

**HELPING ATHLETES MEET THE CHALLENGE: DETERMINANTS OF
CHALLENGE AND THREAT RESPONSES**

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Abstract

Acute stress has numerous potential consequences for individuals, from their behaviour to their performance on a task. Psychological models like the biopsychosocial model (BPSM) of challenge and threat, the theory of challenge and threat states in athletes (TCTSA) and the integrative framework of stress, attention, and visuomotor performance (IFSAMP) have attempted to explain the variability in individual responses to stress in motivated performance situations. The BPSM proposes that individuals engaged in a task make conscious and unconscious evaluations of the situational demands, such as the required effort, and their personal resources, such as their abilities. These demand-resource evaluations result in relatively different psychological outcomes namely, challenge and threat responses which represent two ends of a continuum. Both the BPSM and the TCTSA suggest that these psychological consequences have corresponding physiological responses allowing for objective measurements of challenge and threat responses. Performance differences have been observed between challenged and threatened individuals across a range of tasks, although motor tasks have been relatively under-examined within this context. Furthermore, as put forward in the IFSAMP, challenge responses are associated with better attentional control compared with threat responses though this has also been under-examined. As challenge responses are characterised by better physiological, performance and attentional outcomes, it is important to understand what determines challenge and threat responses. Therefore, the aim of this thesis was to examine key determinants of challenge and threat responses and to replicate and extend findings regarding performance and attentional outcomes. Four experimental studies were conducted to test proposed determinants and the aforementioned outcomes. Arousal reappraisal

and self-efficacy were found to be determinants of challenge and threat responses across both subjective (self-report) and objective (cardiovascular reactivity) measures. Self-control was shown not to influence challenge and threat responses via either measure while situational motivation regulations predicted only subjective but not objective measures of challenge and threat. Importantly, situational motivation regulations also predicted task engagement, a prerequisite of challenge and threat responses. Across all four studies, there were no performance effects and of the three studies which examined attention, there were no attention effects. Descriptive data trends however, indicated a more complex and nuanced relationship between challenge and threat responses and performance and attention. The findings of this thesis develop the BPSM, the TCTSA and the IFSAVP. They also have several other theoretical and practical implications.

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Preface

This thesis includes published manuscripts and manuscripts submitted for publication. Therefore, there may be some repetition in the description of theories and past research in each introduction which has been adapted from the published article. The data from this thesis has also been presented at Institutional, Regional and National Conferences.

Articles

Study 1 is published as: Sammy, N., Anstiss, P. A., Moore, L. J., Freeman, P., Wilson, M. R., & Vine, S. J. (2017). The effects of arousal reappraisal on stress responses, performance and attention. *Anxiety, Stress, & Coping*, 37(3), 1-11.

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Chapter 1. Literature Review

1.1 Introduction

Across numerous fields (e.g. sports, surgery, military), there is a requirement for individuals to perform in stressful environments (Neil, Hanton, Mellalieu, & Fletcher, 2011). However, there can often be significant individual differences in responses to these situations which psychological theories centred on, and around stress, emotion and coping have attempted to explain. Lazarus and Folkman's (1987) transactional theory focused on how the person-environment relationship is mediated by cognitive appraisals and coping. Thus, stress was viewed as a relationship or transaction between the individual and their environment. The Biopsychosocial Model (BPSM) (Blascovich, 2013) of challenge and threat, developed and extended this idea. The model suggested that distinct psychological responses, with concomitant physiological responses, resulted from an individual's evaluations of their personal coping resources and the situational demands. These conscious and unconscious cognitive evaluations were proposed to occur only in motivated performance situations in which individuals were engaged in the task. When demands were deemed to outweigh resources, a threat response occurred; whereas when resources were judged to match or outweigh demands, a challenge response occurred. Importantly, the authors suggested that these responses lay along a continuum of challenge to threat and that challenge responses were associated with better physiological, emotional, cognitive and performance outcomes compared to threat responses (Blascovich, 2013).

While the BPSM suggested possible determinants of challenge and threat responses- danger, uncertainty, required effort, skills, knowledge and abilities- they

acknowledged that the list was exhaustive and dependent upon the specific motivated performance situation (Blascovich, 2013). The Theory of Challenge and Threat States in Athletes (TCTSA) (Jones, Meijen, McCarthy, & Sheffield, 2009) developed the BPSM by proposing three determinants specific to competitive settings: self-efficacy, perceptions of control and achievement goals. The TCTSA also highlighted that emotions, effort, attention, decision-making, physical functioning and sport performance were likely to differ, dependent on whether the sportsperson was relatively more challenged or threatened (Jones et al., 2009). This was significant progress as it highlighted possible underlying mechanisms of the challenge/threat response-performance relationship.

Vine and colleagues (2016) developed the attentional constituent and presented the Integrative Framework of Stress, Attention, and Visuomotor Performance (IFSAVP) which proposed that the interaction of challenge and threat responses and attention explained how elevated stress led to differences in visuomotor performance outcomes. They suggested that anxiety was a key emotion in explaining why threat responses led to poor attention and furthermore, poorer performance (Vine et al., 2016). This rich tapestry of literature on individual responses to stress highlights several testable assertions. Research into the determinants of challenge and threat responses, their effects on performance and whether these effects occur due to differences in attention has both theoretical and practical implications. Therefore, this thesis sought to establish key determinants of challenge and threat responses and extend and replicate previous findings on the relationships between challenge and threat responses and performance, as well as attention.

1.2. An Introduction to Stress

Individuals constantly encounter demanding events, situations and conditions; these environmental demands are considered 'stressors' (Fletcher, Hanton, & Mellalieu, 2006). Stressors are acute or chronic and differ in their intensities. Pacak and Palkovits (2001) suggested that stressors fall into four categories and include physical stressors, psychological stressors, social stressors, and stressors that may cause disturbances in cardiovascular and metabolic homeostasis (Pacak & Palkovits, 2001). How individuals evaluate and respond to these environmental demands leads to differential stress responses (Seery, 2011). Early theories on stress focused on stress as a product of disrupted homeostasis as well as its physiological outcomes (e.g. Cannon, 1929; Hennessy & Levine, 1979; Munck & Guyre, 1986; Selye, 1956).

Physiological responses to acute stressors allow for enhanced physiological and mental functioning to meet environmental demands (Sapolsky, 1996). In response to an acute stressor, physiological systems are activated to ensure that resources are rapidly mobilised for action and then appropriately reduced for rest and recovery (Pacak & Palkovits, 2001). The autonomic nervous system (ANS) includes the sympathetic nervous system (SNS) and parasympathetic nervous system (PSNS). While the SNS stimulates bodily processes such as heart rate and force, pupil size and mucus production, the PSNS inhibits them, as necessary. The interplay between these two divisions of the ANS ensures appropriate bodily responses depending on the situation. For example, when faced with a stressor the body may need to be readily mobilised for a "fight or flight" response while upon

removal of the stressor, the body should return to a “rest and digest” response (Pacak & Palkovits, 2001).

Appropriate responses to stressors are not only important for physiological functioning, but for psychological well-being and the performance of tasks as well (Charmandari, Tsigos, & Chrousos, 2005). Furthermore, inappropriate responses to stressors can have a number of negative effects including impaired growth and development, and metabolic and psychiatric disorders (Charmandari et al., 2005). It is therefore important to understand stress responses and particularly, what psychological factors lead to divergences in stress responses such as challenge and threat. Certainly, as research into this topic grew and changed over time, authors acknowledged the role of psychological factors, such as perceptions (Goldstein, 1995) and person-environment transactions (Krantz & Lazar, 1987) on stress responses. This latter approach in considering stress allows for explanations into inter- and intra-individual stress responses (Lazarus, 2000).

From a psychological perspective, stress is a state that results from demands that are placed on the individual which require that person to engage in a coping behaviour (Jones & Hardy, 1990). Lazarus (1991) proposed that in order to fully understand psychological stress, it is important to understand stress appraisals which are dependent on perceptions of environmental demands and personal resources (Lazarus, 1991). This subjective view of psychological stress allows insight into why individuals respond differently in similar circumstances such as competitive situations. Using a meta-theoretical systems approach in their transactional model of stress and coping, Lazarus and Folkman (1987) described this appraisal process in two steps. Primary appraisals consist of an evaluation by the individual of their stakes, if any, in an encounter (Lazarus & Folkman, 1987).

Smith and Kirby (2009) reinforced that primary appraisals are dependent on evaluations of motivational relevance and congruence. In the former case, the individual assesses whether the situation will affect their welfare and in the latter case, whether the situation is consistent with their goals (Smith & Kirby, 2009). In cases of anticipated loss, an individual makes a threat appraisal whereas challenge appraisals are made in situations with potential for gain, (Lazarus & Folkman, 1984a). Secondary appraisals on the other hand, are dependent on a person's assessment of their coping resources and options in a given situation (Folkman, Lazarus, Dunkel-Schetter, DeLongis, & Gruen, 1986; Lazarus, 1991). Utilisation of these coping resources are carried out to prevent harm or to improve outcome scenarios (Folkman et al., 1986). Stress responses according to this model are therefore considered to occur due to the interaction of these primary and secondary appraisals. This theory gave rise to other theories on stress and coping, of which the BPSM of challenge and threat (Blascovich & Tomaka, 1996) is the primary focus of this thesis.

1.3. The Biopsychosocial Model of Challenge and Threat

Similar to Lazarus and Folkman's (1984b) theory, the BPSM emphasises person-environment transactions; it is perceptions of demands and resources which account for individual differences in responses to stress. The BPSM proposes that the evaluative process in which situational demands (demand evaluations) are weighed against personal resources (resource evaluations) results in specific psychological responses, challenge or threat. These have corresponding physiological effects which have been used as objective measures of challenge and threat responses (Seery, 2013). According to the BPSM, a necessary prerequisite of challenge and threat responses is task engagement (Blascovich, 2008). Task

engagement occurs in motivated performance situations to the extent that the situation is relevant to the individual (Seery, 2013), thereby showing some conceptual overlap with primary appraisals, described previously. Typically, research paradigms seek to engender task engagement in all participants to make it possible to test for relative differences in challenge and threat responses (e.g. Moore, Vine, Wilson, & Freeman, 2012; Turner et al., 2013). However, no known research has thoroughly examined task engagement in the context of the motivated performance situation proposed by the BPSM. Specifically, relative differences in task engagement may impact the psychological and physiological processes proposed by the model (Seery, 2013). Nevertheless, being actively engaged in the task at hand is mandatory for challenge and threat responses to occur (Blascovich & Tomaka, 1996).

A key tenet of the BPSM is that challenge and threat responses are not considered two distinct constructs within the primary appraisal process as described by Lazarus and Folkman (1984) earlier on, but two ends of a single, bipolar continuum which results from the demand-resource evaluation process. Specifically, these stress responses are the outcome of conscious and unconscious evaluations of situational demands and personal resources. Indeed, the authors of this model use the term 'evaluation' to highlight that these processes may be automatic and unconscious rather than the consciously deliberative process implied by the term 'appraisal' (Blascovich, 2008). When resources are perceived to match or outweigh demands, a challenge response occurs while a threat response occurs when demands are perceived to outweigh resources (Blascovich, 2008). Interestingly, though the terms "challenge state" and "threat state" have been widely used in the literature (e.g. Hunter, 2001; Vick, Seery, Blascovich, & Weisbuch, 2008) this

terminology is in contradiction of the exemplification of challenge and threat as two extremities of a single, bipolar continuum. Terms such as a challenge/threat “evaluation” or “response” perhaps more accurately reflect this continuum and are therefore used throughout this thesis.

1.4. Physiological Measures of Challenge and Threat Responses

The BPSM extended the transactional theory (Lazarus & Folkman, 1987) by accounting for physiological responses to stress which are concomitant to the psychological responses of challenge and threat. Three studies conducted by Tomaka and colleagues (1997) tested the proposition that cognitive appraisals precede physiological responses and vice versa. They found that manipulations of cognitive appraisals via instructional sets resulted in specific corresponding physiological reactivity but that manipulation of this physiological reactivity first, did not result in the corresponding cognitive appraisals (Tomaka, Blascovich, Kibler, & Ernst, 1997). This correspondence between psychological and physiological measures allows for the propositions of the BPSM to be tested in a more comprehensive way than the transactional theory. To put it another way, the BPSM allows for subjective and objective measures of these cognitive evaluations.

Dienstbier’s (1989) theory of physiological toughness provided a foundation from which the physiological underpinnings of challenge and threat responses were born. Dienstbier (1989) presented findings from nonhuman (e.g. Anisman & LaPierre, 1982; Levine, 1980) and human (e.g. Frankenhaeuser, Lundberg, & Forsman, 1980; Ursin, Murison, & Knardahl, 1983) research on peripheral physiological arousal in response to intermittent stressors, and illustrated two divergent patterns which characterised physiological toughness and physiological weakness. Both patterns were marked by sympathetic-adrenomedullary (SAM)

activation which led to the release of peripheral catecholamines epinephrine (adrenaline) and norepinephrine (noradrenaline). These catecholamines are responsible for increases in heart rate (HR), blood pressure, cardiac output (CO) and blood glucose levels in response to an acute stressor. However, physiological weakness was indicated by activation of the hypothalamic-pituitary-adrenal (HPA) axis as well, which dampens the effects of SAM (Dienstbier, 1989). Notably, HPA activation releases adrenocorticotropin (ACTH) into the blood which stimulates the production and release of cortisol which temporarily shuts down those functions not immediately required for survival (e.g.) digestive and immune functions.

A meta-analysis of two hundred and eight laboratory studies reinforced the effect of acute psychological stressors, such as social-evaluative threat, on elevated cortisol activation in humans (Dickerson & Kemeny, 2004). Harvey and colleagues (2010) illustrated that cortisol levels are elevated during self-reported threat responses as compared with challenge responses. Furthermore, the higher the threat response, the higher the cortisol response (Harvey et al., 2010); this study supports the hypothesis that HPA activation differs on an individual basis in response to perceptions of stressors. Importantly, frequent and sustained HPA activation is proposed to lead to damaging health consequences such as oxidative damage (Aschbacher et al., 2013). It is therefore of importance to understand the determinants of challenge and threat responses regarding possible health interventions in particular.

Further, the activation of the SAM and HPA axes leads to differences in CO and total peripheral resistance (TPR). CO reflects the amount of blood in litres pumped by the heart per minute while TPR is a measure of net constriction versus dilation in the arterial system ($\text{mean arterial pressure} \times 80/\text{CO}$) (Sherwood, Dolan, &

Light, 1990). These measures provide a non-invasive way of measuring challenge and threat responses. A challenge response is characterised by relatively higher CO and lower TPR while threat responses show small or no fluctuations in CO and TPR (Blascovich, 2008). Some research has measured challenge and threat responses by examining these variables separately (e.g. Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001; Blascovich, Mendes, Hunter, & Salomon, 1999) however, recent research has combined CO and TPR into a single challenge and threat index (CTI) (e.g. Feinberg & Aiello, 2010; Frings, Rycroft, Allen, & Fenn, 2014) thereby representing it as a continuum. CTIs result from transforming residualised change scores for CO and TPR scores into z scores and summing them. TPR is assigned a weighting of -1 and CO a weighting of +1 so that lower values indicate more of a threat response while higher values indicate more of a challenge response (Seery, Weisbuch, & Blascovich, 2009). These measures have been validated in numerous studies on challenge and threat responses (see Blascovich, 2008 for further detail).

Evidence that self-report data corroborates the physiological indices of challenge and threat responses has been demonstrated in past literature (e.g. Feinberg & Aiello, 2010; Zanstra, Johnston, & Rasbash, 2010) however, there have been a few cases in which it has not (e.g. Chalabaev, Major, Cury, & Sarrazin, 2009; Meijen, Jones, Sheffield, & McCarthy, 2014; Turner, Jones, Sheffield, Barker, & Coffee, 2014). Measuring challenge and threat responses via cardiovascular reactivity provides three major advantages over self-report measures; namely, there is no need to consciously direct attention away from the task at hand which may change the individual's experience of the situation; it is less susceptible to social desirability bias; and it encompasses those demand-resource evaluations which may not be processed consciously (Seery et al., 2009). Still, the use of self-report

measures is valuable when examining attitudes and perceptions since objective measures may be unable to fully encapsulate these (Schmitt, 1994).

1.5. Performance Consequences of Challenge and Threat Responses

Challenge responses have been associated with better athletic performance (e.g. Blascovich, Mendes, Tomaka, Salomon, & Seery, 2003; Moore, Vine, Wilson, et al., 2012; Turner et al., 2013) and cognitive performance (e.g. Feinberg & Aiello, 2010; Mendes, Major, McCoy, & Blascovich, 2008) than threat responses. However, there has been limited research on the effects of challenge and threat on motor-task performance specifically. Motor abilities are major determinants of motor performance which is a central aspect of sport (Strauss, 2002). Furthermore, such tasks have been frequently used in experimental sport psychology research as they allow for a controlled, uniform and measurable performance outcome which may be easily replicated in future research and interpreted across numerous studies (e.g. Behan & Wilson, 2008; Oudejans & Pijpers, 2010; Wilson, Vine, & Wood, 2009).

Turner and colleagues (2013) examined challenge and threat responses and performance in elite, male, county and national academy cricketers. They found that cardiovascular reactivity indicative of a challenge response predicted superior batting performance under pressure as compared with participants who displayed cardiovascular reactivity indicative of a threat response (Turner et al., 2013). Interestingly, there were cases in which participants displayed a threat response but performed well; these participants reported high self-efficacy. Further, participants exhibiting a challenge response who performed poorly, reported higher performance avoidance goals (Turner et al., 2013) which suggests that the challenge/threat-performance relationship may be somewhat nuanced.

Another study which illustrated a positive relationship between challenge responses and performance in a motor-task among expert performers was conducted by Moore et al., (2013). The authors showed this finding in pressurised conditions across a real competition and in a laboratory golf-putting task. In the first case, one hundred and ninety-nine experienced golfers reported their demand-resource evaluations prior to a competition; evaluating the competition as a challenge was associated with better performance. In the second case, sixty experienced golfers were randomly assigned to a challenge or threat group and challenge and threat responses were manipulated by instructional sets. Again, the challenge group outperformed the threat group in the golf-putting task (Moore et al., 2013). These findings extended to novice performers according to research by Moore and colleagues (2012) who also manipulated participants into challenge and threat groups via instructional sets. The challenge group holed a higher percentage of putts and achieved a lower performance error as compared with the threat group. This study also sought to identify potential mechanisms of the challenge/threat-performance relationship and mediation analysis indicated that multiple kinematic variables mediated the relationship between group and performance (Moore, Vine, Wilson, et al., 2012).

The performance effects described above further extended to a study in which a proposed determinant of challenge and threat responses, arousal reappraisal, was manipulated. Moore and colleagues (2015) demonstrated that an arousal reappraisal group reported feeling more challenged than a control group and outperformed the control group in a pressurised golf-putting task. Following on from these findings, the studies in this thesis examined golf putting as well as dart throwing tasks as measures of motor-task performance. Golf putting was examined to replicate the

above findings, while dart throwing was examined to assess whether these findings extend across motor tasks.

The positive relationship between challenge responses and motor-task performance and the negative relationship between threat responses and motor-task performance are seen across a range of study designs and samples, as described above. Understanding the underlying mechanisms of challenge and threat responses on performance is therefore of great importance in the interpretation of the literature.

1.6. Attention

A range of research supporting the hypothesis that attention, as well as performance, is disrupted in threatened performers on visuomotor tasks (e.g. Moore, Vine, Wilson, et al., 2012; Vine, Freeman, Moore, Chandra-Ramanan, & Wilson, 2013), led to the grounds for examining attention as a critical underlying mechanism of the challenge/threat and performance relationship, in this thesis. Challenge responses have been denoted by better attentional control than threat responses (e.g. Frings et al., 2014; Moore et al., 2013). Vine and colleagues (2016) conceptualised the IFSAVP which proposes that challenge and threat responses influence attentional control and furthermore, performance, in stressful conditions. They hypothesised that challenge responses are associated with a balance between goal-directed and stimulus-driven attentional systems. This allows for better attentional control via sustained attention and optimal information processing of relevant stimuli. Threat responses on the other hand, are associated with the dominance of the stimulus-driven attentional system over the goal-directed one (Vine et al., 2016). For example, the TCTSA (Jones et al., 2009) suggests that individuals who are more challenged focus on task relevant cues while those who are more

threatened focus on both task relevant and irrelevant cues which may inhibit performance.

A number of studies support the hypothesis that challenge responses are associated with better attentional control than threat responses. For instance, Vine and colleagues (2013) assessed the effects of challenge and threat responses on attentional control during laparoscopic surgery at baseline and again under pressurised conditions after participants had been trained to proficiency. Participants who evaluated the task as a challenge displayed more effective attentional control in both conditions as seen via target locking (fixating the target and ignoring distracting environmental stimuli) (Vine et al., 2013). The association between challenge responses and superior attentional control was further demonstrated by Frings et al., (2014) who examined this relationship during a visual search task. Participants performed sixty visual search trials (condition 1) during which cardiovascular data (used to calculate physiological challenge and threat responses) were recorded for two minutes. Upon completion of the trials, participants were manipulated into challenge or threat groups via false feedback and completed another sixty trials (condition 2) during which another two minutes of cardiovascular data were recorded. Attentional data were measured using an eye tracker, and eye movement data indicated that the challenge group had a faster, more gain oriented search pattern than those in the threat group (Frings et al., 2014).

An additional measure of attentional control used in challenge and threat response research is the quiet eye (QE) (e.g. Moore, Vine, Wilson, et al., 2012; Moore et al., 2013). The QE is defined as the final fixation or tracking gaze directed to a single location or object in the visuomotor workspace within 3° of visual angle (or less) for a minimum of 100 ms (Behan & Wilson, 2008). The QE is a robust marker

of attentional control in a number of tasks, from targeting to tactical, with longer QE durations linked to more successful motor performance (Vickers, 2009). Past research has established the utility of QE as an attentional measure across a variety of motor tasks and under varying pressure conditions (see Vickers, 2009) making it of particular interest in the study of motor task performance. Longer QE periods are said to improve performance by permitting individuals to extend the duration of cognitive programming required for accurate aiming movements (Janelle, 2002). One strength of QE is that it provides an on-line measure of attentional control so that individuals are not required to direct attention away from task performance as this may modify the psychological processes of demand-resource evaluations and thus challenge and threat responses (Seery, 2013).

Moore et al. (2012) demonstrated the relationship between challenge and threat responses and attention via QE in a motor task performance situation. One hundred and twenty-seven golf putting novices were randomly assigned to a challenge or threat group and performed six golf putts during which a number of outcome variables such as emotions, putting kinematics and attention were recorded. The challenge group not only displayed better emotions, better kinematics and a longer QE, but performed better than the threat group as well. This finding was replicated in a later study by Moore and colleagues (2013) with sixty experienced golfers who were randomly assigned to either challenge or threat groups and performed a golf putting task under pressurised conditions. Notably, QE is a gaze measure affected by high levels of performance pressure and anxiety (e.g. Behan & Wilson, 2008; Wilson, Wood, & Vine, 2009). The challenge group displayed a longer QE and also outperformed the threat group in the pressurised conditions.

Additionally, the challenge group reported less anxiety and a more favourable interpretation of anxiety compared to the threat group in this study.

The IFSAVP elaborated on the possible interaction of challenge and threat responses, attention and anxiety in performance contexts. According to the IFSAVP, anxiety is proposed to impair attentional control in individuals exhibiting threat responses thereby leading to poorer performance (Vine et al., 2016). This proposition is rooted in the attentional control theory (ACT) (Eysenck, Derakshan, Santos, & Calvo, 2007), which suggests that anxiety disrupts the balance of goal-directed and stimulus driven attentional systems by increasing the influence of the stimulus-driven attentional system. Further, it causes a diversion of processing resources from task relevant stimuli towards task irrelevant (and particularly threatening) stimuli (Eysenck et al., 2007). Though correlational studies have illustrated that challenge and threat responses have a weak and inconsistent relationship with anxiety (Meijen, Jones, McCarthy, Sheffield, & Allen, 2013; Turner, Jones, Sheffield, & Cross, 2012), experimental research has suggested a stronger relationship (Quested et al., 2011; Tugade & Fredrickson, 2004; Williams, Cumming, & Balanos, 2010). For example, as one part of an investigation on challenge and threat responses, Williams and colleagues (2010) investigated whether imagery scripts: challenge, threat, and neutral, influenced emotions in athletes. They found that a greater intensity of cognitive anxiety was experienced during the threat script compared with the challenge script supporting findings from Moore et al. (2012; 2013) that threat responses are associated with higher cognitive anxiety and furthermore, worse performance. These findings support Vine et al.'s (2016) proposition that anxiety may disrupt attentional control therefore leading to poorer performance.

1.7. Determinants of Challenge and Threat Responses

It should now be evident from the literature that a myriad of research supports distinctions between challenge and threat responses and outcome variables such as physiological responses, performance and attention. An important endeavour however, is establishing the relative importance and influence of the determinants of challenge and threat responses (Moore, Vine, Wilson, & Freeman, 2014). This contributes to the development of theory and has important practical implications particularly regarding the formulation and implementation of interventions promoting challenge in order to reap its proposed benefits. Though previously divided into separate demand and resource categories, the antecedents of challenge and threat responses are now specified as interdependent in their effects (Blascovich, 2013). According to the BPSM, the determinants of challenge and threat responses include required effort, danger, uncertainty, skills, knowledge, abilities, dispositional characteristics and external support (Blascovich, 2008). Still, it has been acknowledged that determinants of challenge and threat responses are many and should be considered within the context of the specific motivated performance situation in question (Blascovich, 2008).

1.7.1. The Theory of Challenge and Threat States in Athletes

The theory of challenge and threat states in athletes (TCTSA) proposed determinants of challenge and threat responses specific to competitive contexts (Jones et al., 2009). Like the BPSM, the TCTSA proposes that individuals engage in demand-resource evaluations in goal-relevant situations which leads to challenge and threat responses, indexed physiologically via CO and TPR (Jones et al., 2009). Similar to Lazarus and Folkman's (1984) description of primary appraisals, Jones and colleagues (2009) suggested that demands influence the relevance of the

situation and went on to clarify three resource components influential in challenge and threat responses in competitive settings. Drawing from previous theories and research on challenge and threat responses (e.g. Skinner & Brewer, 2004) and competitive anxiety (e.g. Jones, 1995) to name a couple, the authors suggested self-efficacy, perceptions of control and achievement goals as determinants of challenge and threat responses (Jones et al., 2009). The authors proposed that if an athlete believes they have sufficient skills to cope with the situational demands, sufficient control to display those skills, and a focus on approach goals, they will experience a challenge response (Jones et al., 2009). Therefore, these resource components are considered interrelated in their influence on challenge and threat responses.

Partial support for the TCTSA was provided by Meijen and colleagues (2012) who used a cross-sectional design to explore the resource components of the theory. Though challenge responses were not predicted by any of the factors, threat responses were positively predicted by avoidance goals and negatively predicted by self-efficacy and approach goals (Meijen et al., 2014). An experimental approach in eliciting challenge and threat responses by manipulating resource constituents was carried out by Turner and colleagues (2014). Across two studies, the authors showed that promoting self-efficacy and perceived control, with a focus on approach goals resulted in cardiovascular reactivity consistent with challenge responses. Importantly, perceived task demands were not manipulated, thereby suggesting the influence of resource antecedents in determining challenge and threat responses (Turner et al., 2014). However, the authors proposed that future research should examine self-efficacy, perceptions of control, and approach and avoidance goals separately to more comprehensively ascertain their effects on challenge and threat responses. This suggestion was in response to the limitation that it was not possible

to determine the success of the manipulation for each of the three components individually (Turner et al., 2014).

A notable feature of the TCTSA is that it outlined relationships between challenge and threat responses and self-regulation. Drawing from the self-control strength literature (Baumeister & Heatherton, 1996), the authors proposed that self-regulation strength is limited and depletion of strength in one area may negatively affect performance in another. Importantly, this self-regulation, also known as self-control strength is proposed to control all emotions, thoughts and behaviours (Baumeister, Vohs, & Tice, 2007). Jones and colleagues (2009) suggested that challenged individuals devote less resources to self-regulation compared to threatened individuals. This allows for sufficient self-regulatory resources for other possible demands which may arise, thereby promoting an adaptive approach prior to competition (Jones et al., 2009). While self-regulation strength is suggested to be an outcome of challenge and threat responses, it may be that it determines them, particularly in cases of high pressure. Individuals with depleted self-regulatory strength may have a decreased ability to adequately regulate their automatic or negative dominant responses under high pressure conditions thereby resulting in threat responses.

1.7.2. Manipulating the Determinants of Challenge and Threat Responses

Researchers have successfully manipulated individuals into reporting (via self-report measures) and displaying (via physiological measures) challenge and threat responses using different methods, including instructional sets, modifying the performance environment and psychological strategies like imagery.

For example, prior to a mental arithmetic task, Tomaka and colleagues (1997) used one set of instructions with participants which emphasised the importance of speed and accuracy in completing a task and another set which encouraged participants to consider themselves capable of meeting the challenge of the task (Tomaka et al., 1997). The authors found that the first instructional set elicited threat responses while the second set elicited challenge responses, as indexed via cardiovascular reactivity (Tomaka et al., 1997). To elicit threat responses in their study, Moore and colleagues (2012), emphasised high task difficulty in their instructional set, and communicated that previous participants struggled to perform well on the task. Similar to Tomaka et al. (1997), challenge instructions encouraged participants to consider themselves as capable of meeting the challenge of the task. Further, the instructions emphasised that previous participants performed well on the task (Moore, Vine, Wilson, et al., 2012). In both of these studies, manipulating individuals into eliciting challenge and threat responses had an influence on subsequent performance (Moore, Vine, Wilson, et al., 2012; Tomaka et al., 1997).

Modifications to the performance environment have also been used in manipulating challenge and threat responses. For example, participants performing a novel task in front of an audience, as opposed to a learned task, exhibited physiological markers indicative of a threat response while those participants performing a learned task in front of an audience illustrated physiological markers indicative of a challenge response (Blascovich et al., 1999). Psychological skills such as imagery (Williams et al., 2010) have also been utilised in manipulating challenge and threat responses. The authors formulated challenge, threat and neutral imagery scripts which described moments before a hypothetical competition. The challenge script highlighted that the athlete's resources met the situational demands and

included content encouraging feelings of high efficacy, high control and the potential to gain, while the threat script emphasised the opposite (Williams et al., 2010). Participants reported the threat script to be more threatening than the challenge script yet there were no differences in CO between challenge and threat scripts. However, CO is only one measure of the cardiovascular response associated with challenge and threat evaluations (Seery, 2013). Including TPR measurements would have provided a more comprehensive assessment of the success of the imagery scripts in eliciting challenge and threat responses.

Research has indicated that challenge and threat responses can be influenced by stable psychological constructs. For example, Mikolajczak and Luminet (2008) examined whether trait emotional intelligence influences challenge and threat responses. The authors found that trait emotional intelligence is associated with self-reported challenge rather than threat evaluations (Mikolajczak & Luminet, 2008). Furthermore, Schneider (2004) found that self-reported threat evaluations were associated with high neuroticism and low agreeableness. In fact, personality accounted for 26% of variance in self-reported cognitive evaluations (Schneider, 2004).

