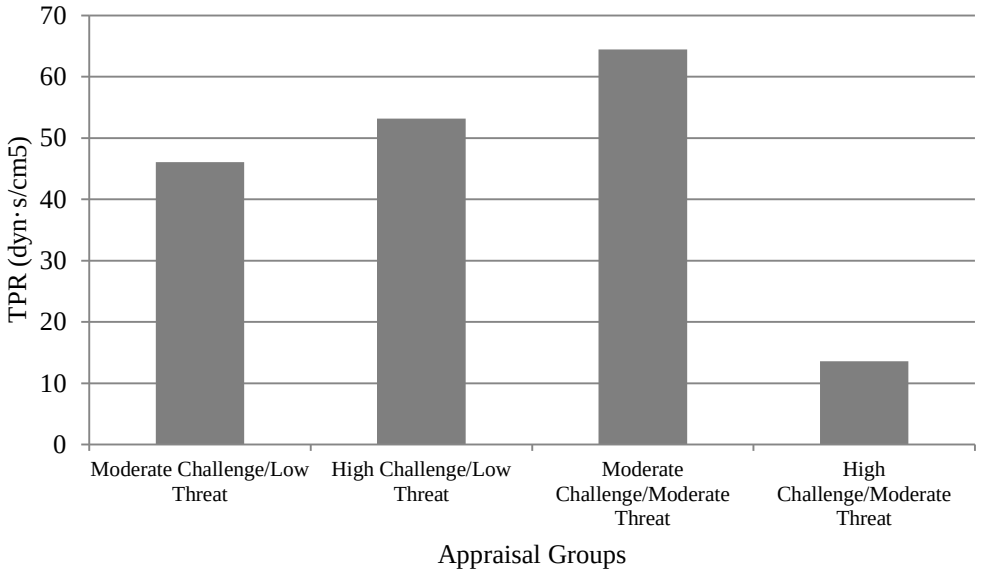


Figure 5:11: TPR Reactivity Values from Study 3 Challenge and Threat Groups

It would be expected that the High Challenge/Low Threat group would have the lowest levels of TPR reactivity as higher levels of Challenge are associated with a decrease in TPR and lower levels of Threat are associated with a smaller increase or no increase in TPR compared to that of High Threat (Figure 5:10). However, High Challenge/Moderate Threat had the lowest level of TPR reactivity.

One explanation of this may be Lazarus (2000) suggestion that appraisals are dynamic; therefore a change in appraisal during the task may have altered cardiovascular reactivity. These explanations further highlight the issues with using cardiovascular response to measure Challenge and Threat and may contribute to why there is mixed support for the BPSM within the existing literature. It could be argued that within this study and recent studies (Turner et al., 2012; Turner et al., 2013; Moore et al., 2012) the analysis adopted takes a static snapshot of cardiovascular indices (for example this study takes 3 minutes) and therefore there may be change occurring at a vascular level which may be indicative of Challenge and Threat. Recent studies such as

Turner et al. (2012) do not contain any direct evidence of the underpinning mechanisms by which Challenge and Threat cardiovascular reactivity influences cognitive and motor performances.

Another explanation is that of repressors or of individuals who are not as aware of their own physiological responses as others. This is important in understanding Challenge and Threat, as cardiovascular indices may not be able to decipher between an individual in a Challenge or Threat state and a self-report measure may not be able to differentiate between Challenge and Threat in the instance of a repressor.

Furthermore, for emotion direction and intensity, this study showed support for the suggestion (Jones et al., 2009) that Challenge is associated with a positive valence of emotion. As Challenge increased, excitement intensity increased and positive valence of emotion (happiness and excitement) were also reported as more facilitative.

In light of these findings, collectively this study suggested that rather than examining Challenge and Threat from a bipolar perspective that self-report of Challenge and Threat combinations may be a more useful way to examine Challenge and Threat rather than cardiovascular responses. This study has shown that combinations of Challenge and Threat yield relationships with performance and emotion intensity.

Furthermore, performance accuracy differed between the appraisal groups, see below in Figure 5:12.

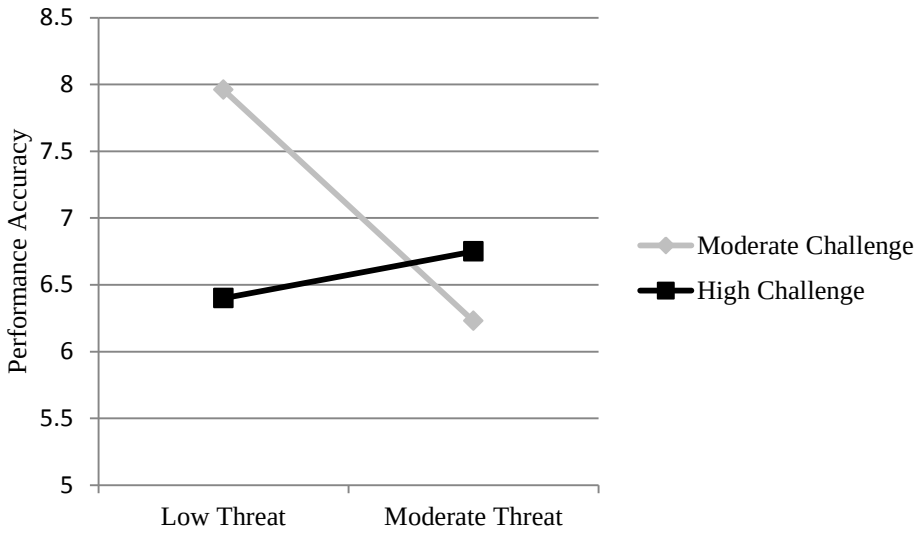


Figure 5:12: Appraisal Groups and Performance Accuracy

Differences were also observed in excitement intensity between the groups, see in Figure 5:13.

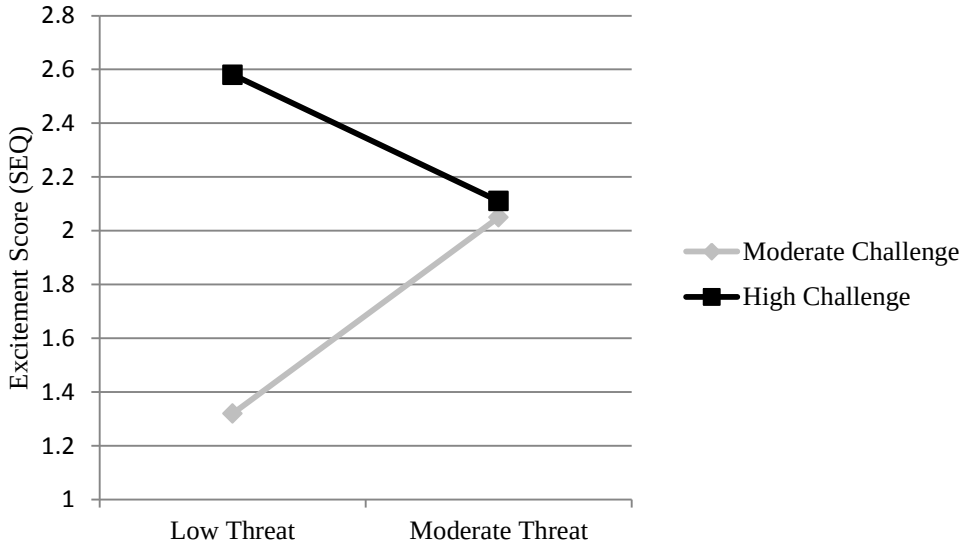


Figure 5:13: Appraisal Groups and Excitement Intensity

In regard to performance, it seems that there is little difference between the High Challenge groups in combination with Low Threat and Moderate Threat. However, this

differs when a combination of Low/Moderate Threat is examined in combination with Moderate Challenge. This highlights the use of the examination of Challenge and Threat in combination with one another, as using a bipolar perspective would not have captured these findings, this approach would only allow an individual to report being Challenged or Threatened.

Moreover, from these two results extracted using a bivariate perspective it can be concluded that in shooting when Threat is Low, Moderate Challenge seems to be associated with facilitative performance. In addition higher levels of Challenge seem to be associated with enhanced excitement, but have a debilitative effect on shooting performance. Therefore, an examination of Challenge and Threat using a bivariate approach potentially affords greater sensitivity in assessing various outcomes, such as emotion and performance and enables the researcher to examine various different questions in relation to Challenge and Threat components and their potential relationships.

It could be suggested that a more continuous measure of Challenge and Threat may be necessary, similar to that of Cacioppo, Berntson and Klein (1992) suggestion regarding positive and negative evaluative processes. It may be suggested that Challenge and Threat can be viewed from a bivariate perspective rather than a bipolar perspective. This will be discussed in further detail in Chapter 6.

Although this study offers a unique exploration of Challenge and Threat within a holistic approach, it is acknowledged that there are a number of limitations to the study. Although Challenge and Threat was not manipulated, the study was still conducted under laboratory conditions and therefore may not be a true reflection of how individuals would behaviour outside of this environment and lacks in ecological

validity. Due to the lack of associations found between cardiovascular reactivity and the variables examined (self-report of Challenge and Threat, emotion, endocrine response and performance) in this study, it may be that examining Challenge and Threat in a more ecologically valid environment might be a more appropriate way to ascertain the impact of Challenge and Threat upon performance.

In light of the method chosen, caution should be exercised when generalising these findings to the athlete population in general. The study recruitment process was based upon volunteers, therefore the sample has self-selected to partake in the study, and therefore as with any non-random sample its generalisability to the wider athlete population is weakened.

Moreover, sample size estimation to explore self-reported psychological factors and their potential relationship to cardiovascular reactivity and performance a sample of 70 participants was based upon achieving a power of 0.8 for significant medium effects ($r=.3$, $p<.05$; Turner et al., 2012). This estimation however was not based upon a replicated study design to the current research programme as previously discussed. Moreover, analysis within this chapter did reveal significant effect statistic ranging from small to moderate. It is important to note that a small effect size within shooting performance may have a substantial impact upon performance, as small influences may be the difference between winning a gold and silver medal for an athlete, for example the gold medallist of the 10m air rifle final at the London 2012 Olympics scored a total of 10.31 average for each shot and the silver medallist 10.25 average for each shot (BBC Sport, 2012).

In regards to endocrine responses of Challenge and Threat, only measures of cortisol were explored. It was not pragmatic to examine adrenaline, as this would

require invasive techniques which may have reduced participant numbers and affected their stress response as previously discussed. Therefore, this would not have been desirable for the current study as this may have impacted upon endocrine response (cortisol; stress response) and may have heightened anxiety, which has an impact upon TPR as previously discussed.

In conclusion, this study suggested that self-report of Challenge are associated negatively with shooting performance and that a pattern of Challenge and Threat (Moderate Challenge/Low Threat) have an association with higher performance compared to other groups. The study also suggested that the cortisol response increased with Threat report on the CAR and that Threat report on the CAT has an association with the CAR in the expected direction. Challenge was shown to have a negative association with anxiety. However Threat and the CAR were shown to have a positive association with anxiety. Excitement was reported as more intense as Challenge report increased and happiness and excitement more facilitative as Challenge report increased. In combination with one another, Moderate Challenge and Low Threat were associated with lower intensity excitement and happiness. However, this study does not support the cardiovascular indices of Challenge and Threat within this study, which may be for a number of reasons previously discussed.

