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A Theory of Challenge and Threat States in Athletes

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Abstract

We propose a Theory of Challenge and Threat States in Athletes (TCTSA) which is an amalgamation and extension of the biopsychosocial model of challenge and threat, the model of adaptive approaches to competition and the debilitative and facilitative competitive state anxiety model. In the TCTSA we posit that self-efficacy, perceptions of control, and achievement goals determine challenge or threat states in response to competition. Distinct patterns of neuroendocrine and cardiovascular responses are indicative of a challenge or threat state. Increases in epinephrine and cardiac activity, and a decrease in total peripheral vascular resistance (TPR) characterise a challenge state and increases in cortisol, smaller increases in cardiac activity and either no change or an increase in TPR characterise a threat state. Positive and negative emotions can occur in a challenge state while a threat state is associated with negative emotions only. Emotions are perceived as helpful to performance in a challenge state but not in a threat state. Challenge and threat states influence effort, attention, decision–making and physical functioning and accordingly sport performance. The TCTSA provides a framework for practitioners to enhance performance, through developing a challenge state, and encourages researchers to explore the mechanisms underlying performance in competition.

Keywords: Challenge; threat; appraisal; emotion; cardiovascular.

A Theory of Challenge and Threat States in Athletes

"... there is nothing either good or bad, but thinking makes it so." – Hamlet

Success in sport is partly a function of how well athletes deal psychologically with the demands of competition. This literature review takes as its basis the notion that there is a dichotomy in the way athletes respond to competition. Specifically, athletes can be classified into those who respond positively – the competition is a *challenge*; and those who respond negatively – the competition is a *threat*. The response is, as the quote from Hamlet suggests, determined by the way in which the competitive situation is perceived. This literature review describes the cognitive, emotional, and physiological aspects of challenge and threat states along with potential performance consequences. It concludes with the presentation of a psychophysiological Theory of Challenge and Threat States in Athletes (TCTSA).

In proposing the TCTSA we draw on the biopsychosocial (BPS) model of challenge and threat (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996), the model of adaptive approaches to competition (Skinner & Brewer, 2004) and other related contemporary approaches to understanding athletes' perceptions and experiences of an upcoming competition (e.g., achievement goal theory, interpretation of anxiety symptoms). Although the TCTSA concerns athletes' preparedness for competition, because it explains how athletes respond to an upcoming competition, we also consider how the cognitions, emotions and physiological responses associated with challenge and threat states may influence sport performance. That is, we posit athletes' psychophysiological states before competition will predict, at least partly, performance levels in competition.

We propose that the TCTSA outlines more fully than existing approaches *why* athletes may perceive an upcoming competition as either a challenge or threat, *how* they respond emotionally and physiologically when they do, and *how* challenge and threat states can influence performance. While the TCTSA draws on existing models, a number of aspects unique to the TCTSA contribute to the literature. Specifically, the TCTSA outlines: how a unique combination of psychological constructs *interact* to determine challenge and threat states; that high intensity negative emotions can be experienced in a challenge state; how challenge and threat states influence performance through effort, attention, decision-making and physical functioning.

Challenge and threat are motivational states that reflect how an individual engages in a personally meaningful situation and includes cognitive, affective, and physiological components (Blascovich & Mendes, 2000). This literature review begins by explaining why athletes experience challenge or threat states. The emotional and physiological aspects of challenge and threat states are then described before potential performance consequences are outlined. At each stage, we describe the extant literature and outline how the proposed theory extends previous work. We conclude this literature review by presenting the Theory of Challenge and Threat States in Athletes (TCTSA) and discussing its implications for future research and practice.

Determinants of Challenge and Threat States

The simple dichotomy between individuals who perceive an upcoming competitive situation as a challenge (positively) and those that perceive it as a threat (negatively)

is intuitively appealing because it supports the commonly held belief that some individuals will rise to the demands of competition and perform well, while some wilt and perform poorly. Theoretical approaches and empirical strands of research support this dichotomy: the BPS model (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996), the model of adaptive approaches to competition (Skinner & Brewer, 2004), and the model of debilitative and facilitative competitive state anxiety (Jones, 1995). We will briefly describe each of these approaches in turn.

In the BPS model, a challenge state is experienced when sufficient, or nearly sufficient, resources to meet the demands of a situation are perceived, whereas a threat state is experienced when insufficient resources to meet the demands of situation are perceived (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996). Accordingly, appraisal is a key component of model and comprises demand and resource appraisals (Blascovich & Mendes, 2000). Demand appraisals include the perception of danger, uncertainty and required effort in a situation. For example, demand appraisals would be made if a rugby player perceives his opponent to be physically imposing (danger of injury and humiliation), is unsure of how he may perform (uncertainty) and recognises it will take much physical and mental effort to succeed in his personal duel (effort). Resource appraisals relate to a person's ability to cope with the demands of a situation and include skills, knowledge, abilities, dispositional factors (e.g., self-esteem, sense of control) and external support available to a person (Blascovich, Mendes, Tomaka, Salomon, & Seery, 2003). For example, a tennis player may experience a challenge state if she has recently been playing well (experience and skills), and is about to compete against an opponent whom she has beaten on the last few occasions (knowledge).

Skinner and Brewer's (2004) concept of challenge and threat appraisals

differed slightly from that proposed in the BPS model because they also considered what an athlete may be striving for in a competitive setting. For Skinner and Brewer, a challenge appraisal is characterised by opportunities for success, mastery, learning and personal growth, which indicates that with confidence the demands of the situation can be met. A threat appraisal, however, is characterised by potential and anticipated danger to one's well-being or self-esteem and low confidence in one's ability to cope with the threat.

In addition to existing models of challenge and threat, evidence from the competitive anxiety literature, and clarified in the control model of debilitative and facilitative competitive state anxiety (Jones, 1995) suggested that athletes' emotional responses to upcoming competition can be broadly categorised in two ways. That is, whether the symptoms are perceived as helpful or unhelpful to performance (see Hanton, Neil, & Mellalieu, 2008 for a review). In general, a positive perception of anxiety symptoms is reported by elite performers in comparison with non-elite performers (e.g., Jones & Swain, 1995) and a positive perception of anxiety symptoms is associated with higher performance levels (e.g., Jones, Swain, & Hardy, 1993). A positive interpretation of anxiety symptoms results from an athlete's perception of control over the environment and the self, and sufficient positive belief to cope, and that the goal can be achieved (Jones, 1995).