Experimental studies have been instrumental in establishing determinants of challenge and threat responses. For instance, upward and downward social comparisons were manipulated by Mendes and colleagues (2001) who found that participants interacting with upward comparison partners reported (demand-resource evaluations) and exhibited threat (increased ventricle contractility, no changes in CO, and vasoconstriction) responses. Further, participants interacting with downward comparison partners exhibited cardiovascular reactivity consistent with challenge responses (Mendes et al., 2001). Vick et al. (2008) observed that performance

based gender stereotyping influenced challenge and threat responses during a mathematics test. Stereotype threat was manipulated via audio instructions which described an upcoming test as either showing gender differences in performance (gender-biased) or not showing gender differences in performance (gender-fair) in previous studies. Continuous cardiovascular data were recorded during performance with women in the gender-biased condition exhibiting a threat response but, on the other hand, exhibiting a challenge response in the gender-fair condition. These findings were opposite for men who displayed a threat response in the gender-fair condition but a challenge response in the gender-bias condition (Vick et al., 2008).

While the above studies manipulated social contexts to observe changes in challenge and threat responses, Seery and colleagues (2009) investigated how manipulating outcome framing, the potential for gain versus loss, affected challenge and threat responses. This measure was classified as a component of the danger antecedent (Blascovich, 2008) with the potential for loss contributing to greater danger and lower safety than the potential for gain (Seery et al., 2009). The authors found that gain framing led to physiological markers consistent with a relative challenge response and loss framing, with physiological markers consistent with a relative threat response (Seery et al., 2009). Another experimental study which examined determinants was implemented by Moore and colleagues (2014) who experimentally manipulated perceived required effort and support availability and examined their effects on challenge and threat responses. Though there was no significant impact of support availability on challenge and threat responses, participants in the low perceived required effort condition exhibited cardiovascular reactivity indicative of a challenge response while those in the high perceived

required effort condition exhibited cardiovascular reactivity indicative of a threat response (Moore et al., 2014).

Finally, Moore et al., (2015) examined whether an arousal reappraisal intervention could influence challenge and threat responses. Following a pressure manipulation, both the control and arousal reappraisal groups exhibited a threat response. The latter group was exposed to a brief arousal reappraisal intervention after which they displayed a non-significant but meaningful descriptive trend indicating a challenge response (Moore et al., 2015). Arousal reappraisal is proposed to influence challenge and threat responses by promoting perceptions of resources. To explain, reappraising physiological arousal in a stressful situation as facilitative rather than debilitating fosters perceptions of these physiological signs as coping tools (Jamieson, Peters, Greenwood, & Altose, 2016). This work has important practical implications since the intervention is aimed at changing the type of stress response rather than eliminating or dampening it. Replication of Moore and colleagues' (2015) study would clarify their findings since analyses indicated a medium effect size in spite of non-significance.

The research described above not only enhances the BPSM specifically, but adds to the literature on stress and coping and provides a sound foundation for interventions which may promote the more physiologically efficient challenge response. However, there is still extensive scope for examining what factors or combination of factors, are the most prominent in producing challenge and threat responses particularly in specific contexts.

1.8. Aims of the PhD

Examining the factors involved in demand-resource evaluations which result in challenge and threat responses is important for a number of reasons. These include adding to and enhancing theories and models on and around the topic of stress and coping, such as the BPSM and the TCTSA, and formulating interventions promoting challenge in sport, health, and other applied settings. Apart from more physiological efficient outcomes, challenge responses are associated with a number of positive consequences including performance and attention benefits as described in the IFSAVP (Vine et al., 2016). The aim of this PhD therefore, was to examine key determinants proposed to influence challenge and threat responses and to replicate and extend findings on the effects of these responses on performance and attention. The fundamental framework employed in this thesis is the BPSM, though more contemporary theories which have evolved from the BPSM (Blascovich, 2013), such as the TCTSA (Jones et al., 2009) and the IFSAVP (Vine et al., 2016), were also utilised.

Study 1 focused on whether arousal reappraisal affected challenge and threat responses under pressurised conditions. Arousal reappraisal involves re-evaluating physiological arousal as facilitative, not debilitating, to performance (Jamieson et al., 2016). This study aimed to illuminate the extent to which appraisal of arousal symptoms influences the demand and resource evaluations process and thus, challenge and threat responses. Further, it attempted to provide evidence regarding the efficacy of arousal reappraisal as an intervention for athletes to adopt. Finally, it examined potential mechanisms that explain why arousal reappraisal influences performance. This study was a replication of Moore et al.'s (2015) arousal reappraisal study but systematically modified an individual facet (i.e.) type of motor

task and extended the scope of research (i.e.) potential underlying mechanisms, in order to corroborate and extend the authors' findings. This was considered an essential elementary step in conducting research for this thesis by duplicating sampling and experimental procedures to test a targeted construct and was partially in response to the 'reproducibility crisis' (Baker, 2016).

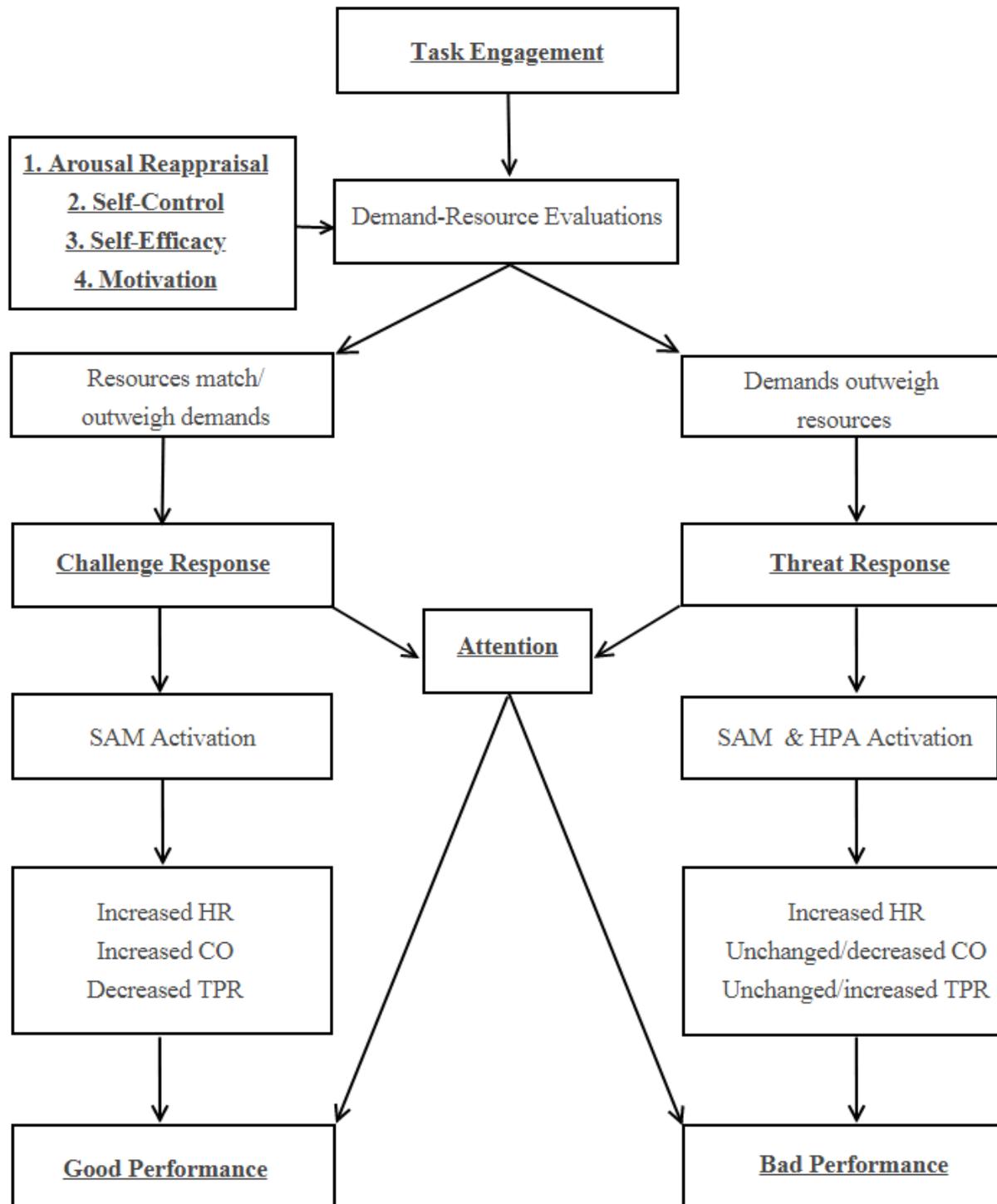
Study 2 examined self-control strength, another possible determinant of challenge and threat responses. Self-control strength involves regulation of the self by the self and thus includes regulation of cognition, emotions, and attention (Muraven & Baumeister, 2000). Though the TCTSA (Jones et al., 2009) suggests that self-regulation differences are a consequence of challenge and threat responses, this study aimed to demonstrate for the first time whether self-control strength determines challenge and threat responses. Exerting self-regulation on an initial task was proposed to deplete cognitive resources thereby negatively affecting demand-resource evaluations and so, challenge and threat responses. Importantly, it attempted to demonstrate how the compensatory strategy of mental effort may protect against motor-task performance breakdown in threatened individuals in high pressure circumstances thus supporting a key component of the IFSAVP (Vine et al., 2016).

Study 3 tested a third possible determinant of challenge and threat responses by examining self-efficacy. Self-efficacy, or "beliefs in one's capabilities to organise and execute the courses of action required to produce given levels of attainments" (Bandura, 1998, p. 53), is proposed to be a determinant of challenge and threat responses in competitive situations (Jones et al., 2009). This study attempted to demonstrate differences between low and high self-efficacy in determining challenge and threat responses thereby providing empirical evidence for a central tenet of the

TCTSA (Jones et al., 2009). It also aimed to add to the self-efficacy literature since self-efficacy beliefs are proposed to determine how people feel, think, behave and motivate themselves (Tahmassian & Jalali Moghadam, 2011).

Study 4 approached the testing of determinants of challenge and threat responses in a slightly different way to the previous studies as it also attempted to examine a possible influence on task engagement. This study examined the effects of situational motivation regulations on task engagement and challenge and threat responses using regression analyses. This direction aimed to utilise a methodologically different approach to ascertain how the self-relevance of a motivated performance situation provides a framework in which demand-resource evaluations are executed. Since motivation energises and directs behaviour (Niv, Joel, & Dayan, 2006), this study sought to provide insight into the direction and strength of relationships between different self-determined motivations with task engagement and challenge and threat responses.

Figure 1.1. An overview of the BPSM incorporating elements from the TCTSA and IFSAVP. Bolded, underlined text represents variables examined in this thesis.



Note: SAM – sympathetic-adrenomedullary; HPA – hypothalamic-pituitary-adrenal;
CO – cardiac output; TPR – total peripheral resistance

Chapter 2 (Study 1): The effects of arousal reappraisal on challenge and threat responses

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2.1. Introduction

Individual responses to pressure situations vary considerably which, according to the Biopsychosocial Model (BPSM; Blascovich, 2008) of challenge and threat, may be explained by individuals' evaluations of their personal coping resources and the situational demands (e.g. skills, uncertainty, psychological danger). The BPSM postulates that when individuals are engaged in a task, as evidenced through an increased heart rate (Seery, 2011), and are motivated to perform well, they enter into conscious, unconscious and dynamic demand and resource evaluation processes. When task demands are deemed to outweigh personal coping resources, a threat response occurs, whereas when coping resources are judged to match or outweigh demands a challenge response occurs; these responses do not act as two dichotomous entities but are instead two ends of a bipolar spectrum (Blascovich, 2008).

A crucial component of the BPSM is that the demand and resource evaluation process results in distinct neuroendocrine and cardiovascular responses. Catecholamines (adrenaline and noradrenaline) are released in both challenge and threat responses which results in an increase in sympathetic-adrenomedullary (SAM) activation. This, in turn, causes increased blood flow to the brain and muscles due to increased cardiac activity and vasodilation of blood vessels. However, a threat

response is proposed to also cause a release of cortisol, resulting in pituitary-adrenocortical (HPA) activation, which causes a dampening of cardiac activation. A challenge response in comparison to a threat response is therefore characterised by relatively higher cardiac output (CO) and lower total peripheral resistance (TPR) (Blascovich & Tomaka, 1996). These indices suggest that a challenge response is characterised by more efficient mobilisation and transportation of energy as compared with a threat response (Scheepers, de Wit, Ellemers, & Sassenberg, 2012).

The relationship between challenge and threat responses and the aforementioned physiological markers has been demonstrated in past research (Seery, 2011). For instance, challenge and threat responses were experimentally manipulated via instructional sets in the first of a three part study by Tomaka and colleagues (1997). The physiological responses described above were consistent with each response. Parts two and three of their research tested whether challenge and threat responses would follow on from the distinct physiological responses described above. As hypothesised, physiological manipulations did not result in the corresponding cognitive responses (Tomaka et al., 1997). This reinforces that cognitive processes may result in physiological responses which underpins the idea that changing such processes can thus influence physiological outcomes.

The BPSM further asserts that a challenge response is associated with improved performance in comparison to a threat response (e.g. Moore, Vine, Wilson, et al., 2012; Vine et al., 2013). However, challenge/threat and closed skill task performance is still relatively under researched. This is surprising considering the number of instances in which such skills are performed, particularly in competitive settings; they range from taking a basketball free throw to performing a tennis serve.

Not only did this research aim to illustrate the performance benefits of being challenged but aimed to do so under pressure conditions. The mechanisms behind these proposed performance benefits have yet to be fully identified however, it is hypothesised that attentional control could be a key component (Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2004; Turner et al., 2012; Vine et al., 2013). Vine et al. (2013) investigated the effects of challenge and threat responses on attentional control in a novel surgical task. Their findings showed that evaluating the task as a challenge, at both baseline and pressurised stages, was associated with superior attentional control and improved performance. Further support for challenge and threat states resulting in differential attention control was demonstrated by Moore and colleagues (2012). They found that challenged individuals reported more favourable attentional focus than threatened individuals as evidenced by an increase in their quiet eye (QE) duration (Moore, Vine, Wilson, et al., 2012). The QE is the final fixation or tracking gaze that occurs prior to the final movement of a task and a longer QE duration has been associated with higher levels of performance in numerous tasks (Vickers, 2009). Indeed, it is proposed to represent the time period in which critical visual information is processed (Vickers, 2009).

Limited research has explicitly tested interventions aimed at promoting challenge responses from a state of threat with even fewer examining such in high pressure sporting scenarios or the mechanisms behind why they might work. One promising line of research has indicated that arousal reappraisal may be an effective intervention in promoting challenge states, particularly in such pressure situations. The process of arousal reappraisal focuses on reinterpreting bodily signals such as increased heart rate, 'butterflies' in the stomach, and tense muscles as being facilitative rather than debilitating. This reappraisal has been consistently linked to a

more adaptive stress response, more favourable emotions, more favourable interpretation of emotions, and superior task performance (Jamieson et al., 2016). An important factor in arousal reappraisal is that it promotes the reconceptualisation of stress as a coping mechanism (Jamieson et al., 2016). By increasing perceptions of coping resources, individuals may experience elevations in their situational self-confidence regarding performance. Increases in self-confidence may therefore be a direct effect of arousal reappraisal as well as a possible mediating factor in the challenge and performance relationship.

Additional support for arousal reappraisal comes from a recent study by Moore and colleagues (2015) who investigated the effects of arousal reappraisal on pressurised golf putting performance. They found that following a pressure manipulation, those who received the reappraisal intervention reported more favourable cardiovascular responses, a more favourable interpretation of physiological arousal and also performed better on a pressurised, single-trial golf putting task (Moore et al., 2015). The abovementioned is the only study so far to investigate an arousal reappraisal intervention as an aid to motor performance. However, though the cardiovascular response equated to a medium effect size, it was not statistically significant. Additionally, performance was assessed via only one putt following the intervention limiting the generalisability of the performance finding among other motor tasks that may require several trials in a row such as in darts and snooker. Recent debate by authors about the replicability crisis in social psychology (e.g. Earp & Trafimow, 2015; Ioannidis, 2005; Loken & Gelman, 2017) highlights the importance of direct and conceptual replication of studies in the discipline. It is therefore of importance to test the robustness of current findings on arousal reappraisal interventions.

Furthermore possible underlying mechanisms such as self-confidence and attention were not examined in Moore and colleagues' (2012) aforementioned research. Our study therefore extends their research in a novel way by examining why arousal reappraisal may facilitate and even enhance motor performance specifically under pressure conditions. Indeed, such research is not only important in academia but in applied settings as well, particularly for practitioners who may employ such interventions to enhance sporting performance. The bolstering and extension of current theory not only affects the likelihood of use but the delivery of such interventions as well.

2.1.1. Aims and Hypotheses

The aims of the present study were to examine the influence of arousal reappraisal on challenge and threat responses and pressurised motor performance as well as to identify the potential mechanisms through which these responses operate (self-confidence and attention). We predicted that the intervention group would display cardiovascular measures more akin to a challenge state and report more favourable resource evaluations and higher self-confidence as compared with the control group. Further, the intervention group was predicted to outperform and display longer QE durations than the control group on the pressurised task. Finally, to explore if differences in self-confidence and QE duration mediated any between-group differences in performance, mediation analyses were conducted (Hayes, Preacher, & Myers, 2011).

2.2. Methods

2.2.1. Participants

Fifty-four undergraduate students (33 male, 21 female) with a mean age of 21.72 years (SD 3.31) agreed to take part in the study. A required sample size of 50 was calculated using G*power 3.1 software, setting power ($1-\beta$ err prob.) at .8, alpha (α err prob.) at $p = .05$, and using the effect size ($d = .46$) from Moore and colleagues (2015). All participants were self-reported novice darts players, who had had no prior formal coaching or playing experience. In addition, all participants were right handed, non-smokers, had normal or corrected vision and had not performed vigorous exercise or ingested alcohol 24 hours before testing.

2.2.2. Measures

2.2.2.1. Arousal intensity and interpretation

The Immediate Anxiety Measurement Scale (IAMS) (Thomas, Hanton, & Jones, 2002) was used to measure the intensity and direction of somatic anxiety. After a definition was provided, participants completed two items on a 7 point Likert scale to assess intensity (1 = not at all, 7 = extremely) and again to assess direction (-3 = a very negative effect on performance, +3 = a very positive effect on performance).

2.2.2.2. Cardiovascular (Task Engagement (TE) and Challenge and Threat Index (CTI))

A morphology-based impedance cardiology device (PhysioFlow, PF05L1, Manatec Biomedical, Paris, France) was used to collect cardiovascular data during the experiment while blood pressure measurements were taken using an automatic blood pressure monitor (A&D Medical, UA-767PC, California, USA). Heart rate has

been found to be a strong indicator of task engagement and both CO and TPR have been found to be viable indicators of challenge and threat states (Moore et al., 2013; Seery, 2011). Unlike CO values, which were taken directly from the PhysioFlow, TPR values were derived by using the formula: mean arterial pressure/CO * 80 (Sherwood et al., 1990). Mean arterial pressure was calculated using the formula [(2 * diastolic blood pressure) + systolic blood pressure/3] (Cywinski & Tardieu, 1980). To differentiate challenge and threat responses, a challenge and threat index (CTI) was created by converting each participant's CO and TPR residualised change scores into z scores and summing them (Seery et al., 2009). Residualised change scores were calculated in order to control for baseline values. TPR was assigned a weight of -1 and CO a weight of +1, such that a larger value corresponded with greater challenge (Moore et al., 2015).

2.2.2.3. Demand and Resource Evaluations (DRES)

The cognitive appraisal ratio (Tomaka, Blascovich, Kelsey, & Leitten, 1993) was used to assess demand and resource evaluations. Participants answered two separate questions, “How demanding do you expect the upcoming dart throwing task to be?” and “How able are you to deal with the demands of the dart throwing task?” For each question, participants rated their responses on a 6 point Likert scale (1 = not at all, 6 = extremely). Some researchers have calculated a ratio score by dividing evaluated demands by resources (e.g. Feinberg & Aiello, 2010). However, subtracting demands from resources is a more representative measure of challenge and threat responses as this produces a linear range (-5 to +5) which corresponds to the principle of challenge and threat responses as two anchors of a single bipolar continuum (Seery, 2011). Positive scores are indicative of challenge responses while negative scores are indicative of threat responses (Moore et al., 2014).

2.2.2.4. Self-Confidence

The IAMS (Thomas et al., 2002) was also used to measure the intensity of self-confidence following the same procedure as the measurement of arousal intensity and direction.

2.2.2.5. Performance (Mean Radial Error)

Mean radial error (the average distance that the dart finished from the bullseye in cm) was recorded as a measure of performance. All throws were performed from the regulation distance (236 cm) to the facing wall where the dartboard was fixed at the regulation height (172 cm). A dart which landed in the bullseye was given a score of 0 cm. For any attempts that missed the dartboard, a maximum score of 22.5 cm (the radius of the dartboard) was recorded.

2.2.2.6. Attention (Quiet Eye Duration)

An Applied Science Laboratories (ASL; Bedford, Massachusetts, USA) mobile eye tracker was used to collect gaze data during the study. This particular make and model of mobile eye tracker has previously been used in the challenge and threat literature (Moore et al., 2013; Vine et al., 2013). The system utilises two features: the pupil and corneal reflection (determined by the reflection of an infrared light source from the surface of the cornea) to calculate a point of gaze (at 30 Hz) relative to the eye and scene cameras. A circular cursor, representing 1° of visual angle with a 4.5 mm lens, indicating the location of gaze in a video image of the scene, was viewed by the co-experimenter in real time on a laptop screen.

The QE duration was operationally defined as the final fixation on the dartboard's bullseye prior to the initiation of elbow extension (Vickers, Rodrigues, & Edworthy, 2000). Quiet eye onset occurred before this extension and it's offset

occurred when the gaze deviated off the bullseye by 1° or more for longer than 100 ms. Each dart thrown was analysed using Quiet Eye Solutions software (www.QuietEyeSolutions.com) which allows frame-by-frame analysis to occur. Unfortunately, due to calibration issues (related to inadequate recording speed of the motor camera), gaze data could only be collected for 26 participants (intervention = 13, control = 13).

2.2.3. Procedure

The method was approved by the university ethics committee, and written informed consent was obtained from each participant prior to testing. Participants were randomly assigned to either a control ($n = 26$) or arousal reappraisal intervention ($n = 28$) group prior to entering the laboratory using an online research randomiser tool (<https://www.randomizer.org>). Height, weight and blood pressure measurements were recorded, after which participants were instrumented to the non-invasive cardiovascular and eye tracking devices. Following another blood pressure measurement, participants performed six baseline dart throws during which gaze measurements were recorded. Upon completion, cardiovascular data was measured in one minute intervals during a five minute baseline period (five minutes has been extensively used as a measure of true baseline in previous challenge/threat research with the last minute of baseline used for reactivity calculations e.g., Blascovich et al., 2004; Turner et al., 2013). Cardiovascular data were measured while participants were seated in an upright position. Measurements were not taken during the task due to possible movement artefacts (Siebenmann et al., 2015). Blood pressure measurements were taken alongside self-report measures at each stage of cardiovascular recordings. Following baseline recording, all participants received a pressure manipulation followed by one minute of

cardiovascular recording and then self-report measurements (arousal intensity and direction, demands, resources and self-confidence). The arousal reappraisal group then received the reappraisal intervention while the control group completed a non-demanding task designed to match for time. Another minute of cardiovascular recordings and self-report measurements (arousal intensity and direction, demands, resources and self-confidence) were taken followed by six pressurised dart throws during which gaze measurements were also recorded. Following completion, all equipment was removed and participants were thanked and debriefed about the study.

2.2.3.1. Pressure Manipulation and Reappraisal Instructions

All participants received the pressure manipulation following their baseline set of dart throws. This manipulation was previously used by Moore et al. (2015) and was largely adapted from the manipulations used by Moore et al. (2012). To ensure an increase in pressure and task engagement, all participants were advised about the importance of the experiment; that they were going to be compared against other individuals (through an online leader board); that the top performers would be awarded prizes; and that very poor performers would be interviewed about their performance. Participants were also instructed that, following their previous six throws, they were in the bottom thirty percent of those tested so far, and that if they were to perform the same way again, their data would not be useable.

The control task consisted of reading a non-threatening nature article about birds (see Appendix 1) which was matched for time with the delivery of the reappraisal instructions. Participants were informed that they would not be tested about the article. The reappraisal instructions were the same as those used in Moore et al. (2015), adapted from previous studies investigating arousal reappraisal

(Jamieson, Mendes, Blackstock, & Schmader, 2010; Jamieson, Nock, & Mendes, 2012) and are as follows:

“In stressful situations, like sporting competition, our bodies react in very specific ways. The increase in arousal you may feel during stressful situations is not harmful. In fact, recent research has shown that this response to stress can be beneficial and aid performance in stressful situations. Indeed, this response evolved because it helped our ancestors survive by delivering oxygen to where it was needed in the body to help address stressors. Therefore, before and during the upcoming dart throwing task, we encourage you to reinterpret your bodily signals and any increases in arousal as beneficial and remind yourself that they could be helping you perform well.”

2.2.4. Statistical Analysis

In order to check for task engagement, a dependent *t*-test was used to compare heart rate reactivity at baseline and post-pressure manipulation, and show that across both groups task engagement was present (Blascovich, 2008). To examine the effects of the intervention, an independent *t*-test was used to compare demand-resource evaluations by group. Furthermore, a 2 (time: post-pressure manipulation, post-intervention/control) x 2 (group: control, intervention) mixed ANOVA was conducted with the challenge and threat index (CTI) as the dependent variable. A further two 2 (time: baseline, pressurised) x 2 (group: control, intervention) mixed ANOVAs were conducted with mean radial error and QE duration as the dependent variables. A MANOVA was conducted on the self-report data: arousal intensity, arousal interpretation, demands, resources and self-confidence. Effect sizes were calculated using partial eta squared (η_p^2). Finally, to determine if

differences in self-confidence and QE duration mediated any between-group differences in performance, mediation analyses were performed using the PROCESS add-on for SPSS (version 2.16) (Hayes, 2017). Recent developments in statistical analyses software, like PROCESS for example, have allowed for the implementation of inferential tests of indirect effects of X (group) on Y (performance) without making unnecessary assumptions about the shape of its sampling distribution (Hayes, 2017). Furthermore, this add-on allows for the testing of indirect effects regardless of the significance for the individual paths in the mediation model (Hayes, 2017).

2.3. Results

2.3.1. Task Engagement Manipulation Check

The dependent t -test showed that both groups' heart rates significantly increased from baseline ($M = 4.47$, $SD = 5.34$), $t(51) = 6.04$, $p < .001$, $d = 1.18$, confirming task engagement and permitting the subsequent investigation of challenge and threat states.

2.3.2. Challenge and Threat (DRES and CTI)

The independent t -test showed that there was a significant difference between groups following the intervention, $t(52) = -2.16$, $p = .04$, $d = 0.54$ with the intervention group reporting a higher DRES ($M = 2.00$, $SD = 1.70$) than the control group ($M = 1.08$, $SD = 1.70$).

The ANOVA on the CTI¹ data revealed no significant main effect for Time, $F(1,43) = .00$, $p = .98$, $\eta_p^2 = .00$, and no significant main effect for Group, $F(1,43) =$

¹ CO means for the control and intervention groups were $M=0.25$, $SD = 0.39$ and $M=0.14$, $SD = 0.44$ respectively while TPR was $M=-94.17$, $SD=119.88$ and $M=-33.5$, $SD=160.36$ respectively. Following the intervention/control task, CO means for the control and intervention groups were $M=-0.45$,

.18, $p = .66$, $\eta_p^2 = .00$. However, a significant interaction between group and time was found, $F(1,43) = 5.63$, $p = .02$, $\eta_p^2 = .11$. Post hoc t -tests with a Bonferroni correction to the alpha revealed that there was no significant difference between groups following the pressure manipulation, $t(46) = 1.92$, $p = .06$, $d = 0.53$ but there was a significant difference between groups following the intervention/control task, $t(44) = -3.08$, $p < .025$, $d = 0.90$ with the intervention group displaying a significantly higher CTI than the control group (see Table 2.1).

2.3.3. Self-Report Data

The multivariate result was significant for group, Wilks' Lambda = .78, $F(5, 48) = 2.72$, $p = .03$, $\eta_p^2 = .22$ indicating a difference in self-report data by group following the intervention. The univariate F tests showed there was a significant difference between the intervention and control groups for resource evaluations, $F(1,52) = 8.71$, $p = .01$, $\eta_p^2 = .14$ and self-confidence, $F(1, 52) = 7.43$, $p = .01$, $\eta_p^2 = .13$ with the intervention group reporting both higher resources and self-confidence than the control group (see Table 2.1).

$SD=0.98$ and $M=0.01$, $SD=0.66$ respectively while TPR was $M=87.07$, $SD=118.7$ and $M=1.16$, $SD=272.18$ in that order.

Table 2.1. Means and standard deviations of demands, resources, self-confidence, cardiovascular reactivity, performance and QE data for control and intervention groups.

	Control		Intervention	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Arousal Intensity	2.62	1.02	3.14	1.41
Arousal Interpretation	0.16	0.27	0.29	0.26
Demand Evaluation	2.88	1.28	2.64	1.16
Resource Evaluation	3.92	1.02	4.68*	0.86
Self-confidence	3.23	1.45	4.21*	1.2
Post-Pressure Manipulation CTI	0.44	1.63	-0.43	1.50
Post-Intervention/Control CTI	-0.26	0.98	0.61**	0.91
Baseline Mean Performance (cm)	11.05	2.84	9.29	3.28
Pressurised Mean Performance (cm)	9.80	3.68	7.65	2.82
Baseline QE Duration (ms)	392.03	241.78	540.68	324.32
Pressurised QE Duration (ms)	638.52	511.57	687.75	350.33

Note. Significantly different from control group * $p < .05$; significantly different from control group ** $p < .01$

2.3.4. Performance (Mean Radial Error)

The ANOVA revealed that there was a significant main effect for Time, $F(1,48) = 12.21, p = .001, \eta_p^2 = .20$, with participants performing better at the pressurised time point (see Table 2.1). There was also a significant main effect for Group, $F(1,48) = 5.02, p = .03, \eta_p^2 = .10$, with the intervention group participants performing better at both time points. However, there was no significant interaction effect, $F(1,48) = .12, p = .72, \eta_p^2 = .00$.

2.3.5. Attention (Quiet Eye Duration)

The ANOVA, revealed that there was no significant main effect for Time, $F(1,22) = 2.15, p = .16, \eta_p^2 = .09$. There was also no significant main effect for Group, $F(1,22) = 1.82, p = .19, \eta_p^2 = .08$ and no significant interaction effect either, $F(1,22) = .002, p = .96, \eta_p^2 = .00$.

2.3.6. Mediation Analysis

A significant total effect of X (group) on Y (performance) is not a prerequisite for examining the significance of indirect effects (Preacher & Hayes, 2004) permitting the testing of such. In other words, the significance of the total effect of group on performance is not pertinent to whether the indirect effect is significant. Therefore, to test if the effect of group on performance was indirectly affected by any of the process variables, experimental group (coded challenge = 1, threat = 0) was entered as the independent variable, mean radial error was entered as the dependent variable, self-confidence and QE duration were entered separately. Based on a

10,000 sampling rate, the results from bootstrapping revealed no significant indirect effects for self-confidence 95% CI = -3.44 to 0.65 or QE duration, 95% CI = -5.34 to 0.71 (see Table 2.2).