To conclude, further exploration of alternative conceptualisation of Challenge and Threat might prove a useful area for future study. Alongside this, a further examination of mixed patterns of Challenge and Threat in regard to sport performance may be useful in examining Challenge and Threat experience and sport performance.

# CHAPTER 6 GENERAL DISCUSSION

## 6.1 Introduction

The aims of the research programme were as follows:

a. Further examine and develop existing self-report measures of Challenge and Threat within a sport context
b. Examine Challenge and Threat self-report with performance in a sport context
c. Further examine the Biopsychosocial model (BPSM) prosed in relation to Challenge and Threat and sport performance
d. Examine endocrine response, specifically cortisol outlined in the Arousal and Physiological Toughness model in relation to Challenge and Threat self-report and sport performance
e. Examine self-report of emotion direction and intensity experienced during a sport performance in regard to Challenge and Threat
f. Examine Challenge and Threat in combination with each other in regard to sport performance

The purpose of this chapter is to summarise and discuss the main findings, consider the limitations within the programme of research, consider applied implications and future research directions, and conclude with a summary of how the research contributes to the extant literature.

## 6.2 Discussion of Findings

First, the findings from Chapter 4 and 5 provide evidence and support of the reliability and validity of a self-report measure examining Challenge and Threat, which can be utilised within a sport related sample. Furthermore, this extends previous literature by examining existing self-report measures of Challenge and Threat and

testing these models within a sport related sample. Cerin (2003) identifies that at present there is a lack of valid and reliable self-report measures to examine Challenge and Threat within a sport context. The findings of Chapters 4 and 5 identified a suitable tool that can be utilised to examine Challenge and Threat in sport (CAT).

Second, Challenge was shown to have a positive association with running performance and a negative association with shooting performance. Whilst some support is offered for an association with Challenge and Threat report and performance, specifically Challenge report yielding a facilitative performance (Jones et al., 2009).

There is limited research examining Challenge and Threat and sport performance (Moore et al., 2012; Turner et al., 2012; Turner et al., 2013). The findings of the current research programme show mixed support for the existing literature that Challenge is associated with facilitative performance. Within the current research programme, Challenge report in runners was associated with a facilitative performance. However, the findings show that Challenge can be of decrement to shooting performance. An explanation for this may be related to the endocrine responses (Dienstbier, 1989) associated with Challenge and Threat. As Chapter 5 speculates adrenaline release is associated with Challenge report, and can be of decrement to shooting performance as this can increase physiological tremor.

These findings suggested that Challenge report may have a differing impact upon performance between sporting activities. This highlights the complexity of examining Challenge and Threat and its association with differing types of sport performance.

Another important finding extends previous literature by examining the endocrine response of cortisol associated with Challenge and Threat. The present

research programme suggests that cortisol response is associated with Threat self-report on the CAR, and therefore supports previous suggestions that cortisol has an association with Threat report within a sport context (Jones et al., 2009). These endocrine responses are said to be the mechanism behind the cardiovascular reactivity associated with Challenge and Threat (Blascovich & Mendes, 2000). However, it is important to take into consideration recent literature (Blascovich & Berry-Mendes, 2010) suggesting that both neuroendocrine responses associated with Challenge and Threat (SAM and PAC activation) can be co-activated. Therefore, cortisol response may be related to simultaneous experience of both Challenge and Threat, as later discussed within this section.

The current research programme also found that the more cortisol (endocrine response associated with Threat) reactivity the less mental effort is invested in the task, which may suggest that Threat is associated with a decrease in mental effort. However, the TCTSA suggested that in a Threat state mental effort increases. As previously discussed in Chapter 5, noradrenaline is suggested to be associated with Challenge within the TCTSA, however Peters et al. (1998) suggested that high mental effort leads to greater increases in noradrenaline, which is suggested to be associated with Challenge. Collectively these findings suggested that mental effort may increase in a Challenge and decrease in a Threat. This however does not support the TCTSA. Furthermore, it is important to note that adrenaline or noradrenaline was not measured and therefore a direct examination of the suggestion regarding mental effort was not possible within this research programme.

Another important finding extends previous research by examining cardiovascular reactivity during a sporting task (Chapter 5). Firstly, an examination of the cardiovascular reactivity said to be indicative of Challenge and Threat yielded no

association to the self-report of Challenge or Threat or performance within Chapter 5. These finding have some implication for the measurement of Challenge and Threat within a sport context.

First, the existing cardiovascular indices to examine Challenge and Threat using the current suggested cardiovascular measures outlined by Blascovich and colleagues may not be appropriate to examine Challenge and Threat in combination, only isolation. As previously discussed in Chapter 5, it is also important to highlight that the cardiovascular indices of Challenge and Threat can also be affected by other cognitive processes, such as anxiety which is associated with Challenge and Threat (Jones et al., 2009). This can cause an individual to be tense and in turn have an impact upon TPR (Turner et al., 2012).

Moreover, it could be suggested that cardiovascular indices of Challenge and Threat may not reflect the self-report of Challenge and Threat, due to a number of areas. Firstly, individuals who are unable to report negative affect and may answer self-report measures in a positive way (repressors), secondly individual differences, e.g. what is experienced as a Challenge to one individual, might be experienced as a Threat to someone else, even though they are experiencing the same cardiovascular reactivity, and therefore cause discrepancies between Challenge and Threat self-report.

Second, within the current research programme Challenge and Threat were not manipulated therefore the cardiovascular reactivity may not have been as heightened compared to a situation where Challenge and Threat were manipulated. As Challenge and Threat states were not manipulated, the individual may not have been experiencing Challenge or Threat in isolation or at high intensity, this may offer an explanation as to why the cardiovascular reactivity of Challenge and Threat were not elicited. Based upon

these findings and the analysis of Challenge and Threat in combination with each other, it is suggested that cardiovascular reactivity has no predictive validity within Chapter 5. Therefore an alternative way to examine Challenge and Threat may be in combination with one another.

Further to this, Chapter 5 extends the extant literature by examining Challenge and Threat in combination with one another based upon the CAT. Similar conclusions have been drawn in regards to experiencing two constructs at the same time, which have previously been viewed as bipolar. The current research programme suggested that a combination of both Challenge and Threat can have an effect upon performance and therefore the use of the CAT has some utility in examining these constructs in combination with one another with reference to sport performance. Without the examination of both Challenge and Threat independently of one another, interaction between Challenge and Threat and performance outcome would not have been identified. If this approach can differentiate between Challenge and Threat combination and performance outcome, this has important implications for sports performers and researchers. Therefore, Challenge and Threat could be examined from a bivariate rather than a bipolar perspective.

Recent literature has adopted a similar approach when examining constructs such as emotion. For example Larsen, McGraw and Cacioppo (2001) suggested that happiness and sadness can be experienced simultaneously rather than being viewed as bipolar (Russell & Carroll, 1999). Larsen et al. (2001) suggested that happiness and sadness should be viewed as bivariate, for example graduating college students may have experienced happiness and sadness simultaneously.

Moreover, Larsen et al. (2001) further explain their rational for using a bivariate approach to happiness and sadness by exploring how University students felt during a move-out day compared to a typical day. Individual's emotions were recorded via a self-report tool to capture emotion. University students were given the measure on a typical day and then on a move-out day (leaving University). Participants were more likely to report experiencing both happiness and sadness when they completed the self-report measure on a move-out day compared to a typical day. This was similar to findings on graduation day, amongst graduates and non-graduates, with graduates experiencing both happiness and sadness simultaneously.

From a psychobiological perspective, Berridge and Grill (1984) evidence the coactivation of taste systems, which governs affective and behavioural reactions to food. For example, the sweet taste of sucrose selectively potentiates intake and the bitter taste of quinine triggers the reflexes that potentiates rejection. Berridge and Grill (1984) report that a combination of both sucrose and quinine triggered the reflexes associated with both responses. Therefore, it could be suggested that the PAC and SAM systems could be coactivated or reciprocally inhibited as previously suggested by Blascovich and Mendes (2010). This may make it more difficult for researchers to ascertain Challenge and Threat via the measurement of endocrine responses. The implications of this suggestion is substantive, as Challenge and Threat is grounded in Dienstbier (1989) suggestion that Challenge and Threat are associated with PAC and SAM activation. If these systems are coactivated in both a Challenge and Threat state, we are unable to differentiate between them using endocrine responses, and secondly, this suggested that if Challenge and Threat are associated with endocrine response, that it is possible to experience both physiologically at the same time.

Another example to support this suggestion is that of rats who were placed in runaways. The runaways contained both the promise of reward (i.e. food) and Threat of punishment (i.e. shock). Although rats ultimately responded with approach or avoidance, they initially were indecisive, suggesting coactivation of positive and negative affect (Miller, 1959). This could be applicable to Challenge and Threat, as some of the findings within the current research programme suggest that Challenge and Threat can be experienced simultaneously, in agreement with Cerin, (2003) and Meijen et al. (2013)[a].

The current research programme suggested that a mixture of Challenge and Threat self-report has implications for shooting performance. In particular, Moderate Challenge and Low Threat yielding the best shooting performance. This supports suggestions that a mixture of Challenge and Threat could have an impact upon sporting performance and that using a dichotomous approach to Challenge and Threat is too simplistic within a sporting context.

In addition, Chapter 5 also extends the extant literature by examining emotion intensity and direction in relation to Challenge and Threat and an actual sporting performance. This is in line with the suggestion that Challenged and Threatened states will impact upon the intensity and direction of emotions experienced (Jones et al., 2009).

The findings within the current research programme suggests that experiencing excitement was linked to an increase in Challenge, and happiness and excitement were seen as more facilitative as Challenge report increased. Furthermore, anxiety increased as Threat increased, in contrast as anxiety decreased, Challenge increased. Therefore

this shows some support for the TCTSA in relation to differing direction of emotions between Challenge and Threat report.

One approach that may have utility in advancing our understanding of Challenge and Threat in sport is the Evaluative Space Model (ESM: Cacioppo and Berntson, 1994). This model was originally developed to help explain positive and negative evaluative processes in combination with each other using a bivariate evaluative plane (Figure 6.1). However, there are several reasons to think that it may have some utility in understanding the complex nature of Challenge and Threat outlined thus far in this chapter.