Determinants in the TCTSA

In proposing the TCTSA, we amalgamate and extend the BPS model, the model of adaptive approaches to competition, and the control model of debilitative and facilitative competitive state anxiety. We agree with the BPS model that challenge and threat states occur because of the appraisal of a goal-relevant evaluative

situation. Indeed, in all three models, appraisals are made based on evaluations of demands compared to resources. Because an individual's goals are arranged hierarchically, the stronger and more important the goal, the more intense the response will be (Lazarus, 1991). For example, the physiological and emotional response of a soccer player before a regular season game may be less intense than that before a cup final game. In line with the BPS model we propose that demand appraisals determine the relevance of the situation and we clarify the exact nature of the resource appraisals in challenge and threat states.

In the TCTSA, the resource appraisals are an amalgamation and extension of those factors outlined in the BPS model, the model of adaptive approaches to competition and the control model of debilitative and facilitative competitive state anxiety. The resource appraisals comprise three inter-related constructs: self-efficacy, perceptions of control and goal orientation. The importance of self-efficacy is outlined in all three models and perceptions of control are important for Blascovich and Tomaka (1996) and Jones (1995). The importance of goal orientation is outlined by Skinner and Brewer (2004), and we build on this by using the 2x2 achievement goal framework (Elliott & McGregor, 2001) to explain how goal orientations play a role in challenge and threat states. The TCTSA contributes to an understanding of athletes' responses to competitive situations by explaining how self-efficacy, perceptions of control and goal orientation interact to determine challenge and threat states and it is to this that we now turn.

Self-efficacy

Self-efficacy beliefs are judgments of what an individual can accomplish with his/her skills (Bandura, 1986). Sources of self-efficacy include performance accomplishments, vicarious experiences, verbal persuasion, and physiological states

(Bandura, 1986). In addition, imaginal experiences (Bandura, 1997; Maddux, 1995) and emotional states may contribute as additional sources of self-efficacy information (Schunk, 1995; Treasure, Monson, & Lox, 1996).

Self-efficacy is an important aspect of the resource appraisals because an athlete's belief that she has the skills necessary to execute the courses of action required to succeed clearly contributes to a perception that she can cope with the demands of the situation (cf. Lazarus, 1999). An athlete who believes she has the necessary skills to cope with the demands of the situation and execute the strategies required to succeed will experience a challenge state in competition. However, it is not enough for an athlete to believe that she has sufficient skills to cope with the demands of the situation. An athlete must also perceive she has sufficient control to display those skills. Self-efficacy is associated with perceived control because individuals need to believe that they are in control, and can intentionally execute their actions, for self-efficacy to develop (Bandura, 1997).

Control

Control is central to the debilitative and facilitative competitive state anxiety model (Jones, 1995), is mentioned as a dispositional factor in the BPS model, and is an essential part of self-efficacy. To explain the notion of control, we draw on the notion of objective control, perceived control, and experiences of control (Skinner, 1996). Objective control is the actual control present in the situation and the individual. Perceived (also referred to as subjective) control refers to the beliefs of an individual about how much control is available. Finally, experiences of control refer to the feelings of the individual in the situation and are a product of external conditions, subjective interpretations, and individual actions. Perceived control is a powerful predictor of functioning, probably more so than objective control (Averill,

1973; Skinner, 1996) and, as such, an athlete's perception of control has an important influence on resource appraisals and accordingly, challenge and threat states in competition.

To illustrate how an athlete's perception of control influences challenge and threat states in competitive settings, and is associated with self-efficacy, consider a basketball player may feel confident in her offensive skills but may not believe her team-mates will provide enough possession to enable her to perform to the best of her ability. In short, not only does an athlete need to feel able to execute the skills required, but also to have sufficient control to perform as well as possible. Many aspects in sport are out of an athlete's control (e.g., weather conditions, official's decisions), however, this does not mean an athlete will experience a threat state. A threat state will occur only when an athlete fixates on those factors which cannot be controlled, leading to a low level of perceived control. On the other hand, if an athlete accepts that there are aspects of the situation that cannot be controlled but chooses to focus on aspects that can be controlled, a challenge state may follow. Thus, what an athlete is striving for is clearly important for challenge and threat states and we now describe the types of goals related to challenge and threat states.

Goals

An athlete's achievement behaviours in evaluative settings represent motives for participating in sport. Achievement goal theory explains how goals play an important part in athletes' responses to competitive sport settings. A central tenet of this theory is that people's achievement behaviours are observable through the goals they adopt (Roberts, Treasure, & Conroy, 2007). According to this practice, two distinct goal types emerge: mastery and performance goals. Mastery goals focus on developing competence through mastering tasks and develop task involvement.

Performance goals focus on demonstrating competence relative to others and develop ego involvement (Ames & Archer, 1988, Dweck, 1986). Elliot and his colleagues (Elliot & Church, 1997; Elliot & Harackiewicz, 1996) proposed a trichotomous model of the achievement goal framework with an extension of the mastery-performance dichotomy. In their framework, the mastery goal construct is unchanged, however, the performance goal construct splits into approach and avoidance components resulting in three independent achievement goals: mastery goals, performance-approach (PAp) goals and performance-avoidance (PAv) goals. Approach goals reflect striving for competence and therefore, PAp goals reflect a motivation to be seen as more competent (e.g., more talented badminton player) than another person. Avoidance goals reflect a drive to avoid incompetence and PAv goals reflect a motivation not to be regarded more incompetent (e.g., a worse badminton player) than another person.

There is evidence supporting the proposition that achievement goals play a role in determining challenge and threat states. As such achievement goals are a key determinant of challenge and threat states in the TCTSA. For example, students supporting mastery and PAp goals tended to interpret the anticipatory time to exam as a challenge while students pursuing PAv goals, however, tended to interpret the exam as threatening (McGregor & Elliot, 2002). More recently, the trichotomous model has been developed to include a fourth possible achievement goal: mastery avoidance goals (MAv), providing a 2x2 achievement goal framework (Elliott & McGregor, 2001). Mastery Approach (MAp) goals reflect a motivation to appear competent in relation to a self-referenced target (e.g., beat a personal time for the 400 metre race). MAv goals reflect a motivation to avoid incompetence in relation to a self-referenced target (e.g., I don't want to run the 400 metres slower than my

average). Evidence from this 2x2 framework also supports the proposition that achievement goals play a role in determining challenge and threat states. Adie, Duda, and Ntoumanis (2008) used the 2x2 achievement goal framework to examine hypothesised relationships between achievement goals, challenge and threat appraisals of sport competition among 424 team sport participants. MAp goals were strongly, and positively, associated with challenge appraisals of sport competition and MAv goals were a strong predictor of threat appraisals but unrelated to challenge appraisals. PAp goals related positively to both challenge and threat appraisals but the relationship was stronger between PAp goals and threat. PAv goal adoption, however, did not predict threat appraisals of sport competition.