Table 2.2. Mediation results for self-confidence and QE.

	Effect	SE	LL95% CI	UL 95% CI
Self-Confidence	-1.39	1.02	-3.44	0.65
Quiet Eye	-2.31	1.46	-5.34	0.71

Note. LL: lower limit; CI: confidence interval; UL: upper limit.

2.4. Discussion

Facilitative stress reactions, such as challenge responses, have been consistently linked with a number of positive psychological, physiological and performance outcomes (Blascovich, 2008). Interventions which help to promote such responses are therefore highly beneficial to performers across a range of situations and tasks. One such intervention which has previously received support, arousal reappraisal, was investigated here. The current study aimed to add to the robustness of previous findings which have supported the effectiveness of this intervention (e.g. Moore et al., 2015). Further, this research is novel in its investigation of why arousal reappraisal might positively influence performance through the examination of potential underlying mechanisms namely, self-confidence and attention. Compared to a control group, the arousal reappraisal group displayed cardiovascular markers indicative of a challenge response and reported a higher DRES, more favourable resource evaluations as well as higher self-confidence. There were no effects of the intervention on performance or attention. Furthermore, neither self-confidence nor attention mediated the group and performance relationship.

Following the intervention, the arousal reappraisal group was significantly more challenged than the control group. The arousal reappraisal intervention therefore resulted in a more efficient and adaptive cardiovascular response for this group. Arousal reappraisal is proposed to break the link between negative affective experiences and malignant physiological responses by reframing the meaning of the physiological signals that accompany stress (Jamieson et al., 2012). Interestingly, there were no differences between groups in the interpretation of arousal following the intervention/control task. However, resource evaluations were significantly higher for the intervention group than the control group suggesting that arousal reappraisal's effectiveness in promoting challenge may be via its positive consequences on coping. Indeed, research recent on arousal reappraisal in educational settings has supported this conclusion (Jamieson et al., 2016).

The intervention group also reported higher self-confidence compared to the control group. This increase in self-confidence is in line with the predictions of the Theory of Challenge and Threat states in Athletes (TCTSA) (Jones et al., 2009) which suggests that self-efficacy, state self-confidence, is a critical determinant of challenge and threat. It is proposed to influence the individual's perceptions of their resources since it incorporates beliefs about the individual's ability to succeed in specific situations (Bandura, 1977). Indeed, beliefs regarding the ability to successfully employ arousal reappraisal strategies may have been a key factor in the success of the intervention.

In contrast to the hypothesis, the arousal reappraisal intervention did not improve performance, above that achieved by the control group. Indeed, both groups performed better during the pressurised trials. According to the Attentional Control Theory (ACT) (Eysenck et al., 2007), anxiety may not impair quality of performance

when it leads to the use of compensatory strategies, such as increased effort. Therefore, both groups may have utilised compensatory strategies in order to prevent performance decrements in the pressurised performance situation. Additional future research should examine possible compensatory strategies such as mental effort. Alternatively, no previous research has examined challenge and threat effects on dart throwing performance so employing another type of motor task might show differential effects.

The ANOVA on QE duration revealed no significant effects for time, group or an interaction, despite previous research suggesting that it is sensitive to high levels of performance pressure and anxiety (e.g. Behan & Wilson, 2008; Wilson, Wood, et al., 2009). Standard deviations of QE durations were high in both groups indicating high variability amongst participant measures across groups which may have influenced results. Indeed Vickers et al., (2000) suggested very specific optimal attentional guidelines when performing a dart throw. Based on analysis on five skilled dart players, the authors proposed that QE fixation should be timed for onset to occur during late alignment with duration extending into early flexion. Importantly, they suggested that offset should occur immediately prior to arm extension, during mid-flexion (Vickers et al., 2000). Furthermore, on a methodological note, post-hoc power analyses indicated that the study was underpowered ($1-\beta$ err prob. = 0.3) to find QE effects meaning there is scope for future research to re-examine this avenue with a larger sample.

Mediation analyses revealed that neither levels of self-confidence nor QE duration mediated the relationship between challenge/threat and performance. Therefore, while self-confidence may be a determinant of challenge and threat, it may not result in performance consequences. Though there were no mediation

effects of attention, there is scope for future replication studies to verify these findings, particularly due to the aforementioned methodological limitation regarding study power. Furthermore, future research could investigate mediation effects for motor tasks for which main effects of challenge/threat and attention have been previously established (e.g.) golf putting (Moore, Vine, Cooke, Ring, & Wilson, 2012).

The current study has several theoretical and practical implications. The reappraisal intervention was successful in leading to more efficient cardiovascular adaptations. As aforementioned, the proposed theoretical view that arousal reappraisal influences stress responses via reframing physiological arousal may not fully explain this relationship. It may however, be explained via an increase in the perception of an individual's coping resources among other factors. This leaves scope for future research to assess possible moderators such as social support; validation for such has recently come from work by Slater and colleagues (2016) who highlighted the importance of social support in promoting a positive reappraisal of stress. The authors proposed that psychological factors such as social identity and social support may enhance resource appraisals and/or reduce demand appraisals thereby increasing the chances of evaluating stressful situations as challenge states rather than threat states (Slater, Evans, & Turner, 2016). From a practical viewpoint, our findings suggest that arousal reappraisal could act as a low-resource intervention to help promote challenge states. Arousal reappraisal can be incorporated into performer-focused cognitive behavioural therapy to promote adaptive stress responses (Baron, Baron, & Foley, 2009). Finally, as the cardiovascular responses associated with recurrent threat evaluations may be adverse to health (Blascovich, 2008), arousal reappraisal may be a protective factor via its role in promoting challenge.

Limitations of the current study include the lack of measures of compensatory strategies such as mental effort which would have allowed for a better understanding of challenge/threat and performance. In addition, the study was underpowered to determine attentional effects suggesting replication studies in future to clarify such. Further, only one known study (Vickers et al., 2000) with a relatively small sample size ($N=5$) has examined the effects of QE on dart throwing performance. The lack of supporting evidence suggests that the relationship between QE and dart throwing performance may not yet be fully understood. In order to verify the attentional findings in this study, future research should investigate challenge and threat and QE in relation to motor tasks, such as golf putting, for which there has been previous corroboration (e.g. Moore et al., 2013).

The present chapter demonstrated that arousal reappraisal is effective in determining challenge responses. Findings support the proposition that arousal reappraisal is effective in promoting a more adaptive stress response via its beneficial impact on perceptions of resources, challenge responses and self-confidence as well as more efficient cardiovascular reactivity. While the present study indicated the influence of changing the meaning of stress-based arousal in order to promote a challenge response, study 2 (Chapter 3) sought to demonstrate that having the capacity to do so is an important factor as well. The next study in this thesis therefore aimed to illustrate that depleted self-control strength would impact challenge and threat resources in stressful conditions. This was proposed to extend the findings of the first study by demonstrating that having the self-control resources to regulate such cognitive processes as arousal reappraisal is a core component in influencing demand-resource evaluations.

Furthermore, there were no performance or attention effects of challenge and threat responses in study 1 (Chapter 2). Vine and colleagues' (2016) IFSAVP states that threat responses may not necessarily always cause poor performance if compensatory strategies, such as increased effort, are employed (Vine et al., 2016). This supports the proposition from the ACT that compensatory strategies may attenuate the effects of anxiety on performance (Eysenck et al., 2007). Therefore, study 2 (Chapter 3) examined mental effort as a mediator of the challenge and threat and performance relationship. Study 1 (Chapter 2) did not replicate previous findings that challenge responses are associated with better motor task performance compared to threat responses (e.g. Moore et al., 2015; Vine et al., 2013). Golf-putting performance however, has been shown to be sensitive to challenge and threat response effects (e.g. Moore, Vine, Wilson, et al., 2012; Moore et al., 2015). Therefore, the following study in this thesis aimed to clarify previous findings on challenge/threat responses and performance while also providing evidence for two possible key underlying mechanisms: attention and mental effort.

Chapter 3 (Study 2): The influence of self-control strength on challenge and threat responses

Being prepared for submission as: Sammy, N., Wilson, M. R., & Vine, S. J.

The influence of self-control strength on challenge and threat responses.

3.1. Introduction

An individual exercises self-control when they attempt to control or override dominant behaviours or responses in order to achieve an aim (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Self-control is needed in sporting situations in order to regulate mental and physical responses and behaviours such as emotion (Muraven, Tice, & Baumeister, 1998) and attention (Schmeichel & Baumeister, 2010). In the previous study in this thesis (Chapter 2), the intervention group was encouraged to reappraise their physiological arousal in the face of high pressure and increased anxiety which stimulated the question of what affects the ability to reappraise the meaning of bodily changes in the first place. The strength model of self-control suggests that self-control is a limited resource which can become diminished through use; this is known as ego depletion (Baumeister et al., 1998). Individuals may be unable to efficiently manage regulatory behaviours in motivated performance situations if their self-control strength is depleted, possibly leading to threat responses.

Importantly, all types of self-control are proposed to draw from the same global pool (Baumeister et al., 2007). Dual-task paradigms have been widely used in experimental research to observe the effects of ego depletion (Hagger, Wood, Stiff, & Chatzisarantis, 2010). This paradigm usually involves two groups, control and ego depleted, in which the latter group performs a task which utilises self-control and the

former group performs a neutral task, followed by both performing a secondary task which also requires the use of self-control. Several studies have provided evidence for this relationship whereby depleted self-control in one sphere negatively affects the utilisation of self-control in another sphere and subsequently, performance (Hagger et al., 2010). Such effects have been observed for both cognitive performance (e.g. Schmeichel, Vohs, & Baumeister, 2003) and sporting performance (e.g. Wagstaff, 2014). A meta-analysis of eighty three studies indicated significant effect sizes for the effect of ego depletion on performance, effort, perceived difficulty, negative affect, subjective fatigue and blood glucose levels (Hagger et al., 2010).

However, results from a more recent meta-analysis by Carter and colleagues (2015) concluded that self-control is not necessarily a limited resource (Carter, Kofler, Forster, & McCullough, 2015) challenging not only the results of the aforementioned meta-analysis but a core tenet of the strength model of self-control as well. Nevertheless, Englert (2016) pointed out that the inconsistencies in the findings of these meta-analyses should encourage the execution of replication studies in future (Englert, 2016). There are a number of concerns regarding replication, from theories being so loosely constructed that there isn't testable content (Folger, 1989), to the difficulty in drawing conclusions from results (Earp & Trafimow, 2015). However, replication may still prove informative in social science research (Earp & Trafimow, 2015) thus prompting the continuation of research into self-control strength and more specifically, ego depletion effects on psychological, physiological and performance outcomes in sport.

The negative effect of ego depletion has been observed in sport and exercise psychology research specifically. In one such study, Englert and Wolff (2015) asked twenty active participants to perform a high-intensity cycling task at two time points,

seven days apart. In counterbalanced conditions, self-control strength was experimentally manipulated at one of the two time points via a Stroop test. The authors found that participants invested less effort in, and performed worse in the depleted condition (Englert & Wolff, 2015). This particular study not only highlighted an overall negative effect of ego depletion on a sporting task but on a long lasting task, which required high physical exertion.

Ego depletion effects on performance have not only been observed for intense, physically demanding tasks, like the one described above, but for motor tasks as well. McEwan and colleagues (2013) randomly assigned participants to a depletion or non-depletion group and asked them to perform in three conditions: baseline, Round 1, Round 2. Notably, the self-control manipulation occurred prior to Rounds 1 and 2 for the depletion group. All participants were required to throw darts as soon as they observed a green light but not when they observed a red or yellow light in Round 1 while in Round 2, they were required to throw darts as soon as they observed a red light only. Accuracy (average distance of the dart from the bullseye) and impulse control (reaction time) were measured at both time points. The depleted group had poorer mean accuracy at Round 2 compared with the control group and also showed deterioration in consistency at this time point while the control group's consistency improved between Rounds 1 and 2 (McEwan, Ginis, & Bray, 2013). Importantly, this study indicated that performance accuracy on a motor task is susceptible to the negative effects of ego depletion.

Self-control strength is particularly salient in high pressure situations where individuals are likely to experience high arousal and anxiety (Englert, 2016) which can be detrimental to performance (Johns, Inzlicht, & Schmader, 2008). Englert and Bertrams (2015) integrated the strength model of self-control (Baumeister et al.,

2007) with the attention control theory (ACT) (Eysenck et al., 2007); to illustrate how self-control strength moderates the anxiety-performance relationship. The ACT proposes that anxiety hinders the goal-directed attentional system and fosters the influence of the stimulus-driven attentional system thus affecting processing efficiency (Eysenck et al., 2007). Apart from less efficient attentional control, attention to threatening stimuli may be increased with the influence of anxiety. These adverse effects of anxiety may impair subsequent performance however, the authors suggest that the quality of performance may not be impaired if compensatory strategies, such as increased effort, are used (Eysenck et al., 2007). Englert and Bertrams (2015) propose that under anxiety, counteracting this activation of the stimulus-driven system depends on self-control strength. Further, intact self-control strength would allow for the employment of the compensatory strategies crucial to performance maintenance under high anxiety conditions (Englert, Zwemmer, Bertrams, & Oudejans, 2015).

Support for these hypotheses comes from experimental studies by Englert and Bertrams (2012, 2013). The authors demonstrated that for perceptual-motor tasks in which efficient attention regulation was necessary: basketball free-throws and dart-throwing, anxious participants in a state of ego depletion performed worse than anxious participants with intact self-control strength (Englert & Bertrams, 2012, 2013). Furthermore, empirical support for worsened attentional regulation in a state of ego depletion regarding the above perceptual-motor tasks was illustrated across two additional studies. Using gaze behaviour as a measure of attention (as in Vine, Moore, & Wilson, 2011), Englert and colleagues (2015) observed less efficient attentional regulation and worse performance for ego depleted participants as compared with non-depleted ones under high anxiety conditions (Englert, Zwemmer,

et al., 2015). In another study, ego depleted participants were less able to ignore irrelevant thoughts and performed worse on a basketball free-throw task compared to participants with intact self-control strength (Englert, Bertrams, Furley, & Oudejans, 2015). This highlights that depleted participants were less able to regulate their attention by shifting it away from this distracting stimuli.

The studies described above (Englert, Bertrams, et al., 2015; Englert, Zwemmer, et al., 2015) provide support for the decreased ability of ego depleted individuals to adequately regulate their automatic or negative dominant responses under high pressure conditions. It is likely that challenge and threat responses are another indicator of the effects of self-control strength on psychological and physiological responses particularly in pressure situations where anxiety is experienced. Pressurised performance situations have been associated with both self-report and physiological threat responses in previous studies (Moore et al., 2015). A reduced capacity to exert self-control due to depletion should theoretically lead to a threat response in such situations as individuals are less able to regulate their predominant or automatic negative responses to pressure. For instance, Johns and colleagues (2008) suggest that in test situations where stakes are high, students will evaluate arousal as anxiety (Johns et al., 2008). Possible strategies to manage this anxiety might include downregulating it or changing one's interpretation of it as facilitative rather than debilitating or, in other words, reappraising anxiety symptoms such as increased physiological arousal. Certainly, Folkman and colleagues (1986) suggest that as a part of the secondary appraisal process, individuals assess what resources are necessary to minimise, tolerate or eradicate a stressor (Folkman et al., 1986). A lessened ability to employ such strategies due to ego depletion may lead to threat responses.

Further, the attentional findings described above may be incorporated into the explanation for why depleted self-control may lead to threat responses. Ego depletion may increase attention to threatening stimuli such as high situational demands and low personal resources thereby skewing demand-resource evaluations and so leading to a threat response. Conversely, individuals with intact self-control strength should theoretically be able to volitionally shift or inhibit their attention away from negative stimuli for a more balanced evaluation of their demands and resources in a motivated performance situation. This is a component of the circularity of transactional models where a proposed outcome variable, (e.g.) attention, may also act as an antecedent variable (Lazarus, 1995). Vine et al., (2016) suggested that this process occurs as part of a feedback loop, (i.e.), where consequences of challenge/threat responses then act as variables within subsequent demand-resources evaluations. It is possible however, that in cases of ego depletion when attentional regulation is critical to coping, attentional control is involved in demand-resource evaluations from the outset of the task.

Recent research on the neuroscience behind ego depletion provides support for the hypothesis that depleted individuals are less proficient at self-regulation. As pointed out by Inzlicht and colleagues (2016), this research supports the strength model by demonstrating that ego depletion is consistent with decreases in brain activity in those regions relating to cognitive control (Friese, Binder, Luechinger, Boesiger, & Rasch, 2013; Wang & Yang, 2014). Indeed, ego depletion is proposed to influence activities which require higher order cognitive processes but does not necessarily impair more basic forms of information processing (Schmeichel et al., 2003). Though demand-resource evaluations may be unconscious, conscious evaluations involve active instrumental responding to stimuli (Seery, 2011)

suggesting the involvement of higher order cognitive processing. For example, the limbic structures of the forebrain are thought to play a part in how the hypothalamic-pituitary-adrenal (HPA) axis is regulated (Smith & Vale, 2006). As discussed in the Literature Review (section 1.4, Chapter 1), the HPA axis is a central component in the physiological indices consistent with a threat response.

As previously mentioned, following the proposition from the IFSAVP (Vine et al., 2016) that compensatory strategies such as effort may attenuate the negative effects of threat responses on performance, mental effort was examined as a possible underlying mechanism of the challenge/threat and performance relationship. Demonstrating this would be valuable in explaining situations in which threatened individuals experience mild levels of anxiety yet maintain performance (e.g. Skinner & Brewer, 2002). Mental effort investment refers to energy mobilisation in response to cognitive goals (Gaillard, 2001). It is therefore possible that mobilisation of effort in order to achieve task goals would compensate for performance decrements in threatened individuals in spite of poorer cardiovascular reactivity and even attentional control (Vine et al., 2016).

Furthermore, in order to replicate findings from study 1 (Chapter 2) in this thesis that state self-confidence is associated with challenge responses, this variable was measured in each condition. Self-confidence is proposed to have a positive, linear relationship with performance (Martens, Vealey, & Burton, 1990). Finally, positive affect has been shown to replenish depleted self-control strength (Tice, Baumeister, Shmueli, & Muraven, 2007). Across a series of four experiments, Tice and colleagues (2007) demonstrated that positive affect counteracts ego depletion. Therefore, in order to ensure that there were no differences in affect between the

control and ego depleted groups which may have confounded results, measures of affect were assessed.

3.1.1. Aims and Hypotheses

Based on previous research, an ego depleted group was predicted to report and display threat responses, worse self-confidence, worse performance and worse attentional control in both low and high pressure conditions as compared with a control group. Attention and mental effort were predicted to mediate the challenge and threat response and performance relationship in both low and high pressure conditions.

3.2. Methods

3.2.1. Participants

35 university students (Male = 23, Female = 12) with a mean age of 20.8 ± 2.12 were recruited via flyers, email and word-of-mouth to participate in this study. A required sample size of 35 was calculated using G*power 3.1 software, setting power (1- β err prob.) at .8, alpha (α err prob.) at $p = .05$, and using the effect size ($f = 0.25$) from Hagger and colleagues (2010). In order to check the sample size was not underpowered to detect possible QE effects as in the previous study in this thesis (study 1, Chapter 2), a required sample size of 10 was calculated using G*power 3.1 software, setting power (1- β err prob.) at .8, alpha (α err prob.) at $p = 0.05$, and using the effect size ($\eta_p^2 = .24$) from Englert and colleagues (2015).

Participants were randomly allocated to either an ego depleted group (ED) or non-depleted group (Control), and exposed to two randomised, counterbalanced conditions of varying pressure (low and high). All participants were novice golfers as they had no official golf handicap or official putting training (Moore, Vine, Wilson, et

al., 2012). The study was approved by the local ethics committee, and written informed consent was obtained for each participant prior to the start of the procedure.

3.2.2. Measures

3.2.2.1. Ego Depletion (ED) Manipulation

Self-control strength (SCS) was manipulated using a transcription task (Bertrams, Baumeister, Englert, & Furley, 2015); participants copied a neutral text (see Appendix 2) on to a separate sheet of paper for six minutes which was timed by the researcher. The ED group was asked to omit the letters 'e' and 't' in the first transcription task and 'a' and 'n' in the second; deliberately overriding automatic writing tendencies is one way in which to induce ego depletion (Muraven, 2008). The Control group transcribed the text conventionally, leaving SCS intact (Bertrams, Englert, & Dickhäuser, 2010). After finishing the transcription task, all participants were asked to complete a three-item manipulation check on a Likert-type scale ranging from 1 (not at all) to 7 (very much). The items consisted of the following questions: 'How difficult did you find the task?', 'How effortful did you find the task?', 'How depleted do you feel at the moment?' (Bertrams et al., 2010). For the occasional case in which a participant did not understand the term 'depleted', the researcher provided the definition of 'mentally drained or exhausted'.

3.2.2.2. Pressure Manipulation

Verbal instructions (adapted from Moore et al., 2015), were used to induce varying degrees of pressure during putting performance; resulting in two conditions: low and high pressure. Instructional pressure manipulations have been shown to be

effective in inducing anxiety in laboratory settings (e.g. Vine et al., 2013; Vine & Wilson, 2010).

Two items from the Mental Readiness Form – L (MRF-L) (Krane, 1994) were administered to check the effectiveness of the pressure manipulation by measuring cognitive anxiety. Participants verbally indicated which number on the 11-point Likert type scale (from ‘worried’ to ‘not worried’) most accurately reflected how they felt at that specific moment in time. The cognitive anxiety scale from the MRF has previously been used to examine state anxiety levels in several studies examining motor task performance in pressurised conditions (e.g. Vine & Wilson, 2011; Wilson, Vine, et al., 2009; Wilson, Wood, et al., 2009).

Though study 1 (Chapter 2) utilised the IAMS (Thomas et al., 2002) as a measure of cognitive anxiety, pilot testing informed the decision to use the MRF-L (Krane, 1994) as a measure of cognitive anxiety for this and subsequent studies in this thesis. Participants indicated that the MRF-L was more ‘user-friendly’ than the IAMS as characterised by the anchoring terms ‘worried’ and ‘not worried’ as well as the larger rating scale (11-point Likert scale as opposed to the 7-point Likert scale used in the IAMS).

Low pressure task instructions

“You will shortly be asked to perform 6 golf putts. Your performance data will only be recorded for reference purposes and will not be compared against any other data.

With these instructions in mind, please sit quietly for 1 minute and think about the upcoming task.”

High pressure task instructions

“You will shortly be asked to perform 6 golf putts. For unsuccessful putts the distance (in centimetres) between the ball and the hole will be recorded while successful putts will carry a score of 0 cm. A mean score will be calculated after your putts with lower scores being better.

At the end of the study your scores will be entered into a leader board against other participants and will be emailed to all participants. The worst 10% of performers will be required to return for a short interview on their poor performance while the worst 5%’s data will not be usable so it is important to perform to the best of your ability.

With these instructions in mind, please sit quietly for 1 minute and think about the upcoming task.”

3.2.2.3. Self-Confidence

One item from the Mental Readiness Form – L (MRF-L) (Krane, 1994) was administered to measure state self-confidence following instructional sets and data collection followed the same procedure as for the cognitive anxiety measure above.

3.2.2.4. Affect

The Positive and Negative Affect Schedule (PANAS) (Watson, Clark, & Tellegen, 1988) was administered to assess whether there were affect differences between groups. The PANAS comprises two, 10-item scales which consist of words which describe feelings and emotions; participants rate to what extent they are experiencing each feeling and emotion using a 5 point Likert-type scale ranging from 1 (very slightly or not at all) to 5 (extremely) (Watson et al., 1988).

3.2.2.5. Demand-Resource Evaluations (DRES)

DRES data was collected using the same measures and procedure as in study 1 (Chapter 2).

3.2.2.6. Cardiovascular Measures (Task Engagement (TE) and Challenge and Threat Index (CTI))

Cardiovascular data were collected using the same equipment as in study 1, (Chapter 2). The data were recorded while the participant was in a seated position, resting (5 minutes) and post-pressure manipulations: low (one minute) and high (one minute).

Task engagement and the challenge and threat index were calculated following the same procedures as in study 1 (Chapter 2).

3.2.2.7. Performance (Mean Radial Error)

Medial radial error (the average distance the ball finished from the hole in centimetres) was used as the measure of golf putting performance. Zero was recorded for when the putt was holed whilst 90 cm was recorded for when the ball hit the boundary of the green, the largest error possible (Moore, Vine, Wilson, et al., 2012). All participants used a Cleveland Classic 1.0 putter and regular sized white golf balls (diameter = 4.27cm).

3.2.2.8. Attention (Quiet Eye Duration)

Gaze data was collected using the same equipment as in study 1 (Chapter 2).

The QE duration was operationally defined as the final fixation toward the ball prior to the initiation of the backswing (Vickers, 2009). A fixation was defined as a gaze maintained on a location within 1° of visual angle for a minimum of 120 ms (Wilson, Vine, et al., 2009). QE onset occurred before the backswing and QE offset

eventuated when the gaze deviated off the fixated location by 1° or more, for greater than 120 ms. If the cursor disappeared for one or two frames (e.g., a blink) and then returned to the same location, the QE duration resumed. QE durations were calculated using Quiet Eye Solutions software (QE solutions Inc.).

3.2.2.9. Mental Effort

The Rating Scale of Mental Effort (RSME) (Zijlstra, 1993) is a unidimensional, valid and reliable measure of mental effort (Veltman & Gaillard, 1993) and was administered to assess the amount of mental effort participants invested in the task. Participants rated the effort they invested in the task using a scale from 0 mm (absolutely no effort) to 150 mm (most effort) (Zijlstra, 1993).

3.2.3. Procedure

After reading the information sheet, participants provided written consent to take part in the study. Demographic information (age, weight, height) was then taken and the first blood pressure measurement after which participants performed twenty practise putts to become familiarised with the nature of the golf putting task (club, putting distance, putting green etc.) A second blood pressure measurement was taken after the practise putts, following the fitting of the PhysioFlow and eye tracking equipment. Upon being seated, participants completed baseline self-report measures: PANAS and MRF-L and were asked to stay in a seated position. Following PhysioFlow calibration, five minutes of resting cardiovascular data were recorded. The participants were instructed to and then completed six baseline putts where performance and attention were measured. Upon completion, they rated the amount of mental effort they invested in the task using the RSME and were asked to return to a seated position. Participants then received transcription task instructions (convention or ego-depleted) and they then performed this task. Participants were

instructed to stop transcribing words after six minutes and, the SCS manipulation check and PANAS data were collected. Participants then received the golf putting task instructions (low or high pressure, counterbalanced) after which one minute of CV data and then DRES and MRF-L data were collected. Participants then performed six putts where performance and attention data were recorded. Following this, participants rated the amount of mental effort they invested using the RSME. Participants were asked to return to a seated position where the same procedure was followed for the second condition. Upon completion, participants were debriefed and thanked for their participation.

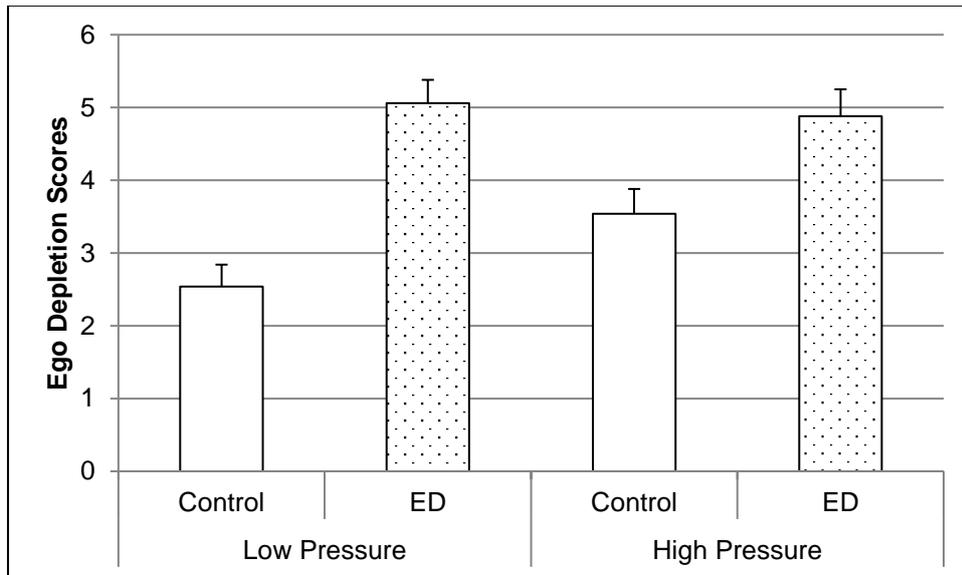
3.2.4. Statistical Analysis

Dependent *t*-tests were used to compare heart rate reactivity at baseline and post-pressure manipulations, and show that task engagement was present (Blascovich, 2008). Three, 2 (group: control, ED) x 2 (condition: low pressure, high pressure) mixed-model ANOVAs were conducted on the ED manipulation, DRES and CTI (CO, TPR) data. Seven, 2 (group: control, ED) x 2 (condition: low pressure, high pressure) mixed-model ANCOVAs were conducted on the pressure manipulation, self-confidence, affect (positive and negative), performance, attention and mental effort data, with baseline scores as covariates. Mediation analyses using the PROCESS SPSS custom dialog (Hayes, 2017), were conducted to establish if the effect of the CTI was mediated by any of the predicted process variables: attention, mental effort.

3.3. Results

3.3.1. ED Manipulation Check

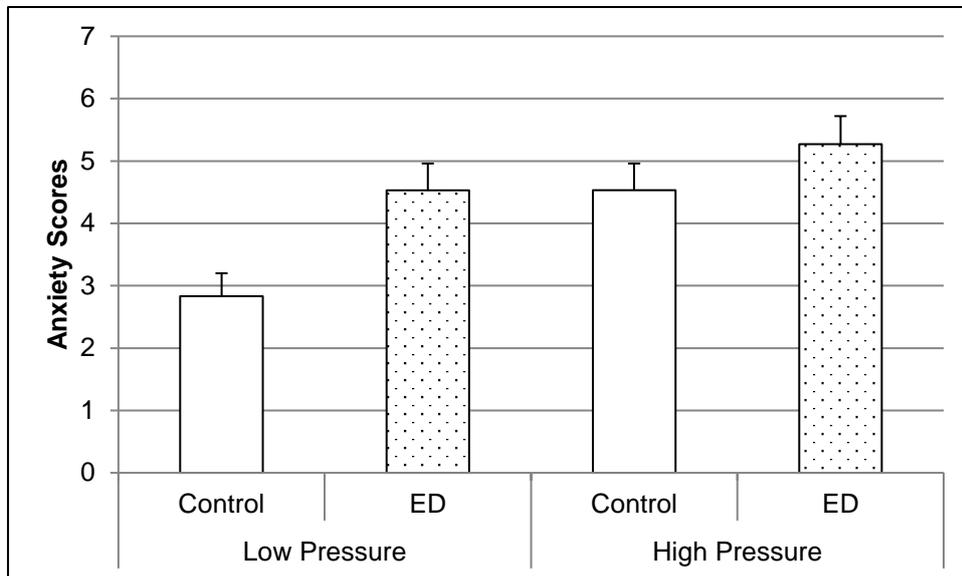
Figure 3.1. Means and standard errors of ego depletion values for control and ego depleted groups.