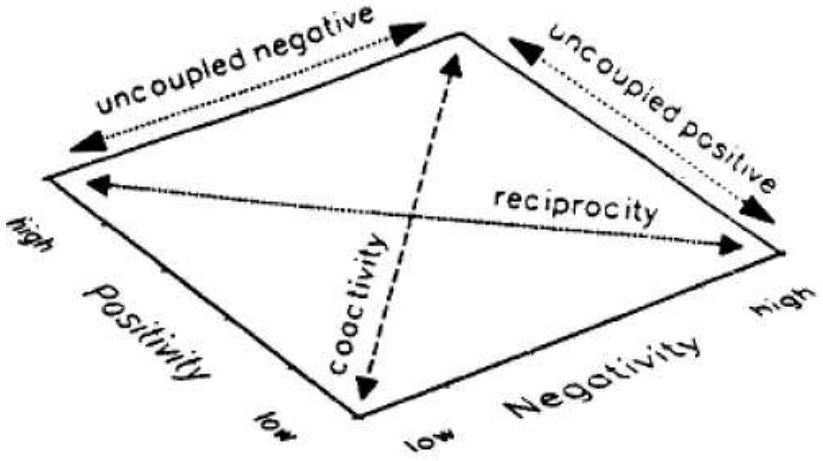


Figure 6:1: Bivariate Evaluative Plane Taken from Cacioppo and Berntson (1994)

Firstly, it is predicated on the assumption that the complex nature of our emotional world, demands the capacity to 'respond quickly and flexibly when determining whether a stimulus is hostile, hospitable or has features of both' (Norris, Larsen & Cacioppo, 2007). Second, rather than consider evaluations as bipolar (Figure 6.2) it conceptualises evaluations as bivariate.


Figure 6:2: Bipolar view of positive and negative evaluation

This notion of evaluations as bivariate is similar to the examination of Challenge and Threat in Chapter 5 and it's contention that examining Challenge and Threat in isolation but also in combination with each other may be worthwhile. Third, it is suggested that modes of evaluation can generally be activated reciprocally (e.g. Challenge and Threatened during one experience), independently activated (e.g. Challenged or Threatened) or co-activated (e.g. Challenge and Threatened simultaneously; Cacioppo and Berntson, 1994). If Challenge (indicative of a generally positive evaluation of circumstances) and Threat (indicative of a generally negative evaluation of circumstances) are considered in this framework, it becomes theoretically plausible that there could be instances of High Challenge and High Threat and Low-Challenge and Low Threat. This conceptualisation has implications for the current measurement of Challenge and Threat via cardiovascular indices, as previously discussed. Anxiety can have an impact upon the current cardiovascular indices associated with Challenge and Threat. However, as Blascovich and Mendes-Berry (2010) suggested there could be coactivation of both the endocrine response associated with SAM and PAC, therefore suggesting that it is possible to experience both Challenge and Threat in combination with one another. Drawing upon this Challenge and Threat could be conceptualised as in Figure 6.3 based on the ESM.

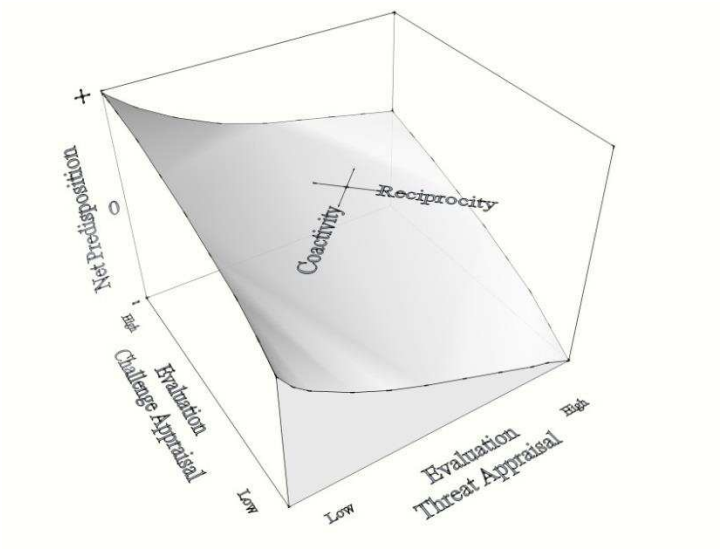


Figure 6:3: Conceptualisation of Challenge and Threat Evaluation based upon the ESM

The notion of evaluation bears close conceptual parallels with appraisal. From this perspective, the precise pattern of appraisal may shape the experience of Challenge and Threat. Differing levels of Challenge and Threat may reflect relatively 'simple' responses (fight or flight response), whereas evolution has conferred the capacity for more reflective/deliberate higher level of processing, this may help to explain some of the discrepancies between physiological and subjective self-report. For example, a river for a zebra might comprise features of hospitality (opportunity for a drink) and hostility (possibility of being attacked by a crocodile). In sport, it could be the norm, rather than the exception that stimuli (such as competition) comprise features that may be evaluated both positively and negatively. For instance, a rugby player may feel positive about their ability to execute certain tactical strategy on the pitch but also have concerns about the potential for physical harm.

Finally, reflecting on the physiological indices of Challenge and Threat, the suggested indices indicative of Challenge and Threat cannot be experienced simultaneously (e.g. TPR cannot decrease and increase at the same time). Therefore

although experiencing Challenge or Threat in isolation may elicit these responses, experiencing the cardiovascular indices of Challenge and Threat simultaneously would theoretically and biologically not be possible. To further this, as previously discussed, Blascovich and Berry-Mendes (2010) have recently indicated that the SAM and PAC systems responsible for the cardiovascular reactivity within a Challenge or Threat state may operate independently, but can also be co-activated. Therefore, although Challenge and Threat in isolation may be measured using endocrine and cardiovascular indices, these indices may not always give a clear indication as to whether an individual is experiencing Challenge or Threat. It is possible that there may be alternative physiological measures that could be examined in order to ascertain whether an individual is Challenge and/or Threatened. As Gramzow, Willard and Berry-Mendes (2008) suggested that it is possible for individuals to experience a coactivation of two physiological indices indicative of different psychological constructs (for example coping and emotional response). It could be suggested that heart rate variability may be a suitable marker to examine Challenge and/or Threat, as this has been shown to have an association with psychological stress and in particular the appraisal system (Thayer, Fredrik, Fredrikson, Sollers & Wager, 2012). This may require some further exploration to ascertain the use of this physiological parameter as an indicator of Challenge and/or Threat.

Furthermore, within the current research programme there was little examination of control, which is seen as a central tenant within the TCTSA. Perceived control is seen to be a powerful predictor of functioning (Skinner, 1996), this link is important as an individual's level of perceived control may have an impact upon resource appraisal and therefore their Challenge and Threat levels (c.f. Jones et al, 2009). Furthermore Jones et al (2009) suggest that a Threat state will occur when an athlete fixates on

factors which cannot be controlled (e.g. weather conditions) resulting in low perceived control. Whereas an individual's focus on the elements of the sporting competition that can be controlled, may lead to a Challenge state. An individual's sense of perceived control is a further avenue for future research, it could be that from an applied perspective to encourage an individual to focus on the controllable elements of sport competition may increase a Challenge state but this has been seldom examined within the literature thus far.

In summary, given limitations in the extant theories to date and extending the ESM framework to an understanding of Challenge and Threat could a. yield a range of new hypothesis and b. help to reconcile some of the inconsistent findings observed to date within this research programme and some of the extant literature.

## 6.3 Limitation of Current Research Programme

Despite the number of novel contributions made by the present thesis to further understand Challenge and Threat in sport, it is important to acknowledge that there are a number of limitations with the design and scope of the research and the conceptualisation of Challenge and Threat within the extant literature.

### 6.3.1 Design and scope of the present research programme

Firstly, the development of the self-report measure of Challenge and Threat (CAT) was only developed on two different sport related samples. Therefore one might question the usability of the self-report measure across a larger range of sport related samples. However, the construct validity, internal consistency and predictive validity of the measure within these constructs suggested that the CAT has utility to examine Challenge and Threat in combination with one another and the ability to predict performance in both gross and discrete motor skills.

Secondly, although this research programme examined Challenge and Threat through a holistic approach, Chapter 5 presents findings collected with a laboratory context. One could question the ecological validity of the study as participants performed the task within a laboratory environment.

### 6.3.2 Conceptual and Theoretical limitations

One limitation of the scope of the present research and research examining Challenge and Threat is the limited available theory specific to Challenge and Threat in a sport context, as discussed in Chapter 2. Recent theory suggested that Challenge and Threat may be associated with performance outcome (Jones et al., 2009) but to date this suggestion is supported with limited extant research. Challenge and Threat are broadly conceptualised as being dichotomous and are typically examined by cardiovascular reactivity outlined in the BPSM. Due to this salient support within the literature regarding Challenge and Threat, there is limited use of self-report measures to examine Challenge and Threat.

It has been intimated within the extant literature that Challenge and Threat can be experienced in combination with one another (Cerin, 2003); however, there has been seldom research to examine this (Meijen et al., 2013[a]). Within the extant research there is a lack of clarity concerned with conceptualising Challenge and Threat, thus far Challenge and Threat has been examined adopting the BPSM hypothesis and several suggestions of antecedents that have an influence over a Challenge or Threat appraisal leading to a Challenge or Threat state (Jones et al., 2009).

Importantly, the finding of the present research programme highlights several limitations to current theoretical accounts of Challenge and Threat in relation to sport performance. Firstly, the research highlights that if cardiovascular indices of Challenge

and Threat are used to examine Challenge and Threat simultaneously, it may be appropriate to examine what these cardiovascular indices are. Secondly, Challenge and Threat in combination with each other may account for differences within sporting performance. Furthermore, it could be suggested that the extant literature regarding Challenge and Threat may need further examination within a sport context, as the Challenge and Threat cannot always be seen as dichotomous. Thirdly, examining further the approaches individuals might take (i.e. avoidance or approach) might give further information regarding Challenge and Threat mixed appraisals, in line with the ESM approach outlined within this chapter. The areas highlighted need to be examined further to gain a more robust understanding of Challenge and Threat within sport.

## 6.4 Suggestions for Future Research

In light of the present findings, several strands of future research are considered to be useful. The first of these concerns the further testing of the CAT and its reliability and validating within differing sporting contexts. Within the present research programme, this was only exposed to two different sporting performances (runners and shooters), in Chapters 3-5. In order to avoid any 'noise' that may have been recorded through the use of the novel self-report measures of Challenge and Threat within a sport context (CAT) a more thorough examination of the CAT might add depth to the finding of this research programme. A more thorough examination of the CAT might be carried out by examining the predictive validity in differing sporting populations, for example more gross and discrete motor skills and individual and team sports to attempt to further validate this tool and its utility within a variety of sporting contexts. The CAT could be implemented into study designs similar to that of Meijen et al. (2013) [a,] to further examine relationships between Challenge and Threat patterns and cognitive and affective components. The CAT also needs further examination with reference to

sporting performance, potentially as the utility to indicate which Challenge and Threat pattern is the most facilitative to sporting performance.

Chapter 5 provides some important implications for the methods used to examine Challenge and Threat within a sporting context. Through a holistic approach, the present research programme has identified some limitations when adopting cardiovascular indices to examine Challenge and Threat within a sporting context. Moreover the present research programme suggested that a further exploration of cardiovascular indices associated with a mixture of both Challenge and Threat may help to gain further understanding.

