THE EFFECT OF MASTERY IMAGERY ABILITY ON APPRAISALS AND RESPONSES TO PSYCHOLOGICAL STRESS

By

CLARA MAUDE MÖLLER

A thesis submitted to the University of Birmingham

for the degree of

MASTER OF SCIENCE BY RESEARCH

School of Sport, Exercise, and Rehabilitation Sciences

College of Life and Environmental Sciences

University of Birmingham

September 2018

Abstract

The aim of this thesis was to investigate the effect of mastery imagery ability in regulating the appraisals and responses to stress. Following a review of the imagery and stress literature in Chapter 1, Chapter 2 consisted of an investigation on the associations between mastery imagery ability, perceived stress, general anxiety, and immediate anxiety intensity and interpretation. Chapter 2 also included an examination of whether perceived stress was a potential mechanism through which mastery imagery ability was related to anxiety. Building on the associations exhibited in Chapter 2, Chapter 3 used an experimental study design to conduct a pilot study investigating if mastery imagery ability could be increased using layered stimulus response training (LSRT), and whether increasing mastery imagery ability decreased perceived stress and general anxiety, and altered psychological appraisals and responses as well as cardiovascular responses to an acute stress task compared to a control group. Chapter 4 (i.e., the general discussion) then discussed the results found in Chapters 2 and 3 and provides avenues for future investigation. Overall, this thesis contributes to imagery and stress literature by identifying new relationships between mastery imagery ability and constructs associated with stress and coping. Findings also highlight the importance of mastery imagery ability in a non-athletic setting, and suggest that layered stimulus response training could be an effective technique to increase mastery imagery ability and subsequently lead to more adaptive coping under stress.

Acknowledgements

I would first like to give a huge thank you to my amazing supervisor Sarah Williams, for her unwavering support throughout my whole MSc by research programme. Unknowingly, she always provided a calm, engaged, and optimistic outlook that was contagious. Even when I was at the height of my stress, she always provided meaningful feedback and helped me stay confident in my abilities. I am beyond grateful to have been given the chance to work with her.

I also want to thank my other two supervisors, Jet and Annie, who dealt with my ever evolving schedule and were always willing to give me phenomenal feedback throughout my programme. I admire all the work my three advisors do and cherish getting the chance to work with them, as well as learn from them. This thesis would not have been possible without them and their incredible guidance.

I would also like to thank my fantastic lab mates, Gavin Trotman and Jack Davies, without whom I would have been completely lost. I could not have asked for better people to work alongside and learn from. Not only were they brilliant to work with, they also made every day amusing.

A massive thank you goes to my mom and two sisters, who motivated me to go for this programme in the first place as well as made it possible for me to do it. Thank you for all the late night calls and pep talks, they meant the world to me! In every step of my academic journey thus far they have endlessly supported me and always given me a reason to do my very best. I look forward to celebrating this achievement with you!

Last but not least, thank you to my incredible friends Chloe, Beth, Nathalie, and Emilia. Your friendship kept me going and gave me much needed laughs along the way. I cannot imagine my experience in Birmingham without you!

Table of Contents

Chapter 1 General Introduction	**Page**
Stress and Health	2
Anxiety and Perceptions of Anxiety and Stress	4
Mental Imagery	5
Imagery Interventions	8
Chapter 2 Investigating the Mediating Role of Perceived Stress on Mastery Imagery Ability and Anxiety	
Introduction	16
Method	21
Results	27
Discussion	31
Chapter 3 The Effects of Increasing Mastery Imagery Ability on Perceived Stress, General Anxiety, and Psychological and Cardiovascular Responses to Acute Psychological Stress	
Introduction	37
Method	45
Results	56
Discussion	66
Chapter 4 General Discussion	
References	80

Chapter 1

General Introduction

General Introduction

Stress is prevalent and on the rise in today's society. According to the Mental Health Foundation's 2018 study done within the United Kingdom, 74 percent of people reported feeling so stressed they have been overwhelmed or unable to cope. Dean Debnam from Huffington Post stated that based on global data, employees are seeking assistance for more severe and intense emotional health issues than ever before (2017). Furthermore, within U.S. industry, job related stress is estimated to cost over $300 billion annually due to its effects on things such as diminished productivity, accidents, and employee turnover (Workplace Stress, 2018). Taken as a whole, stress is not just a problem in the work force or a concentrated area, but has also been acknowledged in the popular media for being wide-spread. These reports of increasing stress are alarming as stress has detrimental effects on individuals' health and well-being.

Stress and Health

Prolonged stress has harmful effects on the body, both mentally and physically. Exposure to prolonged stress can increase an individual's risk of developing depression, anxiety, cardiovascular problems, obesity, and other diseases (Mayo Clinic Staff, 2016; Heslop et al., 2001; Greenwood et al., 1996). Not only can prolonged stress lead to poorer long term health, it can also lead to destructive psychological states. For example, Rosiek et al. (2016) found that chronic stress and anxiety among medical students lead to a negative influence on mental health and confirmed a relation to suicidal thinking. A Labour Force Survey estimated that in 2007/08, 442,000 workers in Britain felt that the work-related stress they were experiencing was making them ill (Labour Force Survey Government Stats; ISMA 2009). In support of this notion, research has shown that self-reported stress is related to health-related behaviours, such as higher fat diet, less frequent exercise, and cigarette smoking (Ng & Jeffery, 2003). Racic et al. (2017) determined that higher levels of perceived stress predisposed health professionals for anxiety and a lower quality of life. Chronic anxiety has the potential to leave individuals susceptible to developing coronary heart disease (Coryell, Noyes & Hause, 1986; Kawachi, Sparrow, Vokonas & Weiss, 1994), depression (Weger & Sandi, 2018), and if left untreated can lead to suicide attempts (Nepon, Belik, Bolton & Sareen, 2010). Based on the severe harmful effects that chronic stress can have on health and well-being, research is needed to identify characteristics associated with lower stress, as well as establish inexpensive, non-invasive, and convenient techniques that people can implement in day to day life to lower stress and decrease stress' harmful psychological and physiological effects.

One potential mechanism explaining the relationship between stress and disease could be in the way the body physiologically responds to acute psychological stress (Dimsdale, 2008). Acute stress elicits different psychological and biological responses, such as higher anxiety levels and elevated blood pressure, which are thought to be two of the main contributing factors to what leads to the damaging health outcomes associated with stress (Carroll et al., 2012; Racic et al., 2017). Indeed, high cardiovascular responses to stress have been associated with cardiovascular disease and cardiovascular disease mortality (Carroll et al., 2012; Chida & Steptoe, 2010). Some research has shown those with higher perceived stress can experience greater activation of the acute stress response in a laboratory setting, which can be maladaptive and involve prolonged increases in blood pressure and vascular hypertrophy (Brosschot, Gerin & Thayer, 2006; Henry et al., 1975; Selye, 1956). Furthermore, high levels of stress predispose individuals to increased symptoms of anxiety (Shekhar, Truitt, Rainnie & Sajdyk, 2005; Wiegner et al., 2015). Consequently, it is important that techniques target not only lowering stress itself, but also regulating the responses experienced such as anxiety and increased blood pressure, to decrease the negative long term effects these responses can have on health.

Anxiety and Perceptions of Anxiety and Stress

Anxiety is typically defined as a state of unease or nervousness about an upcoming event (Buss, Wiener, Durkee & Baer, 1955). Anxiety is a multidimensional construct which has distinct components described as cognitive and somatic. Cognitive anxiety is the mental disturbances of anxiety, such as negative thoughts or worries, and somatic anxiety is the physical disturbances of anxiety, such as increased heart rate and butterflies in the stomach (Steptoe & Kearsley, 1990; Ree et al., 2008). Although work has typically attempted to reduce anxiety symptoms (i.e., lower its intensity), more recent research has also focused on changing perceptions or interpretations of anxiety. In other words, helping an individual assess their feelings of anxiety to be helpful (facilitative) rather than unhelpful (debilitative). An emerging area of research on interpreting anxiety as facilitative, which refers to anxiety that is helpful to performance rather than debilitative, has provided evidence that changing perceptions of anxiety may at times be more effective in helping individuals in high stress situations (Jones & Hanton, 2001; Hanton, Mellalieu & Hall, 2004). Jones and Hanton (2001) found that individuals with more facilitative interpretations of their anxiety reported significantly more positive feelings (e.g. confidence) than those who interpreted their anxiety as more debilitative, who reported significantly more negative feelings (e.g. anxious) before competition.

Anxiety perceived as being facilitative is also related to better performance and coping under pressure (Hanton et al., 2008; Hanton, Neil & Mellalieu, 2008; Ntoumanis & Biddle, 2000; Jones & Swain, 1995). Indeed, when comparing elite and non-elite performers, there was no difference in anxiety intensity, however, elite performers interpreted their anxiety intensity as more facilitative compared to non-elite athletes (Jones & Swain, 1995). Further studies have even suggested that cognitive and somatic anxiety interpretation is at times more important in predicting performance than the intensity of the anxiety symptoms

(Chamberlain & Hale, 2007; Neil, Wilson, Mellalieu, Hanton, & Taylor, 2012). Beyond the sport setting, Raffety, Ronald, and Ptacek (1997) determined in a population of college students that those with debilitating (i.e., unhelpful) instead of facilitating (i.e., helpful) test anxiety, had lower examination scores, higher anxiety, and less problem-solving coping. Compared to facilitative test anxiety, those with debilitative test anxiety also showed higher levels of tension, worry, distraction, and avoidant coping, while those with high facilitative test anxiety showed support seeking, proactive and problem-solving coping (Raffety et al., 1997). Such findings further highlight the importance of not just looking at anxiety in terms of intensity, but also looking at whether an individual perceives their anxiety as facilitative or debilitative.

Similar to the interpretations of anxiety, Keller et al. (2012) found that it is not just the amount of stress but also the perception of stress which affects health. For example, those who reported high levels of stress but also felt that this stress substantially impacted their health, had a 43% increased risk of early death. While those who reported high levels of stress, without feeling it affected their health, did not have an increased risk for premature death (Keller et al., 2012). These findings are in line with the transactional model of stress and coping (Lazarus & Folkman, 1984; Wenzel, Glanz, & Lerman, 2002), which states that the impact of a stressor is mediated by an individual's appraisal or interpretation of the stressor. Consequently, when examining techniques to regulate stress and the subsequent responses such as anxiety, it is important to examine the effects of these techniques not only on lowering the stress levels and subsequent responses, but also their effectiveness at altering the negative and positive perceptions of these responses.