The ANOVA on the self-control strength data revealed no significant main effect for Condition, $F(1,33) = 3.75$, $p = .06$, $\eta_p^2 = .10$, but a significant main effect for Group, $F(1,33) = 20.78$, $p < .001$, $\eta_p^2 = .39$. A significant interaction between group and condition was also found, $F(1,33) = 8.02$, $p = .01$, $\eta_p^2 = .20$. Post hoc t -tests with a Bonferroni correction to the alpha revealed that groups were significantly different at low pressure, $t(33) = -5.74$, $p < .001$, $d = 1.99$ and at high pressure $t(33) = -2.65$, $p = .01$, $d = 0.92$ with the ego depleted group reporting higher depletion in both conditions indicating the success of the manipulation.

3.3.2. Pressure Manipulation Check

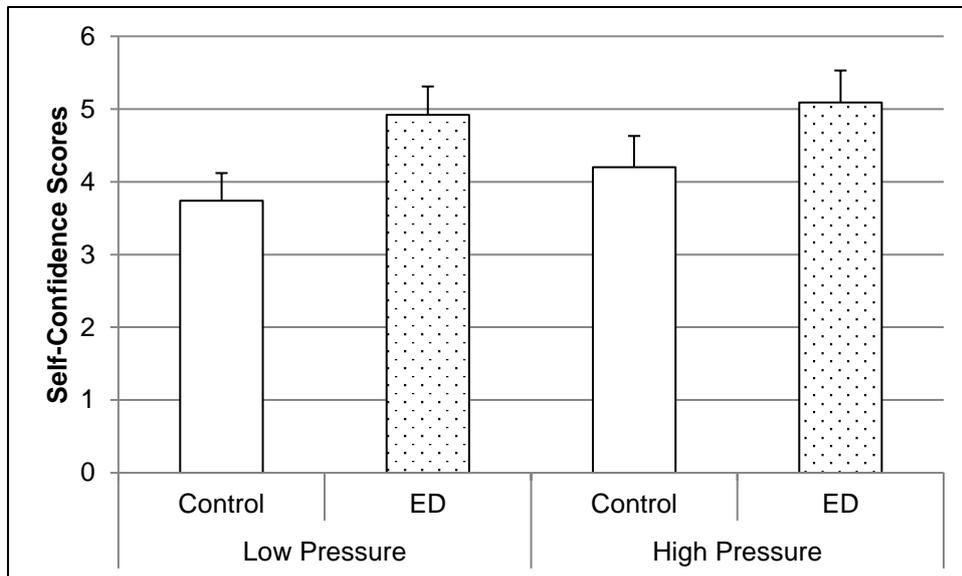
Figure 3.2. Adjusted means and standard errors of anxiety values for control and ego depleted groups.



After adjusting for scores at baseline, $F(1, 32) = 39.52, p < .001, \eta_p^2 = .55$, the ANCOVA on the anxiety data revealed a significant main effect for Condition $F(1, 32) = 5.85, p = .02, \eta_p^2 = .15$, with descriptive statistics indicating participants were more anxious in the high pressure condition. There was also a significant main effect for Group $F(1, 32) = 6.23, p = .02, \eta_p^2 = .16$ with descriptive statistics showing higher anxiety scores for the ego depleted group at both low and high pressure. However, there was no significant interaction for group and condition $F(1, 32) = 2.43, p = .13, \eta_p^2 = .07$.

3.3.3. Self-Confidence

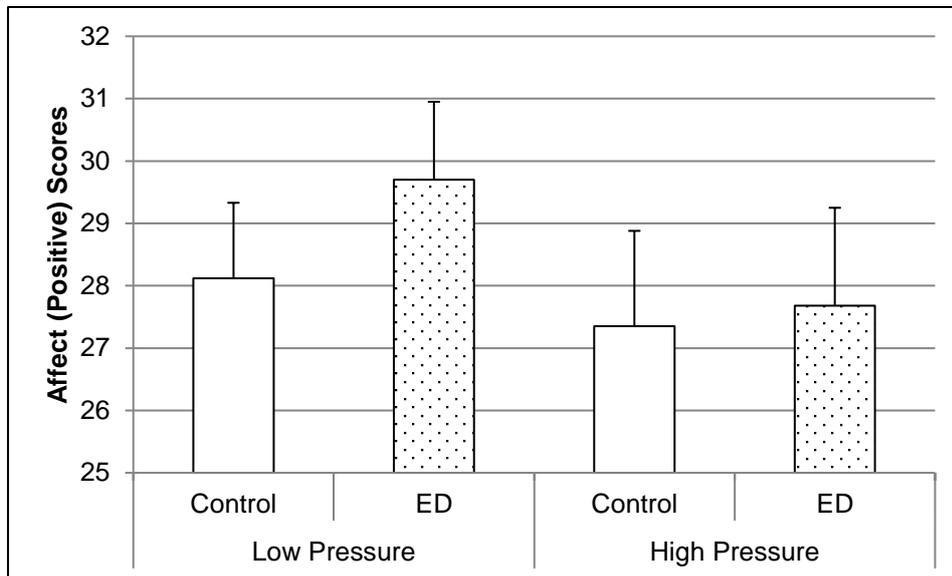
Figure 3.3. Adjusted means and standard errors of self-confidence values for control and ego depleted groups.



After adjusting for scores at baseline, $F(1, 32) = 26.7, p < .001, \eta_p^2 = .46$, the ANCOVA on the self-confidence data indicated no main effects for Condition $F(1, 32) = 1.57, p = .22, \eta_p^2 = .05$ and no main effects for Group on self-confidence $F(1, 32) = 3.94, p = .06, \eta_p^2 = .11$. A significant interaction between group and condition was not found, $F(1, 32) = 0.32, p = .57, \eta_p^2 = .01$.

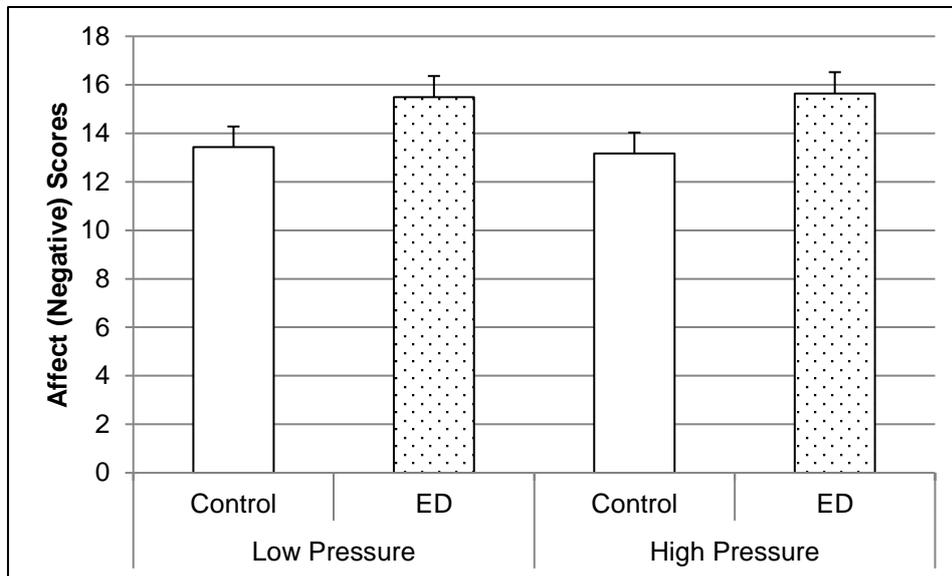
3.3.4. Affect Manipulation Check

Figure 3.4.1. Adjusted means and standard errors of positive affect values for control and ego depleted groups.



After adjusting for scores at baseline, $F(1, 32) = 17.62, p < .001, \eta_p^2 = .36$., the ANCOVA on the positive affect data revealed no main effects for Condition $F(1, 32) = 0.25, p = .62, \eta_p^2 = .01$, and no main effect for Group $F(1, 32) = 0.28, p = .60, \eta_p^2 = .01$. There was also no significant interaction between group and condition, $F(1, 32) = 0.65, p = .43, \eta_p^2 = .02$.

Figure 3.4.2. Adjusted means and standard errors of negative affect values for control and ego depleted groups.

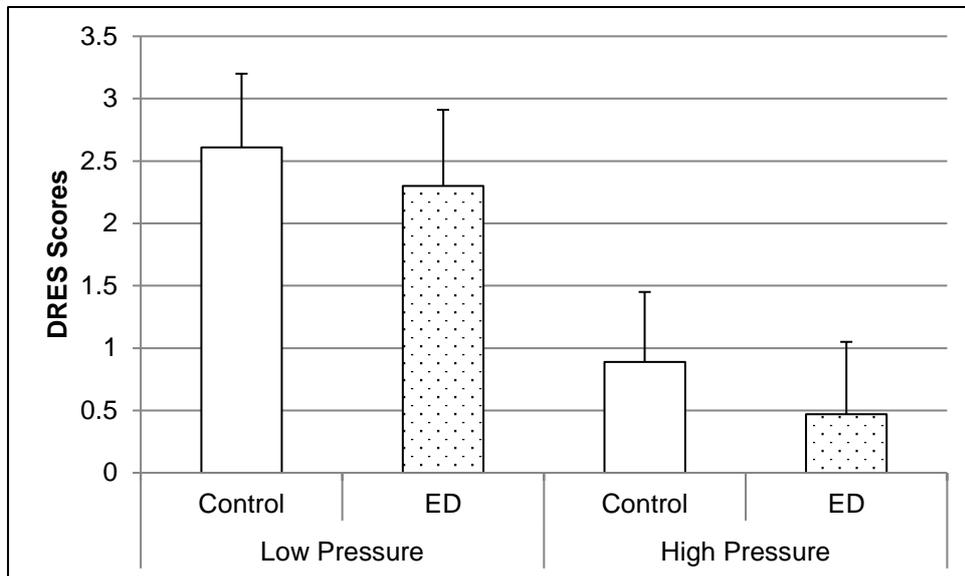


After adjusting for scores at baseline, $F(1, 32) = 37.00, p < .001, \eta_p^2 = .54$, the ANCOVA on the negative affect data revealed no main effects for Condition $F(1, 32) = 1.22, p = .28, \eta_p^2 = .04$, and no main effect for Group $F(1, 32) = 3.54, p = .07, \eta_p^2 = .10$. There was also no significant interaction between group and condition, $F(1, 32) = .42, p = .52, \eta_p^2 = .01$.

Overall therefore, there were no differences in affect across groups at low pressure and high pressure. This illustrates that positive affect could not have been a factor in overriding any possible effects of ego depletion (Tice, Baumeister, Shmueli, & Muraven, 2007).

3.3.5. DRES

Figure 3.5. Means and standard errors of DRES values for control and ego depleted groups.



The ANOVA on the DRES data revealed a significant main effect for Condition, $F(1,33) = 29.71, p < .001, \eta_p^2 = .47$ with both groups reporting a relatively lower challenge response in the high pressure condition than the low. There was no significant main effect for Group, $F(1,33) = 0.23, p = .63, \eta_p^2 = .01$. There was also no significant interaction between group and condition, $F(1,33) = 0.02, p = .88, \eta_p^2 = .00$.

3.3.6. Cardiovascular Measures (TE and CTI)

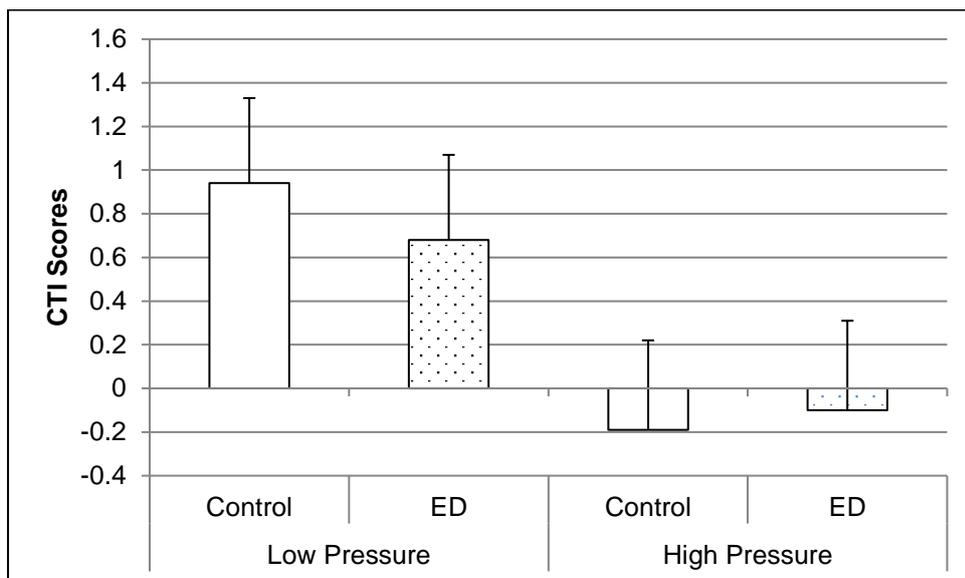
3.3.6.1. TE

The dependent t -test on HR data for the low pressure condition showed that HR significantly increased from the five minute resting period ($M = 3.64, SD = 6.89$), $t(34) = -3.13, p = .004, d = -0.75$ illustrating task engagement at this time point. For the high-pressure condition, the dependent t -test also illustrated task engagement via the significant increase in HR from resting ($M = 3.32, SD = 6.02$), $t(34) = -3.26, p$

= .003, $d = -0.78$. A dependent t -test on HR data for low and high pressure conditions indicated no significant differences, $t(34) = 0.36$, $p = .72$, $d = 0.05$.

3.3.6.2. CTI

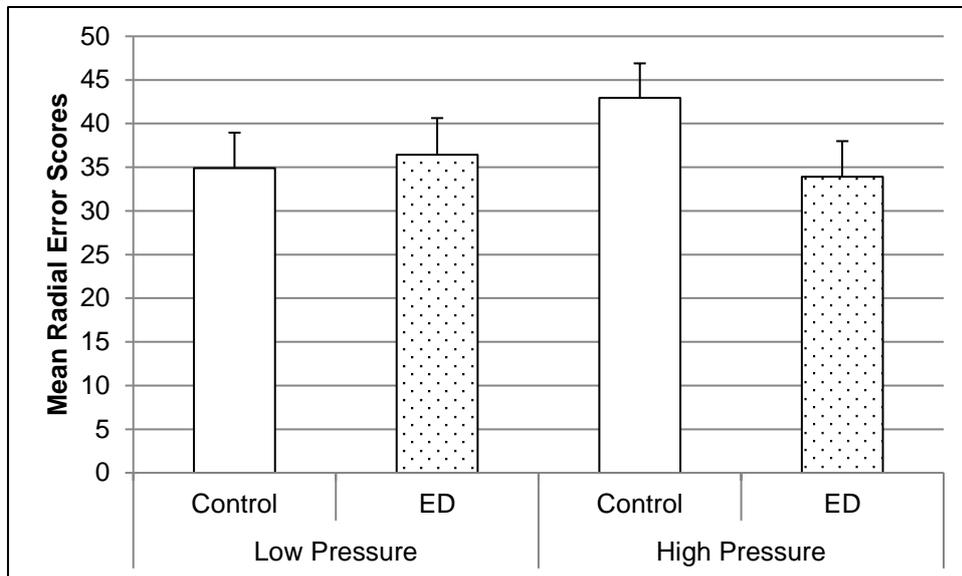
Figure 3.6. Means and standard errors of CTI values for control and ego depleted groups.



The ANOVA on the challenge and threat response data revealed a significant main effect for Condition, $F(1,32) = 6.28$, $p = .02$, $\eta_p^2 = .16$, with both groups displaying a relatively more threatened response in the high pressure condition. There was no significant main effect for Group, $F(1,32) = 0.04$, $p = .84$, $\eta_p^2 = .00$ and no significant interaction between group and condition, $F(1,32) = 0.22$, $p = .64$, $\eta_p^2 = .01$.

3.3.7. Performance

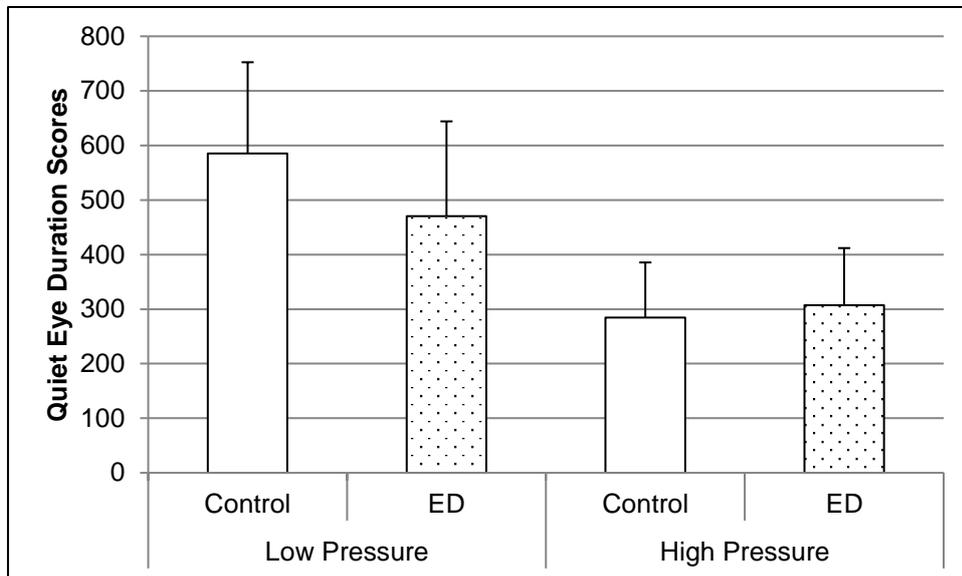
Figure 3.7. Adjusted means and standard errors of performance values for control and ego depleted groups.



After adjusting for scores at baseline, $F(1, 32) = 13.51, p = .001, \eta_p^2 = .30$, the ANCOVA on the performance data revealed no main effects for Condition $F(1, 32) = 1.22, p = .28, \eta_p^2 = .04$, and no main effect for Group $F(1, 32) = 0.65, p = .43, \eta_p^2 = .02$. There was also no significant interaction between group and condition, $F(1, 32) = 2.27, p = .14, \eta_p^2 = .07$.

3.3.8. Attention (QE)

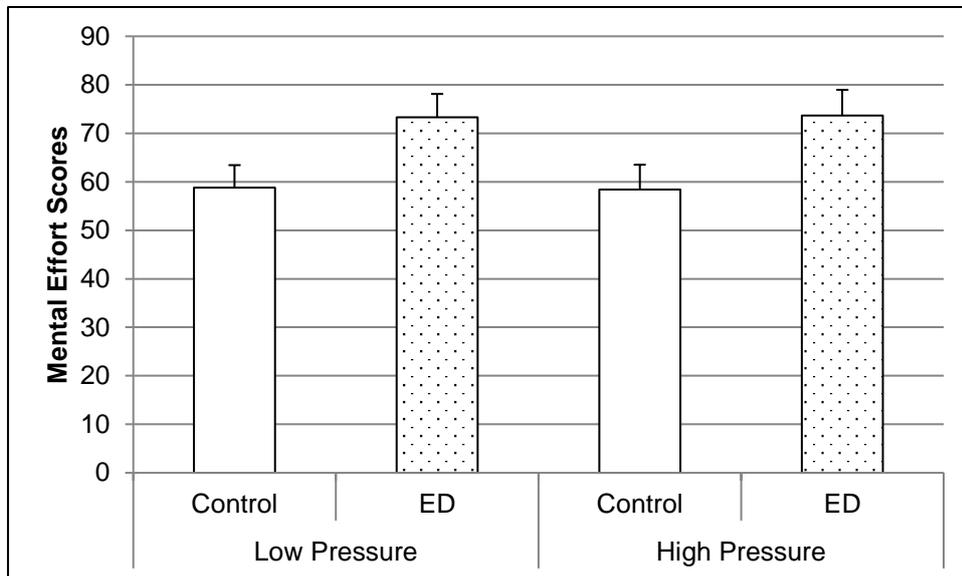
Figure 3.8. Adjusted means and standard errors of QE values for control and ego depleted groups.



QE data could not be collected in any of the conditions for four participants and for one participant in one condition due to calibration issues with the eye-tracking equipment. After adjusting for scores at baseline, $F(1, 24) = .11.71$, $p = .002$, $\eta_p^2 = .33$, the ANCOVA on the QE data revealed no main effects for Condition $F(1, 24) = 0.26$, $p = .61$, $\eta_p^2 = .01$, and no main effect for Group $F(1, 24) = 0.16$, $p = .74$, $\eta_p^2 = .01$. There was also no significant interaction between group and condition, $F(1, 24) = 0.22$, $p = .64$, $\eta_p^2 = .01$.

3.3.9. Mental Effort

Figure 3.9. Adjusted means and standard errors of mental effort values for control and ego depleted groups.



After adjusting for scores at baseline, $F(1, 32) = 15.28, p < .001, \eta_p^2 = .32$, the ANCOVA on the QE data revealed no main effects for Condition $F(1, 32) = 2.46, p = .13, \eta_p^2 = .07$. There was a main effect for Group $F(1, 32) = 4.87, p = .04, \eta_p^2 = .13$, with descriptive statistics illustrating the ego depleted group invested more mental effort at both low and high pressure. There was no significant interaction between group and condition, $F(1, 32) = 0.03, p = .86, \eta_p^2 = .00$.

3.3.10 Mediation Analysis

To test if the effect of group on performance was indirectly affected by attention and mental effort for each pressure condition, experimental group was entered as the independent variable, mean radial error was entered as the dependent variable and attention and mental effort were entered as mediators at each stage. Based on a 10,000 sampling rate, the results from bootstrapping at low pressure revealed no significant indirect effects for either attention, 95% CI = -2.67 to

5.93, or mental effort, 95% CI = -1.29 to 7.43. There were also no significant indirect effects for attention, 95% CI = -2.12 to 4.08, or mental effort, 95% CI = -7.15 to 1.18, at high pressure.

3.4. Discussion

Self-control strength was predicted to be a determinant of challenge and threat responses in low and high pressure conditions. The findings indicate that there was no effect of group (control or ED) on either self-report or cardiovascular indices indicative of challenge and threat responses. Furthermore, there was no effect of group on self-confidence, performance or attention, though there was an effect on mental effort. Neither attention nor mental effort mediated the group and performance relationship. There was however, an expected effect of condition on challenge and threat responses with both groups displaying a relatively higher threat response in the high pressure condition.

Though the data suggests that self-control is not a determinant of challenge and threat responses, several important points must be considered when interpreting the findings and therefore, in appreciating the theoretical and practical implications. For instance, participants' perceptions of self-control strength might have been a key factor in whether they indicated a challenge or threat response. Job and colleagues (2010) illustrated that individuals' beliefs about self-control strength influences ego depletion. Specifically, they experimentally manipulated beliefs about self-control and observed ego depletion effects only in those individuals who thought of self-control as a finite resource (Job, Dweck, & Walton, 2010). Indeed, believing that self-control is vulnerable to depletion could lead to skewed demand-resource evaluations

whereby participants feel they are unable to efficiently regulate their attention, emotions and so on thus resulting in a threat response.

A key point here is that self-control beliefs may be a component of self-efficacy beliefs since perceived self-efficacy entails perceptions on regulating cognitive, motivational and affective processes in the face of demands (Bandura, 1994). In fact, some authors propose self-regulation as an outcome of self-efficacy levels (Pajares, 1996). Self-efficacy instruments are characterised by asking individuals to rate their confidence towards accomplishing a task (Pajares, 1996) and the terms 'self-efficacy' and 'state self-confidence' have been used interchangeably (Stajkovic & Luthans, 1979). However, there were no effects of group or condition on self-confidence in this study. Still, methodological issues may have affected findings related to self-efficacy since the data were only correlational. Indeed, Pajares (1996) has suggested that the use of experimental techniques is called for to better understand how self-efficacy influences outcome variables. Though the author made this claim regarding outcomes in academic settings, experimentally manipulating self-efficacy to observe its influence on challenge and threat responses in sport settings would provide evidence for its predictive role. It would certainly lend evidence to the TCTSA's hypothesis that self-efficacy is a determinant of challenge and threat responses in competitive contexts (Jones et al., 2009).

On the other hand, it is possible that ego depleted participants reserved resources on the first task knowing they would be asked to engage in a second task with which they were unfamiliar. This would certainly explain why the ego depleted group invested more mental effort into performance compared to the control group for both low and high pressure conditions. Indeed, authors have suggested that ego depleted individuals are able to self-regulate in anticipation of an upcoming situation

which requires self-control once they are motivated to do so (Baumeister, 2014). In this case, it may be that individuals have to be depleted to a certain degree before the negative effects of depletion influence cognitive and other processes. The degree of depletion likely differs across situations and individuals as well as the quantity and quality of motivation experienced. This ties in to alternative accounts of self-control which propose that self-control strength is not, in fact, a finite resource prone to depletion but represents a shift in priorities and motivations (Inzlicht et al., 2016).

The shifting priorities model (Inzlicht & Schmeichel, 2012) for example, proposes that ego depletion triggers a shift in motivations whereby individuals display reduced attention to 'have-to' tasks and increased attention to 'want to' tasks. Provided this account of ego depletion best explains its negative effects, then individuals would theoretically experience task disengagement or at least reduced task engagement in those tasks they feel compelled to engage in such as in the high pressure condition. Interestingly, the findings indicated significant task engagement for participants, with large effect sizes at both low and high pressure. However, in order to better understand just how differences and changes in motivational influence outcome, future research should assess the impact of motivational regulations on challenge and threat responses (see Chapter 5).

Of further theoretical importance is that the results indicate that the transcription task was successful in manipulating self-control strength in this study. Some research has indicated that the ego depletion effect can be cancelled by habituation to a task (Converse & DeShon, 2009). In spite of executing the transcription task twice, participants in the ego depleted group were required to exclude different letters in each task which proved effective enough in averting

possible habituation. This finding is of note for replication studies and future experimental research on self-control strength.

Also of empirical importance, is the finding that there was an effect of condition on challenge and threat responses with participants as a whole displaying a threat response under the high pressure condition as compared with a challenge response under the low pressure condition. The findings therefore support previous research which has indicated the influence of pressure on challenge and threat (e.g. Moore et al., 2015). Pressure is defined as "...any combination of factors that increases the importance of performing well on a particular occasion" (Baumeister, 1984, p. 610). Theoretically, experiences of pressure would differ on an individual basis since perceptions and beliefs about these factors are likely to vary person-to-person. However, the findings indicate that high situational demands generally increase pressure and further, influence challenge and threat responses regardless of self-control strength.

There were no effects of group on performance suggesting that self-control strength did not influence motor task performance. However, descriptive statistics indicated that while the control group outperformed the ego depleted group at low pressure, the ego depleted group outperformed the control group at high pressure. Authors have recently suggested that ego depletion may be beneficial to certain types of performance. DeCaro and Van Stockum Jr. (2017) found that participants in an ego depleted condition performed better on an insight problem-solving task compared with those in a non-depleting control condition. The authors suggested that ego depletion is beneficial to performance when engaging in executive control on a task can limit successful outcomes (DeCaro & Van Stockum Jr, 2017). For instance, pressure induces explicit monitoring of the execution of procedural tasks

such as golf putting which can be detrimental to performance (DeCaro, Thomas, Albert, & Beilock, 2011). A reduced capacity for explicitly monitoring the steps involved in golf putting may therefore facilitate performance under pressurised conditions indicating how ego depletion may facilitate performance in such circumstances. Nevertheless, this theory contradicts past research which demonstrated that ego depleted participants performed worse on other perceptual-motor tasks such as basketball free-throws and dart-throws compared to control participants (Englert & Bertrams, 2012).

Although the ego depletion manipulation was successful, this did not translate into differences in challenge and threat responses between groups. While a challenge response has been associated with better golf putting performance, as compared with a threat response (Moore, Vine, Wilson, et al., 2012; Moore et al., 2015), it is possible that the relationship may be limited to particular circumstances. For example, the relationship may stand when participants are manipulated into challenge and threat groups (e.g. Moore, Vine, Wilson, et al., 2012) or when they are required to perform only one set of competitive putts (e.g. Moore et al., 2015). In the current study, participants were required to perform putts across three conditions with two sets of putts following a transcription task. It is possible that participants experienced fatigue or boredom across conditions thereby reducing the motivation to perform to a high standard (Inzlicht et al., 2016). Higher rewards for peak performance or more severe punishments for under-performance may have resulted in performance differences.

There was no direct effect of group on attention; this variable was examined to ascertain whether it mediated the challenge/threat and performance relationship. Ego depletion was predicted to negatively affect attention via a reduced ability to

regulate attention in high pressure conditions. This effect was likely not observed as self-control may not be a finite resource as previously thought. Alternatively, it may be that ineffectiveness of attentional regulation due to depleted self-control is only evident under conditions of extreme depletion. As previously mentioned, the study procedure was relatively long with participants asked to perform three putting tasks and two transcription tasks. Along with the fitting and calibration of equipment as well as being asked to answer a number of questionnaires, it is possible that alertness on the putting task was not maintained due to under-arousal during task performance (Mackworth, 1969).

Interestingly, there was an effect of group on mental effort with the ego depleted group investing more mental effort at both high and low pressure as compared to the control group. This supports alternative accounts of self-control strength which suggest that it is not, in fact, a finite resource. In other words, though the ego depletion manipulation was successful, the ego depleted group were still capable of investing more mental effort into their performance, regardless of condition, compared with the control group. This however, did not translate to significant performance differences between groups for either condition.

Though alternative accounts of self-control are not necessarily at odds with this study's hypothesised relationships between self-control and outcome variables such as mental effort and challenge and threat responses, they highlight an important methodological issue. Self-control may have simply not been depleted or perhaps not depleted enough to ascertain effects on dependent variables. Furthermore, it may be that being depleted in one domain, (e.g.) for a cognitive task, has no influence on self-control in another domain, (e.g.) for a behavioural task, as suggested by the strength model (Baumeister et al., 1998). While some

neuroscience research has shown that ego depletion decreases brain activity in regions associated with cognitive control (Inzlicht & Gutsell, 2007; Wang & Yang, 2014), others have indicated that this is not the case and have shown increases in activity in regions related to motivation and rewards (Wagner, Altman, Boswell, Kelley, & Heatherton, 2013). These inconsistencies in findings suggest future research still needs to discern what brain regions are involved in ego depletion and whether these differ by not only situation but individual as well. Perhaps such functional neuroimaging research will aid in clearing up the abovementioned conceptual issues on self-control.