The findings have also suggested that a more thorough examination of Challenge and Threat in combination with each other may provide impetus to understanding that Challenge and Threat in a sport context is more complex than first hypothesised. A further examination of these areas highlighted may illuminate if Challenge and Threat in combination have an impact upon performance and also may be used in finding an alternative way to measure Challenge and Threat physiologically within a sport context. Using the ESM approach may help to identify not only Challenge and Threat experienced in isolation but also in combination with one another and the change in Challenge and Threat throughout a sporting event. This ESM approach has the utility to examine Challenge and Threat in a number of different ways, which have been previously seldom examined in the extant literature.

The areas identified for future research could be examined, broadly in three different areas. Firstly, further studies might aim to examine the predictive validity of the CAT within different sport types, for example basketball (gross skill) and golf (discrete skill). Secondly, an examination of possible alternative physiological

responses associated with Challenge and Threat might be examined. On the one hand, alternative cardiovascular indices indicative of Challenge and Threat could be examined in combination with sport performance and in contrast, a further examination of neuroendocrine responses such as adrenaline might be examined. Lastly, a further examination of the model proposed of Challenge and Threat within this research programme might provide further impetus for the proposal that Challenge and Threat can be experienced in combination with one another. Moreover, different sport types might require different levels of Challenge and Threat to facilitate performance, this requires further attention.

Although not a focus within this research programme, health outcomes may also be influenced by reoccurring stress appraisals. As briefly discussed within Chapter 2 of this document, stress has also been associated with autoimmune disease (Harbuz, et al., 2003), coronary heart disease and mental health issues (Scneiderman et al., 2005). Moreover, this may be an area to be examined in further detail regarding Challenge and Threat states and its impact upon health outcomes.

There are some implications regarding future research in the area of Challenge and Threat. Firstly, it is important to acknowledge the potential of individual differences for example repressors. Previous research has demonstrated that mental resilience is associated with repressors (Bonanno, 2008). Furthermore, individuals may interpret their physiological state differently. Drawing on the example of emotions, visceral arousal must be perceived to have an impact upon emotional experience (Reisenzein, 1983). Although Wiens et al. (2000) suggested that there has been little empirical investigation regarding the relationship between these constructs (emotions and visceral arousal). Within the literature, Schachter (1964) suggested that individuals who are more sensitive to their own visceral arousal should experience emotions more

intensely than people who are less sensitive to their own viscera. Some of the current literature suggested that Challenge and Threat can be examined using cardiovascular measures, however based upon the findings of Wiens et al. (2000) and Schachter (1964) it can be suggested that individuals may be more sensitive to their own physiological responses and therefore some may experience a more intense Challenge or Threat appraisal over others.

Indeed, Wiens et al. (2000) study examining heartbeat detection found that heartbeat detection (as an index of self-perception of visceral activity) is associated with intensity of emotional experience but not positive or negatively labelled emotions. More specifically, good heartbeat detectors reported experiencing emotions more intensely that did poor detectors in response to a range of film clips chosen to elicit a range of emotions. Moreover, these findings support Cacioppo et al. (1992) suggestion which states, perceived visceral activity affects experienced emotions.

Relating this to Challenge and Threat, some individuals may be accurate at detecting visceral activity whereas others may not be so accurate. Therefore individuals experiencing a Threat cardiovascular response may not be self-reporting this due to either the repressor explanation or their inability to detect their visceral activity. Repressors are individuals who dissociate their somatic reactions from their perceptions of stress (Eysenck & Derakshan, 1997), therefore causing potential discrepancies between self-report and cardiovascular arousal. This may also explain some of the discrepancies within the extant literature (Turner et al., 2012), where individuals may be reporting Challenge but are experiencing a physiological response of Threat. Within the present study, this is pertinent, as individuals may be experiencing patterns of Challenge and Threat which differ to their physiological response; however, their self-report measures appear to have an association with performance. The current research

programme suggested that self-report of Challenge and Threat using the CAT may be utilised within a sporting context in regard to performance. However, the areas highlighted within this discussion should also be acknowledged.

## 6.5 Application to Sporting Performance

Given the infancy of Challenge and Threat research in sport, it is perhaps a little premature to endorse particular practices for use within the 'field'. However, the findings of this current research programme identify, broadly three different considerations that might be considered by those working with athletes.

First, the present research programme supports the view that Challenge and Threat can be associated with sporting performance, suggested within the recent extant literature (Jones et al., 2009; Turner et al., 2012). The performance outcomes highlighted by the current research programme demonstrate that Challenge is are associated with performance, and the influence of Challenge and Threat on performance may be mediated by characteristics of the sport. The finding of the current research programme also suggested that a mixture of Challenge and Threat could result in differing performance outcomes. For those athletes that experience Challenge and Threat leading to a decrement in performance, cognitive strategies, such as reframing to try and change the appraisal process of an athlete to a more desirable response might be a useful way to deal with this. For example Gould, Eklund and Jackson (1993) study examining Olympic Wrestler's perception and coping with competition, found that 35% of the athletes interviewed coped with the stress of the Olympics' by treating the competition as just another tournament. Jones (1993) suggested that this reframing reduces the goal relevance (how much is at stake). This might alter cognitive appraisal if the resource and demand of the task relevance is not as heightened. Therefore

emphasis on resource and demand could be altered leading to differing Challenge and Threat states.

Secondly, this current research programme presents a self-report measure of Challenge and Threat in relation to sport. Utilising this measure before competition may help to clarify what levels of Challenge and Threat report may be beneficial to the individual athlete's performance. This may help to identify, in particular, what sporting demands require differing levels of Challenge and/or Threat to produce the best performance.

Finally, the present research programme suggests that a further examination of cardiovascular indices of Challenge and Threat in combination with each other might lead to a more accurate measure of the simultaneous experience of Challenge and Threat proposed by Cerin (2003). If coaches and researchers are to further examine the physiological indices of Challenge and Threat and their relationship with performance, this may be implemented.

## 6.6 Conclusion

Despite the recent examination of Challenge and Threat in regard to sporting performance (Jones et al., 2009), the area of self-report of Challenge and Threat has received little attention. Although several approaches have contributed to the TCTSA, including the BPSM and Arousal and Physiological Toughness Model, these hypotheses have not been fully examined in combination with one another regarding sport performance. With this in mind, the current research programme sought to examine Challenge and Threat using a holistic approach to gain a further understanding within a sport context. This included an examination of the BPSM, one of the neuroendocrine responses associated with Challenge and Threat suggested by the Arousal and

Physiological toughness model, a more robust examination of Challenge and Threat via self-report, and an examination of emotion direction and intensity in regards to a sporting performance.

It is hoped that the current research programme provides a platform from which further Challenge and Threat research in sport might take place. To this end, the research programme provides a small but nonetheless significant contribution to the Challenge and Threat literature and more specifically to the sport psychology literature by the way of the following key developments/ findings:

1. Provided and developed an initial validation of a self-report measure of athletes' Challenge and Threat experience.
2. Athlete's reports of Challenge were positively related to running performance and negatively related to shooting performance.
3. Happiness and excitement were perceived as more facilitative as Challenge self-report increased.
4. Interaction of Challenge and Threat self-report were demonstrated to have an impact upon performance and emotions.
5. A novel way of conceptualising Challenge and Threat (i.e. bivariate) using the ESM.

The results of this the current research programme developed a self-report measure of Challenge and Threat (CAT) and proposed a new model for the conceptualisation of Challenge and Threat. Although the new model remains to be tested, support for a number of its propositions have been provided.

As an emerging area of enquiry, it may be useful for future research to examine the self-report of Challenge and Threat in combination with one another to further

understand Challenge and Threat and its relationship, if any, with performance outcome. Alongside this, a further examination of possible cardiovascular indices that could be associated with patterns of both Challenge and Threat may also help to reconcile some of the equivocal findings within the present research and extant literature.

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CHAPTER 8 APPENDICIES

Appendix 1: Primary Appraisal Secondary Appraisal Scale (PASA) Gaab et al. (2005)

| Name: | Date: | | | | | |
|---|---|---|---|---|---|---|
| The following sentences refer to the upcoming situation. Please indicate what goes through your mind regarding all these sentences by ticking the respective answer. For each sentence, you can thereby indicate how much you agree or disagree with it.<br>Please answer all sentences by making a clear visible tick: | | | | | | |
| | Totally Disagree | Rather Disagree | Disagree to some extent | Agree to some extent | Rather Agree | Totally Agree |
| I do **not** feel Threatened by the situation | | | | | | |
| The situation is important to me | | | | | | |
| In this situation I know what I can do | | | | | | |
| It mainly depends on me whether my performance is successful | | | | | | |
| I find this situation very unpleasant | | | | | | |
| I do not care about this situation | | | | | | |
| I have no idea what I should do now | | | | | | |
| I can best protect myself against failure in this competition through my performance | | | | | | |
| I **do not** feel worried because the situation does not represent any Threat for me | | | | | | |
| The situation is **not** a Challenge for me | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| In this situation I can think of lots of alternative activities | | | | | | |
| I am able to determine a great deal of what happens in this competition myself | | | | | | |
| This situation scares me | | | | | | |
| This task Challenges me | | | | | | |
| I can think of lots of solutions for solving this task | | | | | | |
| If the outcome of the competition is positive it will be a consequence of my effort and personal commitment | | | | | | |

Appendix 2: Information and Informed Consent for Study 1

**Exploring Stress Responses to Competition**

**Information and Informed Consent**

**Information: What is this study about?**

The aim of this study is to explore how individuals perceive novel and competitive situations, and to measure their stress response to the situation.

The questionnaire is short (16 questions) and should take no longer than 5 minutes to complete. We will ask you to provide demographic information on the cover sheet. Personal information such as name will not be included within the data analysis of any data collected.

**Who is carrying out this study?**

Claire Rossato is conducting this study, as part of her PhD research at Canterbury Christ Church University, which is supervised by Dr Mark Uphill, Dr Jon Swain and Dr Damian Coleman who work as Senior Lecturers and Readers in the Sport and Exercise Science Department at Canterbury Christ Church University. Permission for this study has been undertaken and has been approved by the ethics committee at Canterbury Christ Church University.

**Who to contact for further information?**

If you would like to discuss any issues related to this study please contact Claire Rossato at:-

claire.rossato@canterbury.ac.uk or 01227 767700 ext 3170

**What else do I need to know? (Confidentiality, withdrawal from study and use of data)**

You have the right to withdraw from the study at any time without any consequences. All your data will be treated confidentially. Any data used for publication purposes will remain anonymous. Please note you have to be over the age of 18 to take part in this study.

**CONSENT FORM**

**Title of Project:** **Exploring Stress Responses to Competition**

**Name of Researcher**: Claire Rossato

**Contact details:**


| | |
|---|---|
| Address: | Canterbury Christ Church University,<br>North Holmes Road,<br>Canterbury,<br>Kent,<br>CT1 1QU |
| Tel: | 01227 767700 ext 3170 |
| Email: | claire.rossato@canterbury.ac.uk |


| | **Please initial box** |
|---|---|
| 1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | |
| 2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. | |
| 3. I understand that any personal information that I provide to the researchers will be kept strictly confidential. | |
| 4. I agree to take part in the above study and confirm that I am 18 years or over. | |

| | | |
|---|---|---|
| _____ | _____ | _____ |
| Name of Participant | Date | Signature |
| _____ | _____ | _____ |
| Name of Person taking consent | Date | Signature |

Appendix 3 Challenge and Threat in Sport scale (CAT) Item Development: Study 2: Stage 1

The items below are designed to assess athletes' experience of Challenge and/or Threat in anticipation of a forthcoming event (typically a sport competition). In this first stage of questionnaire development, as a current or former athlete, we are seeking your thoughts about the applicability of each item to the assessment of Challenge and Threat in sport.

