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Challenge and threat states: examining cardiovascular, cognitive and affective responses to two distinct laboratory stress tasks

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ABSTRACT

Background: The theory of challenge and threat states in athletes (TCTSA) proposes psychological antecedents will predict psychological and cardiovascular responses to stress. The present study investigated this theory in two contextually different stress tasks.

Method: 78 males completed a computerised competition and a public speaking task. Cardiovascular activity was measured with impedance cardiography and a blood pressure monitor. Challenge and threat antecedents, indicators of challenge and threat and emotions were assessed pre- and post-tasks.

Results: Both tasks induced significant perturbations in cardiovascular activity and were perceived as highly challenging. Reported perceived threat was higher in the public speaking task compared to the competition task. Associations between the proposed antecedents, self-report and cardiovascular indices of challenge and threat and emotions support the TCTSA for the competition task, but less so for the public speaking task.

Conclusion: The TCTSA is supported during competitive stress, however during social stress there is dissociation between self-report appraisals and cardiovascular reactivity.

1. Introduction

Stress can induce cardiovascular perturbations and the magnitude of cardiovascular reactivity (CVR) has been related to health outcomes such as cardiovascular disease and depression (Chida and Steptoe, 2010; Kamarck and Lovallo, 2003; Phillips et al., 2011). There are individual differences in CVR, and given the association between CVR and health, it is important to explore factors contributing to these individual differences. One such factor is the psychological appraisal of stress. The current study aims to explore how cognitive appraisals associate with CVR to different stress tasks.

The biopsychosocial (BPS) model of challenge and threat provides a framework which relates task appraisals with physiological responses (Blascovich, 2008; Blascovich and Tomaka, 1996). According to this theory, challenge and threat appraisals are conceptualised as multi-dimensional responses to a stressful situation, where environmental demands and personal resources to cope are evaluated either consciously or unconsciously (Blascovich, 2008). A challenge state occurs when the situation is appraised as self-relevant and the individual perceives to have sufficient (or nearly sufficient) personal resources to meet or exceed the demands of the task. In a threat state, the situation is also appraised as self-relevant, but the individual perceives to have insufficient personal resources to meet the demands of the task

(Blascovich, 2008; Seery, 2011). The theory further suggests that these cognitive evaluations precede the physiological responses to a stressful situation (Blascovich, 2008; Blascovich and Tomaka, 1996). Evidence from socially evaluative stress tasks supports the distinction between challenge and threat states based on demand and resource evaluations (e.g., Tomaka et al., 1993; Tomaka et al., 1997).

The theory of challenge and threat states in athletes (TCTSA; Jones et al., 2009) has extended the BPS model by suggesting challenge and threat states are more nuanced than a balance of coping resources and task demands. Specifically, the TCTSA proposes that three antecedents (self-efficacy, perceived control, approach goals) likely influence whether individuals feel they have the resources to cope with a stressful situation. In turn, this is thought to determine a challenge or threat state, and the subsequent physiological and psychological responses associated with a challenge or threat state (Jones et al., 2009). It is proposed that greater levels of self-efficacy, perceived control, and a focus on approach goals lead to a challenge appraisal and lower levels of self-efficacy, perceived control, and a focus on avoidance goals evoke a threat appraisal (Jones et al., 2009). The subsequent appraisal is thought to influence cardiovascular responses to stress (see below) and the emotions experienced during the situation, with a challenge appraisal typically associated with more positive emotions, and a threat state associated with more negative emotions (Jones et al., 2009). The

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intensity and interpretations of these emotions are thought to influence performance, with greater challenge and more positive affect leading to improved performance (Skinner and Brewer, 2004).

One emotion explored extensively with regard to performance is anxiety, with greater anxiety proposed to be associated with perceptions of threat (Moore et al., 2012; Skinner and Brewer, 2002; Williams et al., 2010). While anxiety is often seen as negative, the TCTSA proposes that emotions such as anxiety may still be experienced during a challenge state, but will be perceived as more facilitative towards performance. By contrast, similar levels of anxiety are proposed to be seen as more debilitating to performance during a threat state (Jones et al., 2009). In support of the notion that anxiety can be seen as either facilitative or debilitating, research has demonstrated that anxiety can have a facilitative/positive impact on performance during stressful situations in sport (Chamberlain and Hale, 2007; Jones and Swain, 1995; Moore et al., 2013), as well as academic settings (Carrier et al., 1984). Specifically supporting the anxiety predictions of the TCTSA, research demonstrates that anxiety is present in both challenge and threat states, but a threat state has been related to anxiety being perceived as more debilitating towards performance, compared to a challenge state (Jones et al., 2009; Moore et al., 2012; Williams et al., 2010). Despite these findings, the majority of challenge and threat studies investigating anxiety only examine its intensity, even though the extent an individual perceives their anxiety as facilitative/debilitative (i.e., directional perception) is proposed to be a more important predictor of performance than the anxiety intensity (Chamberlain and Hale, 2007).