Mental Imagery

Mental imagery is one technique which can be used to regulate stress and anxiety. In a study conducted by Bigham et al. (2014), guided imagery use decreased cognitive and emotional stress scores, and decreased behavioural symptoms of stress. There are numerous studies showing how mental imagery can reduce trait and state anxiety (e.g., Afshar, Mohsenzadeh, Gilasi & Sadeghi-Gandomani, 2018; Charalambous, Giannakopoulou, Bozas & Paikousis, 2015; Holmes et al., 2006). For example, Holmes et al. (2006) showed that participants in an imagery training condition reported greater increases in positive affect and greater decreases in state anxiety after positive interpretation training. Mental imagery has also been shown to lower physiological indicators of stress (Lee, Kim & Yu, 2013; Yijing et al., 2015). Tolgou et al. (2017) discovered that health-anxious subjects, determined by cortisol levels, showed a stronger reduction of cortisol level after imagery re-scripting, a technique that alters the content of an emotion-inducing past event to be positive rather than negative, compared to the other groups. The re-scripting group also displayed a trend of the most extreme reduction in heart rate, thus the strongest reduction in physiological activation.

Re-scripting using mental imagery is thought to be effective in regulating stress as it allows individuals to mentally re-experience a feared outcome that gives them anxiety, use the imagery as a way to change the perception or reaction in their imagined scenario (Holmes, Arntz & Smucker, 2007; Lee & Kwon, 2013). Consequently, when the actual event is experienced again, the individual might be able to weaken the anxiety and stress experienced, because they have altered their beliefs about the feared situation and realize it actually causes no danger and thus there is no reason to have heightened anxiety and stress (Arntz, 2012; Hagenaars & Arntz, 2012; Tolgou et al., 2017). In support of this, Williams et al. (2017) demonstrated that imagery can alter stress appraisals, and cardiovascular and psychological responses to an acute stress immediately following imagery re-scripting of the situation. Participants mentally visualized three different imagery scripts, a challenge, threat, and neutral script. All scripts included the same situation of getting nervous to give a speech, however the interpretation of the situation was changed for each script so that compared to the threat condition the challenge condition made participants feel confident in their ability to cope, through feelings of efficacy and control over the situation. The threat imagery elicited lower levels of self-confidence, more negative interpretations of anxiety symptoms, significantly more feelings of stress and threat, and significantly higher heart rate during the task. Furthermore, Jamieson, Nock and Mendes (2012) researched whether reappraising arousal could improve cardiovascular and cognitive responses to stress and found that compared to the controls, participants that were told to reappraise their arousal during a stressful task as functional and adaptive exhibited more adaptive cardiovascular stress responses and decreased attentional bias for emotionally-negative information. Furthermore, John-Henderson, Rheinschmidt, and Mendoza-Denton (2015) investigated the effects of reappraising physiological arousal during stress. The researchers found that this reappraisal reduced increases of an immune marker of inflammation, cytokine Interleukin-6 (IL-6), indicating reappraisal as a potential effective buffer of inflammatory responses during stress. These findings indicate the potential for imagery, especially imagery that includes elements of reappraising, to alter cardiovascular stress responses. Together, this provides evidence that imagery and reappraisal, which can be done through imagery training, could influence both cardiovascular and psychological responses to acute stress.

Mental imagery has also been shown to increase feelings of confidence (Mamassis & Doganis, 2004; Munroe-Chandler, Hall & Fishburne, 2008). These increases in confidence are likely to be a mechanism through which imagery makes anxiety and other responses to stress (e.g., cardiovascular responses) more positive in how they are interpreted (Skodzik, Leopold, & Ehring, 2017; Tolgou et al., 2017; Williams et al., 2017). Skodzik, Leopold, and Ehring (2017) examined whether training high worriers to use more mental imagery in their everyday lives would be an effective intervention to reduce pathological worry. The authors found that mental imagery training had beneficial effects on controllability of worry, state anxiety, and positive mood in highly anxious participants (Skodzik et al., 2017). These findings suggest that imagery aimed at changing perceptions of anxiety and giving an individual more control over their thoughts could be effective in helping those suffering from high anxiety and stress. In line with this idea, Williams et al. (2017) suggested that imagery interventions should acknowledge the stressful nature of events, while emphasizing feelings of confidence/self-efficacy and control in order to elicit more adaptive coping from the individual. In other words, instead of focusing on reducing feelings of stress or anxiety, techniques should provide individuals with tools to appraise these feelings as in control and give them confidence in their ability to cope with stress and anxiety.

Imagery Interventions

In order to develop an imagery intervention that is effective, it is important to follow guidelines from well-established frameworks. The revised applied model of deliberate imagery use was designed to provide researchers and applied practitioners with a framework of different factors to consider when trying to implement effective imagery (See Figure 1; Cumming & Williams, 2013). Expanding on the original applied model by Martin, Mortiz, and Hall (1999), Cumming and Williams developed the revised applied model of deliberate imagery use, which includes "where", "when", "why", and "imagery ability" components proposed to be important in imagery training. The revised

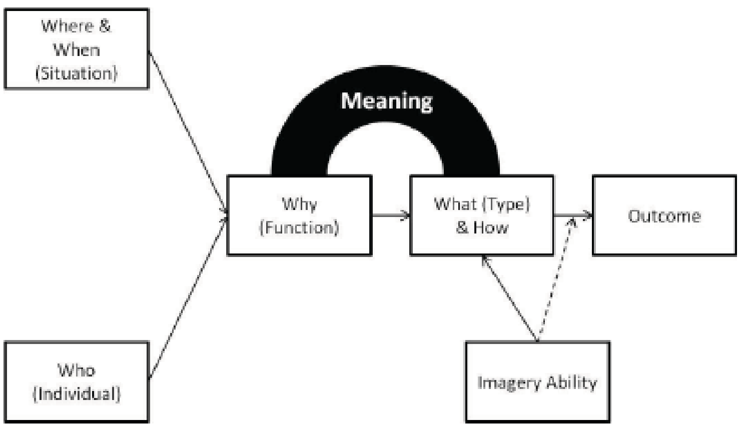

Figure 1. Revised applied model of deliberate imagery use. Adapted from "Revised applied model of deliberate imagery use" in Cumming J., & Williams S.E. (2012b). The role of imagery in performance, in S. Murphy (Ed), *Handbook of Sport and Performance Psychology* (p. 213-232), New York, NY: Oxford University Press.

applied model distinguishes between what is imaged from why it is imaged (2013). Furthermore, it includes additional components that focus on how someone might image a scenario, and considers important factors such as "who" the individual is as well as the "meaning" an image is likely to have to the individual. The model also emphasizes the relationship imagery ability has with imagery use and outcomes.

The "where and when" component refers to the location and situation in which the imagery is being conducted (e.g. at home the night before an important job interview), while the "who" component refers to the individual performing the imagery (e.g., the individual who is going to be interviewed the next day). The "why" refers to the intended function of the imagery (e.g., increase self-confidence and regulate anxiety), the "what" is the specific imagery content (e.g., themselves performing well during the interview ahead), the "how" refers to characteristics within the images (e.g. real time, visual perspective adopted). The model proposes that first the function of the imagery should be identified (e.g., to increase confidence and regulate anxiety), before deciding on the specific content and characteristics to address this function (Cumming & Williams, 2013). This is because the "meaning" refers to how content may serve an intended particular function depending on the individual (e.g., imagery on performing well may improve confidence for one person, but imaging the feelings associated with confidence may be more effective at improving confidence for another person). Consequently, different images may serve the same functions for different people (Cumming & Williams, 2013).

Within the present thesis, the function of imagery is to regulate stress levels by helping individuals reappraise their stress and anxiety as facilitative to performance under pressure, rather than debilitative. Research suggests that mastery type imagery (i.e., imagery content associated with feelings of confidence and control during difficult and/or challenging situations) compared to skill, strategy, goal, or affect imagery ability, appears to be the most effective type of imagery for regulating stress. For example, Cumming, Olphin and Law (2007) examined self-reported psychological and physiological responses experienced during different motivational general imagery scenarios and found that mastery-based coping imagery enabled athletes to experience elevated levels of anxiety intensity at the same time as perceiving thoughts and feelings as helpful. Other studies have similarly found that mastery imagery can elicit positive interpretations of anxiety and more adaptive cardiovascular responses (Williams, Cumming, & Balanos, 2010; Williams et al., 2017). Additionally, Williams et al. (2010) found that participants thought the mastery imagery was more effective than the relaxing imagery at helping them regulate their responses to stress. Consequently, mastery imagery will be utilised in the present thesis.

The revised applied model also highlights the importance of imagery ability as a key determinant in imagery's effectiveness. Imagery ability refers to how well the individual can perform the imagery and is reflected in things such as the ease, vividness, and controllability of what is imaged and how this is performed. Williams and Cumming (2013) propose that imagery ability directly impacts what is imaged and mediates the relationship between what is imaged and the function of the image. In other words, if an individual does not have the ability to image the intended content (e.g. imaging successfully competing under pressure) then they will not be able to benefit from the intended function of the imagery (e.g. increasing confidence at being able to perform under pressure). In support, interventions have demonstrated that imagery can either be less, or not at all effective for those with poorer imagery ability compared to those more proficient at imaging (McKenzie & Howe, 1997; Robin et al., 2007; Williams, Cooley, & Cumming, 2013). Furthermore, imagery ability explains a large proportion of variance in imagery use. Specifically, those with poor imagery ability are less likely to use imagery (Gregg et al. 2011; Williams & Cumming, 2012a). As expected, the ability to image mastery type content, predicted the use of the motivational general functions of imagery such as to increase confidence and regulate anxiety (Gregg et al., 2011; Williams & Cumming, 2012a). Therefore, an individual's mastery imagery ability is likely to influence the effectiveness of the imagery in regulating stress and anxiety.

Beyond its association with effective imagery use, higher mastery imagery ability is also associated with greater levels of confidence, more frequent challenge appraisals, lower anxiety, and a greater tendency to perceive symptoms as more facilitative in relation to an upcoming task (Williams & Cumming, 2012b; 2015; Quinton, Cumming & Williams, 2018). Collectively these findings suggest that individuals with higher mastery imagery ability display healthier coping characteristics. Additionally, Quinton, Cumming, & Williams (2018) conducted a cross-sectional study on an athlete population and found that higher confidence levels directly predicted lower cognitive and somatic anxiety intensity. Furthermore, mastery imagery ability mediated the relationship between confidence and anxiety intensity, and the relationship between confidence and a challenge appraisal tendency was mediated by positive mastery imagery ability. This evidence suggests that mastery imagery ability may be important in equipping people with the appropriate skills to help them successfully cope during stressful situations. However, the current research has not yet examined whether mastery imagery ability relates to anxiety in a non-sport population.