For each item below, please think carefully about whether the item is applicable to your experience of evaluating a forthcoming situation as a Challenge and/or a Threat before an important sporting competition. In particular, consider whether each item captures the types of thoughts and feelings you have when you are Challenged and/or Threatened in before competing in sport.

If you think the item is applicable please tick the appropriate box. If you are "in two minds" or uncertain about the applicability of an item for you personally, but believe it *could be applicable to others'* experience of Challenge or Threat, please tick the "applicable" box.

| | Applicability | |
|---|---|---|
| | Applicable | Not Applicable |
| I do **not** feel Threatened by the situation | | |
| The situation is **not** a Challenge for me | | |
| This situation Challenges me | | |
| This situation scares me | | |
| I am focusing on the positive aspects of this situation | | |
| I worry that I will say or do the wrong things | | |

| | Applicability | |
|---|---|---|
| | Applicable | Not Applicable |
| I am thinking about what it would be like if I do well | | |
| I am worrying about the kind of impression I will make | | |
| I am concerned that others will find fault with me | | |
| I expect that I will achieve success rather than experience failure | | |
| I am looking forward to the rewards and benefits of success | | |
| I am concerned what other people will think of me | | |
| I feel I cannot overcome the difficulties in this task | | |
| I lack self-confidence | | |
| A challenging situation motivates me to increase my efforts | | |
| I am thinking about being successful in this task rather than expecting to fail | | |
| I worry what other people will think of me, even though it won't make any difference | | |
| I am concerned that others will not approve of me | | |

| | Applicability | |
|---|---|---|
| | Applicable | Not Applicable |
| I am looking forward to the opportunity to test my skills and abilities | | |
| I worry what other people are thinking of me | | |
| I feel like this task is a Threat | | |
| I feel like this task is a Challenge | | |
| The situation is important to me | | |
| I do not care about this situation | | |
| I believe that most stressful situations contain the potential for positive benefits | | |

Appendix 4: Information and Informed Consent for Study 3: Stage 2

**Understanding Approaches to Competition**

**Information: What is this study about?**

How athletes approach competition and participation in sport can vary between individuals and between different events. The aim of this study is to better understand the different approaches that athletes adopt in relation to competition, and to do this you are asked to complete a brief questionnaire. This study is in a series of studies directed toward understanding the approaches that athletes adopt in relation to competition. By participating in this study, you will be helping to develop a measurement tool that captures the ways in which athletes broadly approach competition.

**Who is carrying out this study?**

Claire Rossato is conducting this study, as part of her PhD research at Canterbury Christ Church University, which is supervised by Dr Mark Uphill, Dr Jon Swain and Dr Damian Coleman who work as Senior Lecturers and Readers in the Sport and Exercise Science Department at Canterbury Christ Church University. Permission for this study has been undertaken and has been approved by the ethics committee at Canterbury Christ Church University.

**Who to contact for further information?**

If you would like to discuss any issues related to this study or would like a summary of the results please contact Claire Rossato at:-claire.rossato@canterbury.ac.uk or 01227 767700 ext. 3170

**What else do I need to know? (Confidentiality, withdrawal from study and use of data)**

You have the right to withdraw from the study at any time without any consequences. All your data will be treated confidentially. Only the informed consent form and cover sheet will contain your name and participant number, in case you decide to withdraw from the study. Information & informed consent sheet will be locked away separately from the questionnaires with only the principal investigator having access. No data file will contain your name. All data will be used only for scientific purposes (e.g., conference presentations, publications), education purposes (student training, athlete/coach seminars), and public media coverage (e.g., BBC radio programmes). The data will not be used for commercial purposes. Any data used for publication purposes will remain anonymous.
Please note you have to be the age of 18 or over to take part in this study.

**CONSENT FORM**

**Title of Project:** **Understanding Approaches to Competition**

**Name of Researcher**: Claire Rossato

**Contact details:**


| | |
|---|---|
| Address: | Canterbury Christ Church University,<br>North Holmes Road,<br>Canterbury,<br>Kent,<br>CT1 1QU |
| Tel: | 01227 767700 ext. 3170 |
| Email: | claire.rossato@canterbury.ac.uk |


| | **Please initial box** |
|---|---|
| 1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | |
| 2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. | |
| 3. I understand that any personal information that I provide to the researchers will be kept strictly confidential. | |
| 4. I agree to take part in the above study and confirm that I am 18 years or over. | |

| _____ | _____ | _____ |
|---|---|---|
| Name of Participant | Date | Signature |
| _____ | _____ | _____ |
| Name of Person taking consent | Date | Signature |

Appendix 5: Challenge and Threat in Sport Scale (CAT) used in Study 3:Stage 2

| Name: | Date: |
|---|---|
| Please circle to indicate gender: | |
| Gender: Female Male | Age: |

How athletes approach competition may vary considerably and **THERE ARE NO RIGHT OR WRONG ANSWERS**.

The following sentences may or may not be relevant to you, but with reference to the upcoming competition, please select the most appropriate response **FOR YOU** in relation to each of the statements below. Please answer **ALL** statements.

| | Totally Disagree | Rather Disagree | Disagree to some extent | Agree to some extent | Rather Agree | Totally Agree |
|---|---|---|---|---|---|---|
| I do **not** feel Threatened by the situation | | | | | | |
| The situation is **not** a Challenge for me | | | | | | |
| This situation Challenges me | | | | | | |
| This situation scares me | | | | | | |
| I am focusing on the positive aspects of this situation | | | | | | |
| I worry that I will say or do the wrong things | | | | | | |
| I am worrying about the kind of impression I will make | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| I am concerned that others will find fault with me | | | | | | |
| I expect that I will achieve success rather than experience failure | | | | | | |
| I am looking forward to the rewards and benefits of success | | | | | | |
| I am concerned what other people will think of me | | | | | | |
| I feel I cannot overcome the difficulties in this task | | | | | | |
| A challenging situation motivates me to increase my efforts | | | | | | |
| I am thinking about being successful in this task rather than expecting to fail | | | | | | |
| I worry what other people will think of me, even though it won't make any difference | | | | | | |
| I am concerned that others will not approve of me | | | | | | |
| I am looking forward to the opportunity to test my skills and abilities | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| I worry about what other people are thinking of me | | | | | | |
| I feel like this task is a Threat | | | | | | |
| I feel like this task is a Challenge | | | | | | |
| I find this situation daunting | | | | | | |

Appendix 6: Information and Informed Consent for Study 3: Stage 3

**Understanding Approaches to Competition**

**Information and Informed Consent**

**Information: What is this study about?**

How athletes approach competition and participation in sport can vary between individuals and between different events. The aim of this study is to better understand the different approaches that athletes adopt in relation to competition, and to do this you are asked to complete a brief questionnaire. This study is in a series of studies directed toward understanding the approaches that athletes adopt in relation to competition. By participating in this study, you will be helping to develop a measurement tool that captures the ways in which athletes broadly approach competition.

The questionnaire is short (12 questions) and should take no longer than 3 minutes to complete. You are asked to complete the questionnaire in relation to how you feel about the upcoming competition.

**Who is carrying out this study?**

Claire Rossato is conducting this study, as part of her PhD research at Canterbury Christ Church University, which is supervised by Dr Mark Uphill, Dr Jon Swain and Dr Damian Coleman who work as Senior Lecturers and Readers in the Sport and Exercise Science Department at Canterbury Christ Church University. Permission for this study has been undertaken and has been approved by the ethics committee at Canterbury Christ Church University**.**

**What else do I need to know? (Confidentiality, withdrawal from study and use of data)**

You have the right to withdraw from the study at any time without any consequences. All your data will be treated confidentially. Only the informed consent form and cover sheet will contain your name and participant number, in case you decide to withdraw from the study. Information & informed consent sheet will be locked away separately from the questionnaires with only the principal investigator having access. No data file will contain your name. All data will be used only for scientific purposes (e.g., conference presentations, publications), education purposes (student training, athlete/coach seminars), and public media coverage (e.g., BBC radio programmes). The data will not be used for commercial purposes. Any data used for publication purposes will remain anonymous.
Please note you have to be the age of 18 or over to take part in this study

**CONSENT FORM**

**Title of Project:** **Understanding Approaches to Competition**

**Name of Researcher**: Claire Rossato

**Contact details:**


| | |
|---|---|
| Address: | Canterbury Christ Church University,<br>North Holmes Road,<br>Canterbury,<br>Kent,<br>CT1 1QU |
| Tel: | 01227 767700 ext. 3170 |
| Email: | claire.rossato@canterbury.ac.uk |


| | Please initial box |
|---|---|
| 1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | |
| 2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. | |
| 3. I understand that any personal information that I provide to the researchers will be kept strictly confidential. | |
| 4. I agree to take part in the above study and confirm that I am 18 years or over. | |

| | | |
|---|---|---|
| _____ | _____ | _____ |
| Name of Participant | Date | Signature |
| _____ | _____ | _____ |
| Name of Person taking consent | Date | Signature |

Appendix 7: Challenge and Threat in Sport Scale (CAT) used in Study 3:Stage 3

| Name: | Date: |
|---|---|
| Please circle to indicate gender: | |
| Gender: Female Male | Age: |