Authors have illustrated that positive affect may override the effects of ego-depletion (Tice et al., 2007). However, the findings show that there were no differences in positive or negative affect between groups in any of the conditions. Though this measure was only used as a manipulation check, mood may well be a variable of interest in future challenge and threat research. The TCTSA (Jones et al., 2009) highlights that challenge and threat responses are associated with differential emotions and certainly differential interpretations of these emotions. For example, challenge responses are associated with more positive emotions and more facilitative interpretations of emotions as compared with threat responses (Jones et al., 2009). Emotions and moods are considered related but distinct phenomena though researchers acknowledge these differences may be semantic only (Beedie, Terry, & Lane, 2005). Still, conceptual clarity on how moods, as opposed to emotions, influence and are influenced by challenge and threat responses would be of interest in academic research to not only enhance models of stress and coping such as the BPSM but to inform possible interventions. For instance, mood is not necessarily related to cognitive processes, such as demand-resource evaluations, in

the way emotions are proposed to be (Neumann & Strack, 2000) and may therefore act as a determinant of challenge and threat. This is highlighted in the concept of 'mood contagion' whereby there may be automatic transfer of moods between individuals on a completely subconscious level (Neumann & Strack, 2000). This would be of particular note in group scenarios such as team sports whereby congruent moods may be activated in observers who unintentionally imitate another person's behaviour (Neumann & Strack, 2000). Mood states may therefore be unconsciously considered within the demand-resource evaluative calculus in motivated performance situations.

Chapter 3 demonstrated that self-control was not a determinant of challenge and threat responses in this competitive setting. It further indicated that ego depletion does not appear to lead to differences in self-confidence, motor task performance, attention as compared to a control group but it does lead to differences in mental effort. Since performance effects were not observed in Chapter 2 (study 1), mental effort was examined as a proposed mediator of the challenge/threat response and performance relationship in low and high pressure conditions though no indirect effects were observed for either attention or mental effort. This suggests that other mediating variables may be more salient in the challenge/threat response and motor task performance relationship in laboratory settings. However, attention and mental effort should not be discounted as possible mediating variables since extraneous variables specific to this study may have influenced their impact.

One emerging construct of interest from this study, which is already prominent in the challenge and threat literature (e.g. Jones et al., 2009), is self-efficacy. Self-efficacy concerns an individual's beliefs in their ability to carry out the behaviours necessary for realising task accomplishments (Bandura, 1977). According to social

cognitive theory (Bandura, 1986), perceived self-efficacy works in tandem with self-regulation (Pajares & Graham, 1999). In academic settings at least, instruction in self-regulatory strategies was shown to increase self-efficacy (Pajares, 2003) underlining the association between the two.

According to Bandura (1986), individuals make efficacy judgments in response to task demands in meaningful contexts. Challenge and threat responses occur in motivated performance situations where individuals experience task engagement to the extent that it is self-relevant (Seery, 2013). Self-efficacy is proposed to facilitate or debilitate performance via its impact on cognitive intervening processes (Bandura, 1989) one of which may be challenge and threat responses. Jones et al. (2009), suggested that self-efficacy beliefs are one determinant of challenge and threat responses in the TCTSA. They proposed that an athlete's perceptions of their ability to cope with situational demands and execute strategies necessary for success, influences their demand-resource evaluations (Jones et al., 2009).

Furthermore, perceiving a lack of efficacy or self-inefficacy is associated with physiological arousal as well as anxiety (Bandura, 1986). As demonstrated in Chapters 2 (study 1) and 3 (study 2), perceptions of arousal and heightened anxiety are both associated with challenge and threat responses. Study 1 (Chapter 2) in this thesis indicated that challenge responses, following an arousal reappraisal intervention, were associated with higher state self-confidence, a term used interchangeably with self-efficacy (Stajkovic & Luthans, 1979). Cognitive reappraisal, an emotion regulation strategy, has also been shown to foster self-efficacy beliefs in stress situations (Denson, Creswell, Terides, & Blundell, 2014). Study 2 (Chapter 3) however, did not show a statistically significant relationship between challenge

responses and self-confidence. Even though participants were relatively more challenged in the low pressure condition, they were no more self-confident than in the high pressure condition in which they were relatively more threatened. Importantly, the inconsistencies in this data, taken with existing theory and research described in the following Chapter (4; study 3) provided a foundation from which to experimentally investigate self-efficacy as a determinant of challenge and threat responses.

Chapter 4 (Study 3): The impact of self-efficacy on challenge and threat responses

Being prepared for submission as: Sammy, N., Wilson, M. R., & Vine, S. J.

The impact of self-efficacy on challenge and threat responses.

4.1. Introduction

Self-efficacy is an important motivational construct in task execution and goal attainment (Bandura, 1982, 1986, 1997). It refers to “beliefs in one’s capabilities to [organise] and execute the courses of action required to produce given levels of attainments” (Bandura, 1998, p. 624). In other words, when considered in the context of a motivated performance situation, self-efficacy is concerned with beliefs about the behavioural processes involved in task execution and goal attainment. It is considered a central component in energising behaviour since an individual’s belief in their power to produce desired outcomes is vital to their motivation to act (Bandura & Locke, 2003).

Self-efficacy has been implicated in two key theories of stress, appraisal and coping referenced in this thesis: Lazarus and Folkman’s (1984b) transactional theory and Jones et al.’s (2009) TCTSA. According to the transactional theory (Lazarus & Folkman, 1984b) secondary appraisal involves evaluating one’s ability to cope with situational demands therefore integrating self-efficacy beliefs in the cognitive evaluative process (Schönfeld, Preusser, & Margraf, 2017). The TCTSA proposes that self-efficacy is one of three determinants of challenge and threat responses in competitive situations, with the others being perceptions of control and achievement goals (Jones et al., 2009). Crucially, self-efficacy is proposed to influence challenge and threat primarily via resource evaluations (Jones et al., 2009). Therefore, an

athlete's belief that they have the skills necessary to execute the courses of action required to succeed, contributes to a perception that they can cope with the demands of the situation, resulting in better subsequent outcomes such as a challenge response (Jones et al., 2009).

Despite the predictions of the TCTSA, studies have found that self-efficacy has weak and inconsistent relationships with challenge and threat responses (Meijen et al., 2013; Meijen et al., 2014; Turner et al., 2012). Furthermore, some of these studies have used only self-report measures of challenge and threat responses (e.g. Meijen et al., 2013) while others have used cardiovascular reactivity measures associated with challenge and threat responses (e.g. Meijen et al., 2014) for analysing relationships with self-efficacy. In a cross-sectional study, Meijen and colleagues (2013) found that self-reported challenge and threat responses were not predicted by self-efficacy. However, a negative relationship between self-efficacy and threat responses was marginally significant ($\beta = -0.15$, $p = 0.06$) indicating scope for future research to clarify this finding.

Research examining self-efficacy beliefs and physiological indices associated with challenge and threat responses has painted a different picture to the aforementioned findings. Meijen and colleagues (2014) demonstrated that high self-efficacy was associated with cardiovascular reactivity indicative of threat responses. Forty-eight collegiate athletes participated in a counterbalanced, repeated-measures design. In one condition (sport task), participants were required to talk for three minutes about thoughts, feelings and expectations prior to an important upcoming competition in their primary sport, while in the other condition they were required to talk about friendship for this same length of time (control task). Contrary to the TCTSA's predictions (Jones et al., 2009), it was found that participants exhibiting a

threat response reported higher self-efficacy than those exhibiting a challenge response in the sport task (Meijen et al., 2014). The authors suggested that participants with high self-efficacy may have found the task more threatening as failure would have indicated under-performance (Meijen et al., 2014). Importantly, their findings indicated a positive association between coping perceptions and self-efficacy thereby supporting the TCTSA's (Jones et al., 2009) notion that self-efficacy enhances perceived ability to cope with demands (Meijen et al., 2013). Finally, the authors expressed that assessing self-reported challenge and threat responses and self-efficacy would provide a more comprehensive overview of this relationship (Meijen et al., 2014). Indeed, examining the effects of self-efficacy on both subjective and objective measures of challenge and threat responses in one study would facilitate this.

A change in methodological approach to examining the aforementioned relationship would also facilitate the clarification of the relationships between self-efficacy and challenge and threat responses. To date, self-efficacy has not been experimentally manipulated in a sporting context to unpick some of the inconsistencies in the literature regarding how it influences challenge and threat responses and subsequent outcomes such as performance. Correlational research allows us to make predictions but not determine causation (Pearl, 2009) which is vital in establishing causality between determinants such as self-efficacy and challenge and threat responses.

Previous research has indicated that self-efficacy may be successfully manipulated with resultant changes to cardiovascular reactivity (Gerin, Litt, Deich, & Pickering, 1996). Forty female students were randomly assigned to either a low or high self-efficacy condition. The participants completed a questionnaire which

evaluated a set of abilities proposed to be relevant to the upcoming task. The experimenters then provided false positive or negative feedback dependent on condition which informed participants that they were liable to do well or poorly on the upcoming task based on their responses. Though heart rate differences were not observed, participants in the high self-efficacy condition had significantly higher blood pressure increases than subjects in the low self-efficacy condition. Furthermore, participants in the high self-efficacy condition performed significantly better than those in the low self-efficacy condition (Gerin et al., 1996). This research is important in demonstrating that self-efficacy may be successfully manipulated through false feedback in laboratory settings with consequential effects on physiological functioning as well as performance.

To replicate previous motor task performance (Moore, Vine, Wilson, et al., 2012; Moore et al., 2015) and attention findings (Moore, Vine, Wilson, et al., 2012; Vine et al., 2013) for challenge and threat responses, both performance and attention were measured. Attention and mental effort were again assessed as possible mediators of the challenge/threat response and performance relationship.

4.1.1. Aims and Hypotheses

With the intention of better understanding what pre-empted challenge and threat responses, the aim was to experimentally examine self-efficacy as a determinant of challenge and threat responses. It was hypothesised that there would be no differences in perceptions of demands between the low and high self-efficacy groups. It was also hypothesised that individuals in the high self-efficacy condition would not only report higher resources and a challenge response but would exhibit cardiovascular reactivity representative of a challenge response as compared to the low self-efficacy group. The high self-efficacy group was also predicted to outperform

and indicate more effective attentional control than the low self-efficacy group in a motor task. Further, attention and mental effort were predicted to mediate the challenge/threat response and performance relationship.

4.2. Methods

4.2.1. Participants

Thirty university students (Male = 18, Female = 12; mean age, 22 ± 2) who did not take part in study 1 or 2, were recruited by flyers, email and word-of-mouth to participate in this study. The sample size was calculated using G*Power 3.1 software, setting power ($1-\beta$ err prob.) at .8, alpha (α err prob.) at $p = .05$, and using the effect size ($f(U) = 0.5$) from Blascovich et al., (2001). All participants were exposed to a baseline and self-efficacy manipulation condition (either low or high) in that order. As in studies 1 and 2 (Chapters 2 and 3), a between-subject design was utilised to avoid possible carry-over or residual effects (Cox & Reid, 2000). All participants were novice golfers as they had no official golf handicap or official putting training (Moore, Vine, Wilson, et al., 2012). In addition, all participants were non-smokers and had not performed vigorous exercise or ingested alcohol 24 hours before testing. The study was approved by the university ethics committee, and written informed consent was obtained from each participant prior to the start of the procedure.

4.2.2. Measures

4.2.2.1. Self-Efficacy (SE)

Prior to performance, participants rated their self-efficacy for each of six putts for a golf-putting task in each condition (baseline and post-manipulation). Following recommendations from Bandura (2006), task self-efficacy was measured by asking

participants to rate their degree of confidence in their ability to perform a putt at three different levels (successful putt, putting to zone 1, putting to zone 2) using a scale from 0 (cannot do at all) to 100 (highly certain can do). Zones were concentric circles around the hole spaced 25 cm apart from each other and based on pilot testing of novice golfers. Averages were then calculated from these scores to provide a singular self-efficacy score for each participant for each condition (baseline and post-manipulation).

4.2.2.1.1. Condition manipulations

Following the baseline condition, verbal instructions (adapted from Gerin et al., 1996; McAuley, Talbot, & Martinez, 1999), were used to manipulate self-efficacy resulting in two groups, high self-efficacy and low self-efficacy.

4.2.2.1.1.1. Low Self-Efficacy Manipulation

“Unfortunately your performance on the last 6 putts has placed you in the bottom 20th percentile for novices performing this task based on norms constructed for skill level and experience. This first performance is a good indicator of future performance.”

4.2.2.1.1.2. High Self-Efficacy Manipulation

“Congratulations! Your performance on the last 6 putts has placed you in the top 20th percentile for novices performing this task based on norms constructed for skill level and experience. This first performance is a good indicator of future performance.”

4.2.2.2. Demand and Resource Evaluations (DRES)

DRES data was collected using the same measures and procedure as in study 1 (Chapter 2) and study 2 (Chapter 3).

4.2.2.3. Cardiovascular Responses (Task Engagement (TE) and Challenge and Threat Index (CTI))

Task engagement and CTI were determined following the same procedures as in study 1 (Chapter 2) and study 2 (Chapter 3).

4.2.2.4. Performance (Mean Radial Error)

Performance data was collected using the same equipment and procedures as in study 2 (Chapter 3).

4.2.2.5. Attention (Quiet Eye Duration)

Gaze data was collected using the same equipment as in study 1 (Chapter 2) and study 2 (Chapter 3).

4.2.2.6. Mental Effort

Mental effort data was collected using the same measures and procedures as in study 2 (Chapter 3).

4.2.3. Procedure

Participants were randomly assigned to either a low self-efficacy ($n = 15$) or high self-efficacy ($n = 15$) group prior to entering the laboratory using an online research randomiser tool (<https://www.randomizer.org>). After the participant read the information sheet and consented to participate in the study, demographic information was taken (age, weight, height) as well as an initial blood pressure measurement. The participant then performed twenty practise putts in order to become familiarised with the nature of the golf putting task (club, putting distance, putting green etc.) Participants were then instrumented to the non-invasive cardiovascular and eye tracker devices after which, another blood pressure measurement was recorded. Following this, cardiovascular data were measured in one minute intervals during a

five minute seated, resting period. Participants were then informed that they were required to perform six golf putts to the best of their ability for a baseline assessment of performance (baseline condition). One minute of cardiovascular data and then self-report measurements (self-efficacy, demands and resources) were recorded. Following performance of the first set of putts in which gaze and performance were recorded, participants rated the amount of mental effort they invested in the task using the RSME and returned to a seated position. They then received the self-efficacy manipulation (low or high) after which another minute of cardiovascular and subsequently self-report data (self-efficacy, demands and resources) were recorded. Following performance of the next six putts and the mental effort rating, the equipment was removed, and participants were thanked and debriefed about the study.

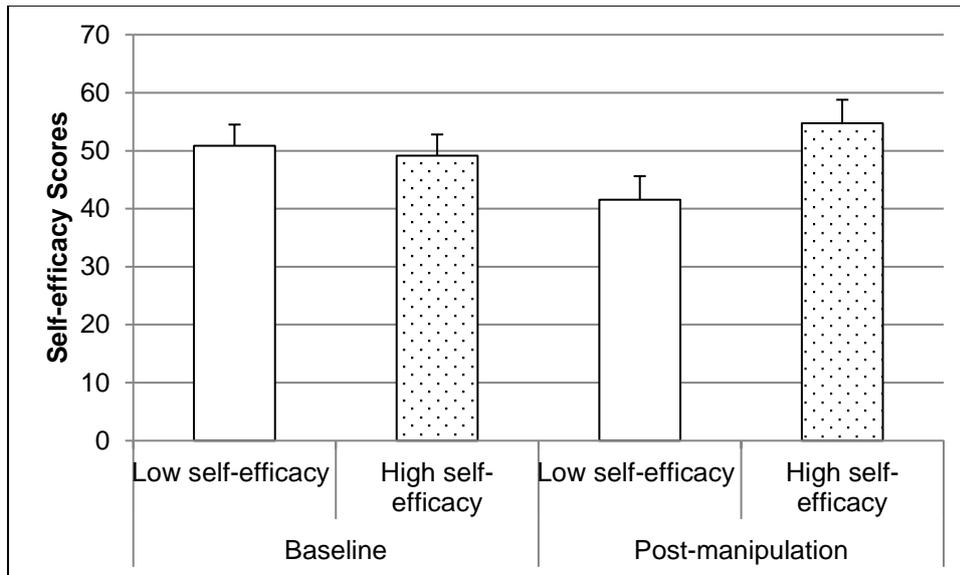
4.2.4. Statistical Analysis

Dependent *t*-tests were used to compare HR reactivity between resting and baseline, and resting and post-manipulation conditions to check for task engagement (Blascovich, 2013). Eight, 2 (time: baseline, post-manipulation) x 2 (group: low, high) ANOVAS were conducted on the following data: self-efficacy, demands, resources, DRES, CTI, performance, attention and mental effort. If there was a significant 'time x group' interaction, post hoc *t*-tests with a Bonferroni correction to the alpha were conducted. Finally, to determine the indirect effect of attention and mental effort on the challenge/threat response and performance relationship in both conditions, mediation analyses were performed using the MEDIANTE SPSS custom dialog developed by (Hayes et al., 2011).

4.3. Results

4.3.1. SE Manipulation Check

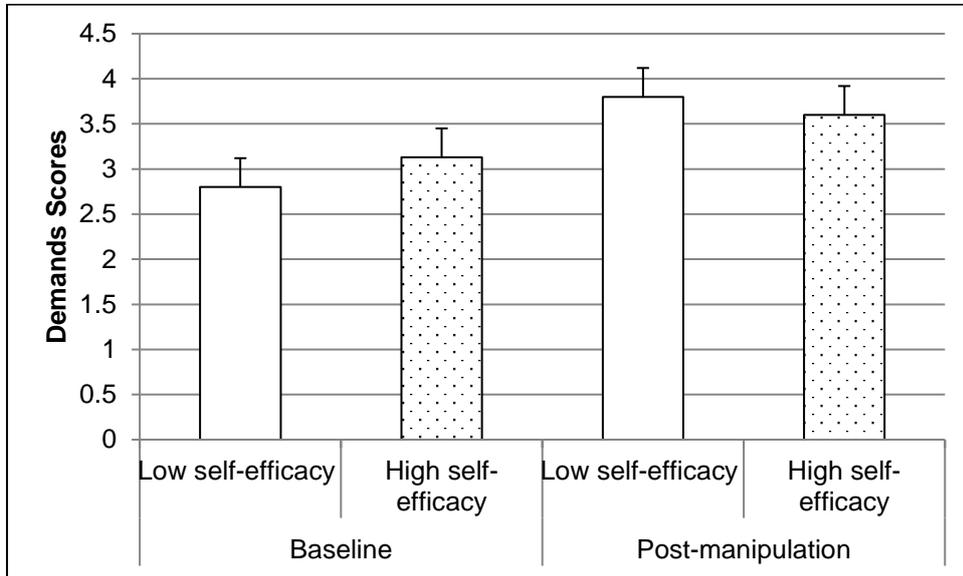
Figure 4.1. Means and standard errors of self-efficacy values for low and high self-efficacy groups.



The ANOVA on the self-efficacy data revealed no significant main effect for Time, $F(1,28) = 1.01$, $p = .32$, $\eta_p^2 = .04$, and no significant main effect for Group, $F(1,28) = 1.91$, $p = .18$, $\eta_p^2 = .06$. However, a significant interaction between group and time was found, $F(1,28) = 17.36$, $p < .001$, $\eta_p^2 = .38$. Post hoc t -tests with a Bonferroni correction to the alpha revealed that at baseline there was no significant difference between the low and high self-efficacy groups, $t(28) = 0.48$, $p = .64$, $d = 0.18$. However, there was a significant difference between groups following the manipulation, $t(28) = -2.6$, $p = .01$, $d = 0.95$, with the high self-efficacy group reporting higher self-efficacy than the low, indicating the success of the manipulation.

4.3.2. Demand Evaluations

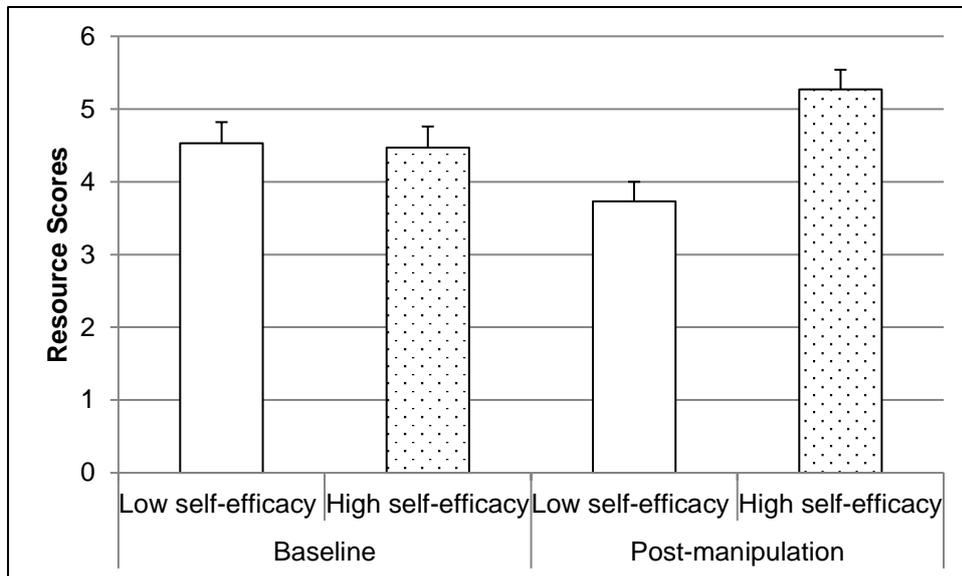
Figure 4.2. Means and standard errors of demand values for low and high self-efficacy groups.



The ANOVA on the demands data revealed a significant main effect for Time, $F(1,28) = 17.55$, $p < .001$, $\eta_p^2 = .39$, with both groups reporting higher demands post-manipulation. There was no significant main effect for Group, $F(1,28) = .03$, $p = .87$, $\eta_p^2 = .00$, and no significant interaction between group and time, $F(1,28) = 2.32$, $p = .14$, $\eta_p^2 = .08$, meaning there were no differences in perceptions of demands among groups.

4.3.3. Resource Evaluations

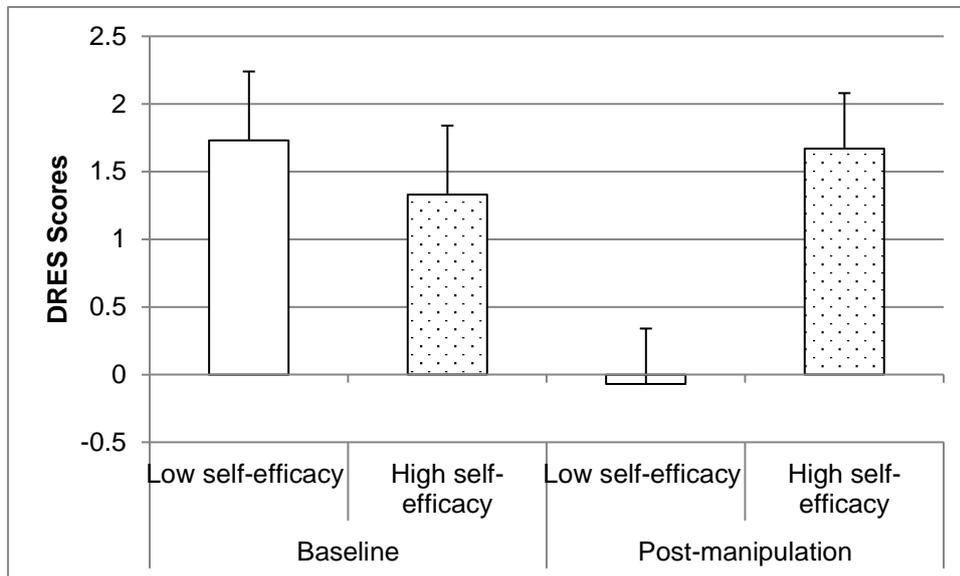
Figure 4.3. Means and standard errors of resource values for low and high self-efficacy groups.



The ANOVA on the resources data revealed no significant main effect for Time, $F(1,28) = .00$, $p = 1.00$, $\eta_p^2 = .00$, but a significant main effect for Group, $F(1,28) = 6.47$, $p = .02$, $\eta_p^2 = .19$. There was also a significant interaction between group and time, $F(1,28) = 8.30$, $p = .01$, $\eta_p^2 = .23$. Post hoc t -tests with a Bonferroni correction to the alpha revealed that at baseline there was no significant difference between the low and high self-efficacy groups, $t(28) = 0.16$, $p = .87$, $d = 0.05$. However, there was a significant difference between these groups following the manipulation, $t(28) = -3.94$, $p < .001$, $d = -1.43$, with the low self-efficacy group reporting lower resources than the high self-efficacy group.

4.3.4. DRES

Figure 4.4. Means and standard errors of DRES values for low and high self-efficacy groups.



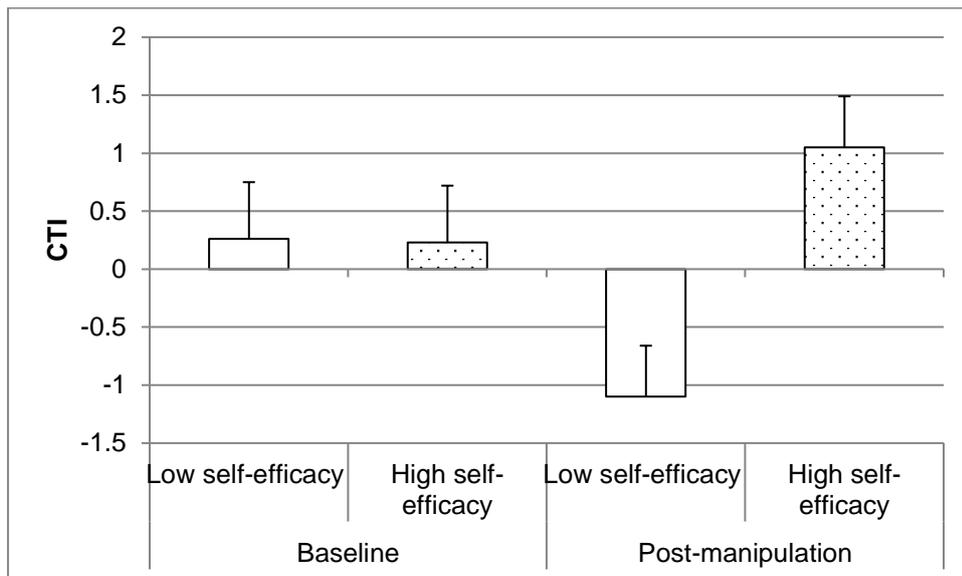
The ANOVA on the DRES data did not reveal a significant main effect for Time, $F(1,28) = 4.27$, $p = .05$, $\eta_p^2 = .13$, and no significant main effect for Group, $F(1,28) = 1.25$, $p = .27$, $\eta_p^2 = .04$. There was however, a significant interaction between group and time, $F(1,28) = 9.04$, $p = .01$, $\eta_p^2 = .24$. Post hoc t -tests with a Bonferroni correction to the alpha revealed that at baseline there was no significant difference between the low and high self-efficacy groups, $t(28) = 0.51$, $p = .61$, $d = 0.19$. However, there was a significant difference between these groups following the manipulation, $t(28) = -2.92$, $p = .007$, $d = -1.07$, with the high self-efficacy group reporting a challenge response and the low self-efficacy group, a threat response.

4.3.5. Cardiovascular responses (TE and CTI)

The dependent t -test on HR data for the baseline condition showed that HR significantly increased from the 5 minute resting period ($M = 2.30$, $SD = 3.23$), $t(29) = -3.89$, $p = .001$, $d = -1.00$, illustrating task engagement at this time point. For the

post-manipulation condition, the dependent t -test also illustrated task engagement via the significant increase in HR from resting ($M = 5.62$, $SD = 5.90$), $t(29) = -5.21$, $p < .001$, $d = -1.35$.

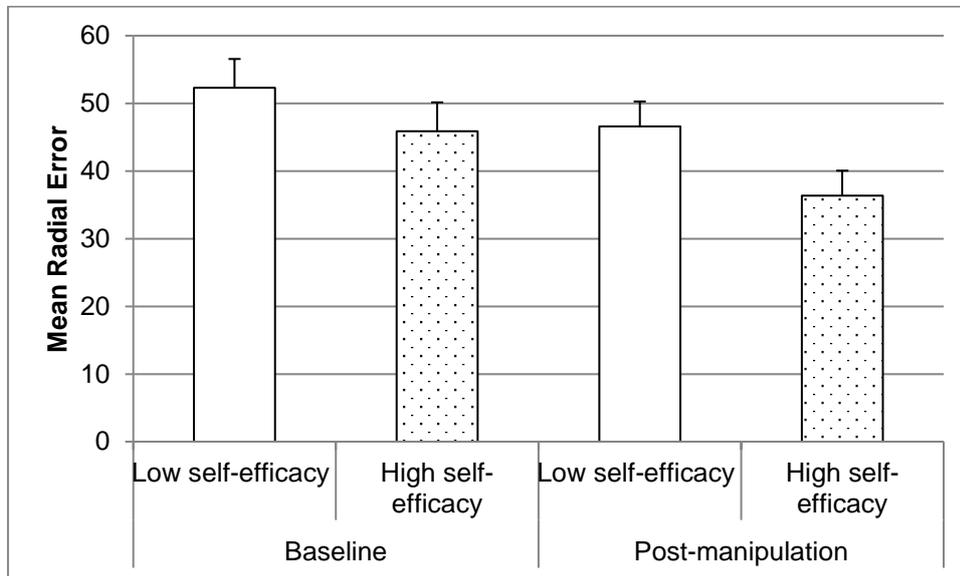
Figure 4.5. Means and standard errors of CTI values for low and high self-efficacy groups.



The ANOVA on the challenge and threat response data revealed no significant main effect for Time, $F(1,28) = 0.84$, $p = .37$, $\eta_p^2 = .03$, and no significant main effect for Group, $F(1,28) = 3.09$, $p = .09$, $\eta_p^2 = .10$. However, a significant interaction between group and time was found, $F(1,28) = 13.19$, $p = .001$, $\eta_p^2 = .32$. Post hoc t -tests with a Bonferroni correction to the alpha revealed that at baseline there was no significant difference between low and high self-efficacy groups, $t(28) = 0.04$, $p = .97$, $d = .02$. However, there was a significant difference between groups following the manipulation, $t(28) = -3.38$, $p = .002$, $d = -1.22$, with the high self-efficacy group displaying a challenge response and the low self-efficacy group, a threat response.

4.3.6. Performance

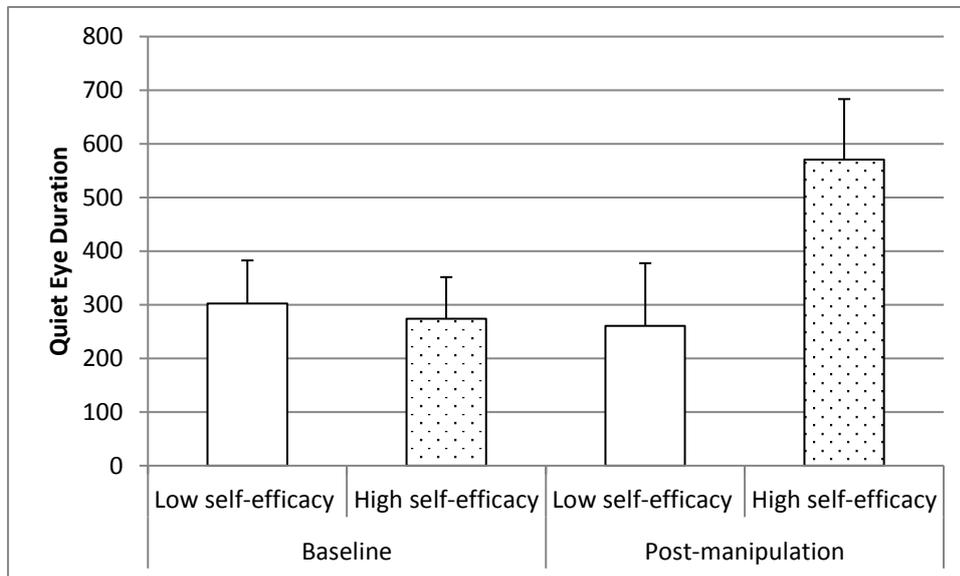
Figure 4.6. Means and standard errors of performance values for low and high self-efficacy groups.