In summary, although research in sport settings is in its early stages it appears that individuals with avoidance goals will tend to view an upcoming competition as a threat while those with approach goals, in particular mastery, will view an upcoming competition as a challenge. An individual focused on approach goals, and therefore demonstrating competence, particularly when that competence is determined by self-referenced standards, is more likely to view a demanding and potentially stressful event as a challenge. In a challenge state it ensures that the high self-efficacy and feelings of control are directed towards a more purposeful outcome than simply avoiding incompetence. Although MAp goals are associated with a challenge state, the relationship between PAp and a challenge state is a little more unclear. It is possible the roles of self-efficacy and control are important factors in determining how PAp goals relate to a challenge state. If an individual aims to perform better than someone else, and believes he has the skills to do so and has sufficient perceived control over the situation, then PAp should be associated with a challenge state. In short, athletes should recognise that they have potential costs in a

competition (e.g., recognise the talents of opponents, the potential to lose), but their focus should be on demonstrating competence.

Summary

The TCTSA outlines more fully than existing approaches *why* athletes may perceive an upcoming competition as either a challenge or threat. The TCTSA proposes that an athlete will experience a challenge state if he has high self-efficacy, a perception of control and a focus on approach goals. A threat state is associated with low self-efficacy, low perceived control and a focus on avoidance goals. A further tenet of the TCTSA is that all three constructs are inter-related and all three are necessary for a challenge state. That is, an athlete needs to have a high perception of control to experience high self-efficacy and be focused on demonstrating competence in the sport setting. The appraisal process, which determines the interplay between demand and resources, can be conscious or unconscious and may fluctuate during competition as the demands and resources are continuously appraised.

Physiological and Emotional Changes in Challenge and Threat States

Challenge and threat states in sport are associated with contrasting emotional and physiological patterns and it is these changes that we now explore.

Physiological Changes in Challenge and Threat States

The physiological changes associated with challenge and threat states are a key aspect of the BPS model. Specifically, distinct patterns of neuroendcorine and cardiovascular responses are indicative of a challenge or threat state. A challenge response is characterised by an increase in sympathetic-adreno-medullary (SAM)

activity and accompanying increases in epinephrine and cardiac activity along with a decrease in peripheral vascular resistance. In contrast, a threat response is characterised not only by an increase in SAM activity by also by an increase in pituitary-adreno-cortical (PAC) activity, accompanying increases in cortisol, smaller increases in cardiac activity and either no change or an increase in peripheral vascular resistance. This response pattern is displayed in Figure 1.

(Insert Figure 1 about here)

The cardiovascular response pattern proposed in the BPS model to be indicative of challenge and threat responses is based on the work of Obrist (1981) and Dienstbier (1989). The challenge and threat cardiovascular responses are proposed to be indicative of differential activation of the SAM and PAC axes. A challenge response is proposed to result from SAM activation producing greater cardiac activity (increased heart rate), and left-ventricular contractility that increases stroke volume. The combination of increased heart rate and enhanced left-ventricular contractility enhances cardiac output. SAM activation releases epinephrine, which causes vasodilatation (widening of blood vessels resulting from relaxation of the muscular wall) and a decrease in systematic vascular resistance (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996). Together these changes represent the efficient mobilization of energy for immediate action and coping (Blascovich, Mendes, Hunter, & Salomon, 1999). This efficiency occurs because of increased blood flow to the brain and muscles, higher blood glucose levels, which is the fuel of the nervous system, and an increase in free fatty acids that can be used by the muscles as fuel (c.f. Dienstbier, 1989).

A threat response is proposed to result in an increase in both SAM and PAC activation. The activation of the PAC axis results in the release of adreno-corticotrophic hormone that causes the adrenal cortex to secrete corticosteroids into the bloodstream. Thus, although cardiac activity increases similar to a challenge condition, there is no corresponding decrease in systemic vascular resistance, and indeed it may even increase (Dienstbier, 1989). As a result, blood pressure typically increases (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996). The combination of increased cardiac activity and stable, or increased, systemic vascular resistance represents a less efficient pattern for coping because, in this instance, the blood flow to the brain and muscles is not increased and while stored fat and protein is converted into usable energy, it is done so over a longer period of time.

A demand, therefore, has two potential responses that serve different functions. In the challenge response, the SAM activation represents an attempt to mobilize energy for action (fight or flight) and coping, whereas the threat response results from PAC (and SAM) activation and is a "distress system" associated with perceptions of actual or physical harm (Blascovich & Tomaka, 1996).

A growing body of research supports the BPS model and its central tenet that appraisals play a role in the distinct cardiovascular response patterns of challenge and threat states (that are proposed to be indicative of neuroendocrine changes). First, challenge and threat states can be manipulated by altering the instructional set given to participants. For example, Tomaka, Blascovich, Kibler, and Ernst (Study 1, 1997) asked participants to complete a mental arithmetic task. Half of the participants were informed of the importance of completing the task as accurately as possible and that performance would be scored for speed and accuracy (threat condition) while the other half were told to think of the task as a challenge and that

they were capable of meeting that challenge (challenge condition). Participants demonstrated cardiovascular responses consistent with the instructional set they received. Similarly, individuals in situations of social uncertainty (Mendes, Blascovich, Hunter, Lickel, & Jost, 2007) tend to display cardiovascular responses associated with threat. Likewise, increasing the goal-relevance of a task performance (by introducing an audience) can induce cardiovascular responses consistent with either challenge or threat depending on whether the task is well-learned (Blascovich, et al., 1999). Cardiovascular patterns consistent with that proposed in the BPS model have also been demonstrated when a threat to social identity is presented (Scheepers & Ellemers, 2005), when interacting with higher or lower ability individuals (Mendes, Blascovich, Major, & Seery, 2001) when discussing emotional issues (Mendes Reis, Seery, & Blascovich, 2003) and in social interactions with a stigmatized person (Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001).

Of importance to this review is the cardiovascular responses outlined by the BPS model have also been observed in athletes (Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2004). Four to six months before the start of the season, 34 players from baseball (men) and softball (women) teams provided a two minute speech about a specific playing situation while impedance cardiography, electrocardiography, and continuous blood pressure measures were recorded. The athletes who experienced a challenge state during this task performed better during the subsequent season compared to players who experienced a threat state. Thus, not only do athletes demonstrate challenge or threat responses when talking about their sport – indicating these states may be experienced before, and possibly during competition – those that exhibited a challenge state typically performed better.

Emotions in Challenge and Threat States

There have been two main foci about athletes' emotional responses during challenge and threat states. First, how the valence of the emotional state differs, and second whether the emotional state is perceived as helpful or unhelpful for performance.