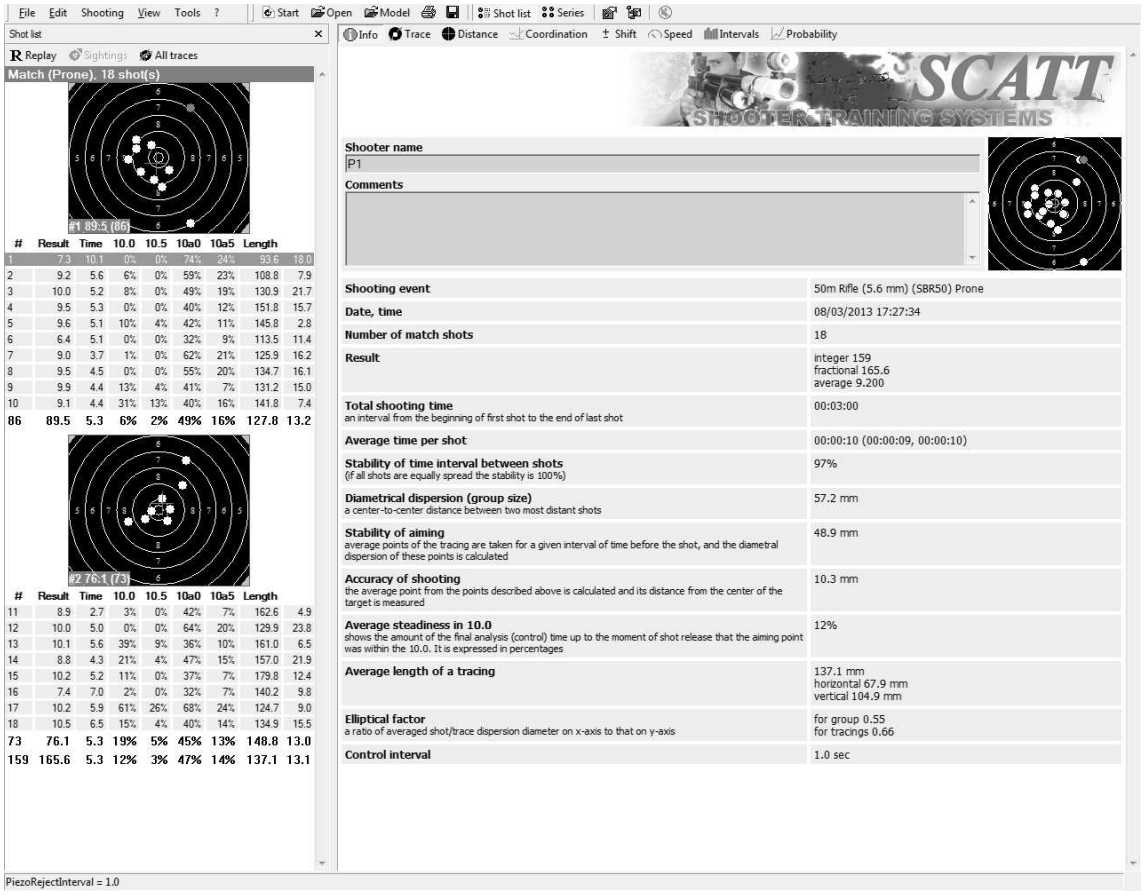
How athletes approach competition may vary considerably and **THERE ARE NO RIGHT OR WRONG ANSWERS**.

The following sentences may or may not be relevant to you, but with reference to the upcoming competition, please select the most appropriate response **FOR YOU** in relation to each of the statements below. Please answer **ALL** statements.

| | Totally Disagree | Rather Disagree | Disagree to some extent | Agree to some extent | Rather Agree | Totally Agree |
|---|---|---|---|---|---|---|
| I am worrying that I will say or do the wrong things | | | | | | |
| I am worrying about the kind of impression I will make | | | | | | |
| I am concerned that others will find fault with me | | | | | | |
| I expect I will achieve success rather than experience failure | | | | | | |
| I am looking forward to the rewards and benefits of success | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| I am concerned what other people will think of me | | | | | | |
| A challenging situation motivates me to increase my efforts | | | | | | |
| I am thinking about being successful in this task rather than expecting to fail | | | | | | |
| I worry what other people will think of me, even though it won't make any difference | | | | | | |
| I am looking forward to the opportunity to test my skills and abilities | | | | | | |
| I am worrying about what other people are thinking of me | | | | | | |
| I feel like this task is a Threat | | | | | | |

# Appendix 8: Sample of the SCATT kit output (Study 3)



File Edit Shooting View Tools ? | Start Open Model | Shot list Series

Shot list

Replay Sightings All traces

Match (Prone), 18 shot(s)

#1 89.5 (86)

| # | Result | Time | 10.0 | 10.5 | 10a0 | 10a5 | Length | |
|---|---|---|---|---|---|---|---|---|
| 1 | 7.3 | 10.1 | 0% | 0% | 74% | 24% | 93.6 | 18.0 |
| 2 | 9.2 | 5.6 | 6% | 0% | 59% | 23% | 108.8 | 7.9 |
| 3 | 10.0 | 5.2 | 8% | 0% | 49% | 19% | 130.9 | 21.7 |
| 4 | 9.5 | 5.3 | 0% | 0% | 40% | 12% | 151.8 | 15.7 |
| 5 | 9.6 | 5.1 | 10% | 4% | 42% | 11% | 145.8 | 2.8 |
| 6 | 6.4 | 5.1 | 0% | 0% | 32% | 9% | 113.5 | 11.4 |
| 7 | 9.0 | 3.7 | 1% | 0% | 62% | 21% | 125.9 | 16.2 |
| 8 | 9.5 | 4.5 | 0% | 0% | 55% | 20% | 134.7 | 16.1 |
| 9 | 9.9 | 4.4 | 13% | 4% | 41% | 7% | 131.2 | 15.0 |
| 10 | 9.1 | 4.4 | 31% | 13% | 40% | 16% | 141.8 | 7.4 |
| **86** | **89.5** | **5.3** | **6%** | **2%** | **49%** | **16%** | **127.8** | **13.2** |

#2 76.1 (73)

| # | Result | Time | 10.0 | 10.5 | 10a0 | 10a5 | Length | |
|---|---|---|---|---|---|---|---|---|
| 11 | 8.9 | 2.7 | 3% | 0% | 42% | 7% | 162.6 | 4.9 |
| 12 | 10.0 | 5.0 | 0% | 0% | 64% | 20% | 129.9 | 23.8 |
| 13 | 10.1 | 5.6 | 39% | 9% | 36% | 10% | 161.0 | 6.5 |
| 14 | 8.8 | 4.3 | 21% | 4% | 47% | 15% | 157.0 | 21.9 |
| 15 | 10.2 | 5.2 | 11% | 0% | 37% | 7% | 179.8 | 12.4 |
| 16 | 7.4 | 7.0 | 2% | 0% | 32% | 7% | 140.2 | 9.8 |
| 17 | 10.2 | 5.9 | 61% | 26% | 68% | 24% | 124.7 | 9.0 |
| 18 | 10.5 | 6.5 | 15% | 4% | 40% | 14% | 134.9 | 15.5 |
| **73** | **76.1** | **5.3** | **19%** | **5%** | **45%** | **13%** | **148.8** | **13.0** |
| **159** | **165.6** | **5.3** | **12%** | **3%** | **47%** | **14%** | **137.1** | **13.1** |

Info Trace Distance Coordination Shift Speed Intervals Probability

SCATT SHOOTER TRAINING SYSTEMS

**Shooter name**
P1

**Comments**

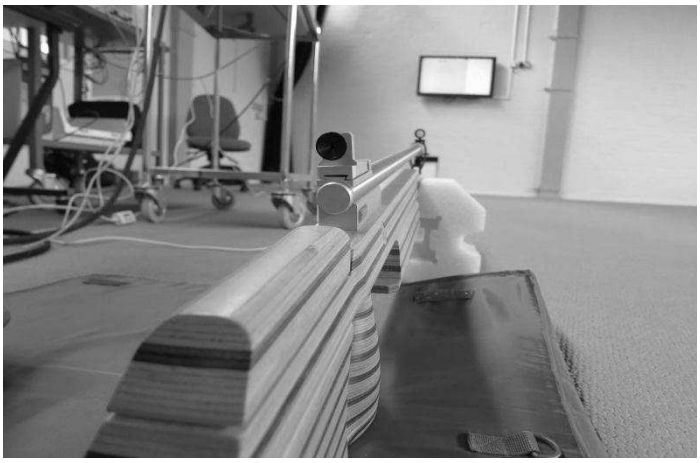
| | |
|---|---|
| **Shooting event** | 50m Rifle (5.6 mm) (SBR50) Prone |
| **Date, time** | 08/03/2013 17:27:34 |
| **Number of match shots** | 18 |
| **Result** | integer 159<br>fractional 165.6<br>average 9.200 |
| **Total shooting time**<br>an interval from the beginning of first shot to the end of last shot | 00:03:00 |
| **Average time per shot** | 00:00:10 (00:00:09, 00:00:10) |
| **Stability of time interval between shots**<br>(if all shots are equally spread the stability is 100%) | 97% |
| **Diametrical dispersion (group size)**<br>a center-to-center distance between two most distant shots | 57.2 mm |
| **Stability of aiming**<br>average points of the tracing are taken for a given interval of time before the shot, and the diametral dispersion of these points is calculated | 48.9 mm |
| **Accuracy of shooting**<br>the average point from the points described above is calculated and its distance from the center of the target is measured | 10.3 mm |
| **Average steadiness in 10.0**<br>shows the amount of the final analysis (control) time up to the moment of shot release that the aiming point was within the 10.0. It is expressed in percentages | 12% |
| **Average length of a tracing** | 137.1 mm<br>horizontal 67.9 mm<br>vertical 104.9 mm |
| **Elliptical factor**<br>a ratio of averaged shot/trace dispersion diameter on x-axis to that on y-axis | for group 0.55<br>for tracings 0.66 |
| **Control interval** | 1.0 sec |

PiezoRejectInterval = 1.0

Appendix 9: Advertisement Poster (Study 3)

Canterbury Christ Church University

Canterbury Christ Church University



**£100 CASH PRIZE ON OFFER!**

PARTICIPANTS ARE REQUIRED FOR A SHOOTING TASK

Participants (male and female) are required to take part in a research study conducted as part of a Ph.D. thesis within the university's Sport Science, Tourism and Leisure Department.

To participate in this research you must:

1. Be able to lay down and lift yourself back up
2. Have no known cardiovascular medical conditions

What will you are required to do?

- Visit the Movement Analysis Lab (Ag54) for a single session (45 minutes)
- The task is simple, all you have to do is take 18 shots at a target with a replica rifle which fires infrared signal (so there is no live fire).
- It doesn't matter if you have never played a shooting computer game before or taken part in a shooting activity, everyone is welcome

Please visit the following website for more information to sign up:

www.clairerossato.co.uk/shooting

Claire Rossato

PhD. Student, Ag53
01227 767 700 (extension 3170)
Email: claire.rossato@canterbury.ac.uk

Appendix 10: Information and Informed Consent Study 3

Canterbury Christ Church University

**Exploring Shooting Performance**

**Information and Informed Consent**

**Information: What is this study about?**

Athletes tend to adopt one of two approaches to competition; these approaches may lead to changes within performance. This study aims to explore this examining performance accuracy and physiological responses.

**What Would You Be Required To Do?**

If you decide to participate you will be asked to visit the Sport Science laboratory at Canterbury Christ Church University for 30 minutes on one occasion on a day that is convenient for you.

**Visit 1:**

You will be asked to lay in a prone position whilst your blood pressure is monitored for five minutes; during this time you will also be required to have a saliva sample taken via a Salivette (a small cotton wool pad), which you will chew for 2 minutes. You will then fill out the two short sports related questionnaires. Following this you will take part in a shooting task, you will be asked to take 20 shots at a target with a training gun. After this task is complete you will then be required to give another saliva sample and stay in prone position for a further five minutes whilst your blood pressure responses are recorded.

**Protocol**

Assessment will take place at the North Holmes Road campus in room Ag50. Each assessment will take approximately 30 minutes.