Although imagery ability appears an important correlate of constructs associated with better coping under stress, imagery ability is a disposition which can be honed and improved through different techniques. Smeeton et al. (2013) used an imagery script based on the physical, environment, task, timing, learning, emotion, and perspective (PETTLEP) approach to imagery and found that it successfully improved visual imagery ability (Holmes & Collins, 2001). Similarly, Anuar, Cumming and Williams (2016) also discovered that incorporating PETTLEP elements during imagery enables greater ease and vividness of movements when using internal visual imagery and kinaesthetic imagery compared to not incorporating the elements. Combined action observation and motor imagery is another technique successful in increasing task specific imagery ability (Eaves, Riach, Holmes & Wright, 2016). In addition, observation experienced prior to imagery can prime imagery so that it is significantly easier compared to imaging with no observation prime (Williams, Cumming & Edwards, 2011). Although these different techniques appear effective, they were all utilized in the improvement of movement based imagery content, which did not involve the reappraisal of feelings and emotions but rather the emphasis was on performing specific motor patterns. As such, the effectiveness of the primes could be questioned when used with more emotive imagery content, because emotion is likely not primed with that type of imagery technique.

One technique known to improve imagery ability, which may be more appropriate for increasing the ability to image emotional content to regulate stress and anxiety, is Layered Stimulus Response Training (LSRT) (Cumming et al., 2017; Williams, Cooley & Cumming, 2013). LSRT is a technique that involves helping individuals easily generate and control their imagery by adding different components of the image in layers. Based on Lang's bio-informational theory (Lang, 1979), LSRT involves developing three different types of propositions, stimulus propositions (e.g. imaging the components of the location of an imaged event vividly), response propositions (e.g. vividly feeling the physiological components of an imaged event) and meaning propositions (e.g. interpreting the physiological responses to an event as either helpful or unhelpful) (Cumming et al., 2017). By breaking down the different components of an image and focusing on making these propositions more clear and rich in detail, it helps individuals develop more vivid imagery, which in turn makes the imagery resemble actual experience and helps them more effectively transfer their images to real life experience. Altering the meaning propositions, such as changing increased heart rate to be viewed as helpful rather than unhelpful in the face of stress, is where LSRT could incorporate re-scripting. The individualized aspect of this layering technique for imagery training suggests it would be an appropriate technique to use when increasing the ability to image content to regulate stress, as the revised applied model's meaning bridge suggests that effective content may differ between individuals for the same function (See Figure 1). LSRT also allows the individual to develop their imagery ability at their own pace. It also involves elements of re-scripting by providing the opportunity for individuals to alter their previous responses to a particular situation in imaging a different response and outcome and then practicing making this image more vivid and realistic.

Previous research has shown LSRT to successfully increase motor imagery ability in as little as four-days (Williams, Cooley & Cumming, 2013). Weibull and colleagues also found results to support the ability of LSRT to increase imagery ability in as little as one session with women who wanted to increase their physical activity levels (Weibull et al., 2017). They only used a single session of LSRT to help participants improve their ability to image stimulus and response information related to going for a walk and found that participants reported significantly greater ease of imaging following the LSRT. Based on the positive results of LSRT, it is likely this technique would be successful in increasing mastery imagery ability and altering the meaning propositions of stress-related imagery to help individuals view and in turn appraise their responses to stress in a more facilitative manner. However, research is yet to examine whether this is possible.

Addressing the aforementioned gaps in the literature, the present thesis aimed to examine the association between mastery imagery ability and general levels of stress and anxiety in the general population (Chapter 2). The second aim was to test the efficacy of LSRT in increasing mastery imagery ability, and examine the subsequent effect this had on the appraisals and responses to general and acute psychological stress (Chapter 3). This thesis took a multi-study approach with a mixture of cross-sectional work to establish relationships between different variables that have not been studied, and experimental work to determine cause and effect with regards to some of these relationships. Specific aims and hypotheses for each study are addressed in the subsequent chapters.

Chapter Two

Investigating the Mediating Role of Perceived Stress on Mastery Imagery Ability and Anxiety

Investigating the Mediating Role of Perceived Stress on Mastery Imagery Ability and Anxiety

According to the Anxiety and Depression Association of America, anxiety disorders are the most common mental illness in the U.S., affecting 18% of the population (Facts & Statistics, 2017). Within the United Kingdom 5.9 in every 100 people have generalised anxiety disorder (NHS Digital, 2016). The psychological symptoms of generalized anxiety disorder include restlessness, a sense of dread, feeling constantly “on edge”, and difficulty concentrating. These symptoms can have detrimental effects affecting many aspects of life ranging from social interactions to work. Kroenke et al. (2007) stated that despite being prevalent and disabling, anxiety disorders are often untreated in primary care. However, before effective treatments are developed, it is essential to determine characteristics likely to be associated with higher or lower trait anxiety symptoms, so that treatments can target these factors.

Trait anxiety is a relatively stable personality trait that assesses environmental events as potentially threatening and involves a consistent response to that threat (Mascarenhas & Smith, 2011; Spielberger, 1966). State anxiety is a temporary emotion defined by physiological arousal and conscious feelings of apprehension and tension (Spielberger, 1966). Trait anxiety is considered to be more stable to an individual’s personality, whereas state anxiety is related to an individual’s situational reaction to a specific event. Although trait anxiety is more commonly measured, it is also crucial to investigate an individual’s state anxiety as this gives insight into their momentary response to anxiety provoking scenarios. State anxiety is a multidimensional construct that is typically classified as somatic or cognitive in nature (Jones, Swain & Hardy, 1993). Somatic anxiety refers to the physical symptoms of anxiety, such as butterflies in the stomach or increases in heart rate, and cognitive anxiety is the mental component of anxiety such as thought processes like worry

(Steptoe & Kearsley, 1990; Edwards & Hardy, 1996; Thomas, Hanton, & Jones, 2002). Apart from anxiety intensity, it is also important to consider the interpretation of anxiety symptoms (Swain & Jones, 1993; Jones, Swain & Hardy, 1993; Chamberlain & Hale, 2007). Anxiety interpretation refers to whether individuals view the intensity of their anxiety symptoms to have a positive (facilitative) or negative (debilitative) influence on performance and/or coping (Jones & Swain, 1992; Edwards & Hardy, 1998).

In support of this, a body of research indicates the importance of considering the interpretation of anxiety symptoms rather than solely looking at the intensity of anxiety (Jones and Swain, 1992; Hanton, 1996). For example, Chamberlain and Hale (2007) found that anxiety interpretation was a better predictor of performance in a golf putting task than the anxiety intensity itself. Specifically, higher facilitative anxiety, and not the anxiety intensity, was associated with better putting performance. Carrier et al. (1984) found similar results in an academic setting, noting that students with high facilitative anxiety had the best quality notetaking, which included accuracy, comprehensiveness, and efficiency compared to those with high debilitative anxiety. They found that as long as students perceived their anxiety as facilitative, anxiety intensity actually enhanced learning rather than hindering it (Carrier et al., 1984). Furthermore, more facilitative interpretations of anxiety have been associated with lower levels of state anxiety (Williams, Carroll, Veldhuijzen van Zanten, & Ginty, 2016). Consequently, examining interpretation of anxiety symptoms as well as the intensity of anxiety symptoms is needed to get a better understanding of anxiety.

One factor that has been shown to be associated with anxiety intensity and interpretation is mental imagery ability (Williams & Cumming, 2015). Mental imagery is described as the internal creation or recreation of thoughts and feelings (Williams & Cumming, 2012b) and imagery ability is defined as “an individual’s capability to form vivid, controllable images and retain them for sufficient time to effect the desired imagery rehearsal" (Morris, Spittle & Watt, 2005, p. 37). Imagery ability is a multidimensional construct that can vary according to the content imaged. Skill and strategy imagery ability relate to the ability to image content that is cognitive in nature, whereas goal, affect and mastery imagery ability relate to the ease of imaging motivational content (Williams & Cumming, 2011). Imagery ability has been associated with performance, emotions, and cognitions (Simonsmeier & Buecker, 2017; Williams & Cumming, 2012b; Williams & Cumming, 2015).

Specific to state anxiety in relation to a specific task, recent research has shown mastery imagery ability (i.e., imaging mastering difficult situations and persevering in the face of adversity) to be the most relevant dimension of imagery ability (Quinton et al., 2018). Research has supported the notion that mastery imagery ability is strongly associated with anxiety intensity and interpretation (Quinton at el., 2018). Williams and Cumming (2015) suggested that individuals with higher mastery imagery ability are able to use their ability to see themselves performing well in difficult situations to reduce the impact of negative images by replacing them with positive ones. When individuals are better at imaging themselves mastering an upcoming challenge or stressor, they optimize cognitive anxiety levels (Williams et al., 2017; Williams and Cumming 2012a). Quinton et al. (2018) demonstrated that the association between confidence and cognitive anxiety intensity is mediated through an individual's ability to image positive and negative mastery imagery content. In other words, higher confidence was associated with greater positive mastery imagery ability and poorer negative mastery imagery ability, which in turn is associated with lower levels of cognitive anxiety intensity. By contrast, greater negative mastery imagery ability was associated with higher levels of cognitive anxiety intensity (Quinton et al., 2018).

Furthermore, Williams and Cumming (2015) found that mastery imagery ability indirectly predicted anxiety interpretation through confidence. Mastery imagery ability positively predicted trait confidence and individuals with high mastery imagery ability were likely to be protected against higher anxiety levels and negative interpretations of anxiety through enhancing their confidence. While this study found that self-confidence partially mediated the relationship between mastery imagery ability and anxiety interpretation, it did not fully mediate the relationship, suggesting there may be other factors that play a role in the association between mastery imagery ability and anxiety symptoms and symptom interpretation.

Collectively, this body of research proposes that mastery imagery ability is closely associated with intensity and interpretation of state anxiety. Although research has investigated the associations between mastery imagery ability and state anxiety in relation to athletes, research has yet to examine whether mastery imagery ability is also associated with general trait anxiety and state anxiety intensity and interpretation related to everyday circumstances in a non-athlete population. A mechanism through which these associations exist is yet to be investigated as well. If a mediating factor can be identified it could lead to discovering traits to target in decreasing trait and state anxiety.