Both the BPS model (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996) and the model of adaptive approaches to competition (Skinner & Brewer, 2004) propose that athletes' emotional states will be more positive in challenge than threat states. In addition the model of adaptive approaches to competition and the work of Jones, Hanton and colleagues (Jones, 1995; Hanton et al., 2008) provide support for the proposition that the perception of emotions as helpful, or unhelpful for performance differs in challenge and threat states. Following a challenge appraisal, positive emotions are likely to occur and are likely to be perceived as beneficial to performance (Skinner & Brewer, 2004). Following a threat appraisal, negative emotions are likely to occur and are likely to be perceived as harmful to performance (Skinner & Brewer, 2004). In support of Skinner and Brewer's model, participants in response to a hypothetical stressful scenario (conference presentation or end of year university exam) and an actual stressful event (university exam) indicated that threat appraisals were associated with a decrease in coping expectancies, positive emotion and beneficial perceptions of emotion. Challenge appraisals were associated with an increase in coping expectancies, positive emotion and beneficial perceptions of emotion (Skinner & Brewer, 2002).

A positive interpretation of anxiety symptoms results from an athlete's perception of control over the environment and the self, and sufficient positive belief to cope, and that the goal can be achieved (Jones, 1995). Athletes who perceive their anxiety symptoms as helpful to performance report more positive feelings (e.g.,

excited, relaxed) and less negative feelings (e.g., tense, angry) than athletes who perceive their anxiety symptoms as unhelpful to performance (Jones & Hanton, 2001; Mellalieu, Hanton, & Jones, 2003). As control and self-efficacy appear to be related to athletes' perceptions of anxiety as helpful or unhelpful to performance then perceptions of other emotions may differ across challenge and threat states and as such are incorporated within the TCTSA.

Physiological and Emotional Changes in the TCTSA

Challenge and threat states are associated with distinct emotional and physiological states. In the TCTSA we incorporate the physiological responses outlined in the BPS model, with the more detailed emotional responses outlined in the model of adaptive approaches to competition (Skinner & Brewer, 2004) and the work of Jones (1995). The TCTSA also extends the model of adaptive approaches to competition by incorporating recent BPS focused research, and evidence from the extant sport literature, demonstrating that high intensity emotions of a negative valence can occur in a challenge state and be perceived as helpful to performance.

Based on the BPS model we propose in the TCTSA a challenge state has increased SAM activity and accompanying increases in epinephrine and cardiac activity along with a decrease in total peripheral vascular resistance (TPR). In contrast, a threat response is characterised by an increase in both SAM and PAC activity, accompanying increases in cortisol, smaller increases in cardiac activity and either no change or an increase in TPR. That is, athletes have different cardiovascular responses before competition depending on whether they are in a challenge or a threat state determined by SAM vs. PAC axes involvement.

Both the BPS model and the model of adaptive approaches to competition suggested that a challenge state is characterised by positive affect or mild levels of

negative affect (whereas a threat state is characterised by high negative affect). Similarly, Lazarus (1991) contended that appraising an encounter as a threat (where there is the potential for loss) makes one feel anxious while appraising an encounter as a challenge (a difficult to attain anticipated gain) results in positive emotions.

We propose in the TCTSA that positive emotions will typically be associated with a challenge response and negative emotions will typically be associated with a threat response. We say typically as the exact emotions will be determined by processes outlined in Cognitive-Motivational-Relational Theory (CMRT: Lazarus, 1991). CMRT describes how specific emotions arise, has been applied to sport (Lazarus, 2000) and support for its central tenets have been reported by athletes during competition (Uphill & Jones, 2007). Also, in competitive sport we can conceive of situations in which negative emotions, such as anger and anxiety, can occur in a challenge state. To explain, challenge and threat reflect motivational states (Blascovich & Mendes, 2000) and thus are orthogonal to the valence of the emotion experienced (Mendes, Major, McCoy & Blascovich, 2008). High intensity emotions of a negative valence, like anxiety and anger that can serve motivational functions would therefore be clearly consistent with a challenge state. To illustrate, cardiovascular responses consistent with a challenge state were associated with higher levels of anger in participants who experienced social rejection (Mendes et al., 2008).

There is also evidence from the competitive anxiety literature that anxiety may be associated with a challenge state. Competing in a meaningful competition in which the outcome is uncertain, against an opponent(s) that is also trying to win, is a demanding and uncertain situation. In short, the conditions for anxiety are present in most competitive sport settings and, because even a challenge state can include

recognition of the potential for loss and uncertainty, anxiety can be experienced in a challenge setting. It is conceivable that both somatic and cognitive aspects of anxiety can be experienced in a challenge state. Indeed, the threat state is associated with smaller increases in cardiac activity indicating that at least one aspect of somatic anxiety may be less intense in a threat state. Cognitive anxiety, which relates to worry about the upcoming competition, may also occur in the challenge state. Reflecting the importance of the competition and recognition that substantial losses could potentially occur, rather than a belief that success cannot be achieved, and there is an opportunity to demonstrate competence. Cognitive anxiety and self-efficacy are orthogonal and it is possible to experience both simultaneously (Hardy, 1996).

Emotions of a negative valence, particularly those that can serve a motivational function in sport, are sometimes seen as helpful by athletes. There is substantial evidence that athletes can feel anxious going into a competition but believe that those symptoms are likely to help performance (Cerin, 2003; Jones & Uphill, 2004). In addition, Hanin's (2000) model of Individual Zones of Optimal Functioning (IZOF) reports that negative affect (e.g., tension, anger, nervousness) is reported by some athletes as helping performance. Further, Lane, and Terry's (2000) conceptual model of mood in sport proposes that negative mood states, specifically anger and tension, have curvilinear effects on performance (that is they enhance performance up to a point) in the absence of depressed mood but reduce performance in the presence of depressed mood. In short, athletes appear to think that emotions of a negative valence can be helpful to sport performance (Hanton et al., 2008; Hanin, 2000) and there is evidence from sport-related models (e.g., Lane & Terry, 2000) that this is actually the case. This is not surprising given that

emotions, even those of a negative valance can be associated with enhanced motivation, focused attention and superior physical functioning (Uphill, McCarthy, & Jones, 2008).