According to the BPS model and TCTSA, there are two distinct CVR patterns reflecting alterations in the activity of the sympathetic-adrenomedullary (SAM) and hypothalamic-pituitary-adrenal (HPA) axes (Seery, 2011). A challenge state is associated with increased SAM activity, which leads to an increase in heart rate (HR) and cardiac output (CO), alongside a reduction in pre-ejection period (PEP) and total peripheral resistance (TPR). This pattern of physiological response is thought to be indicative of efficient energy mobilisation where increased cardiac performance, coupled with decreased vascular resistance, provides more efficient provision of blood flow to the muscles and the brain (Dienstbier, 1989; Seery, 2011). In contrast, a threat state is associated with increased SAM activity as well as HPA activity. Compared to a challenge state, this is proposed to result in relatively less efficient energy mobilisation through vasoconstriction of the vascular system, reflected in higher TPR and relatively lower CO (Seery, 2011). Thus, it is proposed that while both challenge and threat states are characterised by an increase in HR and a decrease in PEP, the two major CVR constructs thought to distinguish a challenge and a threat state are CO and TPR reactivity.

Accumulating research testing the BPS model and the TCTSA have found support for challenge and threat patterns of CVR being associated with performance in a variety of tasks, such as mental arithmetic and public speaking tasks, (Kelsey et al., 2000; Rith-Najarian et al., 2014; Tomaka et al., 1993) as well as golf putting, netball shooting, cricket batting and climbing tasks (Moore et al., 2012; Moore et al., 2013; Turner et al., 2014; Turner et al., 2012; Turner et al., 2013). However, there is less evidence to support the proposed relationships between the challenge and threat antecedents, the psychological and cardiovascular indices of challenge and threat and resulting emotions. Studies employing both psychological and physiological measures have found weak or no associations between the BPS/TCTSA antecedents, appraisal, and CVR from non-sport settings (Rith-Najarian et al., 2014), as well as sport specific settings (Turner et al., 2012; Turner et al., 2013). Furthermore, associations opposing the model's predictions have been reported (e.g., self-efficacy being positively associated with a greater cardiovascular threat response during a non-competitive speech task; Meijen et al. (2014)).

It is important to note that CVR in the studies previously mentioned

has been assessed in anticipation of the stress task. Research is yet to assess cardiovascular activity while experiencing the stress tasks. Although CVR assessment in anticipation of the task minimises the influence of movement related to the task on CVR (Kamarck and Lovallo, 2003), it does not provide any information on how possible antecedents might relate to psychological or cardiovascular indices of challenge and threat during stress. It should also be noted that studies exploring challenge and threat frequently employ either the cardiovascular indices (CO and TPR; Seery et al., 2010; Turner et al., 2012; Turner et al., 2013) or self-report indices (Meijen et al., 2013; Moore et al., 2013) to group subjects as challenged or threatened, which is surprising given that the TCTSA proposes that individuals will experience both the physiological and psychological indices. To comprehensively examine how the TCTSA antecedents and outcomes are associated with challenge and threat, both the physiological and psychological indices of challenge and threat should be measured. It is also important to take the cardiovascular measurements during the stress task and the psychological measurements immediately prior to and following completion of the tasks to measure the entire appraisal process (Hellhammer and Schubert, 2012; Quigley et al., 2002).

Within the psychophysiology literature the very nature of different stress tasks can elicit different psychological and cardiovascular responses (AlAbsi et al., 1997; Kamarck and Lovallo, 2003; Kelsey et al., 2007). These differences may mean the relationship between challenge and threat indices with the antecedents and outcomes may vary depending on the stress-evoking situation (i.e., the stress task). The majority of studies examining the TCTSA have used tasks which tend to be more of a sporting and/or competitive nature (e.g., netball shooting, golf-putting, cricket performance, rock climbing; Moore et al., 2013; Turner et al., 2014; Turner et al., 2012; Turner et al., 2013). Some studies have employed non-competitive tasks, but have found a lack support for the TCTSA (Meijen et al., 2014). To our knowledge research is yet to directly compare how the indices of challenge and threat are associated with the antecedents and the outcomes of challenge and threat across different tasks. Such information would examine the extent to which the TCTSA can be generalised to other less competitive or sport specific stressful situations.

The present study aimed to examine whether the antecedents of challenge and threat are associated with self-reported and cardiovascular indices of challenge and threat, emotional outcomes as well as performance. All participants completed two distinct tasks, i.e., a competitive performance task and a social evaluative public speaking task, which are both known to induce changes in cardiovascular activity (AlAbsi et al., 1997; Bosch et al., 2009; Veldhuijzen van Zanten et al., 2002). The two tasks were chosen to examine if the TCTSA theory is specific to competitive context or whether it can be generalised to other tasks with different, non-competitive, demands. Implementing a within-subject design allowed for the examination that the context of the stress task has on the relationships between challenge and threat antecedents, indices and outcomes.

It was hypothesised that irrespective of task, lower perceived task demand, and greater self-efficacy, perceived control, and coping resources would be associated with increases in CO and decreases in TPR during the tasks (i.e., CVR suggestive of a challenge state). Further, these antecedents would be associated with greater challenge appraisals and lower threat appraisals, as well as more facilitative anxiety and greater positive affect. During the competition task it was hypothesised that greater increases in CO and decreases in TPR would be associated with a faster race time. It was also hypothesised that the results from the competition task would more robustly support the TCTSA's proposed relationships, compared to the public speaking task. This is due to the TCTSA being devised specifically for a sport setting which is likely to be more closely aligned with a competition task rather than a public speaking task due to its competitive nature.

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