A factor likely to be associated with an individual's anxiety intensity and how he/she interprets these symptoms is perceived stress. Anxiety disorders have been characterized by poor tolerance and inability to effectively cope with daily stress, suggesting that those with higher anxiety are likely to have higher perceived stress (Van Praag, 1996; Parker et al., 2000; Connor et al., 2007). Lazarus and Folkman's (1984) appraisal theory has established the importance of perceived stress in mental wellbeing, indicating that affective consequences of a stressor depend on how a stressor is interpreted psychologically. For example, if an individual perceives stress to be higher than what they can cope with, their anxiety is likely to be higher than those individuals who perceive stress to be lower and more manageable. Perceived stress is also highly related to perceived control of a stressful situation, individuals with higher perceived stress have greater feelings of uncontrollability in their environment, which has been associated with more negative interpretations of their anxiety (Watson, 1988; Tetrick & LaRocco, 1987). Individuals with greater feelings of uncontrollability and low self-confidence also tend to display more debilitative interpretations of anxiety as well as higher anxiety intensity (Hanton, Mellalieu and Hall, 2004). It is then logical to hypothesize that higher perceived stress is associated with higher anxiety intensity and more debilitative interpretations of anxiety. Perhaps the higher general perceived stress, the higher general state anxiety intensity and the more debilitative interpretation of anxiety. This finding could give insight to what leads to maladaptive anxiety intensity and interpretation.

Mastery imagery ability is also likely associated with perceived stress, as it is with state anxiety intensity and interpretation. As mentioned before, individuals with the ability to image mastery content, display higher self-confidence, lower anxiety intensity, and more facilitative interpretations of anxiety (Williams et al., 2017; Jones et al., 2009). This can easily be linked to lower perceived stress given the relationship between anxiety and perceived stress. Previous research has presented imagery ability as a method to enable individuals to perceive stress and anxiety symptoms as facilitative and help them feel more in control by facilitating higher self-confidence and self-efficacy (Cumming, Olphin & Law, 2007; Jones et al., 2002). As a result, higher mastery imagery ability is likely to lead to lower perceived stress. Individuals with higher mastery imagery ability are more likely to perceive stressful situations as a challenge, and may have more confidence in their ability to cope with a challenge, translating to lower perceived stress (Williams & Cumming, 2012b). Whereas, individuals with low mastery imagery ability are more likely to be unable to readily generate images of mastering or successfully coping in high pressure situations. This likely leads to higher perceived stress in everyday life. Therefore, it could be suggested that perceived stress mediates the relationship between mastery imagery ability and trait and state anxiety intensity and interpretation.

Aims and Hypotheses

The first aim of the present study was to further investigate the association between mastery imagery ability and anxiety outside of a sport setting. To examine this in detail, the study examined the associations between mastery imagery ability and: (a) general levels of anxiety, and (b) cognitive anxiety intensity, (c) somatic anxiety intensity, (d) cognitive anxiety symptom interpretation, and (e) somatic anxiety symptom interpretation. The second aim of the study was to test whether mastery imagery ability was related to general levels of perceived stress. The final aim of the study was to examine whether perceived stress mediated the relationship between mastery imagery ability and (a) general anxiety, (b) cognitive anxiety intensity, (c) somatic anxiety intensity, (d) cognitive anxiety symptom interpretation, and (e) somatic anxiety symptom interpretation.

It was hypothesized that mastery imagery ability would be negatively correlated with general anxiety, and cognitive and somatic anxiety intensity, and positively correlated with more facilitative interpretations of cognitive and somatic anxiety. It was also hypothesised that mastery imagery ability would be negatively associated with perceived stress and that perceived stress would therefore mediate the relationship between mastery imagery ability and all measures of anxiety.

Methods

Participants

Two hundred and forty participants (male *n* = 46; females *n* = 194) with a mean age of 21.18 (SD = 5.40) participated in the study. The sample was made up of predominantly Caucasian individuals (*n* = 204, 85%), with remaining participants being Asian (*n* = 12, 5%), Black African (n = 9, 3.8%), and classified as Other (n = 15, 6.2%). Ethical approval was obtained by the University of Birmingham ethics committee and all participants provided informed consent.

Measures

Mastery imagery ability. The mastery subscale of the Sport Imagery Ability Questionnaire (SIAQ; Williams & Cumming, 2011) assessed participants' ability to image positive mastery imagery content. Participants were asked to close their eyes and bring a specific image to mind in relation to a sport they participate in. The images were "Giving 100% effort even when things are not going well", "Staying positive after a setback", and "Remaining confident in a difficult situation". They were then asked to rate how easy it was for them to image each item on a 7-point Likert scale from 1 (*very hard to image*) to 7 (*very easy to image*). If they did not play a sport participants imaged the sport they most recently played (e.g., when at school). Scores across the three items were averaged with higher scores reflecting greater ease of imaging. The internal reliability of this factor was slightly lower than the ideal .70 cut-off (Cronbach's α = 0.65), however, other studies have demonstrated the SIAQ questionnaire has good validity and reliability in assessing mastery imagery ability (Williams & Cumming, 2011; Williams & Cumming, 2015). Furthermore, the small number of items in the subscale could be a factor resulting in the lower reliability score (Peterson, 1994).

Trait anxiety. The anxiety subscale of the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) was used to measure trait anxiety. The anxiety subscale consists of seven questions reflecting anxiety (e.g., "I feel tense or 'wound up'", "I get sudden feelings of panic"). Each question was answered on a four-point scale from 0 (*not at all*) to 3 ('*most of the time'/ 'very often'/ 'very definitely and quite badly'*), and these were summed to derive an overall rating of anxiety level. Scores ranged from 0-21 with a higher score indicating a greater level of trait anxiety. Internal reliability for all items was good (Cronbach's $\alpha = 0.82$). The HADS has produced valid and reliable trait anxiety scores (Bjelland et al., 2002).

Perceived stress. The 10-item Perceived Stress Scale (PSS-10; Cohen & Williamson, 1988) measured the extent to which participants perceived life as stressful in the last week. Each item was rated on a 5-point scale ranging from 0 (*never*) to 4 (*almost always*). Items included questions such as "How often have you been upset because of something that happened unexpectedly?" and "How often have you felt 'stressed'?". The PSS-10 scores were obtained by summing the scores across all 10 items, resulting in scores ranging from 0 to 40, with higher scores indicating more perceived stress. The internal reliability for all items was good (Cronbach's $\alpha = 0.85$). Studies have shown the PSS to demonstrate highly valid and reliable scores of perceived stress (Khalili et al., 2017).

State anxiety. The Immediate Anxiety Measure Scale (IAMS; Thomas, Hanton, & Jones, 2002) assessed the intensity and direction of state cognitive and somatic anxiety. A description of the constructs (i.e., cognitive anxiety, and somatic anxiety) was included in the instructions of the questionnaire to ensure participants understood the different constructs assessed. Section one includes three separate items which asks participants to rate the intensity with which they felt cognitively anxious, somatically anxious, and self-confident in that moment. For the present study self-confidence was not used. Each rating was made on a 7-point scale from 1 (*not at all*) to 7 (*extremely*). The second section asks participants the extent to which they perceived the interpretation of their cognitive and somatic anxiety to be generally positive (facilitative) or negative (debilitative). Ratings were made on a 7-point scale from -3 (*very debilitative*) to +3 (*very facilitative*). The IAMS is a valid and reliable measure for assessing both the intensity and direction of state cognitive and somatic anxiety (Thomas et al., 2002).

Procedure

Following ethical approval, participants were recruited over a 6-month period through email, electronic advertisements, and announcements in undergraduate lectures. After reading details of the study and having the opportunity to ask questions about the study, participants provided informed consent, demographic information on gender, ethnicity, and date of birth, completed the mastery subscale of the SIAQ, PSS, HADS anxiety subscale, and IAMS on a computer which took no more than 20 minutes. At the end of the online questionnaire, participants were thanked for their participation and given the lead researcher's email in case of any questions.

Data Analysis

Before data were analysed, they were screened for any missing data by checking frequency data on each questionnaire and reviewed for any outliers (defined as any data that exceeded three standard deviations from the mean) through percentiles. No outliers were found, so all data were retained for the analyses. Data were then analysed using SPSS (version 23). Relationships between mastery imagery ability, PSS, HADS anxiety and the IAMS were explored using correlation analyses. Where there were significant correlations between mastery imagery ability and the IAMS variables and HADS anxiety as well as correlations between PSS and the IAMS variables and HADS anxiety, mediation analysis was undertaken to further investigate the relationship.

Testing for mediation followed Hayes' (2009) criteria. The simple mediation model is displayed in Figure 1. The model is made up of two resultant variables; the mediator (*M*) and the dependent variable (*Y*), and two originator variables; the independent variable (*X*) and the mediator (*M*), with *X* influencing *Y* and *M*, and *M* influencing *Y* (Hayes, 2013). Hayes' (2013) simple mediation model is any system where at least one associated independent variable is proposed as influencing a dependent variable through a mediator variable. It is not necessary for there to be simple association between *X* and *Y* as a precondition for a mediation analysis (Hayes, 2013). A significant correlation between the independent variable and mediator must be established (path *a*) as well as a significant correlation between the mediator and the dependent variable (path *b*). Furthermore, the mediator must predict the dependent variable even when the independent variable is controlled for, and the relationship between the independent and dependent variable must no longer be significant or significantly decrease in the presence of the mediator (path *c'*). Put in simple terms, the ultimate goal is to investigate whether *X* is correlated with *M*, which in turn correlated with *Y* to determine if mediation exists. Mediation was investigated using PROCESS on SPSS (version 23) (Hayes, 2013).

For all mediation analyses, the independent variable was defined as mastery imagery ability and the mediator was defined as perceived stress (See Figure 2). A separate mediation analysis was done for each dependent variable, which included HADS anxiety and the IAMS variables (i.e., cognitive intensity, cognitive interpretation, somatic intensity, somatic interpretation). In order to confirm PSS as a mediating variable, the relationship between PSS and mastery imagery ability was investigated (*a*), as well as the relationship between PSS and HADS anxiety and between PSS and the IAMS variables (*b*) through a series of regressions using process in SPSS. The regression coefficients were *a* = how much two cases that differ by one unit on *X* are estimated to differ on *M*, *b* = how much two cases that differ by one unit on *M* but are equal on *X* are estimated to differ on *Y*, *c'*= the estimate of the direct effect of *X* on *Y*, *ab* = the indirect effect of *X* on *Y* through *M*. The sign of the coefficients determines whether the case higher on one variable is estimated as higher (+) or lower (-) on the other variable. The indirect effect of *X* on *Y* through *M* is the product of *a* and *b*.