Skinner and Brewer (2004) recognised that athletes could experience anxiety during a challenge state but that this would only be a moderate level, and higher levels of competitive anxiety are associated with less favourable perceptions. However, the perception of anxiety symptoms as helpful or unhelpful to performance is determined by self-efficacy and perceived control (Jones, 1995) and not by the intensity of the symptoms. Athletes with an internal locus of control (similar to perceived control) viewed their competitive anxiety as positive for performance (Ntoumanis & Biddle, 1998) and competitive swimmers reported symptoms perceived to be under control as positive for performance (Hanton & Connaughton, 2002). For elite athletes, high levels of self-efficacy were associated with positive interpretations of anxiety symptoms (Hanton, Mellalieu, & Hall, 2004; Mellalieu, Neil, & Hanton, 2006). However, for non-elite athletes Mellalieu et al. found the intensity of the anxiety symptoms accounted for variance in anxiety perceptions (although control was not assessed in this study). Collectively, both theory and research, suggest that in combination, a high perception of control and self-efficacy should, typically, be associated with anxiety symptoms being perceived as helpful to performance. Provided an athlete has a high perception of control and high self-efficacy then even high levels of anxiety can be perceived as facilitative to performance. Other negative emotions may be perceived as helpful to performance in a challenge state, such as a boxer perceiving a high level of anger as useful for performance provided he has high self-efficacy and perceived control.

Summary

In the TCTSA, positive emotions will typically, but not exclusively, be associated with a challenge response and negative emotions will typically, but not exclusively, be associated with a threat response. High intensity negative emotions, such as anger and anxiety, can occur in a challenge state. As the resource appraisals associated with the challenge state (high self-efficacy, perception of control, focus on approach goals) are similar to those associated with a perception emotions will help performance then, in line with Skinner and Brewer (2004), we propose in the TCTSA that athletes in a challenge state, will perceive their emotions as helpful for performance and their emotions in a threat state as unhelpful for performance.

Performance Consequences of Challenge and Threat States

Limited research has explicitly explored the relationship between challenge and threat states and performance. In an academic setting, Skinner and Brewer (2002) reported that perceptions of challenge accounted for the greatest variations in performance in a university exam, with a beneficial perception of state appraisals associated with gains in performance. Cardiovascular responses consistent with a threat state were associated with a poorer performance on a word search task than cardiovascular responses associated with a challenge state (Mendes et al., 2008). The BPS model also makes predictions about motor behavior that informs how challenge and threat states could influence performance in sport. In a threat state, the body should adopt an avoidance or protective stance, characterized by closed body posture and general orientation away from the stimulus. Second, consistent with the orienting response, less general somatic activity should occur (Stern, Ray, &

Quigley, 2001). For example, freezing is an adaptive behavior that allows individuals to monitor whether a potential demand is dangerous (Blanchard, Flannelly, & Blanchard, 1986). Thus, an athlete in a threat state may be less likely to involve him or herself in the competition, for example not seeking possession often. Cognitive factors may also have a role in performance variation. In athletic settings, Blascovich et al. (2004) reported that baseball and softball players who experienced a challenge state when talking about a sport specific situation performed better during the subsequent season compared to players who experienced a threat state. Blascovich et al. speculated that in the threat state the baseball and softball players' experienced a decrease in performance because of an increase in self-focus that interfered with the performance.

Performance Consequences in the TCTSA

In considering how challenge and threat states relate to performance in sport settings, we focus on the likely consequences of the cognitions, and neuroendocrine and cardiovascular responses associated with those states. We also consider how anxiety (as this emotion has been explored extensively in sport), may relate to performance differently depending on whether it is associated with a challenge or threat state. The TCTSA is primarily about athletes' preparedness for competition, and while psychophysiological responses may change during competition an athlete's psychophysiological state before performance will likely have some impact on actual performance levels. In general, because the cognitions, emotions, neuroendocrine and cardiovascular responses associated with a challenge state are advantageous to sport performance, and those in a threat state are a hindrance to sport performance, a challenge state will be associated with increased performance

whereas, a threat state will be associated with a decrease in performance.

First we consider how the cognitions associated with challenge and threat states relate to performance, both directly and through their influence on anxiety. High self-efficacy and perceived control, associated with a challenge state, are positively related to performance (e.g., Bandura, 1997). In addition, MAp and PAp goals, associated with a challenge state are positively related to performance, in comparison with PAv goals (Elliot, Cury, Fryer, & Huguet, 2006). Also important is the interaction of an athlete's cognitions and competitive anxiety. Anxiety can be associated with a decrease or increase in performance depending on the accompanying cognitions. When anxious, athletes' cognitive resources available for a task may be reduced (Janelle, 2002; Moran, 1996) and attention directed to task-irrelevant stimuli (Eysenck, Derakshan, Santos, & Calvo, 2007; Wilson, 2008). However, if an individual is at least moderately confident of success, performance can be maintained even under high anxiety because an individual allocates extra mental resources to the task (Eysenck & Calvo, 1992). This may eliminate any potential negative consequences while benefiting from the motivational consequences of anxiety. Accordingly we propose in a challenge state the focus of attention is on the appropriate cues, whereas in a threat state the attention is also directed to task irrelevant stimuli that could cause harm (c.f. Moran, Byrne, & McGlade, 2002). Consequently, cognitive performance is more effective in the challenge state and athletes are more prepared for competition.

A further way in which anxiety can influence performance is through increasing the likelihood of reinvestment. That is, the athlete consciously focuses on controlling the execution of a motor skill, which in turn results in poorer performance (Masters & Maxwell, 2008). Blascovich et al., (2004) proposed that

the baseball and softball players who experienced a threat state when talking about a sport specific situation performed worse because of an increase in self-focus that interfered with the performance. However, anxiety need not necessarily result in reinvestment if is accompanied by high self-efficacy and perceived control (Mullen & Hardy, 2000). When a performer has low self-efficacy, low perceived control and is focused avoiding demonstrating incompetence (threat state) he may engage in a conscious effort to enhance control of the situation by focusing on the mechanics of the motor skill in the (mistaken) belief that this will increase the likelihood of the skill being executed correctly.

In short, high self-efficacy, perceived control, and approach goals are associated with increased performance levels. Furthermore, anxiety will have a negative influence on performance in a threat state because a low level of self-efficacy and low perceived control does not result in greater mental effort when anxious, and is likely to be associated with increased reinvestment during performance.

Another key feature of the TCTSA is that it outlines how athletes might regulate their psychological states effectively for sport. Regulating psychological responses draws on, and depletes, a limited pool of resources that is available for controlling all emotions, thoughts and behaviours (Baumeister, Heatherton, & Tice, 1994; Baumeister & Heatherton, 1996). Depletion of this self-regulation strength in one area affects performance in another area. For example, the effect of depletion from a cognitive task, negatively affected muscular performance on a maximal isometric task (Bray, Martin-Ginis, Hicks, & Woodgate, 2008). So being able to regulate psychological responses with as few a resources as possible (i.e., by perceiving the situation as a challenge) is helpful because it leaves sufficient self-

regulatory resources for other demands (psychological or physical) arising from the task. Perceiving a competitive situation as a challenge means that there is a need for less regulation as this is an adaptive approach for competition, if the competitive situation is perceived as a threat. In short, prevention is better than cure.