The ANOVA on the performance data revealed no significant main effect for Time, $F(1,28) = 3.91$, $p = .06$, $\eta_p^2 = .12$, and no significant main effect for Group, $F(1,28) = 4.07$, $p = .05$, $\eta_p^2 = .13$, however, both effects revealed marginally significant trends in the predicted directions. There was also no significant interaction between group and time, $F(1,28) = 0.25$, $p = .62$, $\eta_p^2 = .01$.

4.3.7. Attention

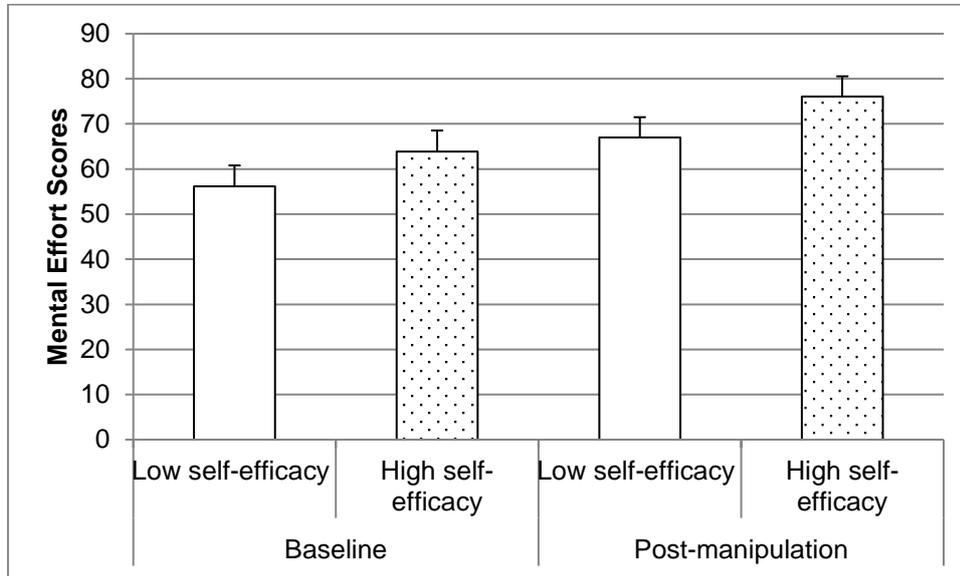
Figure 4.7. Means and standard errors of QE values for low and high self-efficacy groups.



Due to poor video quality, QE data for the same three participants in each condition ($n = 2$ in the low self-efficacy group; $n = 1$ in the high self-efficacy group) could not be analysed. The ANOVA on the attentional data revealed no significant main effect for Time, $F(1,25) = 2.27$, $p = .15$, $\eta_p^2 = .08$, and no significant main effect for Group, $F(1,25) = 1.62$, $p = .22$, $\eta_p^2 = .06$. The interaction between group and time, $F(1,25) = 3.99$, $p = .06$, $\eta_p^2 = .14$, was marginally significant and therefore subsequent follow up tests were conducted. Post hoc t -tests with a Bonferroni correction to the alpha revealed that at baseline there was no significant difference between the low and high self-efficacy groups, $t(25) = 0.25$, $p = .80$, $d = 0.10$. There was also no significant difference between these groups following the manipulation, $t(25) = -1.91$, $p = .07$, $d = 0.74$; however, there was a relatively large effect size. Descriptive statistics indicated that the high self-efficacy group displayed a longer QE duration following the manipulation.

4.3.8. Mental Effort

Figure 4.8. Means and standard errors of mental effort values for low and high self-efficacy groups.



The ANOVA on the attentional data revealed a significant main effect for Time, $F(1,42) = 24.18$, $p < .001$, $\eta_p^2 = .37$ with participants investing more mental effort into the second set of putts as compared with the first. There was however, no significant main effect for Group, $F(2,42) = .86$, $p = .43$, $\eta_p^2 = .04$. There was also no significant interaction between High group and time, $F(2,42) = 1.71$, $p = .19$, $\eta_p^2 = .08$.

4.3.9. Mediation Analysis

To test if the effect of group on performance was indirectly affected by any of the process variables, experimental group was entered as the independent variable, mean radial error was entered as the dependent variable, QE duration and mental effort were entered separately. Based on a 10,000 sampling rate, the results from bootstrapping revealed no significant indirect effects for QE duration, 95% CI [-2.18, 0.31] or mental effort 95% CI [-.25, 0.60].

Table 4.1. Mediation results for QE and mental effort.

	Effect	SE	LL95% CI	UL 95% CI
Quiet Eye Duration	-0.42	1.26	-2.18	0.31
Mental Effort	0.01	0.20	-0.25	0.60

Note. LL: lower limit; CI: confidence interval; UL: upper limit.

4.4. Discussion

Self-efficacy is proposed to be a determinant of challenge and threat responses in competitive settings (Jones et al., 2009). This study indicated that experimentally manipulating self-efficacy resulted in changes to both self-report and physiological indices of challenge and threat responses. Specifically, lower self-efficacy was associated with a threat response, and lower perceived resources, while higher self-efficacy was associated with a challenge response and higher perceived resources. Contrary to the initial hypotheses, there were no statistically significant performance or attention effects. However, descriptive statistics demonstrated that the high self-efficacy group performed better and displayed longer QE durations following the manipulation compared to the low self-efficacy group. Neither of the proposed mediating variables of attention and mental effort mediated the relationship between challenge/threat responses and performance. Still, this work adds to the experimental research on the determinants of challenge and threat responses as related to the BPSM and the TCTSA. It also has practical implications related to possible interventions promoting challenge responses which represent a more efficient physiological outcome as compared to threat responses.

The findings are important in illustrating another way in which both self-report and physiological indices of challenge and threat responses can be modified. They

thus add to the development of the BPSM by demonstrating a key factor which enters into the demand-resource evaluative calculus. Specifying these factors is considered complex due to the number of possible determinants which may influence demand-resource evaluations (Blascovich, 2013). However, the findings corroborate the TCTSA's proposition that self-efficacy is a determinant of challenge and threat responses (Jones et al., 2009). In other words, it demonstrates the plasticity of challenge and threat responses in a motivated performance situation in response to adjustments of self-efficacy beliefs. Moreover, this was demonstrated in a competitive sporting scenario thereby enhancing understanding of how self-efficacy influences challenge and threat responses within such settings specifically.

The data further support the TCTSA's hypothesis that self-efficacy influences challenge and threat responses primarily through a resources medium (Jones et al., 2009). Not only did participants in the high self-efficacy group report feeling more challenged following the manipulation, they also reported higher resources than the low self-efficacy group, while there was no difference in the perception of demands between groups. Self-efficacy may influence this increase in resources from a beliefs perspective. Specifically, the individual's belief in their capability to perform to a certain standard theoretically entails beliefs about coping with the situational demands as well. This is reminiscent of Lazarus and Folkman's (1984) transactional theory of stress and coping whereby cognitive appraisals are divided into primary and secondary components. It is this secondary component in which the individual evaluates how best to deal with the situation and whether they have the relevant resources and capabilities needed to do so (Lazarus & Folkman, 1984b). In other words, secondary appraisals incorporate self-efficacy beliefs in much the same way

resource evaluations do, illuminating the theoretical overlap between earlier and more contemporary theories and models of stress and coping.

The findings also provide support for certain facets regarding the specific construct of self-efficacy. The influence of verbal persuasion as a source of self-efficacy for a motor task in a laboratory setting was demonstrated, thus adding to literature on the determinants of self-efficacy beliefs (e.g. Tierney & Farmer, 2002; Tschannen-Moran & Hoy, 2007). Furthermore, the findings illustrated that verbal persuasion was impactful in creating relatively low and high self-efficacy beliefs between groups of novice performers. This indicates the directional effects of verbal persuasion as a source of self-efficacy and also demonstrates the malleability of self-efficacy in a sporting context.

In spite of successfully manipulating self-efficacy with resultant changes to challenge and threat responses, there were no statistically significant performance effects. There were however, large effect sizes for the main effects for group ($\eta_p^2 = .13$) and time ($\eta_p^2 = .12$), with descriptive statistics indicating that both groups performed better following the manipulation. On average, the high self-efficacy group performed 10.23 cm better than the low self-efficacy group on the putting task. Some previous methodologically similar studies have indicated positive motor performance effects of being relatively more challenged than threatened (Moore, Vine, Wilson, et al., 2012; Moore et al., 2015). Therefore, in spite of a priori power calculations, it is possible that this study was underpowered to determine performance effects. It is also possible that the self-efficacy manipulations inadvertently influenced performance outcomes in this study. This may have been due to a mismatch between the beliefs and actual capacity of participants (Vancouver & Kendall, 2006)

which confounded the predicted positive relationship between challenge responses and performance. In other words, the manipulation may have created unrealistic perceptions of capabilities which led to performance breakdown for some participants. This breakdown might have occurred via reduced investment in preparatory activities prior to task performance (Vancouver & Kendall, 2006). For instance, preparatory activities involve modifications of limb dynamics and kinematics in response to task requirements and performance feedback (Paz, Boraud, Natan, Bergman, & Vaadia, 2003).

There were no effects of group on attention, however, the interaction effect of group and time was nearing significance indicating the hypothesised trend when also considering the medium-large effect size. The high self-efficacy group maintained their quiet eye for 310 ms longer than the low self-efficacy group following the manipulation. Longer QE duration has been demonstrated to facilitate golf putting performance (Vickers, 2007), suggesting a possible link between the two in this study. In fact, a simple bivariate correlation indicated that post-manipulation performance and QE duration were significantly correlated ($r = .39, p < .05$). As discussed above, it is possible that over-efficacious individuals did not invest as much in preparatory activities crucial to the task. Apart from the physical preparation identified above, preparatory activities also involve the cognitive processing of information relevant to a task, with the QE representing the period of time when neural networks are organised prior to motor responses (Vickers, 2009). Less investment in preparatory activities by over-efficacious individuals would therefore inhibit the statistically significantly longer QE duration which was hypothesised. Indeed, Bandura (1997) suggested that complacency due to over-efficaciousness may sometimes inhibit preparation periods in task performance.

As in studies 1 and 2 (Chapters 2 and 3), QE did not mediate the challenge/threat response and performance relationship and, similar to study 2 (Chapter 3), neither did mental effort. This highlights that it is possible that there are no indirect effects of these process variables on the challenge/threat response and motor task performance relationship. It does not however, discount the influence of other possible mediating variables (e.g. goal orientations, information processing, strategy selection) on this relationship, which may be specific to motor task performance. Indeed, future research should aim to replicate the positive relationship between challenge and threat responses and performance across a range of motor tasks and assess other possible underlying mechanisms.

The findings from this study not only contribute to theory, but may be useful to applied practitioners as well. Since the findings indicate the influence of verbal persuasion on self-efficacy beliefs, practitioners could focus on performance feedback that highlights achieved progress rather than personal capabilities, particularly if the latter is poor. Emphasising the latter could influence demand-resource evaluations by diminishing the perception of resources available or even the perception of control over regulating behaviour and action thus increasing the likelihood of threat responses. Furthermore, managing performance expectations to ensure there is no complacency or re-evaluation leading to threat responses if performance is poor, is key. Self-efficacy may also be promoted via vicarious experiences and physiological feedback (Bandura, 1977) which should be considered within the challenge and threat research and definitely regarding possible interventions. Certainly, in addition to study 1 (Chapter 2), recent studies have indicated the strength of arousal reappraisal in promoting challenge (Jamieson et al., 2016; Moore et al., 2015).

Importantly, being relatively more challenged via a pathway of increased self-efficacy bodes well for interventions in applied sport psychology particularly if this malleability extends across domains. While this did not translate into statistically significant performance benefits, past research has shown such and other benefits of being challenged rather than threatened (Gildea, Schneider, & Shebilske, 2007; Moore et al., 2013; Vine et al., 2013). Future research would therefore do well to attempt to disentangle the intricacies of the pliability of self-efficacy to draw conclusions on a number of relevant issues, such as what factors should be targeted to increase self-efficacy, the most effective ways to engage in such an intervention, and possible subsequent outcomes.

Chapter 4 develops the BPSM (Blascovich, 2013) and supports the TCTSA (Jones et al., 2009) by providing experimental evidence that self-efficacy is a determinant of challenge and threat responses. Experimentally manipulating self-efficacy led to differences in challenge and threat responses across groups. Higher self-efficacy was associated with challenge responses while lower self-efficacy was associated with threat responses. Importantly, these relationships were observed via both self-report and physiological data. This chapter is also of theoretical relevance in self-efficacy literature as it demonstrates the utility of self-efficacy as a predictor of cognitive outcomes. It further demonstrates the malleability of self-efficacy to verbal persuasion in laboratory settings which can be useful in applied settings regarding the design of interventions to promote self-efficacy.

Though the fundamental aim of this PhD was to examine the determinants of challenge and threat responses, another key issue became apparent during the unfolding of research for this thesis; specifically, what factors influence task engagement? Though the BPSM (Blascovich, 2013) suggests task engagement is a

prerequisite for challenge and threat responses to occur, little investigation has been done to determine the factors which have bearing on it. Self-efficacy has been shown to contribute to levels of students' academic engagement in school settings (Schunk & Pajares, 2009). To assess whether this finding extended to the motivated performance situation described in this chapter, an independent *t*-test on heart rate reactivity data, an indicator of task engagement (Seery, 2013), was conducted. However, the findings indicated no significant differences between high and low self-efficacy groups following the manipulation. Still, descriptive statistics demonstrated that the high self-efficacy group was more engaged in the task ($M = 6.41$, $SD = 5.91$) than the low self-efficacy group ($M = 4.83$, $SD = 5.99$) but, the effect size was small ($d = 0.27$).

One psychological construct linked to self-efficacy which materialised as a possible predictor of task engagement and furthermore, challenge and threat responses, was motivation. In this study (3; Chapter 4), self-efficacy levels were manipulated using false positive and negative feedback. Positive feedback has been shown to increase intrinsic motivation (Deci, 1971) while negative feedback has been shown to decrease it (Deci & Cascio, 1972). Deci and Ryan (1980) suggested that these findings indicate the importance of competence in affecting motivations. High perceived competence is positively related to self-determined motivation (Ntoumanis, 2001) and importantly, motivation is associated with cognitive engagement (Turner, 1995).

Human behaviour is guided by motivations; motives represent the 'why' of behaviour, and direct and energise it (Nevid, 2013). Different motivations are associated with differential outcomes inclusive of choices, persistence and performance (Wigfield & Eccles, 2000). The motivational aspect of the appraisal

process was highlighted by Lazarus (1991), who suggested that determining motivational relevance is a crucial component of primary appraisals. According to the author, this motivational aspect involves person-environment transactions in which individual goals, and the relevance of the situation to these goals, are determined (Lazarus, 1991). Importantly, goal-directed activities are initiated and sustained by motivation (Cook & Artino, 2016). Essentially, motivations are representative of why a goal is being pursued rather than what goal is being pursued (Deci & Ryan, 2002). Conceptually therefore, it is vital to understand the role of motivational regulations separately from that of goal regulations (Thrash & Elliot, 2001) thereby leading to study 4 (Chapter 5) which examined the predictive value of situational motivation regulations on task engagement and challenge and threat responses.

Chapter 5 (Study 4): The predictive value of situational motivation regulations on task engagement and challenge and threat responses

5.1. Introduction

The self-determination theory (SDT) (Deci & Ryan, 2000) is prominent in sport motivation literature and, similar to the BPSM (Blascovich, 2013), TCTSA (Jones et al., 2009), and Vine and colleagues' (2016) IFSAVP, emphasises person-environment transactions. It proposes that motivation exists along a spectrum from more to less self-determined (Deci & Ryan, 2008). Conditions supporting an individual's satisfactions of the major psychological needs of autonomy, competence and relatedness foster the most volitional and highest quality forms of motivation that is, more self-determined/autonomous (intrinsic) as compared with less self-determined/controlled motivation (extrinsic). Autonomy involves the need to experience activities by choice, competence is the need to interact effectively with the environment, while relatedness is the need to feel close and connected with important others (Deci & Ryan, 2008).

“Intrinsic motivation involves people freely engaging in activities they find interesting, that provide novelty and optimal challenge” (Deci & Ryan, 2000, p. 235). On the other hand, extrinsic motivation is characterised by doing an activity for a separable outcome and includes four different motivation regulations namely: integration, identification, introjection and external, in that order along the continuum. Integration is the most self-determined form of extrinsic motivation and involves the assimilation of identified regulations with the self. Identification is the conscious valuing of the activity while introjection is characterised by focusing on approval from

the self or from others. Then, external is marked by the importance of external demands such as gaining rewards or avoiding punishments. Finally, amotivation is characterised by lacking the intention to act and occurs in instances where the individual lacks competence, does not believe the task is important or where there is disparity between their behaviour and desired outcomes (Ryan & Deci, 2000).

The SDT successfully integrates with the BPSM since both account for the effects of self-relevance upon individual responses. Furthermore, since motivation can be experienced at a contextual and domain-specific level (Linnenbrink & Pintrich, 2002), it is particularly applicable to those performance situations described in the BPSM. While Lazarus (1991) suggested that motivational relevance is a component of primary appraisal, the BPSM suggests that this occurs at the level of task engagement (Seery, 2011). Task engagement is a necessary prerequisite for challenge and threat responses to be experienced. Task engagement occurs to the extent that the situational goal is subjectively self-relevant to the individual with greater self-relevance or goal importance leading to relatively greater engagement in the task (Seery, 2011).

Self-relevance is proposed to be vital in directing an individuals' cognitive effort (Conway, Pothos, & Turk, 2016) and results from various sources such as making a good impression on others or the desire to achieve a performance goal. Furthermore, it is experienced in a myriad of domains and includes those associated with reward, fear and emotions (Schmitz & Johnson, 2007) which may be heightened in performance situations. For example, Seery and colleagues (2009) found that a monetary incentive (in gain and loss conditions) significantly increased task engagement relative to a control group. It is therefore plausible to hypothesise that task engagement would be higher in situations in which the aforementioned domains

are salient, such as pressurised performance scenarios. What is unknown though, is how the different motivation regulations influence the self-relevance necessary for task engagement. Both intrinsic and extrinsic motivation regulations may stimulate high self-relevance via different pathways; either through interest and enjoyment (Horrey, Lesch, Garabet, Simmons, & Maikala, 2017) or through the salience of extrinsic rewards or punishments in (Seery et al., 2009).

Crucially, intrinsic motivation has been associated with better consequences as compared with extrinsic motivation in achievement contexts, including better performance and well-being (Deci & Ryan, 2000). No known research however, has examined how situational motivation regulations might influence the cognitive and physiological processes and outcomes in achievement settings; namely challenge and threat responses. Certainly, the desire to, and reasons behind, engaging in the demand-resource evaluation process may be a factor in challenge/threat responses to the extent that energy is directed differently. In other words, motivation may affect the way in which the demand-resource calculus is evaluated. Individuals are proposed to frame their perceptions of situations in terms of motives (Pervin, 1989) and perceptions are crucial in informing demand-resource evaluations in motivated performance situations (Blascovich, 2013).

Intrinsic motivation is facilitated by tasks which hold novelty, challenge or aesthetic value for an individual thus theoretically impeding conflict between the self and the activity due to the satisfaction of psychological needs (Ryan & Deci, 2000). On the other hand, the four extrinsic motivation regulations ranging from integrated to external represent more to less internalisation and integration of the regulation of a task respectively. Ryan and Deci (2000) have proposed that the more self-determined external motivation regulations are advantageous to behavioural

outcomes via lessened internal conflict and increased accessibility to personal resources. It is via this pathway that more self-determined motivation regulations may facilitate challenge responses and furthermore, performance. Previous research has provided support for the positive relationship between trait intrinsic motivation and positive cognitive appraisals (Moneta & Spada, 2009). The authors assessed how trait intrinsic and extrinsic motivations and situational coping strategies influenced students' approaches to studying prior to an exam. Moneta and Spada (2009) found that intrinsic motivation fostered better approaches to studying as compared to extrinsic motivation. Though the researchers examined trait motivation, intrinsic and extrinsic motivations are liable to fluctuate across situations and tasks (Amabile, 1979; McCullers & Martin, 1971), highlighting the importance of examining state or situational motivation as well.

Furthermore, pressurised performance situations encompass one type of motivational situation in which differences in situational motivation regulations may be of particular interest. Indeed, less self-determined motivation is a result of behaviour undertaken because people feel pressured or compelled to engage in such (Deci & Ryan, 2002). This was observed in work by Pelletier and colleagues (2002), where the pressure to attain certain performance standards negatively impacted self-determined motivation towards work in teachers (Pelletier et al., 2002). Furthermore, threat manipulations in challenge and threat research have previously focused on social evaluation or avoiding negative consequences (e.g. Drach-Zahavy & Erez, 2002; Moore, Vine, Wilson, et al., 2012) which may be considered a form of internal control (Brunet & Sabiston, 2009). Reduced autonomy is also associated with less self-determined motivation according to the SDT (Deci & Ryan, 2008) and

low perceived autonomy has been associated with increased feelings of stress and anxiety (Gagne, 2003; Krane, Snow, & Greenleaf, 1997).

Early research into motivational intensity, physiological reactivity and performance was conducted by Vogel and colleagues (1959). Participants were separated into high and low induced motivation groups and performed the McKinney Reporting Test under stressful conditions with physiological reactivity measured by galvanic skin responses. The authors observed that under stressful conditions, the relationship between physiological reactivity and performance was dependent upon motivation intensity. Specifically, physiological reactivity was positively related to performance under strong induced motivation but not weak induced motivation (Vogel et al., 1959). This research therefore provides a starting point in understanding the relationships between motivation intensity, physiological reactivity and outcome factors such as performance under stressful conditions by indicating directions of relationships between these variables.

Crucially, Houston (1992) argued that assessing motivation is essential in fully understanding the role of stress in cardiovascular reactivity. As aforementioned, challenge and threat responses have been measured in previous research using both self-report and cardiovascular measures (e.g. Turner et al., 2012; Weisbuch, Seery, Ambady, & Blascovich, 2009). Furthermore, task engagement is measured via increases in heart rate (the frequency of pulse beats within a specific time period) and decreases in pre-ejection period (PEP; a measure of the left ventricle's contractile force) from baseline (Seery et al., 2009). The PhysioFlow has widely been used to measure both task engagement and challenge/threat responses but does not allow PEP calculations. However, HR has been utilised as a suitable marker of task engagement in several studies using this particular equipment (e.g. Derks,

Scheepers, Van Laar, & Ellemers, 2011; Moore, Vine, Wilson, et al., 2012). Utilising these physiological measures assists researchers in avoiding some of the limitations associated with self-report measures such as social desirability bias (Sallis & Saelens, 2000). Additionally, levels of task engagement and demand-resource evaluations may be unconscious allowing objective measures to capture what self-report measures are unable to fully encapsulate.

5.1.1. Aims and Hypotheses

The aims of this study were therefore to examine and clarify the relationships between situational motivation regulations and task engagement as well as challenge and threat responses. It was predicted that situational motivation regulations would explain more variance in task engagement and self-report as well as cardiovascular challenge/threat responses under pressurised conditions as compared with control conditions. Since there is no known previous research on the interplay between situational motivation regulations and task engagement or challenge and threat responses, specific magnitude predictions were not made. Instead, how each situational motivation regulation related to each of the dependent variables or in other words, the predictive value of each of the situational motivational regulations, was tested.

Findings from studies 1, (Chapter 2), 2 (Chapter 3) and 3 (Chapter 4) indicated no performance effects of being challenged or threatened. Previous research has indicated a positive relationship between challenge responses and motor task performance and a negative relationship between threat responses and motor task performance (e.g. Moore et al., 2015). In order to replicate performance findings from previous research (e.g. Moore, Vine, Wilson, et al., 2012; Moore et al.,

2013), challenge and threat responses were hypothesised to predict significant variance in performance in both control and pressure conditions.

5.2. Methods

5.2.1. Participants

Forty five university students (Male = 24, Female = 21) with a mean age of 22.89 ± 2.4 were recruited via flyers, email and word-of-mouth to participate in this study. A required sample size of 45 was calculated using G*power 3.1 software, setting power ($1-\beta$ err prob.) at .8, alpha (α err prob.) at $p = .05$, and using the effect size ($f^2 = .3$) from (Meijen et al., 2014). Participants were exposed to a control and pressure condition. All participants were novice golfers as they had no official golf handicap or official putting training (Moore, Vine, Wilson, et al., 2012). The study was approved by the university ethics committee, and written informed consent was obtained for each participant prior to the start of the procedure.

5.2.2. Measures

5.2.2.1. Condition Manipulation

Verbal instructions (below; adapted from Moore et al., 2015) were used to induce high pressure prior to the pressure condition. Instructional pressure manipulation has proven to affect anxiety levels as well as perceptual motor task performance in novices (Vine et al., 2013; Vine & Wilson, 2011).

“You will shortly be asked to perform 6 golf putts; you are required to sink at least 50% of your putts or get your mean error variance rate below 25 cm. If your score is in the top 10% of participants you will be entered into a draw to receive one of three cash prizes. If your score is in the bottom 10% of participants your data will be unusable. At the end of the study your scores will be entered into a leader board

against other participants and will be emailed to all participants. It is therefore important to try to perform to the best of your ability.”

5.2.2.2. Pressure Manipulation

The Mental Readiness Form – L (MRF-L) (Krane, 1994) was administered to check the effectiveness of the pressure manipulation by measuring its effects on cognitive anxiety.

5.2.2.3. Situational Motivation Regulations

The Situational Motivation Scale (SIMS) (Guay, Vallerand, & Blanchard, 2000) was used to assess motivation regulations prior to task performance in each condition. The SIMS is a sixteen item (four items per subscale) questionnaire which assesses intrinsic motivation, identified regulation, external regulation and amotivation. For each question, participants rated their responses on a 7 point Likert scale (1 = corresponds not at all, 7 = corresponds exactly).

5.2.2.4. Demand-Resource Evaluations (DRES)

DRES data was collected using the same measures and procedure as in study 1 (Chapter 2), study 2 (Chapter 3) and study 3 (Chapter 4).

5.2.2.5. Cardiovascular Measures (Task Engagement (TE) and Challenge and Threat Index (CTI))

Cardiovascular data were collected using the same equipment and procedures as in studies (1 (Chapter 2), 2 (Chapter 3), and 3 (Chapter 4).

Task engagement and the challenge and threat index were calculated following the same procedures as in the three previous studies (1 (Chapter 2), 2 (Chapter 3), and 3 (Chapter 4) as well.

5.2.2.6. Performance (Mean Radial Error)

Performance data was collected using the same equipment and procedures as in study 2 (Chapter 3) and study 3 (Chapter 4).

5.2.3. Procedure

After the participant read the information sheet and consented to participate in the study, demographic information was taken (age, weight, height and initial blood pressure). The participant then performed twenty practise putts to become familiarised with the nature of the golf putting task (club, putting distance, putting green etc.) A further blood pressure measurement was taken after the practise putts, subsequent to the fitting of the PhysioFlow equipment. Following calibration, an initial five minutes of baseline cardiovascular data were recorded. Participants then received their first instructional set (condition 1; control) informing them that they would be required to perform six baseline putts to assess their average performance whilst one minute of cardiovascular data were recorded alongside a blood pressure measurement. Participants then responded to the self-report questionnaires (MRF-L; DRES; SIMS) and proceeded to perform their baseline putts. Upon completion of these, participants were asked to sit in a resting position and received the pressure manipulation (condition 2) whilst another minute of cardiovascular data were recorded alongside blood pressure. The self-report questionnaires (MRF-L; DRES; SIMS) were again administered. Participants then performed their second set of six putts after which the equipment was removed and they were debriefed and thanked for their participation.

5.2.4. Statistical Analysis

The effectiveness of the pressure manipulation was assessed using a dependent *t*-test on the MRF-L data, in-order to establish if anxiety was significantly higher in the high pressure condition than control (Vine et al., 2013). A dependent *t*-test was also used to compare heart rate reactivity at baseline and both conditions (control and pressure), and show that task engagement was present (Blascovich, 2008).

In order to assess the physiological responses associated with challenge and threat prior to regression analyses, a challenge and threat index (CTI) was created. In line with previous research (Moore et al., 2013), Shapiro Wilks tests were conducted; if the presence of outliers were detected, data with *Z* scores greater than 3 were removed. Following the outlier analyses the index was calculated in order to differentiate challenge and threat states. Participants' CO and TPR reactivity scores were converted into *z*-scores and summed with a larger index value corresponding with greater challenge and vice versa (Moore et al., 2015).

Six multiple linear regression analyses were conducted in total to assess the effects of the situational motivation regulations (intrinsic, identified, external, amotivation) on each of the dependent variables: 1) task engagement: control, 2) task engagement: pressure, 3) challenge and threat (self-report): control, 4) challenge and threat (self-report): pressure, 5) challenge and threat (cardiovascular): control, 6) challenge and threat (cardiovascular): pressure. Two simple linear regression analyses were conducted to examine the effect of the challenge and threat index on performance at baseline and pressure. All assumptions relating to normality, homoscedasticity, linearity, normally distributed errors and independent errors were met prior to each analysis.

5.3. Results

5.3.1. Pressure Manipulation Check

The dependent *t*-test confirmed that participants experienced lower cognitive anxiety at control ($M = 3.29$, $SD = 1.71$) than at pressure ($M = 4.71$, $SD = 2.04$), $t(44) = -6.49$, $p < .001$, $d = 0.75$ demonstrating that the pressure manipulation successfully increased cognitive anxiety.

5.3.2. TE Manipulation Check

The dependent *t*-tests on the heart rate reactivity data confirmed that heart rate significantly increased at control ($M = 4.22$, $SD = 3.16$), $t(44) = -8.97$, $p < .001$, $d = 1.89$ and pressure ($M = 6.65$, $SD = 4.95$), $t(44) = -9.02$, $p < .001$, $d = 1.90$ illustrating task engagement at both time points.

5.3.3. TE: HR Reactivity

Using the enter method it was found that situational motivation regulations did not significantly predict task engagement at control ($F(4, 40) = .12$, $R^2 = .01$, $p = .97$) but significantly predicted task engagement at pressure ($F(4, 40) = 2.74$, $R^2 = .22$, $p = .04$). *B* values for each regulation are listed in the tables (5.1 and 5.2) below with only external regulation significant at pressure.