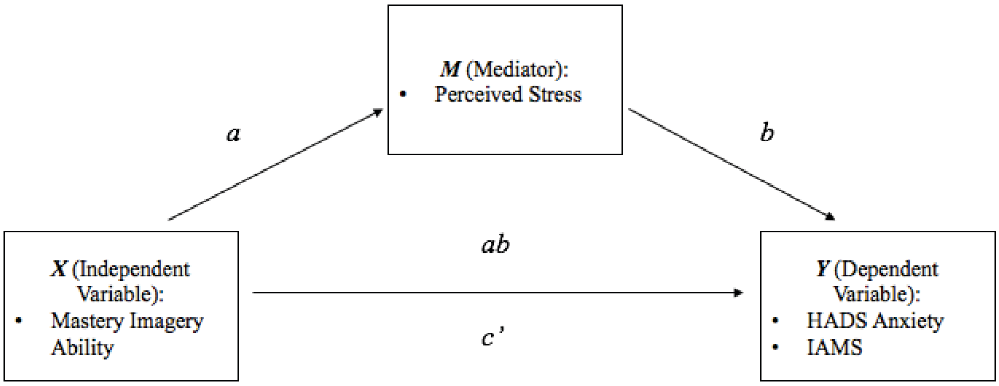

Figure 2. Simple mediation model including coefficients for each path involved in the mediation analysis. A separate mediation analysis was done for each dependent variable.

Results

Means and Correlation Analysis

Means and standard deviations for mastery imagery ability, perceived stress, trait anxiety, and state anxiety intensity and interpretation are displayed in Table 1. Pearson's bivariate correlations revealed significant relationships between mastery imagery ability and perceived stress, trait anxiety, and cognitive and somatic anxiety intensity and cognitive anxiety interpretation (Table 2). Higher mastery imagery ability was associated with lower perceived stress, trait anxiety, state cognitive and somatic anxiety intensity, and more facilitative appraisals of cognitive anxiety. Higher perceived stress was associated with higher trait anxiety and higher cognitive and somatic anxiety intensity, as well as more debilitative interpretations of cognitive anxiety.

Table 1.

Descriptive Means and Standard Deviations of Main Variables of Interest for Sample

Variable (range of scores)	Mean (SD)
SIAQ Mastery Imagery Ability (1-7)	4.74 (0.99)
Perceived Stress (0-40)	19.45 (5.62)
HADS Anxiety subscale (0-21)	8.13 (3.90)
State Cognitive Anxiety Intensity (1-7)	3.17 (1.43)
State Cognitive Anxiety Interpretation ((-)3 - (+)3)	-0.68 (1.51)
State Somatic Anxiety Intensity (1-7)	2.37 (1.22)
State Somatic Anxiety Interpretation ((-)3 - (+)3)	-0.20 (1.43)

Notes. M = mean; SD = standard deviation; SIAQ = Sport Imagery Ability Questionnaire; PSS = Perceived Stress Scale; HADS = Hospital Anxiety and Depression Scale.

Table 2.

Pearson's Bivariate Correlations between Mastery ability, perceived stress, trait, and state anxiety.

	Mastery Imagery Ability	Perceived Stress
Perceived Stress	-.335**	--
HADS Anxiety	-.274**	.711**
Cognitive Anxiety Intensity	-.179**	.453**
Cognitive Anxiety Interpretation	.184**	-.292**
Somatic Anxiety Intensity	-.082	.285**
Somatic Anxiety Interpretation	.083	-.100

Note. ** $p < .001$

Somatic anxiety interpretation did not correlate with perceived stress or mastery imagery ability and therefore, no mediation analysis was conducted for somatic anxiety interpretation.

Mediation Analysis

Trait anxiety. Results of the mediation analysis demonstrated that mastery imagery ability was indirectly associated with trait anxiety through its association with perceived stress scores. Participants with higher mastery imagery ability had lower perceived stress, and lower perceived stress was associated with lower trait anxiety. A bias-corrected bootstrap confidence interval for the indirect effect (ab = -0.916) based on 1,000 bootstrap samples was entirely below zero (-1.263 to -0.601), meaning the indirect pathway was statistically significant. Mastery imagery ability was not significantly associated with trait anxiety independent of its effects on perceived stress scores, suggesting full mediation (p = .413). See Figure 3.

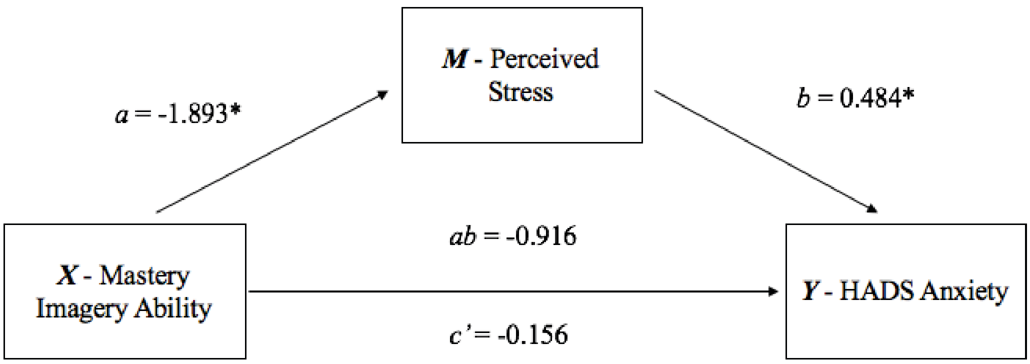

Figure 3. Simple mediation model for mastery imagery ability, perceived stress, and trait anxiety showing full mediation. *Note*. * $p < .05$.

State cognitive anxiety intensity. As can be seen in Figure 4, participants with high mastery imagery ability displayed lower perceived stress scores, and participants with lower perceived stress scores had lower cognitive anxiety intensity. A bias-corrected bootstrap confidence interval for the indirect effect based on 1,000 bootstrap samples was entirely below zero (-0.321 to -0.135). There was no evidence that mastery imagery ability was associated with cognitive anxiety intensity independent of its effects on perceived stress scores, suggesting full mediation ($p = .613$).

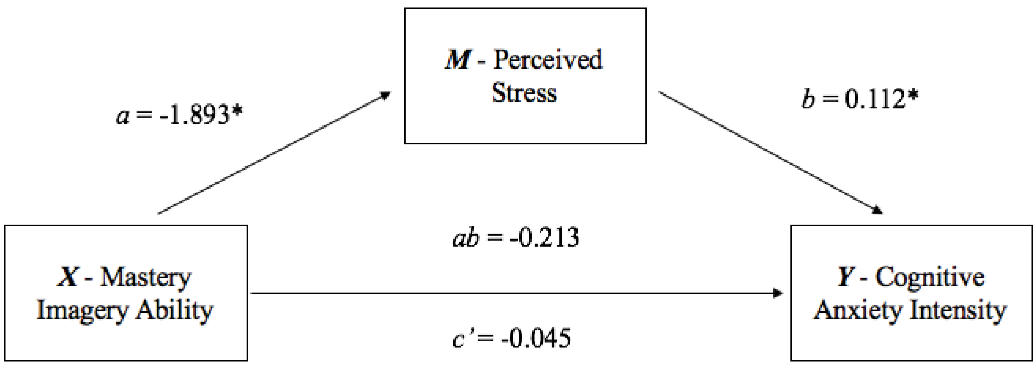

Figure 4. Simple mediation model for mastery imagery ability, PSS, and cognitive anxiety intensity showing full mediation. *Note*. * $p < .05$.

State cognitive anxiety interpretation. Mastery imagery ability was similarly indirectly associated with cognitive anxiety interpretation through its association with perceived stress scores. Participants with high mastery imagery ability had lower perceived stress scores, and participants with lower perceived stress scores perceived their cognitive anxiety to be less debilitative, as seen in Figure 5. A bias-corrected bootstrap confidence interval for the indirect effect based on 1,000 bootstrap samples was entirely above zero (0.067 to 0.232). There was no evidence that mastery imagery ability was associated with cognitive anxiety intensity independent of its effects on perceived stress scores, again suggesting full mediation (p = .143).

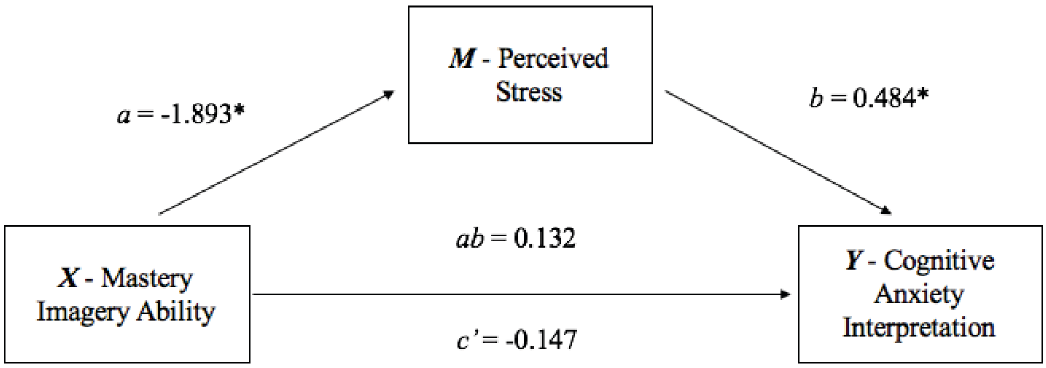

Figure 5. Simple mediation model for mastery imagery ability, PSS, and cognitive anxiety interpretation showing full mediation. *Note*. * p < .05.

State somatic anxiety intensity. Perceived stress scores also mediated the relationship between mastery imagery ability and somatic anxiety intensity. Figure 6 shows participants with high mastery imagery ability had lower perceived stress scores, and in turn had lower somatic anxiety intensity. A bias-corrected bootstrap confidence interval for the indirect effect based on 1,000 bootstrap samples was entirely below zero (-0.202 to -0.054). There was no evidence that mastery imagery ability was associated with somatic anxiety intensity independent of its association with perceived stress scores, suggesting full mediation (p = .818).

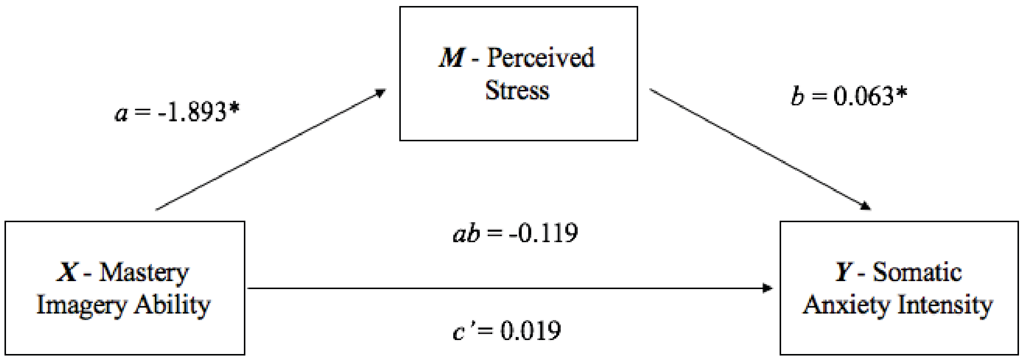

Figure 6. Simple mediation model for mastery imagery ability, PSS, and somatic anxiety intensity showing full mediation. *Note.* * $p < .05$.