The neuroendocrine and cardiovascular response patterns proposed by Blascovich and colleagues are a key component of the TCTSA. The orienting response of these changes may influence behaviour in sport settings. Specifically, in line with the BPS model during a threat state, the body should adopt an avoidance or protective stance, one characterized by closed body posture and general orientation away from the "threatening" stimulus. Thus, an athlete in a threat state may be less likely to involve him or herself in the competition, for example seeking possession less often.

It is also possible that the neuroendocrine and cardiovascular responses experienced in a challenge state are more conducive to athletic performance. Because a challenge state is associated with increases in epinephrine and norepinephrine (rather than cortisol in the threat state) it may have a positive influence on decision-making. Epinephrine and norepinephrine are proposed to helping to speed up decision making because of their role as neurotransmitters in the central nervous system (McMorris et al., 1999). In a challenge state, the SAM activation represents an attempt to mobilize energy for coping. This efficiency occurs because of increased blood flow to the brain and muscles, higher blood glucose levels, which is the fuel of the nervous system, and an increase in free fatty acids that can be used by the muscles as fuel (c.f. Dienstbier, 1989). Accordingly, the physiological responses associated with a challenge state may be associated with short bursts of energy and may enhance performance in sports when anaerobic

power is required (e.g., sprinting).

Summary

There is a complexity inherent in understanding exactly how challenge and threat states relate to athletic performance. Both demand and resource appraisals may fluctuate over the competition period. However, the cognitions associated with a challenge state are positive for performance and ensures anxiety does not influence performance negatively. The influence of the neuroendocrine and cardiovascular responses is harder to unravel as any aerobically demanding sport may generate a pattern of cardiovascular response indicative of a challenge state (Dienstbier, 1989). Despite these difficulties, it is proposed that the neuroendocrine and cardiovascular responses demonstrate a more adaptive approach to competition and are associated with better decision-making, greater involvement in the competition, and increased anaerobic power.

The Theory of Challenge and Threat States in Athletes (TCTSA)

In this section we propose the Theory of Challenge and Threat States in Sport (TCTSA) that fully encompasses the determinants, responses and consequences of challenge and threat states in response to an upcoming sport competition. The focus of the TCTSA is on understanding the state response to a competitive situation. We acknowledge that dispositions such as optimism, hardiness and perfectionism will influence the occurrence of challenge and threat states, but do not make specific predictions about how they, or others, do so. We have chosen to focus on the state response because athletes' responses are dynamic and their appraisals of demands and resources fluctuate.

The TCTSA extends existing research in three ways. First, we have clarified the cognitive appraisal process that determines challenge and threat states and uniquely outlined how self-efficacy, control and achievement goals, based on the 2x2 achievement goal framework inter-relate and determine challenge and threat states in athletes. Second, we have expanded on the affective responses to challenge and threat appraisals and, contrary to the BPS model and the work of Skinner and Brewer (2004), proposed that even high levels of negative emotions can occur in a challenge state and be perceived as helpful to performance. Third, we have outlined how challenge and threat states influence performance through motivation, attention and physical functioning. The TCTSA is displayed graphically in Figure 2a and 2b.

(Insert Figure 2a & 2b about here)

There are a number of strengths to the TCTSA that commend it for use in research and applied work in sport settings. We suggest that research be focused on three main issues. First, the underlying neuroendocrine changes that have hitherto only been presumed from the cardiovascular responses in challenge and threat states (Wright & Kirby, 2003) should be identified. That is, while changes in the athletes are proposed to have different cardiovascular responses depending on SAM or PAC involvement, data on actual neuroendocrine changes accompanying challenge and threat states have yet to be fully elucidated. Second, the emotional and behavioural correlates of challenge and threat states should be clarified. In particular, we should explore whether high levels of emotions with a negative valance can occur in a challenge state and be perceived as helpful to performance. Third the mechanisms by which challenge and threat states influence sport performance and how that

changes over the competition period should be determined. In particular focus should be placed on the relationships between challenge and threat states and physical functioning. Arousal from PAC activation, in a threat state, will not dissipate quickly because cortisol has a much longer half-life (60-90 minutes) than the epinephrine and norepinephrine (3 minutes) released during a challenge state. Further, as the pattern of cardiovascular response indicative of a challenge state is similar to that observed during aerobic exercise (Dienstbier, 1989) an athlete's pre-competition state may have less influence performance in sports that have an aerobic element.

The TCTSA also provides a framework to guide interventions. Specifically interventions to create a challenge state should enhance self-efficacy, develop perceived control and provide a focus on approach goals. There is evidence that psychological interventions can have an influence on physiological states (e.g., Barwood, Dalzell, Datta, Thelwell, & Tipton, 2006; Barwood, Thelwell, & Tipton, 2008) and enhancing self-efficacy, perceived control and focusing on approach goals should result in the neuroendocrine and cardiovascular responses consistent with a challenge state.

A major strength of the TCTSA is that it incorporates the cardiovascular response patterns outlined in the BPS model. These cardiovascular responses provide a non-invasive way of classifying athletes as to whether they approach a competitive scenario with challenge or threat states. Athletes may not be able to articulate their feelings about a specific competition or be aware of their appraisal processes as they can occur unconsciously. In addition, a physiological assessment decreases the social desirability inherent in self-report measures. An athlete may be reticent to admit he does not think he can cope with the demands of a specific

competition to a coach or psychologist, in case it is seen as a sign of weakness and as such assessment of cardiovascular responses should add to our understanding of athletes' responses to competition.

Predictions of the TCTSA

There are a number of predictions that arise from the theory that will help understand athletes' responses to competitive settings and these are outlined in Table 1.

(Insert Table 1 about here)

Concluding Remarks

We propose a Theory of Challenge and Threat States in Athletes (TCTSA) to guide applied work and as a stimulus for further research. The predictions guide applied work because they outline athletes' responses to competition and provide a basis for the development of interventions to facilitate a challenge state. Crucially, the cardiovascular indices of the SAM and PAC axes provide an objective way of classifying athletes' approaches to competitive scenarios, into either challenge or threat states that can be used by both practitioners and researchers. The predictions also provide testable hypotheses to help guide research into understanding athletes' responses to competition. In particular, we encourage future research to: identify the underlying neuroendocrine changes that have hitherto only been presumed from the cardiovascular responses; clarify the emotional and behavioural correlates of

challenge and threat states; determine mechanisms by which challenge and threat states impact sport performance; and explore the most effective strategies of creating challenge states in athletes. In this way the mechanisms underlying the TCTSA will be further delineated and its boundary conditions tested.