Pre-assessment requirements are:

- No caffeine (tea, coffee, fizzy drinks, chocolate) within 12 hours of the assessment
- No alcohol within 12 hours of the assessment
- Not to be taking any medication that may affect cardiovascular function
- Participants must be non-smokers

**You must be awake for more than 60 minutes before the test**

It is also important that participants are free from any medical condition that could conceivably affect their performance. As such if you fall ill or get injured during the study, please do not hesitate to inform us straight away and we will rearrange your visits accordingly.

Listed below are measures that will be recorded during the assessment. Some of the terms may be new to you. If you would like detailed descriptions of any of the measurements do not hesitate to contact me.

The assessment will involve:

- Cortisol Levels
- Cardiovascular responses- in particular cardiac output and total peripheral resistance

**What to wear?**

Light, comfortable clothing should be worn. Due to the fitting of monitoring equipment it will be necessary to wear shorts and a t-shirt for all tests

**Feedback**

After your involvement in the study is complete, you will receive feedback on your assessment results.

**What else do I need to know? (Confidentiality, withdrawal from study and use of data)**

You have the right to withdraw from the study at any time without any consequences. All your data will be treated confidentially. Any data used for publication purposes will remain anonymous. Please note you have to be over the age of 18 to take part in this study.

**CONSENT FORM**

**Title of Project:** **Exploring Stress Responses to Competition**

**Name of Researcher**: Claire Rossato

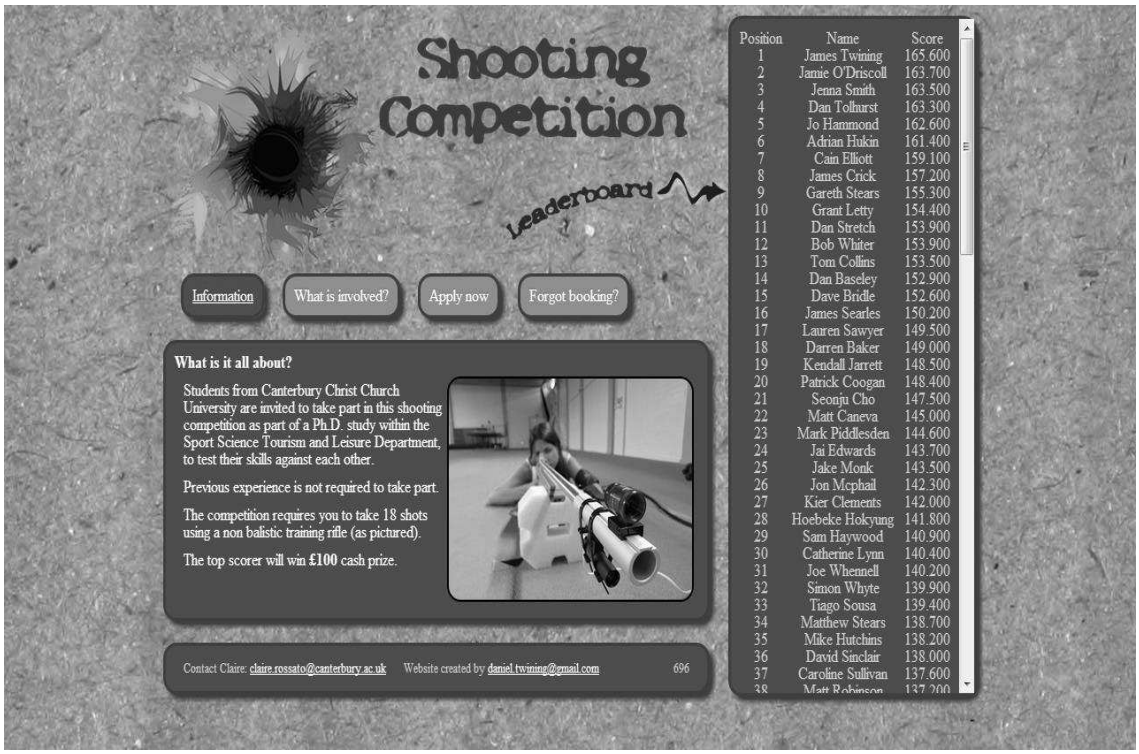
**Contact details:**


| | |
|---|---|
| Address: | Canterbury Christ Church University,<br>North Holmes Road,<br>Canterbury,<br>Kent,<br>CT1 1QU |
| Tel: | 01227 767700 ext 3170 |
| Email: | claire.rossato@canterbury.ac.uk |


| | **Please initial box** |
|---|---|
| 1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | |
| 2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. | |
| 3. I understand that any personal information that I provide to the researchers will be kept strictly confidential. | |
| 4. I agree to take part in the above study and confirm that I am 18 years or over. | |

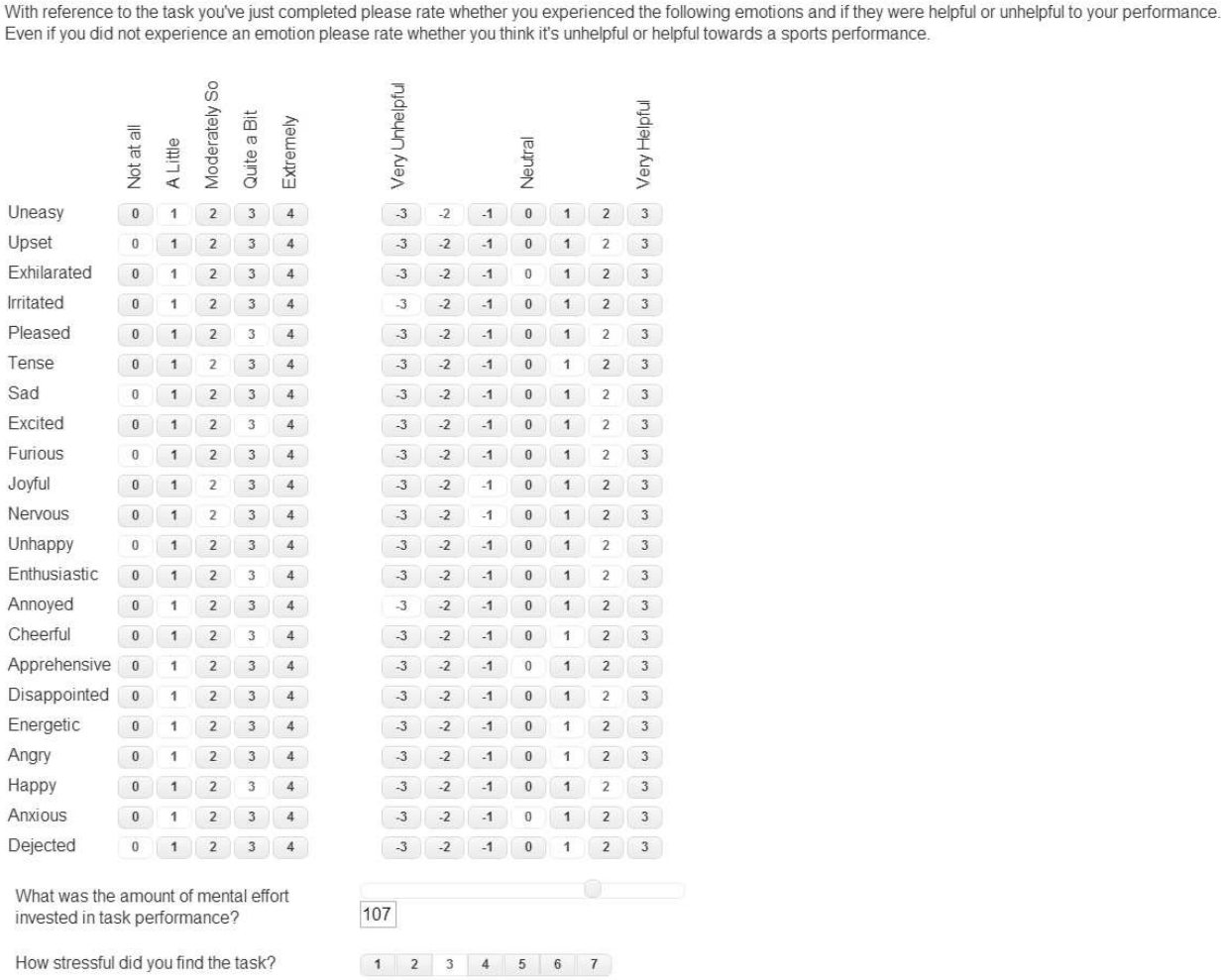
| | | |
|---|---|---|
| _____ | _____ | _____ |
| Name of Participant | Date | Signature |
| _____ | _____ | _____ |
| Name of Person taking consent | Date | Signature |

Appendix 11: Online Leader board (Study 3)



Appendix 12: CAR and CAT display from computer screen (Study 3)

Appendix 13: SEQ (Jones et al., 2005), Subjective Stress and Mental Effort display from the computer screen (Study 3)



Appendix 14: Associations between outcome variables

| | Mean | SD | Performance Accuracy r | Length Trace(mm) r | Snatch (mm) r | Aiming Time (s) r | Steady_10 (%) r | Steady_10 a (%) r | Anxiety Direction | Excitement Direction | Happiness Direction | Challenge and Threat Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAR | 0.4 | 0.27 | 0.009 | 0.093 | -0.008 | 0.27 | 0.046 | 0.031 | -.120 | -.014 | -.063 | .105 |
| Challenge (CAT) | 4.8 | 0.75 | *-0.206 | *0.204 | 0.134 | -0.18 | -0.156 | *-0.231 | .112 | .221* | .247* | -.063 |
| Threat (CAT) | 1.94 | 0.82 | -0.104 | **0.266 | 0.07 | -0.09 | -0.142 | -0.12 | -.127 | .079 | -.001 | -.043 |
| Performance Accuracy | 6.83 | 1.45 | * | **-0.62 | **-.341 | **.588 | **.466 | **.539 | 0.53 | .178 | .055 | .043 |
| Length Trace (mm) | 224.61 | 96.1 | **-.62 | * | **.326 | **-.578 | **-.310 | **-.818 | -.094 | -.119 | .029 | -.131 |
| Snatch (mm) | 43.03 | 18.27 | **-.341 | **.326 | * | **-.488 | **-.638 | **-.423 | -.073 | -.157 | .026 | -.186 |
| Aiming Time (s) | 3.28 | 1.55 | **.588 | **-.578 | **-.488 | * | **.405 | **.658 | .157 | .139 | -.036 | .074 |
| Steady 10 (%) | 2.41 | 3.46 | **.446 | **-.310 | **-.638 | **.405 | * | **.372 | -.034 | -.032 | -.174 | .095 |
| Steady 10a (%) | 24.25 | 18.21 | **.539 | **-.818 | **-.423 | **.658 | **.372 | * | .122 | .084 | -.061 | .077 |
| TPR Reactivity (dyn·s/cm5) | 51.83 | 125.45 | 0.037 | -0.07 | -0.057 | 0.024 | 0.04 | 0.006 | -.133 | -.122 | -.032 | .919** |