Discussion

The aim of the present study was to investigate whether mastery imagery ability was associated with trait anxiety and state cognitive and somatic anxiety intensity and interpretation in a non-sporting population. A second aim was to determine whether perceived stress was a mediator in the relationship between mastery imagery ability and trait and state cognitive and somatic anxiety intensity and interpretation. Confirming the first hypothesis, mastery imagery ability was negatively associated with trait anxiety and state cognitive anxiety intensity and positively associated with state cognitive anxiety interpretation. Specifically, higher levels of mastery imagery ability were associated with lower levels of trait and state cognitive anxiety intensity and more facilitative interpretations cognitive anxiety intensity. There were no significant relationships between mastery imagery ability and somatic anxiety intensity or interpretation. These results extend previous work demonstrating a negative relationship between mastery imagery ability and anxiety (Quinton et al., 2018; Williams & Cumming, 2015) by demonstrating this to occur in non-sport specific anxiety. Perceived stress was associated with all anxiety variables with the exception of somatic anxiety interpretation. Additionally, perceived stress fully mediated the relationship between mastery imagery ability and all outcome variables with the exception of somatic anxiety interpretation. Collectively, the results of the present study strengthen the argument that an individual's mastery imagery ability indirectly relates to stress appraisals (e.g. perceived stress and state anxiety) and general trait anxiety levels.

There was a significant negative relationship between mastery imagery ability and general trait anxiety and state cognitive anxiety intensity. Individuals who had greater levels of mastery imagery experienced lower levels of anxiety and more positive interpretations of cognitive anxiety. The results also confirm a significant negative relationship between mastery imagery ability and perceived stress scores. This is the first study to show that an individual's ability to image successfully completing a challenge is associated with how much stress they experience in their everyday lives. This provides evidence that mastery imagery ability may be an important trait to develop in order to combat high levels of stress.

Similar to the findings of Williams and Cumming (2015), mastery imagery ability indirectly and negatively predicted cognitive anxiety intensity. The current study extended these findings by providing evidence of a mechanism through which this relationship exists (e.g., that perceived stress mediates the relationship between mastery imagery ability and anxiety). As hypothesized, perceived stress fully mediated the relationship between mastery imagery ability and trait anxiety, state cognitive and somatic anxiety intensity and cognitive anxiety interpretation. Individuals with higher mastery imagery ability had lower perceived stress scores, which in turn related to lower trait anxiety, cognitive and somatic anxiety intensity and more facilitative interpretations of cognitive anxiety. These findings contribute to the argument that mastery imagery ability is a key determinant in eliciting more adaptive stress appraisals and optimizing anxiety levels, however this is a cross-sectional study therefore direction of causation is unknown (Williams & Cumming, 2012; Williams & Cumming, 2015; Quinton et al., 2018).

Research has found high levels of self-efficacy and control lead to lower levels of perceived stress and anxiety (Jones et al., 2002). An increased ability to image successfully completing a challenge or coping well in difficult situations could lead to greater feelings of control and self-efficacy. This in turn may be a potential mechanism through which individuals with high levels of imagery ability are able to deal with daily stressors, thus a reason why it is linked to lower levels of perceived stress. However, without measures of self-efficacy or control in the current study, this is just speculation. These lower levels of stress are subsequently associated with lower feelings of anxiety. Indeed, mastery based imagery has been associated with more facilitative interpretations of stress, and greater feelings of self-efficacy and confidence (Munroe-Chandler, Hall & Fishburne, 2008; Cumming, Olphin & Law 2007; Williams et al., 2010). Mastery imagery ability is also associated with greater challenge appraisal (Williams & Cumming, 2012b) – an appraisal proposed to be driven by feelings of efficacy and perceived control (Jones et al., 2009). Mastery imagery ability therefore appears likely to elicit similar cognitions that in turn impact perceptions of stress associated with daily living. Future research should aim to examine the role of control and self-efficacy with imagery ability and its effects on feelings of anxiety.

The current study is not without limitations. The sample is predominantly female and the majority of responses were from undergraduate level students, making the generalizability of the sample weak outside of this sample. Furthermore, the study was cross-sectional, meaning cause and effect cannot be determined and variation in the variables over time cannot be studied (Christenfeld et al., 2004). Another limitation was that there was no specific stressor or situation in which the IAMS was assessing in this study, this measure is usually given in the context of a stressor to assess appraisals. For the purposes of the current study it was given to assess state anxiety levels experienced at that moment in time. Given the associations of mastery imagery ability in stress appraisals, future research should investigate whether using known techniques to increase mastery imagery ability could alter perceived stress scores, in turn reducing anxiety symptoms and creating more facilitative interpretations of anxiety. Research has shown that imagery ability can be increased through different training techniques. One such technique that appears effective is LSRT (Cumming et al., 2016). Williams, Cooley, and Cumming (2013) used LSRT to increase motor imagery ability and found that it successfully increased motor imagery ability and subsequent movement execution following imagery's use. Other studies have suggested that LSRT may also be effective in improving cognitions (Weibull et al., 2015). Therefore, an interesting avenue of future research could be to investigate whether LSRT could be used to increase mastery imagery ability and in turn reduce perceived stress and anxiety experienced during day to day life. If effective, LSRT could be an effective therapeutic tool for those suffering with high levels of stress and/or anxiety disorders.

In addition to reducing general levels of stress and anxiety, it would be beneficial to study whether mastery imagery ability may also regulate the stress and anxiety responses elicited through exposure to acute psychological stress. Williams et al. (2017) demonstrated that using mastery type images could alter how people appraise acute psychological stress as well as the cardiovascular and psychological responses experienced during the stressful situation. The authors suggested that imagery interventions emphasising feelings of efficacy and control are likely to lead to more adaptive coping (Williams et al., 2017). Based on this research and the present findings, it can be suggested that individuals who are better able to image feelings of being confident and in control of adverse situations (i.e., greater mastery imagery ability) may feel more confident and in control when exposed to a stressful situation. This confidence and control may subsequently lead to perceiving the situation to be less stressful and in turn the individuals may experience lower levels of anxiety which are perceived as being more facilitative to performance and coping in the stressful situation. The more facilitative interpretations could also allow for less exaggerated cardiovascular reactivity in response to acute stress.

In conclusion, the present study adds to current research on the association between mastery imagery ability and psychological constructs. Specifically, findings reinforced the notion that mastery imagery ability is associated with lower levels of state cognitive and somatic anxiety intensity, and more facilitative interpretations of state cognitive anxiety symptoms, and this was extended to include trait anxiety. It was also found that mastery imagery ability is negatively associated with perceived stress. The mediation analysis revealed that perceived stress influences the associations between mastery imagery ability and trait anxiety, state cognitive and somatic anxiety intensity and cognitive anxiety interpretation. Based on these findings, it could be suggested that interventions to increase mastery imagery ability may be able to help regulate appraisals and responses to stress. As such, mastery imagery ability could be a beneficial disposition in preventing high levels of anxiety.

Chapter 3

The Effects of Increasing Mastery Imagery Ability on Perceived Stress, General Anxiety, and Psychological and Cardiovascular Responses to Acute Psychological Stress

The Effects of Increasing Mastery Imagery Ability on Perceived Stress, General Anxiety, and Psychological and Cardiovascular Responses to Acute Psychological Stress

The World Health Organization (2008) identified psychological stress as one of the top 10 factors contributing to poor health, such as depression, cardiovascular disease, and cancer (American Psychological Association, 2017). Individuals experience stress when presented with demands and/or threats that they feel they do not have sufficient resources to cope with (Lazarus & Folkman, 1984). Levels of perceived stress reflect the degree to which individuals appraise situations in life as stressful and can give insights into how they are likely to appraise a stressful encounter (Cohen, Kamarck & Mermelstein, 1983). It is perhaps not surprising that those with increased levels of perceived stress experience stressful events more frequently or have been exposed to more stressful life events, therefore they perceive life as more stressful, which has been related to more negative emotions detrimental to health, such as anxiety (van Eck, Berkhof, Nicolson & Sulon, 1996; Wiegner, Hange, Björkelund & Ahlborg, 2015; Doron et al., 2015). Due to their increased frequency of assessing situations as stressful or increased exposure to stressful life events that in turn gives them higher perceived stress, they have a higher risk of experiencing chronic stress at an unhealthy level.

In support, Chapter 2 of this thesis demonstrated that general levels of perceived stress were positively associated with high levels of general, as well as situational specific anxiety. High perceived stress has also been linked to poor cardiovascular health, and poor health behaviours, such as a higher fat diet, less frequent exercise, and cigarette smoking (Ng & Jeffery, 2003; Poirat et al., 2018; Rod, Schnohr, Prescott & Kristensen, 2009). Furthermore, high perceived stress is also related to unhealthy blood pressure, or exaggerated blood pressure, as well as blunted systolic blood pressure and pulse rate reactivity in response to stress (Carroll et al., 2005; Ginty & Conklin, 2011; Suter, Maire, Holtz & Vetter, 1997). It is important to acknowledge that research demonstrates it is not only increased cardiovascular reactivity to stress that is maladaptive. Blunted cardiovascular reactivity to stress can also be maladaptive and reflective of poor health outcomes, such as increased risk for cardiovascular disease, depression, and poor self-reported health (Carroll, Lovallo & Phillips, 2009; Kibler & Ma, 2004; Phillips, Ginty & Hughes, 2013; Schwartz et al., 2003). Consequently, it is necessary to establish non-invasive techniques that individuals with high perceived stress can use to reduce the impact of these negative cardiovascular and anxiety responses to stress, and in doing so, prevent the onset of negative future health outcomes.

When examining anxiety and stress, the intensity and interpretation of anxiety are two key constructs to understanding how an individual responds to stress (Hanton, Neil & Mellalieu, 2008; Neil et al., 2012; Moore et al., 2012). Anxiety intensity reflects the magnitude of the cognitive and perceived physiological symptoms experienced during stress (cognitive anxiety relates to the specific thought processes that occur during anxiety and somatic anxiety identifies the physical symptoms; Jones, 1995), whereas anxiety interpretation relates to the extent to which an individual interprets the intensity of the symptoms as facilitative (helpful to performance) or debilitative (unhelpful to performance) (Jones, 1995; Jones & Hanton, 2001; Mellalieu, Hanton & O'Brien, 2004). More facilitative interpretations of anxiety have been linked to better performance and coping under pressure, as well as more adaptive cardiovascular stress responses, such as more moderate blood pressure and heart rate in response to acute stress (Hollandsworth Jr. et al., 1979; Jones, Meijen, McCarthy & Sheffield, 2009; Neil, Mellalieu & Hanton, 2006; Williams, Cumming & Balanos, 2010). Additionally, research has shown that the interpretation of anxiety can be a better predictor of performance under pressure than the intensity of the anxiety (Chamberlain & Hale, 2007; Neil et al., 2012; Vine et al., 2013). This work suggests that altering interpretations of anxiety can have a positive impact on coping under pressure.