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Table 1

Predictions of the Theory of Challenge and Threat States in Athletes (TCTSA)

Demand appraisals relate to the perception and assessment of danger, uncertainty and effort required in a situation and will stimulate an increase in heart-rate.
Athletes will experience a challenge state if their resource appraisals comprise high self-efficacy, perception of control and are focused on approach goals.
Athletes will experience a threat state if their resource appraisals comprise low self-efficacy, low perceived control and are focused on avoidance goals.
A challenge response is characterised by an increase in SAM activation and the release of epinephrine and norepinephrine as indexed by increased cardiac activity and decreased TPR.
A threat response is characterised by an increase in SAM and PAC activation and the release of cortisol as indexed by increased cardiac activity (albeit lower than that observed in a challenge state) and either no change or increased TPR.
A challenge state will typically, but not exclusively, be associated with emotions of a positive valence.
A threat state will typically, but not exclusively, be associated with emotions of a negative valence.
Emotions experienced during the challenge state will be perceived as helpful to performance
Emotions experienced during a threat state will be perceived as unhelpful to performance.
In a challenge state there is a need for less self- regulation and accordingly greater self-regulatory resources are available for the demands arising from the task.
In a threat state anxiety will decrease the efficiency and effectiveness of cognitive functioning.
In a challenge state anxiety will not lead to reinvestment.
A threat state will be associated with less engagement in the competition (e.g., seeking out possession) as an athlete uses avoidance strategies.
A challenge state will have a positive influence on decision-making
A challenge state will have a positive impact on anaerobic power

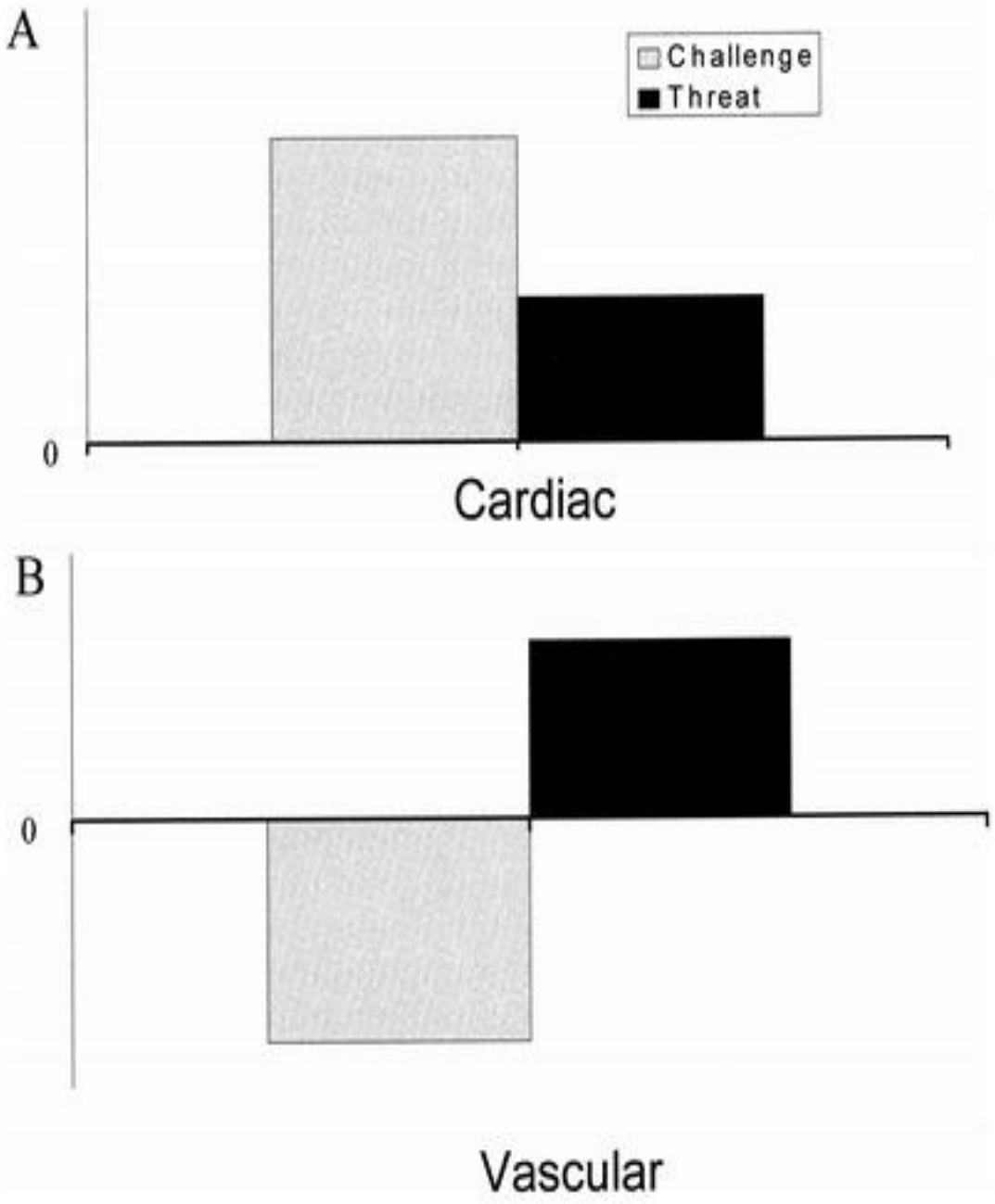

Figure 1.Theoretical pattern of cardiac and vascular activity during challenge and threat (Blascovich et al., 1999, p. 70).