| | Mean | SD | Performance Accuracy r | Length Trace(mm) r | Snatch (mm) r | Aiming Time (s) r | Steady_10 (%) r | Steady_10 a (%) r | Anxiety Direction | Excitement Direction | Happiness Direction | Challenge and Threat Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO reactivity (L/min) | 0.33 | 0.46 | -0.042 | 0.172 | 0.136 | -0.112 | -0.134 | -0.135 | .060 | .305 | -.018 | -.919** |
| Anxiety | 1.05 | 0.76 | 0.068 | 0.022 | 0.068 | 0.045 | -0.007 | -0.003 | -.405** | .092 | .011 | .028 |
| Happiness | 1.86 | 0.89 | 0.15 | -0.084 | -0.175 | 0.018 | 0.021 | 0.27 | -.040 | .402** | .608** | .027 |
| Excitement | 1.87 | 0.89 | -0.019 | 0.024 | -0.094 | -0.025 | 0.02 | -0.05 | -.142 | .444** | .444** | .030 |
| Cortisol Delta (nmol/L) | 0.17 | 0.16 | -0.04 | 0.071 | 0.098 | -0.173 | -0.034 | -0.163 | -.269 | -.024 | .074 | .199 |
| Stability of Aiming (mm) | 88.24 | 15.73 | **-.752 | **.440 | **.324 | **-.458 | **.3.43 | **-.323 | -.099 | -.143 | -.070 | -.011 |
| Stability of time interval (%) | 106.43 | 48.41 | **.281 | -0.162 | -0.147 | **.351 | 0.125 | 0.119 | .113 | .163 | .159 | .010 |
| Mental Effort | 95.7 | 33.26 | 0.051 | 0.048 | -0.079 | 0.083 | -0.055 | 0.124 | .011 | 0.49 | .192 | -.089 |
| Subjective Stress | 2.17 | 1.12 | -0.031 | 0.35 | -0.029 | 0.113 | 0.044 | 0.64 | -.133 | -.083 | -.201* | .045 |
| Total Shooting Time (min:s) | 2.45 | 0.56 | 0.022 | -0.091 | 0.142 | -0.074 | 0.112 | 0.056 | .164 | .065 | .071 | .00 |

| | Mean | SD | Performance Accuracy r | Length Trace(mm) r | Snatch (mm) r | Aiming Time (s) r | Steady_10 (%) r | Steady_10 a (%) r | Anxiety Direction | Excitement Direction | Happiness Direction | Challenge and Threat Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group Size | 124.39 | 50.02 | **-.847 | **.553 | **.290 | **-.435 | **-.367 | **.436 | -.033 | -.176 | -.086 | .00 |
| Anxiety Direction | .233 | 1.12 | 0.53 | -.094 | -.073 | .517 | -.034 | .122 | * | .189 | .173 | .105 |
| Excitement Direction | 1.16 | .92 | .178 | -.119 | -.157 | .139 | -.032 | .084 | .189 | * | .617** | -.095 |
| Happiness Direction | 1.08 | .82 | .055 | .029 | .026 | -.096 | -.174 | -.061 | .173 | .617** | * | -.006 |
| Challenge and Threat Index | -0.50 | 1.83 | -.043 | .043 | -.131 | -.186 | .074 | .095 | -.105 | -.095 | -.006 | * |

| | TPR Reactivity (dyn·s/cm5) r | CO Reactivity (L/min) r | CAR r | Challenge (CAT) r | Threat (CAT) r | Anxiety r | Happiness r | Excitement r |
|---|---|---|---|---|---|---|---|---|
| CAR | 0.325 | 0.338 | * | -0.188 | **0.587 | **0.43 | 0.007 | 0.139 |
| Challenge (CAT) | -0.073 | 0.043 | -0.188 | * | -0.014 | *-0.144 | 0.175 | *0.202 |
| Threat (CAT) | 0.025 | 0.103 | **0.587 | -0.014 | * | *0.383 | -0.094 | 0.104 |
| Performance Accuracy | 0.037 | -0.042 | * | * | * | 0.068 | 0.15 | -0.019 |
| Length Trace (mm) | -0.07 | 0.172 | 0.092 | *.204 | **.271 | 0.022 | -0.084 | 0.024 |
| Snatch (mm) | -0.57 | 0.136 | -0.008 | 0.134 | 0.07 | 0.068 | -0.175 | -0.094 |
| Time Taken (s) | 0.024 | -0.112 | 0.027 | -0.181 | -0.09 | 0.045 | 0.018 | -0.025 |
| Steady 10 (%) | 0.04 | -0.134 | 0.046 | -0.156 | -0.142 | -0.007 | 0.021 | 0.02 |
| Steady 10a (%) | 0.006 | -0.135 | 0.031 | *-.231 | -0.12 | -0.003 | 0.27 | -0.05 |
| TPR Reactivity (dyn·s/cm5) | * | **-.689 | 0.098 | -0.073 | 0.025 | 0.051 | -0.027 | -0.022 |
| CO Reactivity (L/min) | **-.689 | * | -0.096 | 0.043 | 0.103 | -0.002 | -0.074 | -0.075 |

| | TPR Reactivity (dyn·s/cm5) r | CO Reactivity (L/min) r | CAR r | Challenge (CAT) r | Threat (CAT) r | Anxiety r | Happiness r | Excitement r |
|---|---|---|---|---|---|---|---|---|
| Anxiety | 0.051 | -0.002 | **.430 | *-0.147 | **.383 | * | 0.066 | **.307 |
| Happiness | -0.027 | -0.074 | 0.007 | 0.175 | -0.094 | 0.066 | * | **.723 |
| Excitement | -0.022 | -0.075 | 0.139 | *.202 | 0.104 | **.307 | **.723 | * |
| Cortisol Delta (nmol/L) | 0.143 | -0.07 | *.385 | -0.295 | 0.224 | 0.177 | -0.014 | 0.059 |
| Stability of Aiming (mm) | -0.009 | 0.01 | 0.018 | 0.105 | 0.045 | -0.064 | -0.067 | -0.074 |
| Stability of time interval (%) | 0.031 | 0.013 | -0.156 | -0.005 | *-.204 | -0.15 | 0.137 | 0.087 |
| Mental Effort | -0.121 | 0.42 | 0.103 | 0.86 | 0.69 | 0.1 | *.249 | **.348 |
| Subjective Stress | 0.35 | -0.049 | **.519 | *.244 | **.359 | **.528 | -0.081 | 0.022 |
| Total Shooting Time (mins:s) | 0.016 | 0.016 | -0.004 | 0.002 | -0.09 | 0.02 | -0.19 | -0.046 |
| Group Size | 0.003 | -0.004 | 0.078 | *.213 | 0.1 | -0.041 | -0.009 | 0.072 |
| Anxiety Direction | -.133 | .060 | -.120 | .112 | -.127 | -.405** | -.040 | -.142 |

| | TPR Reactivity (dyn·s/cm5) r | CO Reactivity (L/min) r | CAR r | Challenge (CAT) r | Threat (CAT) r | Anxiety r | Happiness r | Excitement r |
|---|---|---|---|---|---|---|---|---|
| Excitement Direction | -.122 | .305 | -.014 | .221* | .079 | .092 | .402** | .444** |
| Happiness Direction | -.032 | -.018 | -.063 | .247* | -.001 | .011 | .0608** | .027 |
| Challenge and Threat Index | .919** | -.919** | .105 | -.063 | -.043 | .028 | 0.27 | .030 |

| | Cortisol Delta (nmol/L) r | Stability of Aiming (mm) r | Stability of Time Interval (%) r | Mental Effort r | Subjective Stress r | Total Shooting Time (min/secs) r | Group Size r |
|---|---|---|---|---|---|---|---|
| CAR | *0.385 | 0.018 | -0.156 | 0.103 | * | -0.004 | 0.078 |
| Challenge (CAT) | -0.295 | 0.105 | -0.005 | 0.086 | *.224 | 0.002 | *.213 |
| Threat (CAT) | 0.224 | 0.045 | *-.204 | 0.069 | **.359 | -0.09 | 0.1 |
| Performance Accuracy | -0.04 | **-.752 | **.281 | 0.051 | -0.031 | 0.022 | **-.847 |
| Length Trace(mm) | 0.071 | **.44 | -0.162 | 0.048 | 0.035 | -0.091 | **.553 |
| Snatch (mm) | 0.098 | **.324 | -0.147 | -0.079 | -0.029 | 0.142 | **.290 |
| Time Taken (s) | -0.173 | **.458 | **.351 | 0.083 | 0.113 | -0.074 | **-.435 |
| Steady 10 (%) | -0.034 | **-.343 | 0.125 | -0.055 | 0.044 | 0.112 | **-0.367 |
| Steady 10a (%) | -0.0163 | **-.323 | 0.119 | 0.01 | 0.064 | 0.056 | **-.436 |
| TPR reactivity(dyn·s/cm5) | 0.143 | -0.009 | 0.031 | -0.121 | 0.035 | 0.016 | 0.003 |
| CO reactivity (L/min) | -0.07 | 0.01 | 0.013 | 0.042 | -0.049 | 0.016 | -0.004 |

| | Cortisol Delta (nmol/L) r | Stability of Aiming (mm) r | Stability of Time Interval (%) r | Mental Effort r | Subjective Stress r | Total Shooting Time (min/secs) r | Group Size r |
|---|---|---|---|---|---|---|---|
| Anxiety | 0.066 | -0.064 | -0.15 | 0.1 | **.528 | 0.02 | -0.041 |
| Happiness | -0.014 | -0.067 | 0.137 | *.249 | -0.081 | -0.019 | -0.009 |
| Excitement | 0.059 | -0.074 | 0.087 | **.348 | 0.022 | -0.046 | 0.072 |
| Cortisol Delta (nmol/L) | * | -0.001 | 0.072 | *-.405 | 0.31 | 0.051 | 0.187 |
| Stability of Aiming (mm) | -0.001 | * | -0.031 | -0.135 | -0.001 | 0.119 | **.801 |
| Stability of time interval (%) | 0.072 | -0.031 | * | -0.014 | *-.213 | .0.36 | -0.018 |
| Mental Effort | *-.405 | -0.135 | -0.014 | * | 0.131 | -0.092 | -0.051 |
| Subjective Stress | 0.31 | -0.001 | *-.231 | 0.131 | * | *-.229 | 0.025 |
| Total Shooting Time (mins:s) | 0.051 | 0.199 | 0.036 | -0.092 | *-.229 | * | 0.89 |
| Group Size | 0.187 | **.801 | -0.018 | -0.051 | 0.025 | 0.89 | * |
| Anxiety Direction | -.269 | -.099 | .113 | .011 | -.133 | .164 | -.033 |

| | Cortisol Delta (nmol/L) r | Stability of Aiming (mm) r | Stability of Time Interval (%) r | Mental Effort r | Subjective Stress r | Total Shooting Time (min/secs) r | Group Size r |
|---|---|---|---|---|---|---|---|
| Excitement Direction | -.024 | -.143 | .163 | .49 | -.083 | .065 | -.176 |
| Happiness Direction | 0.74 | -.070 | .159 | .192 | -.207* | .071 | -.086 |
| Challenge and Threat Index | .199 | -.011 | .010 | -.089 | .045 | .00 | .00 |

Note: Cortisol analysis only included 39 participants *p< 0.05, **< p0.01