As well as altering interpretations of anxiety, it is also important to investigate how altering perceptions of arousal may be able to elicit more adaptive cardiovascular responses to stress, such as moderate cardiovascular reactivity in response to acute stress. Having maladaptive cardiovascular responses can predispose an individual to many future health risks (Carroll, Phillips & Der, 2008), like cardiovascular disease (Lagraauw, Kuiper & Bot, 2015), therefore it is important to investigate ways to stimulate better cardiovascular responses to stress through lowering cardiovascular reactivity from exaggerated to moderate when faced with stress. Jamieson, Nock and Mendes (2012) found that participants, who were given instructions on how to reappraise increases in heart rate as being helpful to their performance rather than unhelpful, exhibited increased cardiac efficiency with lower vascular resistance, as well as decreased attentional bias for emotionally-negative information. In other words, reappraising arousal under stress proved to have physiological and cognitive benefits. Given that cognitive and physiological responses are usually inevitable when exposed to stress (Gaab, Rohleder, Nater & Ehlert, 2005), it is beneficial to find techniques to alter perceptions of such responses from being debilitative to being facilitative. This could help individuals to cope better during stress.

Self-confidence and control are two constructs associated with lower levels of perceived stress and more facilitative perceptions of an individual's responses to stress (Diehl & Hay, 2010; Goette et al., 2015; Jerusalem & Schwarzer, 1992; Tetrick & LaRocco, 1987). For example, Tetrick and LaRocco (1987) found that higher levels of control were associated with lower levels of general perceived stress. Not only do feelings of control relate to lower perceived stress, but they also relate to more moderate cardiovascular reactivity to acute stress (Peters et al., 1998). Gerin et al. (1995) revealed that during acute psychological stress, individuals with higher control experienced more moderate blood pressure and heart rate changes compared to those with low control. Specific to anxiety, Jones (1995) proposed that anxiety symptoms are interpreted as positive when an individual feels control over the stressful situation. In support, Hanton and Connaughton (2002) found that perceived control was a moderating variable in the interpretations of anxiety as facilitative or debilitative. Cognitive and somatic anxiety symptoms viewed as under control consistently lead to facilitative interpretations of anxiety. However, when individuals felt that their state anxiety was outside of their control they experienced debilitative interpretations of their anxiety (Hanton & Connaughton, 2002).

Higher levels of self-confidence have also been linked to lower levels of perceived stress and more facilitative interpretations of the responses experienced during acute stress (Jones, Swain, & Hardy, 1993; Laborde et al., 2014). Specific to anxiety, Koehn (2010) found a positive correlation between confidence and more facilitative interpretations of anxiety symptoms. Furthermore, Jones and Hanton (2001) reported that when comparing athletes who identified their symptoms of anxiety to be either facilitative or debilitative before competition, the 'facilitators' identified most frequently with confidence as their state of feeling. There has also been evidence to suggest low self-confidence leads to exaggerated cardiovascular reactivity to acute stress. O'Donnell, Brydon, Wright, and Steptoe (2008) found that global self-esteem, measured using Rosenberg's (1965) Self-Esteem Scale, was related to lower heart rate and heart rate variability as well as inflammatory responses to acute stress. Since self-esteem is related to how positively you feel about yourself (Baumeister et al., 2003; Lyubomirsky, Tkach & Dimatteo, 2006), it is likely that self-confidence, which has to do with how you feel about your abilities, might yield a similar result. Furthermore, greater levels of self-efficacy and perceived control are likely to influence an individual's cardiovascular reactivity to stress, however it has not been tested. Increasing feelings of self-confidence and control in individuals with high perceived stress could help them develop more facilitative interpretations of their anxiety and experience more moderate cardiovascular reactivity during stressful situations.

A technique which can instill feelings of confidence and control, and alter how people appraise and respond to stress is mental imagery. Mental imagery is the creation or recreation of thoughts and feelings (Cumming & Williams, 2012). Mental imagery has been shown to alter anxiety, self-confidence, control, and cardiovascular reactivity in a number of populations, including adolescents, athletes, pilots, and patients (Charalambous et al., 2015; Cumming, Olphin, & Law, 2007; Evans, Jones & Mullen, 2004; Hanton and Jones, 1999; Jing et al., 2011). Munroe-Chandler, Hall and Fishburne (2008) found that the use of motivational general-mastery imagery was a significant predictor of self-confidence and self-efficacy in both recreational and competitive youth soccer players. Moreover, Williams, Cumming and Balanos (2010) demonstrated that imagery eliciting feelings of confidence and control led to a greater challenge appraisal, in which individuals felt they had sufficient resources to meet the demands, and more facilitative cardiovascular responses, in other words individuals viewed their cardiovascular responses as facilitative to their performance rather than debilitative, and anxiety responses. By contrast, in the same study, the imagery script with low levels of confidence and control lead to a greater threat appraisal and elicited more debilitative, seen as unhelpful to performance, cardiovascular and anxiety responses (Williams et al., 2010). This work was replicated and extended to demonstrate that challenge and threat imagery has similar effects on anxiety responses to an actual acute psychological stress task in the laboratory (Williams et al., 2017). The study revealed that following the threat evoking script participants perceived the task as more stressful and had greater heart rate responses to the task compared to the challenge and neutral script groups, emphasizing imagery before a stressful encounter can influence perceptions of and physiological responses to the subsequent stressor. However, it also highlights that the imagery itself must be positive in nature to elicit more adaptive responses to stress.

Research suggests that for imagery use to be effective, individuals have to be able to image sufficiently (i.e., demonstrate adequate imagery ability; Williams & Cumming, 2012). Imagery ability has been identified as an important characteristic in regulating stress. A greater ability to image feeling confident and in control of difficult and/or stressful situations (i.e., mastery imagery ability) has been associated with greater levels of self-confidence, lower anxiety intensity, and more facilitative interpretations of anxiety (Quinton et al., 2018; Williams & Cumming, 2012b; 2015). Individuals with high anxiety are hindered by negative prospective imagery (ability to vividly image negative future outcomes), which could be counteracted with increasing mastery imagery ability by giving them the ability to replace negative prospective imagery with positive prospective imagery (Hirsch & Holmes, 2007; Holmes & Mathews, 2005; 2010; Lebois et al., 2016). Morina et al. (2011) found that patients with anxiety disorders showed a greater ability to vividly image prospective negative scenarios compared to both patients with major depressive disorder and a control group and displayed poorer ability to deliberately and vividly image prospective positive images. Additionally, the ability to vividly image stressful situations is associated with higher general perceived stress (Lebois et al., 2016). Based on this research, it could be predicted that individuals with high perceived stress have poor positive imagery ability and are debilitated by negative prospective imagery, which causes feelings of less control, lower confidence, and more debilitative interpretations of their state anxiety about upcoming stressors (Moscovitch, Chiupka & Gavric, 2013; Lebois et al., 2016; Tolgou et al., 2017).

Quinton, Williams and Cumming (2018) found that the association between confidence and cognitive anxiety intensity was mediated through an individual's ability to image both positive and negative mastery content. Within this thesis, results from Chapter 2 indicated a negative correlation between perceived stress and mastery imagery ability. Collectively these findings suggest that individuals with high perceived stress and anxiety have poorer imagery ability of positive content such as mastery imagery content (Morina et al., 2011; Quinton et al., 2018). As such, techniques to improve mastery imagery ability in individuals with high perceived stress and anxiety may be beneficial in altering their negative prospective thoughts.

Research has suggested that increasing positive mastery imagery ability could directly influence stress appraisals and anxiety experienced, however, the majority of imagery ability and stress work has been cross-sectional (Quinton et al., 2018). Based on the research described above and the findings in Chapter 2, an intervention to increase mastery imagery ability specifically targeting individuals with high perceived stress, may not only reduce their general stress and anxiety levels, but also elicit more adaptive responses when exposed to acute psychological stress.

One technique likely to be effective in improving mastery imagery ability is Layered Stimulus Response Training (LSRT) (Cumming et al., 2016). This technique is based on Lang's (1977, 1979) bio-informational theory, that behaviour can be changed by revising and strengthening the response (heart rate, emotions, sweating) and meaning propositions (anxiety vs. energy, helpful vs. unhelpful) linked to a certain situation through mental imagery. Lang (1977) describes mental imagery as memory representations of actions comprised of stimulus, response, and meaning propositions. Stimulus propositions refer to the content of the image (e.g., exam venue), response propositions refer to an individual's typical response to the imaged scenario (e.g., increased heart rate), and meaning propositions refer to the individual's perceptions of the relationship between the stimulus and response (e.g., feelings of anxiety vs. feelings of anticipation) (Lang, 1977). By building up stimulus and response propositions in a layered approach, participants are better able to incorporate these elements into an image which is associated with greater imagery ability (Lang et al., 1980). When an individual is better at generating, transforming, and maintaining an image, they display greater imagery ability and benefit more from the effects of imagery use (Williams, Cooley & Cumming, 2013).

LSRT has been employed to increase imagery ability in as little as four sessions (Williams, Cooley, & Cumming, 2013; Cumming et al., 2017), but has yet to be tested in its ability to alter response and meaning propositions of imaged scenarios. Cumming et al. (2017) described the application of LSRT and how it is one of the few techniques that can successfully increase imagery ability. This technique could be used to alter meaning propositions and response propositions to be more facilitative to coping under stress. Weibull et al. (2015) found evidence that even a brief LSRT followed by a week of rehearsal led to improvements in exercise imagery ability, suggesting only a short intervention is necessary to yield positive results. Although LSRT has been shown to be effective in increasing movement based imagery ability and subsequent improvements in movement execution, research has yet to determine whether LSRT can increase mastery imagery ability. Additionally, research has not yet examined whether increasing mastery imagery ability through LSRT alters appraisals and responses to stress.