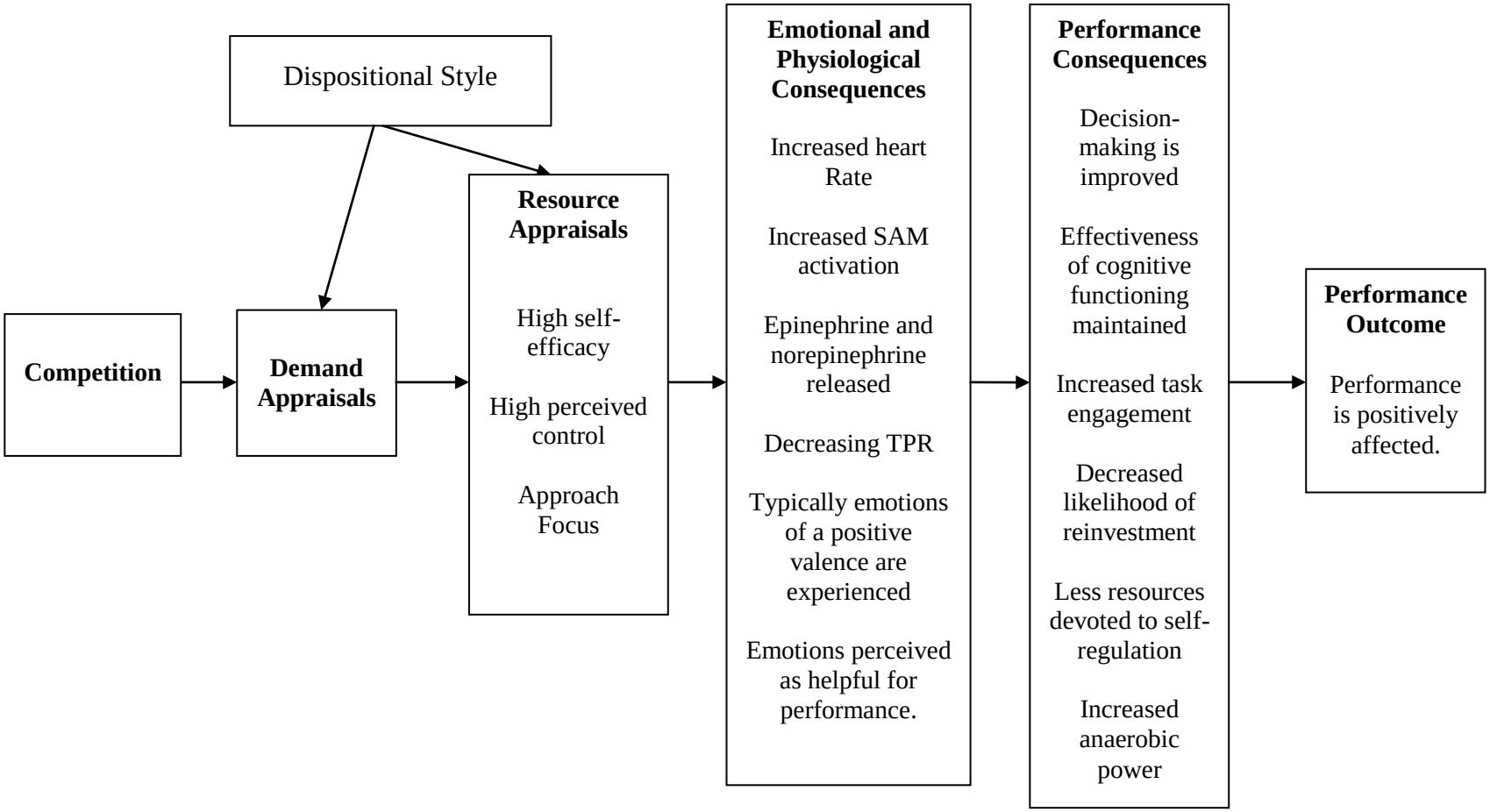

Figure 2a. Theory of Challenge and Threat States in Athletes (TCTSA) – The Challenge State

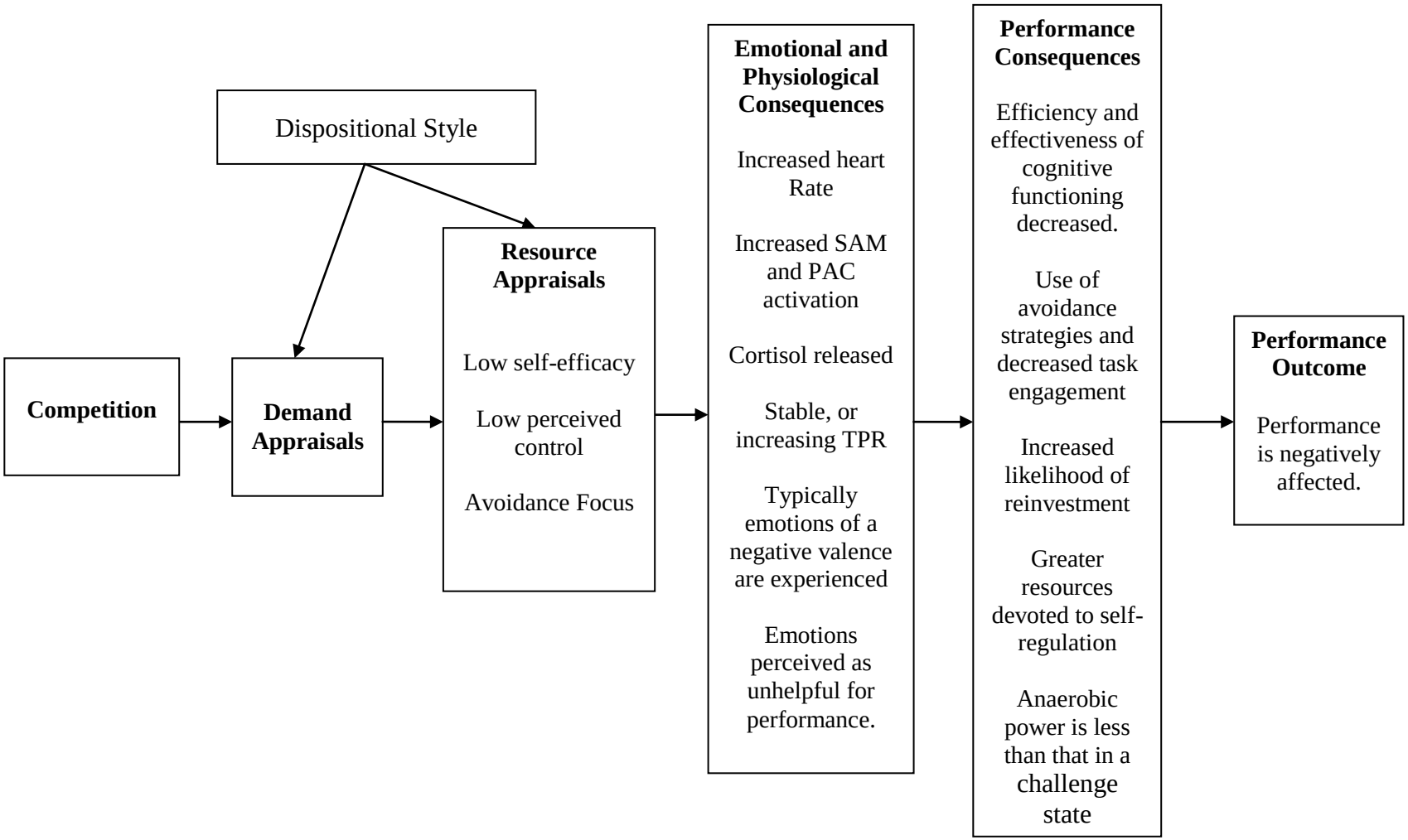

Figure 2b. Theory of Challenge and Threat States in Sport (TCTSA) – The Threat State