Table 5.1. Task engagement (HR Reactivity) values at Control

Situational Motivation Regulation	<i>B</i>	<i>SE</i>	<i>t</i>	Sig	95% CI Lower Bound	95% CI Upper Bound
	Intrinsic	-.20	.59	-.34	.74	-1.34
Identified Regulation	.21	.58	.36	.72	-.96	1.38
External Regulation	.23	.39	.59	.56	-.55	1.01
Amotivation	-.34	.60	-.57	.57	-1.54	.86

Table 5.2. Task engagement (HR Reactivity) values at Pressure

Situational Motivation Regulation	<i>B</i>	<i>SE</i>	<i>t</i>	Sig	95% CI Lower Bound	95% CI Upper Bound
	Intrinsic	.81	.73	1.10	.28	-.67
Identified Regulation	-.34	.71	-.48	.63	-1.78	1.09
External Regulation	1.72	.59	2.92	.01*	.53	2.91
Amotivation	-1.61	.81	-1.99	.05	-3.25	.03

Note: * significant at $p < .05$

5.3.4. Challenge and threat: DRES (Self-report)

Using the enter method, it was found that situational motivation regulations significantly predicted challenge and threat at control ($F(4, 40) = 3.41, R^2 = .25, p = .02$) and significantly predicted challenge and threat at pressure ($F(4, 40) = 2.82, R^2 = .22, p = .04$). *B* values for each regulation are listed in the tables (5.3 and 5.4) below with only intrinsic motivation significant in both conditions.

Table 5.3. DRES (Self-Report) values at Control

Situational Motivation Regulation	<i>B</i>	<i>SE</i>	<i>t</i>	Sig	95% CI Lower Bound	95% CI Upper Bound
	Intrinsic	1.11	.31	3.64	.00*	.49
Identified Regulation	-0.40	.30	-1.34	.19	-1.00	.20
External Regulation	-0.16	.20	-0.82	.42	-.57	.24
Amotivation	0.54	.31	1.76	.09	-.08	1.16

Note: * significant at $p < .05$

Table 5.4. DRES (Self-Report) values at Pressure

Situational Motivation Regulation	<i>B</i>	<i>SE</i>	<i>t</i>	Sig	95% CI Lower Bound	95% CI Upper Bound
	Intrinsic	0.78	0.25	3.15	.00*	.28
Identified Regulation	-0.23	0.24	-0.97	.34	-.72	.26
External Regulation	0.14	0.20	0.70	.49	-.26	.54
Amotivation	0.05	0.27	0.17	.87	-.51	.60

Note: * significant at $p < .05$

5.3.5. Challenge and threat: CTI (Cardiovascular)

Using the enter method it was found that situational motivation regulations did not significantly predict CTI at control ($F(4, 39) = 1.04, R^2 = .10, p = .4$) or pressure ($F(4, 39) = .61, R^2 = .06, p = .66$). *B* values for each regulation are listed in the tables (5.5 and 5.6) below.

Table 5.5. Challenge and Threat Index (Cardiovascular) values at Control

Situational Motivation Regulation	<i>B</i>	<i>SE</i>	<i>t</i>	Sig	95% CI Lower Bound	95% CI Upper Bound
	Intrinsic	-.23	.30	-.77	.45	-.82
Identified Regulation	.47	.29	1.60	.12	-.13	1.06
External Regulation	-.09	.19	-.45	.66	-.48	.30
Amotivation	.30	.30	.20	.33	-.31	.90

Table 5.6. Challenge and Threat Index (Cardiovascular) values at Pressure

Situational Motivation Regulation	<i>B</i>	<i>SE</i>	<i>t</i>	Sig	95% CI Lower Bound	95% CI Upper Bound
	Intrinsic	-.06	.30	-.20	.84	-.66
Identified Regulation	.20	.29	.68	.50	-.39	.78
External Regulation	-.30	.24	-1.26	.22	-.78	.18
Amotivation	-.05	.33	-.15	.89	-.72	.62

5.3.6. Performance

A simple linear regression was calculated to predict performance based on challenge and threat index at baseline and pressure. The regression equation was not significant at baseline $F(1, 42) = 2.88, p = .10$, with an R^2 of .06, or at pressure $F(1, 42) = .03, p = .86$, with an R^2 of .00.

5.4. Discussion

Lazarus (1991) proposed that motivational relevance and congruence are vital aspects of the appraisal process. Motivation underlies behaviour in achievement settings with more self-determined forms associated with better cognitive outcomes (Ullrich-French & Cox, 2009). An individual's motivations to engage in and execute a task may account for the degree of task engagement they experience in a domain. Importantly, task engagement can influence not only the desire to engage in the demand-resource evaluation process but the way in which energy is directed and mobilised for this process, possibly affecting challenge and threat responses. This research examined how situational motivation regulations influence task engagement and self-report and cardiovascular reactivity indicative of challenge and threat responses. This was assessed at both control and pressurised levels since pressure may influence motivations (Gardner, 2012). The hypotheses of this study were only partially supported with situational motivation regulations accounting for a significant amount of variance in task engagement and self-report challenge and threat measures but not cardiovascular challenge and threat responses at pressure.

Situational motivation regulations predicted variance in task engagement at pressure with external regulation, the most extrinsic form of situational motivation, the only significant positive predictor of task engagement. External regulation emphasises the importance of extrinsic rewards or punishments thus indicating that these were most salient within this domain as compared with the more self-determined motivation characteristics such as interest and enjoyment. This is a noteworthy finding when interpreting results from similar study designs conducted in laboratories as it indicates that participants are more engaged in tasks in which there are separable outcomes. Identifying task characteristics which increase engagement

is important for understanding the quality of the individual's experience during participation. It is likely that not only the level of absorption but the quality of engagement in the task influences significant cognitive and emotional outcomes (Fairclough, Moores, Ewing, & Roberts, 2009). This is likely due to task engagement providing a context for the demand-resource evaluative experience (McGregor & Elliot, 2002).

Assessing the effects of external regulations on task engagement by examining whether gaining a reward or avoiding punishment is a stronger predictor in specific motivated performance scenarios is a strong avenue for future research. Seery and colleagues (2009) provided supporting evidence that framing incentives in terms of potential loss elicited stronger task engagement than framing incentives in terms of a potential gain in a cognitive performance task situation. Importantly, this effect was observed via changes in heart rate as well as pre-ejection period. Such knowledge could be useful for interventions aimed at increasing task engagement particularly since it is representative of a state in which there is effortful commitment to relevant goals (Fairclough et al., 2009). This would be of particular use when considering real-world settings since extrinsic factors may be salient in pressurised performance scenarios.

Though only on the cusp of statistical significance, the data illustrated that there was a negative relationship between amotivation and task engagement at pressure, meaning increases in one led to decreases in another. Future research should examine what factors lead to task disengagement. Feelings of incompetence and lack of control are characteristic of amotivation (Deci & Ryan, 1985) and teasing apart these relationships experimentally would allow for a more definitive understanding of why individuals may not have the desire to engage in the motivated

performance situation. Task disengagement due to amotivation may encumber self-regulatory processes necessary for successful task performance (Matthews et al., 2002). It may thus act as a confounding variable in studies particularly where participants have been opportunistically sampled. Furthermore, being able to predict those factors which undermine motivation has implications for interventions aimed at promoting self-determined/autonomous motivation regulations in achievement domains.

While extrinsic motivation explained variance in task engagement, self-report data indicated that there was a positive relationship between intrinsic motivation and challenge at pressure. Therefore, either task engagement does not provide context for the demand-resource evaluative process as suggested in the paragraphs above or a more complex relationship exists between situational motivation regulations and self-reported challenge and threat responses. It is possible that external regulations are more salient in how engaged an individual is in a task but that intrinsic regulations are more salient as an antecedent of challenge and threat responses. Indeed, more variables and more complex interplay among demands and resources during the evaluative process allows for differential impact of motivation regulations at this stage of the model.

Overall, the self-report data illustrates that being motivated by interest, enjoyment and/or inherent satisfaction is related to perceptions of challenge even under conditions of performance pressure. Interestingly, Green and Foster (1986) stated that external rewards can enhance intrinsic motivation when perceived to be advantageous to building competence. In other words, the separable outcomes highlighted in the pressure manipulation may have enhanced intrinsic motives due to the scope for satisfying the psychological need for competence. In the TCTSA,

Jones et al. (2009) proposed that mastery goals are focussed on developing competence. Further, Elliot and Church (1997) demonstrated a positive relationship between mastery goals and intrinsic motivation. This likely explains why even under pressurised conditions, intrinsic motivation facilitated self-reported challenge responses.

However, the data provided discordant conclusions on the influence of situational motivation regulations and challenge and threat responses. On the one hand, the self-report data illustrates a relationship between the aforementioned variables, while the cardiovascular data does not. Some challenge and threat research has revealed little or no significant correlations between self-report and physiological measures of challenge and threat as well (e.g. Turner et al., 2012; Vine et al., 2013). There are a few possible reasons for the lack of corroboration between the self-report and cardiovascular measures of challenge and threat responses which are discussed more comprehensively in Chapter 6 (section 6.2.1.2.1.) of this thesis. These reasons include the possibility that either or both measures are not sensitive or comprehensive enough to capture challenge and threat responses. It is also likely that caveats related to self-report data specifically influenced the findings. This is relevant to not only the challenge and threat scores from the DRES but the motivation scores from the SIMS as well. For example, participants may have been reluctant to report amotivation or a limited ability to cope (social desirability bias). There is however, no known objective measure of motivation regulations meaning this particular issue cannot be so easily resolved. Replication studies would provide more insight into the findings from this study and future research can extend the findings by examining situational motivation regulations and both the subjective and

objective measures of challenge/threat responses across individuals over a variety of situations to ascertain the strength and magnitude of these relationships.

Consistent with the previous three studies (1, 2, 4, Chapters 2, 3, 4, respectively), challenge and threat responses did not influence performance. A key difference in the current study is that the proposed determinant of challenge and threat responses being examined was not explicitly manipulated. Therefore, shortcomings of manipulations associated with each of the three previous studies were not a factor in the current findings. Additionally, the current study utilised a different statistical approach in clarifying the relationship between challenge and threat responses and performance. Simple linear regression was used to predict variance and show the strength of the effect of challenge and threat responses on performance. The findings support the evidence from the three previous studies (1, 2, 3; Chapters 2, 3, 4, respectively) in this thesis that there were no effects of challenge and threat responses on performance. This was observed in both control as well as pressurised performance conditions. Importantly, the proposed determinant was not experimentally manipulated in the current study (4) as in the previous studies where individual limitations specific to each study may have confounded possible performance effects.

A limitation of this study is that while situational motivation regulations were not intentionally manipulated, extrinsic motivation may have been fostered via the pressure manipulation. External regulation is characterised by seeking extrinsic rewards and avoiding external punishments (Deci & Ryan, 2000). The pressure manipulation used highlighted a combination of factors which increased the importance of performing well meaning a drawback of this research is that participants' motivation may have been inadvertently manipulated. Additionally, a key

point in any BPSM research is that the processes within the motivated performance situation are iterative and may continually change over time. What this means is that the motivations behind task engagement and challenge/threat may become more or less self-determined with the addition of new information and experiences. One limitation of this study is that measures were assessed across only two conditions and specifically related to motor performance in novices. There is scope to examine this topic across a range of groups as well as performance spheres to attain a more well-rounded perspective overall.

Another limitation of this study is that not all those physiologically relevant factors associated with task engagement were examined. For instance, PEP would have added further validation to the findings on task engagement but was not used here. That said, several recently published studies have utilised HR as a valid and reliable measure of task engagement in challenge/threat research (e.g. Frings, Eskisan, Spada, & Albery, 2015; Moore, Young, Freeman, & Sarkar, 2017). Still, utilising additional physiological measures would have provided a better profile overall for task engagement in particular.

Future research should examine how more stable traits influence and interact with situational motivation regulations and so, task engagement, challenge and threat responses. For instance, personality variables and even disorders may affect and interact with situational motivation to further explain individual differences in the aforementioned and other related dependent variables such as well-being (e.g. Pushkar, Reis, & Morros, 2002). Understanding this is not only theoretically noteworthy but may have consequences for performers across domains whether novices or experts.

Chapter 5 (study 4) illustrates that situational motivation regulations influence task engagement and self-report challenge and threat but not cardiovascular measures associated with challenge and threat in pressurised conditions. Specifically, more extrinsic motivation was positively related to task engagement while more intrinsic motivation was positively related to self-reported challenge. This allows us to understand an individual's psychological state immediately prior to the demand-resource evaluative process as well as the context in which this process is executed along with self-reported feelings of challenge. Following previous findings in this thesis, there were no effects of challenge and threat responses on performance thereby further reinforcing this conclusion. Chapter 6 will discuss the thesis implications, limitations and directions for future research on challenge and threat responses.

Chapter 6: General Discussion

6.1. Summary of Key Findings

The aim of this thesis was to examine possible determinants of challenge and threat responses and to replicate and extend current findings on performance and attention outcomes. The aims were based primarily on the BPSM (Blascovich, 2013), and also drew from other prominent, contemporary models such as the TCTSA (Jones et al., 2009), and the IFSAVP (Vine et al., 2016).

Studies 1 and 3 (Chapters 2 and 4) indicated that arousal reappraisal and self-efficacy are determinants of challenge and threat responses via both self-report and physiological measures. Conversely, study 2 (Chapter 3) did not find support that self-control strength is an antecedent of challenge and threat responses via either self-report or physiological reactivity data. Study 4 (Chapter 5) indicated that while situational motivation regulations do not predict challenge and threat physiological reactivity responses, they do predict task engagement and self-report measures of challenge and threat responses.

In contrast to previous findings suggesting that challenge responses are associated with better motor task performance (e.g. Moore et al., 2015; Turner et al., 2012), no motor task performance effects of challenge and threat responses were found in the studies outlined in this thesis. Furthermore, studies 1-3 (Chapters 2-4) indicated no effects of attention, which also diverges from findings indicating positive associations between challenge responses and attentional measures (e.g. Moore, Vine, Wilson, et al., 2012; Vine et al., 2013).

Despite these non-expected findings, the results of the thesis have valuable theoretical and applied implications, which are discussed in detail below.

6.2. Significance and Implications of Findings

6.2.1. Theoretical Implications

The findings of this thesis are valuable to theory by producing a more comprehensive interpretation of the BPSM (Blascovich, 2013) and pulling together findings from the TCTSA (Jones et al., 2009) and the IFSAVP (Vine et al., 2016). These are the first studies to attempt to explain results for challenge and threat responses in terms of these three frameworks. This is important in pushing forward knowledge of the role of challenge and threat responses in explaining motor task performance by determining factors that lead to challenge and threat responses and better understanding, how and through what mechanisms challenge and threat influence performance.

The findings add to the BPSM by indicating two determinants of challenge and threat responses (arousal reappraisal, self-efficacy) thereby adding to experimental research on psychological components which factor into demand-resource evaluations. Self-efficacy was proposed by Jones and colleagues (2009) as being a determinant of challenge and threat responses in competitive situations. The findings therefore, provide experimental evidence for a key hypothesis in the TCTSA. Apart from demonstrating the malleability of challenge and threat responses in motor task performance settings, the findings add to the BPSM by demonstrating the impact of situational motivation regulations on task engagement. They also illustrate that the same factors which engender task engagement may likewise lead to task disengagement and encourages future research in better understanding the how and why of it.

Interestingly, some of the findings indicate inconsistencies between the subjective and objective measures of challenge and threat responses proposed by the BPSM. They also do not support the premise that challenge and threat responses lead to differences in performance which has been proposed by the BPSM, the TCTSA, and the IFSAVP. Further, there were also no differences in attention between challenged and threatened groups contradicting the premise that challenge responses are associated with better attention proposed by the TCTSA and IFSAVP. Still, some of the descriptive statistics generally indicated trends to support the postulations regarding performance and attention. The findings showed that relationships between challenge and threat responses and performance and attention may be more nuanced than previously suggested in the literature. The theoretical implications regarding task engagement, determinants, performance, and attention are discussed by topic in more detail below.

6.2.1.1. Task Engagement

The self-relevance of a task is proposed to determine task engagement which is a necessary prerequisite of challenge and threat responses yet task engagement has not been examined extensively within the context of the BPSM (Seery et al., 2009). Since there is conceptual overlap between task engagement and the primary appraisal process suggested by Lazarus and Folkman (1984b), clarity into what determines self-relevance and engagement in a motivated performance situation is of theoretical importance in the stress and coping research. Understanding task engagement is of particular interest since it stimulates the initial activation of the sympathetic neural component of the SAM axis (Chalabaev et al., 2009). The findings from study 4 (Chapter 5) begin filling this gap in knowledge. Though task engagement was generated in both conditions, situational motivation regulations

only significantly predicted task engagement under pressure. The pressure manipulation was characterised by the salience of rewards and punishments related to performance with external regulations being the only significant individual predictor variable. Seery and colleagues (2009) demonstrated that a tangible monetary incentive increased task engagement as compared to a condition without the incentive. Taken with the findings from study 4 (Chapter 5), it indicates the influence of external factors on task engagement across cognitive and motor task performance situations.

Though these findings contradict propositions that intrinsic motivation is a vital component of task engagement (Horrey et al., 2017), they may provide a more authentic portrayal of what drives behaviour in real-world competitive settings. For example, athletes' situational motivation regulations in competition are theoretically less autonomous due to the prominence of external factors such as rankings and prize money (Ryan & Deci, 2007). Such factors can engender task engagement on a situational level if achieving or avoiding these separable outcomes is relevant to, and congruent with their goals. Certainly, in their transactional theory, Lazarus and Folkman (1987) stated that goal relevance and congruence are necessary components of the primary appraisal process. This highlights the importance of examining motivation together with goals in the context of task engagement and therefore underscores a limitation of this thesis but, an avenue for future research.

Interestingly, the descriptive data also suggested the influence of pressure on possible task disengagement. Since task engagement is a prerequisite for challenge and threat responses to be examined, its negative relationship with amotivation, as indicated by descriptive statistics (95% CI [-3.25, .03]), is notable. Motivation intensity theory (Brehm & Self, 1989) suggests that individuals endeavour to avoid

wasting resources and will therefore expend effort to the intensity that is needed and when this expenditure yields returns. Task engagement may therefore break down in instances when individuals are unwilling to invest necessary effort if they perceive that success is both irrelevant and unlikely.

6.2.1.2. Determinants of Challenge and Threat Responses

The findings in this thesis are important for the development of the BPSM and the TCTSA by illustrating key determinants of challenge and threat responses as well as highlighting proposed determinants which do not influence challenge and threat responses. The results of studies 1, 2, and 3 (Chapters 2, 3, and 4) support the use of both self-report and physiological measures of challenge and threat responses in laboratory based settings prior to the performance of a motor task. Study 4 (Chapter 5) however, highlights inconsistencies between these self-report and physiological measures of challenge and threat responses (discussed in further detail in section 6.2.1.2.1. below). Still, the findings support the BPSM and the TCTSA as explanatory models of cognitive and physiological variability under stressful conditions.

Lazarus and colleagues (1985) asserted that each variable in a system has a likelihood of contributing to stress appraisals. Indeed, even the BPSM proposes that any number of relevant factors may enter into demand-resource evaluations (Blascovich, 2008). The approach employed in this thesis involved singling out and manipulating a critical variable, while controlling for others, and measuring challenge and threat responses (Blascovich et al., 2003). Random sampling methods theoretically allowed for equivalent distributions of participants differing by perceptions of psychological and physical danger, familiarity, uncertainty, skills, knowledge and abilities namely, the antecedents proposed by the BPSM

(Blascovich, 2008). Furthermore, strict guidelines regarding possible confounding variables such as consistency in delivery of instructional sets, should have allowed for a controlled and unchanging testing environment. As indicated across the studies in this thesis, this experimental approach is useful in testing variables borne out of existing theories and models as well as findings from correlational research.

For arousal reappraisal (Chapter 2) and self-efficacy (Chapter 4), the findings also establish directions of relationships thereby clarifying that different pre-task instructional sets elicited either relatively more challenged or threatened responses. Importantly, the arousal reappraisal study (study 1, Chapter 2) demonstrated the potency of a short intervention in moving participants from displaying a relatively threatened response to a relatively challenged one. This highlights the swift and malleable nature of demand-resource evaluations in response to additional information but specifically, without changing actual situational demands.

The self-efficacy study (study 3, Chapter 4) on the other hand, demonstrated that following a baseline condition, brief performance feedback produced either a relatively higher threat response or a relatively higher challenge response based upon the verbal content. Not only does study 3 (Chapter 4) enhance the BPSM by establishing an antecedent of challenge and threat responses, it provides support for a key tenet in the TCTSA. Namely, that self-efficacy is a determinant of challenge and threat responses in competitive situations (Jones et al., 2009). The findings indicated that the low and high self-efficacy groups did not differ in their perceptions of demands but did differ in terms of resources, thus showing that the influence of this construct on challenge and threat responses was by changing perceptions of resources specifically. This is a key consideration in motivated performance

situations where it may be too difficult or even impossible to modify demands due to environmental variables.

Turner and colleagues (2014) demonstrated the impact of experimentally manipulating resource antecedents proposed by the TCTSA: self-efficacy, perceptions of control and achievement goals. The authors used instructional sets designed to promote either challenge or threat responses across a throwing task and a climbing task. Challenge instructions focused on promoting high self-efficacy, high perceived control and approach goals while threat instructions focused on promoting the opposite. Importantly, Turner et al. (2014), manipulated only resource evaluations and not demand evaluations via the instructional sets. They found that challenge instructions led to cardiovascular reactivity indicative of challenge responses across both tasks while threat instructions led to cardiovascular reactivity indicative of threat responses across both tasks. While there were positive performance effects of challenge responses in the throwing task, this was not the case for the climbing task (Turner et al., 2014), supporting this thesis' finding that challenge responses are not always associated with better performance outcomes compared to threat responses. Notably, the study design did not account for the effect of each of the individual variables on challenge and threat responses. Not only does study 3 (Chapter 4) provide evidence for the effect of self-efficacy specifically on challenge and threat responses, it demonstrates an empirical approach which can be used in experimentally examining the other suggested resource determinants named in the TCTSA, (i.e.) perceptions of control and achievement goals (Jones et al., 2009).

The thesis' findings also indicated proposed determinants that did not influence challenge and threat responses. In spite of the null findings for self-control

strength, study 2 (Chapter 3) highlighted key areas for future research on related possible antecedents, particularly relevant in sport and health settings. For instance, fatigue has been suggested to influence cardiovascular responses as well as performance in goal-relevant performance situations (Wright et al., 2007). Indeed, Hagger and colleagues (2010) indicated a significant effect of ego depletion on subjective fatigue. The key point of such examples is that demonstrating the lack of effects of proposed variables, such as self-control and situational motivation regulations, on challenge and threat responses is of theoretical importance. At the risk of being somewhat reductionist, it begins to clarify the determinants which do not factor into demand-resource evaluations in particular motivated performance situations and, by extension, promotes future research into related variables which might. Teasing apart constructs and examining their effects on challenge and threat responses thereby allows for insight into responses to stress.

6.2.1.2.1. Measures of Challenge and Threat Responses

An important observation from the findings is that determinants influenced self-reported challenge and threat responses but did not always extend to their concomitant physiological measures. Conversely, it is possible that the opposite is true namely, that determinants influenced the physiological indices of challenge and threat responses but did not always extend to the self-reported ones. Though studies 1-3 (Chapters 2-4) all demonstrate consistency between self-report and physiological measures of challenge and threat responses, study 4 (Chapter 5) did not. Previous studies have also revealed disparate findings for subjective and objectives measures of challenge and threat responses (e.g. Turner et al., 2013; Turner et al., 2012; Vine et al., 2013).

It is possible that the self-report measures used were subject to common response biases in research. For instance, two prominent response biases are social desirability and social approval. In the first case, participants tend towards giving responses in order to avoid criticism while in the second case, they tend towards giving responses in order to receive praise (Hebert et al., 1997). In essence, participants are likely to under-report perceived inappropriate behaviours and over-report perceived appropriate behaviours, (e.g.) ability to cope with situational demands (Donaldson & Grant-Vallone, 2002). It is also possible that participants' introspective ability, regarding demands and resources, is poor. The self-report measures currently used may therefore not be sensitive enough to or adequately reflect conscious demand-resource evaluations.

Rossato and colleagues (2016) have developed a challenge and threat in sport (CAT-Sport) scale which may better complement the observed physiological reactivity patterns in competitive settings at least. Across three studies, the authors demonstrated an acceptable model fit with good internal consistency and criterion validity for a 12-item, 2-factor correlated model. However, as Rossato et al. (2016) acknowledged, they assessed the aforementioned using a small sample size with relatively homogenous participants. Still, there is scope for the CAT-Sport to be assessed and utilised in self-report challenge and threat response research especially in cases, such as real-world competition, in which measuring cardiovascular reactivity proves problematic.

The physiological measures of challenge and threat responses are helpful in eliminating mono-method bias which involves measuring one construct using the same method (Donaldson & Grant-Vallone, 2002). However, interpretations of findings are thwarted when subjective and objective measures are not consistent.

Though response biases are a likely component of self-report measures, objective measures also contain subjective elements in terms of selection, collection, analysis and interpretation (Muckler & Seven, 1992). For example, differences in findings across studies on challenge and threat responses may well be due to variations in the type of task examined (e.g. cognitive vs. motor), the length of reactivity measurements (e.g. seconds vs. minutes), the equipment used (e.g. PhysioFlow vs. HIC-3004), the measure of challenge and threat response (e.g. single challenge and threat index vs. separate measures of CO and TPR) and even habituation to stressful stimuli which leads to dampened cardiovascular reactivity (Kelsey, 1993). An additional key issue is the timing of reactivity measurements specifically, pre-event vs. during the event. Since challenge and threat responses are likely to change over time due to the introduction of additional information (Blascovich, 2008), the timing of reactivity measures is an important variable to consider in interpreting challenge and threat response findings (discussed in greater detail in section 6.2.3.).

The central question then, is which of these measures is more valid and reliable in examining determinants of challenge and threat responses? A strength of the BPSM is that it outlines psychological, neuroendocrine and cardiovascular measures of challenge and threat responses. In order to reduce mono-method bias, all three measures would ideally be incorporated into experimental studies to provide more thorough profiles of challenge and threat responses. In spite of the limitations discussed above which are associated with using objective measures, the physiological measures of challenge and threat responses may be of more salience in sport psychology research. The BPSM proposes that demand-resource evaluations are both conscious and unconscious (Blascovich, 2008) and self-report measures only capture conscious evaluations. Apart from the response biases self-

report measures are subject to, a key concern regards introspective ability. Demand-resource evaluations are rich and complex processes which are subject to acute changes with new information and environmental changes (Seery, 2013). Sporting scenarios are certainly subject to rapid presentations of a range of stimuli which may influence cognitive evaluations and such situations may entail unconscious cognitive processing in the interest of rapid action. Though cardiovascular measures of challenge and threat responses are subject to biases, as discussed above, they may more fully encapsulate challenge and threat responses as compared with self-report measures, particularly if this data is recorded during task performance.

This thesis replicated measurements of cardiovascular reactivity as well as the challenge and threat index calculations used in several key studies examining challenge and threat responses and motor task performance in laboratory settings (e.g. Moore et al., 2014; Moore et al., 2013- performance findings in this thesis however, contrasted those in the studies listed; discussed further in section 6.2.1.3.). Furthermore, reactivity values were used to account for possible individual differences in cardiovascular measures. The studies also followed a paradigm of examining self-reported and physiological reactions to acute, stressful performance situations as in Moore et al. (2015). The replication of methodology, statistical analyses and other contextual factors such as category of task allows for comparison of findings and certainly, the validation of measures.

Demonstrating the efficacy of challenge and threat measurement tools would help to better establish the psychological, physiological and neuroendocrine processes at play in motivated performance situations thereby developing theory. Clarifying inconsistencies in challenge and threat response literature particularly regarding performance outcomes would benefit from the use of established,

standardised measures in replication and future research studies. This would then allow researchers to cumulate and summarise challenge and threat response knowledge to advance the central theories drawn upon in this thesis namely, the BPSM (Blascovich, 2013), the TCTSA (Jones et al., 2009), and the IFSAVP (Vine et al., 2016).

6.2.1.3. Performance

The findings across the four studies (Chapters 2-5) were consistent in showing no effects of challenge and threat responses on either dart throwing or golf putting tasks. These findings are in contrast to a range of previous studies which illustrate that challenge responses are associated with better performance across a range of tasks (e.g. O'Connor, Arnold, & Maurizio, 2010; White, 2008) and for motor task performance specifically (e.g. Moore et al., 2015; Moore et al., 2013). A recent meta-analysis however, assessed nineteen studies and demonstrated relatively small but stable effects of cardiovascular measures of challenge and threat responses on performance (Behnke & Kaczmarek, 2018). The authors observed stronger effects for the challenge and threat index in non-experimental studies as well as bias towards positive results (Behnke & Kaczmarek, 2018). Therefore, while specific limitations associated with each of the thesis studies (discussed in each specific chapter) may have accounted for the null performance findings, there are likely other explanations.

Differences in CV reactivity may not automatically coincide with differences in task performance. Though they focused on cognitive performance, Richter and Gendolla (2006) demonstrated that CV reactivity and task performance are not always explicitly and directly connected. For example, while Vine and colleagues (2013) showed that self-report measures of challenge and threat responses

predicted motor task performance, cardiovascular measures did not mediate the relationships between DRES and performance. The authors did not report main effects of challenge and threat physiological responses on performance. It is likely that there are more salient factors, such as task complexity, which influence motor task performance in novices instead of cardiovascular reactivity indicative of challenge and threat responses. For instance, golf putting is considered a complex motor skill (Maxwell, Masters, & Eves, 2000) as it requires large compound movements with several degrees of freedom (Guadagnoli & Lee, 2004). This means that a novice's attention may be directed to several different task elements before and during performance possibly producing visual attentional disruption and furthermore, extensive performance variability. As discussed in the section below (6.2.1.4.), QE durations in the studies in this thesis were markedly shorter than in similar studies (e.g. Moore, Vine, Wilson, et al., 2012).

On the other hand, other studies have indicated a challenge/threat response and motor task performance relationship where challenge and threat responses have been indicated by cardiovascular reactivity. Importantly, some of these studies have included a design where participants were manipulated into either challenge or threat groups (e.g. Moore, Vine, Wilson, et al., 2012; Moore et al., 2013). It is possible that the instructional sets used in these studies contained an element which directly influenced performance outcomes. For example, participants in the challenge group may have experienced more perceived support which could have positively influenced performance on the task. Though perceived support has been shown to have no influence on challenge and threat responses (Moore et al., 2014), it may act as a process variable which mediates the challenge/threat response and performance relationship. Esteem support has been demonstrated to be the main

perceived support dimension of social support which influences performance with high esteem support associated with high levels of performance (Freeman & Rees, 2009). Esteem support is related to enhancing a person's competence or self-esteem (Rees, Hardy, & Freeman, 2007). According to descriptive statistics, with a p value nearing significance, the high self-efficacy group in study 3 (Chapter four) performed better than the low self-efficacy group following false positive feedback.

However, motor task performance effects of being challenged and threatened have been observed in studies in which challenge and threat responses have not been directly manipulated via instructional sets (e.g. Moore et al., 2015). Therefore, it may be that challenge and threat responses and performance differences, may be due to a methodological issue separate from study design described above. Rossato and colleagues (2016) suggest that some previous research (e.g. Turner et al., 2014) has indicated that challenge and threat groups show overlapping means and standard deviations of cardiovascular reactivity indicative of challenge and threat responses which suggests caution should be taken in interpreting subsequent outcome effects such as performance. In other words, while groups as a whole may indicate a challenge or threat response, differences in individual responses within those groups may skew findings on outcomes such as performance and even attention.

In order to delve into the performance findings, further analyses were done on the data for studies 2, 3, and 4 (Chapters 3, 4, and 5, respectively) since each of these had a measure of challenge/threat response and performance per condition². The data was split by normal responders (relatively more challenged, better

² Study 1 (Chapter 2) replicated Moore et al.'s (2015) study procedure in which the first challenge/threat measures were collected following the pressure manipulation and again following the control/arousal reappraisal intervention both of which were subsequent to baseline performance.

performance and relatively more threatened, worse performance) and opposite responders (relatively more challenged, worse performance and relatively more threatened, better performance) irrespective of experimental group. Study 2 (Chapter 3) contained eighteen normal responders and seventeen opposite responders (nine: more challenged, worse performance; eight: more threatened, better performance) from low to high pressure conditions. Study 3 (Chapter 4) contained seventeen normal responders and thirteen opposite responders (four: more challenged, worse performance; nine: more threatened, better performance) from baseline to post-manipulation conditions. Finally, study 4 (Chapter 5) contained twenty four normal responders and twenty one opposite responders (eleven: more challenged, worse performance; ten: more threatened, better performance) from low to high pressure conditions. The findings show high variability in the individual relationships between challenge/threat responses and motor task performance across the three studies. This illuminates the importance of assessing individual differences when interpreting findings in the challenge and threat response literature.

In order to try to better understand why opposite responders performed as they did, mediation analyses were performed using the *MEDIATE* SPSS custom dialog developed by Hayes and Preacher (2011) for each of the three studies. Based on a 10,000 sampling rate, the results from bootstrapping revealed no significant indirect effects for cognitive anxiety, state self-confidence, mental effort, or QE in any of the data sets (see Appendix 3). It is therefore difficult to say, above and beyond the possibilities already discussed, what exactly led to the performance outcomes of opposite responders. This however, leaves an area rich for future research particularly considering the high number of opposite responders across the studies in this thesis. Recent research for example, points to the importance of individualised

past experiences, such as the number of adverse life events, as a determinant of challenge and threat responses and further, performance. Moore and colleagues (2017) asked one hundred participants to report the number of adverse life events they'd experienced prior to completing a pressurised dart throwing task. The authors demonstrated that participants who had experienced a moderate to high number of adverse life events were not only more likely to display challenge responses, but also performed better under pressurised circumstances (Moore et al., 2017). This research demonstrates the influence of non-sport related past experiences on acute stress responses and performance in a single, pressurised, motor-task performance situation. It is thus important in highlighting the depth of individual factors influential in producing challenge and threat responses and performance effects. Individual past experiences, stable-traits (e.g.) personality traits and even socio-cultural contexts may provide a better understanding of opposite responders and performance effects.

Though the findings illustrate no influence of challenge and threat responses on motor task performance, it is important to acknowledge that the physiological reactivity indicative of challenge and threat responses may influence other types of physical performance. For instance, exercise performance has been shown to increase when there are high concentrations of plasma glucose (Febbraio, Chiu, Angus, Arkinstall, & Hawley, 2000). SAM activation is associated with higher blood glucose levels and, as aforementioned, increased blood flow to the brain and muscles (Dienstbier, 1989). Moreover, threat responses may sometimes produce better performance consequences than challenge responses. Seery (2013) highlighted one such set of instances namely, when performance is dependent on effective vigilance. To explain, relatively higher TPR reflective of the threat response

is associated with a vigilance response whereby there is inhibition of physical activity (Williams, 1985). In situations where such reactions are of importance, threat responses may be more facilitative to performance outcomes. Sustained attention, reaction-timed tasks have previously been used to assess psychomotor vigilance (Loh, Lamond, Dorrian, Roach, & Dawson, 2004) and provide a point of origin from which to test this hypothesis in future. Therefore, it is important to note that performance effects of challenge and threat responses may depend on the type of task (e.g.) aerobic, and the related mechanisms necessary for success (e.g.) vigilance. Assessing performance effects across a scope of tasks would better inform the tenet that challenge responses facilitate performance and threat responses debilitate it (Blascovich, 2013).

6.2.1.4. Attention

Quiet eye duration, a measure of visual attention control (Vickers, 2007), was examined as a main outcome of challenge and threat responses as well as a possible mediating factor of the challenge/threat response and performance relationship. Across studies 1, 2, and 3, (Chapters 2, 3, and 4, respectively), there were no effects of challenge and threat responses on attention and no mediating effects of attention on performance. As before, specific limitations associated with each of the thesis studies (as described in each Chapter) in which attention was assessed may explain the findings. For example, the high self-efficacy manipulation in study 3 (Chapter 4) may have led to increased complacency in over-efficacious individuals and therefore, reduced preparatory time (Bandura, 1997). Descriptive data trends indicated however, that the high self-efficacy group displayed longer QE durations following the manipulation. It is still therefore likely that challenge and

threat responses influence QE duration during motor-task performance and that this relationship is somewhat nuanced.

The counter-regulation principle (Rothermund, Voss, & Wentura, 2008) provides a possible explanation of why challenge responses may not necessarily be associated with a longer QE than threat responses. The principle suggests that individuals experiencing an affective-motivational state display a tendency to attend to information that is affectively incongruent with the current state (Rothermund et al., 2008). Rothermund et al. (2008) demonstrated that participants with gain or loss outcome focuses during a flanker test displayed attentional biases towards stimuli of the opposite valence. The authors proposed that this attentional counter-regulation is beneficial to goal-pursuit and action regulation since emotion and action adaptability is a vital component in achieving aims. Challenge responses are associated with more positive emotions and a gain-related focus as compared to threat responses (Blascovich, 2008).

Providing the counter-regulation principle stands, then challenged individuals will allocate some attention towards negative and loss-related stimuli during goal-pursuit. Being aware of stimuli of the opposite valence allows for a broader scope of information to be processed in pursuit of goals and regulation of action. This was evidenced by Sassenberg and colleagues (2015) who demonstrated that individuals exhibiting a challenge response displayed an attentional bias towards negative stimuli (Sassenberg et al., 2015). As challenge is proposed to be gain-related it was suggested that the perception of having sufficient resources in relation to demands permitted individuals the opportunity to attend to negative stimuli thus allowing them to assess possible hindrances to their goals (Sassenberg et al., 2015). Such attentional biases would theoretically shorten QE durations of challenged individuals.

Interestingly, across studies 1, 2, and 3 (Chapters 2, 3, and 4), mean QE durations were much shorter compared with those of performers with comparable skill levels in other studies. For instance, Querfurth and colleagues (2016) recorded a mean QE duration of 880 ms for novice performers in a baseline dart throwing condition. Following internal or external instructions, mean QE durations were 1300 ms and 1040 ms respectively which translated to improved performance from baseline (Querfurth, Schücker, de Lussanet, & Zentgraf, 2016). However, the mean QE durations for the control and intervention groups in study 1 (Chapter 2) for dart throwing at pressure, were 638.52 ms and 687.75 ms respectively. Furthermore, optimal QE duration in golf-putting is between 2,000 ms and 3,500 ms (Vickers, 2007). Following QE training, Moore and colleagues (2012) noted marked improvements in QE durations and performance for novices in two retention tests and a pressure test. The pre-test mean duration was ~1,200 ms but increased to ~3,500 ms in each of the abovementioned follow-up tests. In both studies 2 (Chapter 3) and 3 (Chapter 4), mean QE durations ranged from 260.54 ms to 620.35 ms across groups and conditions indicating a markedly shorter QE for golf putting as compared with novices in other studies (e.g. Moore, Vine, Wilson, et al., 2012; Vine & Wilson, 2010). It therefore appears that QE duration was simply not long enough to translate to successful performance in either dart throwing or golf putting tasks. Interestingly, in spite of distinctly shorter QE durations, participants' performance scores for the golf putting task were not distinctly worse than in comparable studies in which QE durations were longer. For example, Moore et al. (2012) demonstrated that a challenge group displayed an average QE duration of 1527.34 ms while a threatened group's average QE duration was 1194.86 ms. The challenge group's average mean radial error was 35.8 cm while the threat group's was 46.53 cm. For

golf-putting tasks in this thesis, participants averaged between 33.88 cm to 52.29 cm across conditions in studies 2, 3, and 4 (Chapters 3, 4, and 5).

Though the findings do not support Vine et al.'s (2016) proposition that challenge responses are associated with better attentional control than threat responses, the IFSAVP raises a point of interest for future research. Attention may well be an influential component in the demand-resource evaluative process particularly under pressure conditions. In their integrative framework, Vine and colleagues (2016) suggest that while attentional control may be an outcome of challenge and threat responses, the cyclical nature of stress evaluations means it may well influence subsequent demand-resource evaluations in a feedback loop. The authors propose that threat responses will be reinforced if demand-resource evaluations are skewed due to ineffective attentional control (Vine et al., 2016). In other words, a greater focus on task-irrelevant stimuli and, in cases of high anxiety, increased focus on threatening stimuli, increases the likelihood of evaluating a motivated performance situation in a threatening rather than challenging way. Still, this hypothesis should be tested in future research considering the precepts of the counter-regulation principle regarding attentional allocation biases, discussed above. For instance, researchers could execute multiple motor task trials over the course of multiple conditions to assess attentional biases and tendencies in individuals exhibiting challenge and threat responses. This could be done in tandem with the use of affective stimuli to better understand the interplay of stress responses, emotions and attention in relation to motivated performance outcomes.

The findings support other research which has indicated that attention is not a mediator of the challenge/threat response and performance relationship. Vine and colleagues (2013) used target locking as a measure of visual attention during motor

task performance and found that while self-report challenge and threat responses influenced performance and attention, there was no mediating effect of attention. Furthermore, Moore and colleagues (2012) also found no mediating effects of attention on the challenge/threat and performance relationship; QE duration was used as the attentional measure and mean radial error, as the performance measure of golf putting. It is possible that there is a threshold for QE duration at which mediation effects are observed or that a mediation effect only exists for certain tasks such as psychomotor vigilance tasks (Loh et al., 2004). Furthermore, it is possible that other attentional measures such as speed and accuracy of saccades or the presence or absence of saccadic intrusions (Termsarasab, Thammongkolchai, Rucker, & Frucht, 2015) may be more relevant measures of attention and show mediation effects.

One occasion in which attention might mediate the challenge/threat and performance relationship is for opposite responders. Mediation analysis was therefore executed to test if the effect of group (more challenged, worse performance or more threatened, better performance) on performance was indirectly affected by QE for studies 2 (Chapter 3) and 3 (Chapter 4). However, based on a 10,000 sampling rate, the results from bootstrapping revealed no significant indirect effects for QE duration in either study (see Appendix 3).

6.2.2. Practical Implications

Task engagement is the first stage of the patterning of cognitive evaluations in motivated performance situations (Matthews et al., 2002). Findings from this thesis (Chapter 5) demonstrated that it is engendered by situational motivation regulations and this can inform practices and interventions in applied settings. For instance, task engagement correlates with superior vigilance

performance (Helton, Matthews, & Warm, 2009) which is critical in certain performance scenarios such as military operations. Furthermore, a state of “flow” has been associated with task engagement (Csikszentmihalyi, 2000). Flow influences a number of factors including confidence and automaticity (Harris, Vine, & Wilson, 2017). Further, it has a positive impact on learning (Webster, Trevino, & Ryan, 1993), making it of particular interest when teaching new drills, skills and practices. Better understanding the factors which influence task engagement therefore has positive consequences for learning and training programmes.

The findings from studies 1 (Chapter 2) and 3 (Chapter 4) suggest key factors which could be targeted in practices and interventions promoting challenge responses. Study 1 (Chapter 2) for example, illustrated the effectiveness of an arousal reappraisal intervention in promoting relatively greater challenge responses from a position of both feeling and displaying a relatively greater threat response. Coaches can encourage athletes to evaluate their arousal as facilitative to training and performance. This is closely intertwined with building self-efficacy (study 3, Chapter 4) since perceptions of physiological arousal are hypothesised to influence self-efficacy beliefs (Stajkovic & Luthans, 1979). However, this is just one way of increasing self-efficacy beliefs with others including verbal persuasion (utilised in study 3, Chapter 4), vicarious experience and mastery experiences (Tschannen-Moran & McMaster, 2009). Furthermore, perceptions of affective states also influence self-efficacy beliefs thereby highlighting another way in which self-efficacy may be increased (Tschannen-Moran & McMaster, 2009). The findings from study 3 (Chapter 4) also suggest a caveat which may be of importance to practitioners namely, that while self-efficacy beliefs may promote acute challenge

responses, they may undermine future outcomes if there is a mismatch between beliefs and actual capabilities.

Both the abovementioned studies illustrate ways in which challenge and threat responses can be influenced without explicitly manipulating perceptions of demands. As aforesaid, this is of particular importance in situations in which demands are difficult or impossible to alter. For example, an athlete in a competitive scenario may not be able to change the nature or structure of the competition, but may be able to reevaluate their arousal to produce a challenge response. Furthermore, actively seeking or utilising suggested tactics to increase self-efficacy could produce challenge responses.

6.3. Limitations

An important consideration when interpreting the findings of this thesis regards whether some of the psychological variables examined here are simply different measures of the same construct. Kasl (1978) put forward that a caveat of transactional models is that some constructs which are operationally similar may appear to be two measures of a single concept. This is certainly a point of consideration depending upon how the variables are defined in relation to challenge and threat responses and certainly, when discussing one as an independent variable and the other as dependent. This view however, may be considered somewhat reductionist in nature with Lazarus and Folkman (1984b) arguing that stressors and outcomes are not simplistic concepts and should not be treated as such. Certainly, psychological constructs are internal processes which are inferred via observable cognitive, emotional, and behavioural responses and patterns within a socio-cultural context (Smith, 2005). It is through research that conceptual definitions of these constructs are formulated and from which testable, operational definitions are born

(Smith, 2005). Experimental studies, like those in this thesis, help in teasing apart these constructs thereby advancing psychological theory and practice (Teglasi, Simcox, & Kim, 2007).

A further limitation to this research regards the issue of causal inference. Though it is difficult to disentangle the determinant and challenge/threat response relationship in terms of causality, there is worth in attempting to better understand it. As Lazarus and Folkman (1987) so eloquently wrote three decades ago, identifying determinants that affect processes and thus, consequences, is vital in avoiding the circularity that occurs in recursive systems. Demand-resource evaluations are constantly occurring during motivated performance situations partly due to changing circumstances, stimuli and information (Blascovich, 2013). It is therefore a constant cycle of demand-resources evaluations affecting challenge and threat responses and then the subsequent outcomes, such as attention and performance successes, influencing demand-resource evaluations and so on (Vine et al., 2016). Seemingly, the best compromise in such a situation is to experimentally manipulate one variable and hold others constant to observe whether the effects are as predicted. Providing there is a sound rationale for such, we are able to better understand outcomes from a more positivist standpoint while acknowledging the transactional nature of motivated performance situations (Lazarus & Folkman, 1987). Indeed, examining the interaction of particular variables provides better conceptual and operational understanding as well as a sound platform from which interventions strategies are formulated and implemented (Hall, Kerr, & Matthews, 1998).

Another limitation is that cardiovascular responses were recorded following task instructions but not during task performance. Since demand-resource evaluations are dynamic, subject to change with new information (Blascovich, 2013),

it is likely that the links between challenge and threat responses and performance are somewhat tenuous. This may explain inconsistencies in performance findings among studies which do not record cardiovascular responses during task execution which may provide more accurate reflections of the challenge/threat response and performance relationship. Though previous studies examining challenge and threat responses and motor task performance have also recorded cardiovascular reactivity subsequent to instructional sets but prior to task performance (e.g. Moore et al., 2015; Vine et al., 2013), key data is not chronicled. That is, the exact cardiovascular reactivity during motor task performance is missing. Nevertheless, cardiovascular data was recorded in this way due to possible movement artefacts of recording during motor task performance (Chalabaev et al., 2009; Moore et al., 2014; Wit, Scheepers, & Jehn, 2012). Measurements from impedance cardiology devices such as the one used to collect cardiovascular data in this thesis, are affected by electrical noise and movement (Mehta & Arora, 2014). Other non-invasive methods which measure CO (a measure also necessary for calculating TPR) such as partial gas rebreathing and impedance plethysmography have not been validated (Mehta & Arora, 2014), constraining available, non-invasive methods for recording imperative physiological reactivity measures.

Finally, the neuroendocrine responses associated with challenge and threat responses were not directly measured. This would have allowed for a more comprehensive physiological profile of challenge and threat responses in each of the studies. However, there are several complexities involved in measuring neuroendocrine responses be it via neuroimaging or blood and saliva specimen sampling. For example, some of the hormones implicated in challenge and threat responses, such as norepinephrine and cortisol, have different time-courses of

activation (King & Liberzon, 2009). Furthermore, neuroimaging techniques can be inconvenient and costly (Crosson et al., 2010). While future research may provide unequivocal evidence for the relationships between the cardiovascular and neuroendocrine reactivity implied in challenge and threat responses, cardiovascular alongside self-report measures have been used extensively in previous research (e.g. Blascovich et al., 2004; Moore et al., 2015; Seery, Weisbuch, Hetenyi, & Blascovich, 2010; Turner et al., 2013; Williams et al., 2010).

6.4. Future Research

A key construct which emerged as a variable of interest in this thesis is goals. This is supported from a theoretical standpoint by the TCTSA which proposes that achievement goals are determinants of challenge and threat responses in competitive situations (Jones et al., 2009). Situational motivation regulations were assessed as a possible predictor of challenge and threat responses in study 4 (Chapter 5) however, it is likely that in achievement settings, the quality of motivation is not as salient as the goals which they inform. Though there is research supporting the premise that achievement goals determine challenge and threat responses, the authors only assessed self-report measures of challenge and threat responses and did not examine performance outcomes (Adie, Duda, & Ntoumanis, 2008). They found that mastery-performance goals had strong, positive associations with challenge responses and mastery-avoidance goals predicted threat responses. Furthermore, performance-approach goals had positive associations with both challenge and threat responses but there was no effect of performance-avoidance goals (Adie et al., 2008). Future research should therefore aim to experimentally examine achievement goals as determinants of challenge and threat responses in motivated performance situations and subsequent motor task performance.

This thesis utilised straightforward experimental methods to test determinants of challenge and threat responses but future research can assess more complex models to extend the research. For example, Moore and colleagues (2014) examined two proposed antecedents in a 2 (required effort; high, low) x 2 (support availability; available, not available) design. Since demands and resources are proposed to be interdependent (Blascovich, 2013), more complex models could be used to ascertain the importance and influence of possible antecedents of challenge and threat responses. Conducting this research experimentally would entail large sample sizes and would require control of possible confounding variables. Thereby, establishing determinants using the methodology employed in this thesis is a first-step prior to more complex model testing.

Since the performance and attention findings contrast previous research showing positive relationships between challenge responses and motor task performance (e.g. Moore et al., 2015) and attention (e.g. Moore, Vine, Wilson, et al., 2012), future research should attempt to clarify these inconsistencies. Apart from replicating these studies, prospective studies could examine other types of motor tasks (e.g.) penalty shots in ice hockey, free throws in basketball and pitching in baseball. Furthermore, the possible importance of mediator variables in the challenge/threat response and performance relationship should be assessed. Utilising objective measures of mental effort such as heart rate variability (Harris et al., 2017) could provide stronger support for the role of mental effort as a possible mediator. Other mediators of interest based on the findings presented in this thesis include processing speed and different measures of attention such as speed and accuracy of saccades (Termsarasab et al., 2015).

Apart from motor tasks, future research should attempt to clarify how challenge and threat responses might influence other types of performance. Challenge responses represent a more efficient physiological response via increases in CO and decreases in TPR and this has potential benefits for tasks where physiological processes and consequences are salient in producing performance outcomes such as tasks in which acute and sharp physiological reactions are prominent (Jones et al., 2009). Interestingly, performance benefits may extend to endurance performance. Maximal oxygen consumption, the lactate threshold and efficiency are considered key factors in endurance performance (Joyner & Coyle, 2008). The previously discussed neuroendocrine and cardiovascular reactions associated with challenge responses could facilitate such physiological processes over time. Furthermore, the increased epinephrine and norepinephrine representative of challenge responses may facilitate decision-making (Jones et al., 2009), an integral component of goal-directed behaviour (Araujo, Davids, & Hristovski, 2006). Assessing whether there is transfer from theory to practice is a useful direction for future research.

Future research should also seek to clarify another inferred tenet of the BPSM. As Wright and Kirby (2003) have pointed out, patterns of neuroendocrine reactivity have only been assumed from the differences in cardiovascular responses described in the BPSM. Implications from such research could support and extend the BPSM and associated theories such as the TCTSA by providing evidence for the proposed neuroendocrine responses. Furthermore, it would allow for another measurable, objective measure of challenge and threat responses. Moreover, clarifying the neuroendocrine responses could have possible implications in health and well-being settings. For instance, HPA activity characteristic of a threat response

is accompanied by increases in cortisol which has a half-life of sixty to ninety minutes (Jones et al., 2009). Though cortisol secretion in normal amounts is important in healthy functioning, disrupted cortisol cycles can negatively influence a range of outcomes (Thompson et al., 2012). Negative health outcomes susceptible to prolonged cortisol secretion include hypertension, amenorrhea and immunosuppression (Brindley & Rolland, 1989). It is important to note that this thesis only assessed immediate responses to acute stress and, neuroendocrine responses were not directly measured. However, the findings suggest that threat responses may contribute to a pattern of negative physical consequences when considered across time. Longitudinal studies would be useful in assessing such consequences across time.

Finally, though there are several possible limitations with neuroimaging as discussed above, it has the potential to provide information which has previously only been inferred through theoretical argument such as causal relationships between cognition and emotion. While authors have treated emotions as consequences of cognitive evaluations (e.g. Lazarus & Folkman, 1984b; Skinner & Brewer, 2004) there is difficulty in separating cognition and emotion empirically due to their high interdependence (Storbeck & Clore, 2007). However, separate neuroanatomical structures can be identified for affect and cognition (LeDoux, 2003) making neuroimaging a particularly useful tool in teasing apart their relationship. Certainly, the circularity of the transactional models suggests that emotional variables may act as determinants as well as outcomes of challenge and threat responses. Therefore, future research may lie in examining the neurobiological underpinnings of proposed determinants of challenge and threat responses via neuroimaging techniques.

6.5. Conclusion

The findings in this thesis are important as they establish the relative importance and influence of key psychological variables on challenge and threat responses. This thesis is the first to experimentally examine the proposed determinants and to do so in motor task performance settings. Arousal reappraisal (study 1, Chapter 2) and self-efficacy (study 3, Chapter 4) were illustrated as determinants of both subjective and objective measures of challenge and threat responses. Self-control (study 2, Chapter 3) had no observed effects on self-report and physiological measures of challenge and threat responses while situational motivation regulations (study 4, Chapter 5) influenced self-reported challenge and threat responses but not cardiovascular reactivity indicative of such. However, situational motivation regulations predicted task engagement as indicated by cardiovascular reactivity. Importantly, task engagement is a prerequisite for challenge and threat responses to occur. The findings contribute to the development of the BPSM and also provide support for tenets of other contemporary models such as the TCTSA but not the IFSAVP. Though challenge and threat responses were not associated with the expected motor task performance or attention outcomes, the findings provide a foundation from which additional research can be executed in order to better clarify these relationships. Overall, the thesis makes a novel contribution to the literature by supporting and extending knowledge on responses to stress and has implications in applied settings particularly relevant to interventions promoting challenge responses.

Chapter 7: References

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Appendix 1

Control Task Reading

Although many of our finches flock together at this time of year to find food and benefit from safety in numbers, bullfinches are fairly solitary, often staying in their pairs or in small groups. Many of them don't travel more than a few miles from their breeding grounds, making them one of our most sedentary British birds.

They're also secretive, slipping away through dense cover – the only clue to their presence a flash of white rump and a soft piping whistle. With a good view, the males are dazzling birds with rose-pink underparts and a smart black cap. Females have duller plumage because they don't need to attract attention from predators, especially when incubating their eggs.

Both sexes have stubby black bills, which are perfect for nipping off the tree buds that bullfinches relish. This habit has made them unpopular with growers of fruit trees since a bird can eat up to 45 buds a minute. In the past, a bounty of a penny was paid on the head of each bullfinch killed, and in a single Cheshire parish, nearly 7,000 bullfinches were killed over a period of 36 years.

Now bullfinch numbers are much lower and they are less of a problem. As well as eating buds, they are also partial to ash keys and in midwinter you may see them on a frosty day, nibbling the tiny seeds of nettles and other plants. They are shy birds and will slip away into the shrubbery if you get too close.

Bullfinches will visit bird tables for seeds, but because they don't travel far, will only turn up if they have a territory nearby.

Appendix 2

Transcription Task Text

The red squirrel has been in severe decline in the UK but one island has completely eliminated grey squirrels to promote a red resurgence. Could it lead to a wider programme of eradication, asks Rachel Argyle.

Once common, red squirrels have declined rapidly in the UK since the 1950s, falling in numbers from about 3.5 million, to a current estimated population of around 130,000.

Anglesey, an island off the north-west coast of Wales, declared itself a grey squirrel-free zone earlier this year after an 18-year cull.

Now, it's been announced that a share of £1.2m of Heritage Lottery Fund money will see the cull of grey squirrels extend to the neighbouring county of Gwynedd, where no native nutkins have been spotted for nearly 70 years.

Grey squirrels, said to have been brought to Britain from the US in the 19th Century, crossed the Menai Strait between Anglesey and mainland Wales in the mid-1960s. By 1998 the species had replaced the red squirrel almost completely, with only 40 red squirrels remaining.

It's long been believed that greys act as carriers of squirrel pox - which kills reds.

So in Anglesey a plan was hatched to cull the greys. "It began with the vision of Esme Kirby," says Dr Craig Shuttleworth, adviser to the Red Squirrel Survival

Trust. "She was a conservation campaigner and undaunted in her fight to see the reds return to Anglesey and the UK as a whole. She never shied away from the issues involved with the cull of the greys and was open and transparent in her efforts."

The island last had a sighting of a grey squirrel in 2013 and has now been declared the first area of the UK to become grey squirrel-free, says Shuttleworth. There are other areas of the UK that are regarded as free of greys but they have always been that way - thanks to natural barriers rather than conscious eradication.

But the culling of one species in favour of another was never going to be an easy task. The challenges ranged from resource and technology issues to garnering landowner, public and political support.

Live-trapping techniques were used to control greys and no poison or any type of spring (kill) trap was used. Captured grey squirrels were allowed to venture out from the wire trap into sacking that had been placed around the entrance. The squirrel would then be moved into the corner of the sack and killed by a single blow to the back of the head. This is regarded to be a humane method.

Over 200 volunteers and a project team, as well as contractors, were involved.

The reds are rare and the general public wanted to see them," says Shuttleworth. "We needed to ensure that the reds were visible to help the ongoing support for the campaign."

Anglesey's efforts received public backing but not everybody in Britain has welcomed culling projects in the same vein. There are plenty who regard the progression from wanting to preserve reds to a position of backing elimination of greys as irrational.

Businessman Angus Macmillan and his family set up the Professor Acorn website in December 2006 to "redress the balance and seek the public's support for all squirrels, irrespective of their ethnic origin or the colour of their fur".

"I feel it is morally wrong to slaughter members of one sentient species to protect members of another just because they are regarded as aliens," explains Macmillan. "We have support for our aims throughout the UK and abroad." A petition to "Stop the UK grey squirrel cull" has so far attracted almost 140,000 signatures.

The opponents say the trapping and killing of grey squirrels is indiscriminate and cruel. "It causes stress to a wild animal, lactating females are killed leaving their kittens to die a slow and painful death and there is no guarantee that shooting a squirrel, which can easily move faster than the reactions of the shooter, will result in instant death," says Macmillan.

The Professor Acorn campaigners are currently researching whether red squirrels are in fact native to the UK and attack the theory that greys are the cause of the decline of the reds.

"Greys are blamed for the spread of the Squirrel Pox Virus because they have been found with antibodies - but antibodies don't mean they are all carriers all of the time," says Macmillan. "All it means is they have been exposed to the disease and fought it off. A bit like us if we get flu."

But for the red squirrel conservationists the link is clear and the cull in Anglesey has demonstrated the positive effect on pox transmission and red numbers.

"The cull was never a case of xenophobia," says Shuttleworth. "The greys are an invasive animal and they simply shouldn't be here. The red squirrel project acted as a litmus test for culls of other invasive species. If we couldn't succeed with these cute and furry animals, what hope would the less appealing species have?"

Today Anglesey has the largest and most genetically diverse population of red squirrels in Wales with around 700 recorded on the island.

Other strongholds for the native red include Scotland, the Lake District and Northumberland with some isolated populations further south in both England and Wales including Formby in Merseyside and the Isle of Wight, but will the UK ever be rid of the greys entirely?

"Never say never," says Dr Shuttleworth. "When we first started out, we were greeted with a soundbite reaction that when you kill one grey squirrel, two turn up to its funeral.

"Yet we achieved what we set out to achieve here on Anglesey and there is no reason why, if we take on the many lessons learned, we can't replicate this in other parts of the UK and one day, perhaps the country as a whole."

Appendix 3

Mediation results for cognitive anxiety, self-confidence, mental effort, and quiet eye in opposite responders (low pressure) for Study 2 (Chapter 3).

	Effect	SE	LL95% CI	UL 95% CI
Cognitive Anxiety	-2.15	5.63	-18.72	3.29
Self-Confidence	-1.06	5.17	-19.38	3.43
Mental Effort	.19	2.69	-3.95	5.89
Quiet Eye	.69	3.04	-2.02	7.77

Mediation results for cognitive anxiety, self-confidence, mental effort, and quiet eye in opposite responders (high pressure) for Study 2 (Chapter 3).

	Effect	SE	LL95% CI	UL 95% CI
Cognitive Anxiety	-.10	3.45	-5.25	2.67
Self-Confidence	-2.85	3.74	-12.91	1.89
Mental Effort	1.34	3.76	-3.34	13.41
Quiet Eye	-.27	1.62	-4.21	1.93

Mediation results for cognitive anxiety, mental effort, and quiet eye in opposite responders (post-manipulation) for Study 3 (Chapter 4).

	Effect	SE	LL95% CI	UL 95% CI
Cognitive Anxiety	-.05	3.48	-6.43	9.36
Mental Effort	-1.26	1.80	-8.01	.23
Quiet Eye	-.46	1.13	-6.05	.10

Mediation results for cognitive anxiety, self-confidence, and mental effort in opposite responders (high pressure) for Study 4 (Chapter 5).

	Effect	SE	LL95% CI	UL 95% CI
Cognitive Anxiety	-.04	.88	-1.90	.79
Self-Confidence	-.03	.87	-1.84	1.21
Mental Effort	.66	1.60	-.49	2.74