The present pilot study aimed to examine if a two-week LSRT intervention consisting of four training sessions could improve mastery imagery ability, and whether this could alter general levels of perceived stress and anxiety in individuals displaying high levels of perceived stress compared to a control group with lower levels of perceived stress. Additionally, the second aim was to examine if improving mastery imagery ability instilled feelings of confidence and control during an acute psychological stress task, and could subsequently alter the cardiovascular (blood pressure and pulse rate) and anxiety responses (anxiety intensity, anxiety interpretation) experienced on re-exposure to a psychological stress task at the post-intervention visit. It was hypothesized that following the two-week LSRT individuals would display (1) increased mastery imagery ability, and (2) decreased general perceived stress and general anxiety in comparison to a control group that received no imagery training. It was also hypothesized that when exposed to an acute psychological stress task (i.e., a public speaking task) the LSRT group would have (3) increased feelings of self-confidence, control, and coping ability, (4) have more facilitative anxiety symptoms, (5) and have decreased cardiovascular responses during the post-intervention visit compared to a control group with lower perceived stress scores that did not receive imagery training.

Method

Participants

Twenty-six female students (*M* age = 21.78 years, *SD* = 3.02) participated in this study. Research has demonstrated gender differences in imagery ability, anxiety, and cardiovascular response (Armstrong & Khawaja, 2002; Campos, 2014; Carrillo et al., 2001). Consequently, given that this was a pilot study consisting of smaller numbers, it was deemed logical to only recruit one gender. Females were selected due to their ease of recruitment from a larger study that was exclusively female. Furthermore, women typically experience higher levels of stress (Matud, 2004). Participants were recruited from Chapter 2 based on their perceived stress scores. Participants were selected if they had perceived stress scores above 16, which is two points higher than the average of 14.2 points in individuals between the ages of 18-29 (Cohen, Kamarck & Mermelstein, 1994). Participants who were eligible based on their PSS average were contacted via email and invited to participant in exchange for course credit or monetary compensation (£20 in amazon vouchers). Prior to taking part in the study, participants were provided with information regarding the study. Additionally, participants were informed their data was confidential and that they could withdraw from the study at any time. All participants provided informed written consent and the study was approved by the ethics committee at the University of Birmingham.

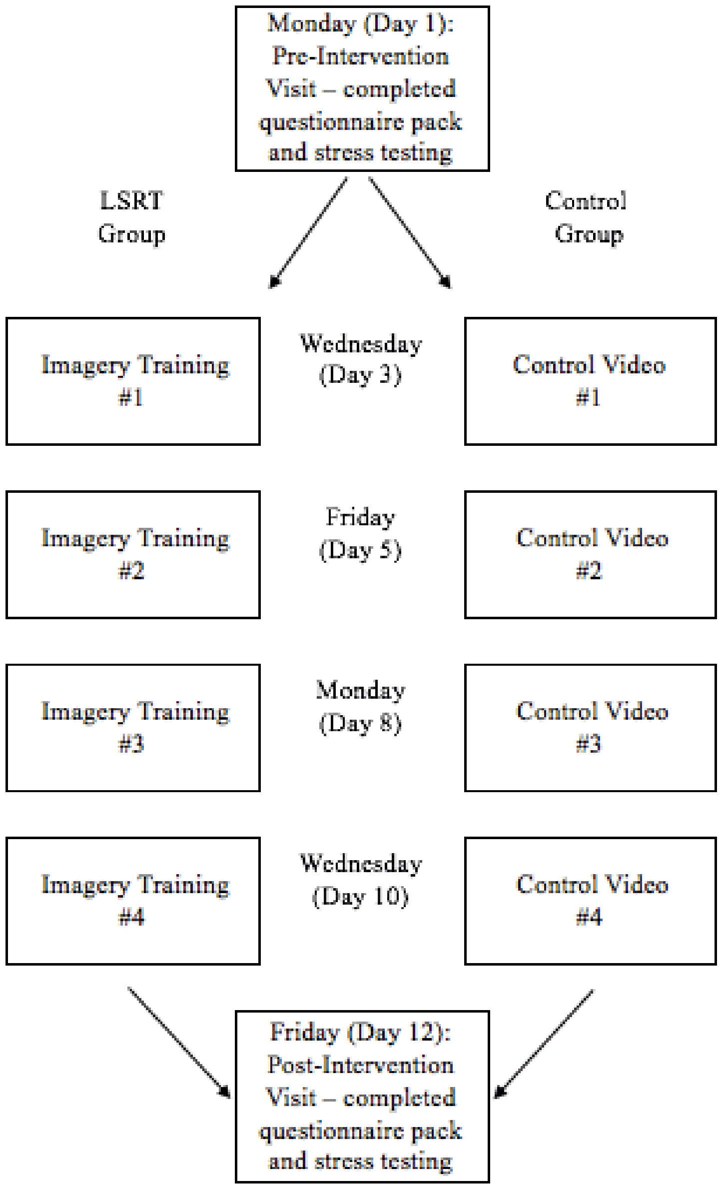

Figure 7. Procedure flow chart.

Procedure

The overall procedure (Figure 7) included all participants completing two stress testing visits, one at the beginning of the study (pre-intervention visit) and one at the conclusion of the study (post-intervention visit). Stress testing was conducted by a different researcher to the one conducting the imagery interventions (Clara Möller conducted all imagery interventions). Participants were randomly assigned using randomly generated numbers and placing even numbers in the experimental group and odd numbers in the control. For both the control and LSRT group, there were four intervention visits over a two-week period in between the two stress testing visits, where different procedures were conducted in each group which are discussed below.

Pre-intervention visit. Upon arrival to the laboratory, participants were seated and asked to complete online questionnaires assessing perceived stress, mastery imagery ability, and general anxiety. A blood pressure cuff was attached to their non-dominant arm while they filled out the online questionnaires to get them acquainted to the feeling of the cuff. Participants were then randomly assigned to the experimental (n = 13) or control (n = 13) group and allocated to a predetermined counterbalanced stress task order. They were asked to remain seated quietly for a 6-minute baseline period, during which BP measurements were taken every minute to establish resting blood pressure and pulse rate values. Following the baseline period, they completed the stress task, during which BP and PR measurements were taken every minute. At the conclusion of the task participants immediately filled out a post-task questionnaire asking about levels of stressfulness, difficulty, ability to cope, and amount of control felt in relation to how they felt during the task. This session took approximately 30 minutes.

Intervention. Over the subsequent 2 weeks, the intervention was delivered. Conditions are described below but sessions took approximately 20 minutes each.

Post-intervention visit. The post-intervention visit followed the same procedure as the pre-intervention visit. Upon completing the post-task questionnaire all participants were debriefed and thanked for their participation.

Psychological Measures

Perceived stress. The 10-item Perceived Stress Scale (PSS; Cohen, Kamarck & Mermelstein, 1983) was used to screen participants for high perceived stress. The questionnaire is comprised of 6 negatively phrased questions (e.g. "How often have you felt ‘stressed’?”) and 4 positively phrased questions (e.g. “How often have you felt things were going your way?”). These items measure the degree to which individuals feel their lives are unpredictable, uncontrollable, and overloading (Cohen, Kamarck & Mermelstein, 1983). Individuals answered the questions on a 5-point Likert type scale ranging from 0 (*never*) to 4 (*very often/always*) for negatively phrased questions and 4 (*never*) to 0 (*very often/always*) for positively phrased questions. Scores for all items were then totalled, resulting in scores between 0 and 40 with a higher score indicating higher levels of stress. The internal reliability for all items was good (Cronbach’s $\alpha = 0.75$). The PSS has been shown to produce reliable and valid scores of perceived stress (Khalili et al., 2017). Cohen (1994) states that based on a poll of 2,387 respondents, 14.2 is the mean perceived stress score in individuals between the ages of 18-29, which reflects the current sample age. However, a more recent study done on the 10-item PSS with a sample of undergraduate students (78% female) revealed the mean PSS score to be 12 and the standard deviation to be 4, so one standard deviation from the mean, 16, and above was determined as an appropriate cut-off to label as high perceived stress in the current sample (Roberti, Harrington & Storch, 2006). In the previous study of 240 participants, 76.3% (183 participants) scored 16 or higher on the PSS.

Mastery imagery ability. The mastery subscale of the Sport Imagery Ability Questionnaire (SIAQ; Williams & Cumming, 2011) was used to measure mastery imagery ability. The subscale consisted of three items (“staying positive after a setback”, “giving 100% effort when things are not going well”, and “remaining confident in a difficult situation”) which participants first imaged and then rated how easy it was to image these scenarios on a 7-point Likert type scale from 1 (*very hard to image*) to 7 (*very easy to image*). Scores for the three items were averaged to give a mastery imagery ability score between 1 and 7, with a higher score indicating greater mastery imagery ability. The internal reliability of this factor was higher than the ideal .70 cut-off (Cronbach’s $\alpha = 0.80$), showing good reliability in the current study. The SIAQ has been shown to generate reliable and valid mastery imagery ability scores (Williams & Cumming, 2011).

General anxiety. General anxiety was measured using the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS-A; Zigmond & Snaith, 1983). The anxiety subscale consists of 7 questions (e.g. "I get sudden feelings of panic") each rated on a 4-point Likert type scale from 0 (*not at all; only occasionally*) to 3 (*most of the time; very definitely and quite badly; A great deal of the time; definitely; very often indeed; very often*). The wording of the anchors was adjusted according to the question being asked. Scores were calculated by summing the scores of the seven questions. Scores range from 0-21, with higher scores reflecting more severe symptoms of anxiety. The internal reliability of this factor was slightly higher than the ideal .70 cut-off (Cronbach's $\alpha = 0.73$). The HADS has been shown to be a reliable and valid measure of anxiety for use in a general population (Bjelland et al., 2002; Hermann, 1997; Zigmond & Snaith, 1983).

Psychological Responses to Acute Psychological Stress

State anxiety and self-confidence. The Immediate Anxiety Measurement Scale (IAMS; Thomas, Hanton & Jones, 2002) was included in the post-task questionnaire to assess the intensity and interpretation of state cognitive and somatic anxiety symptoms and self-confidence experienced by participants during the acute psychological stress task. Questions were worded in relation to how an individual felt during the stressful situation. First participants rated the intensity of each of the three constructs (i.e., cognitive anxiety, somatic anxiety, and self-confidence) on a 7-point Likert-type scale from 1 (*not at all*) to 7 (*extremely*). Next, they rated how they interpreted the intensity of each construct on a 7-point Likert-type scale from -3 (*very debilitative/negative*) to 3 (*very facilitative/positive*). Similar to previous research (Trotman et al., 2018; Williams & Cumming, 2012b), only confidence intensity was measured, and interpretation was not included due to the high correlation between confidence intensity and confidence direction. Definitions of each construct were provided to ensure understanding among all participants. The IAMS has been identified as a valid and reliable measure to assess the intensity and interpretation of state somatic anxiety, cognitive anxiety, and self-confidence (Thomas et al., 2002).

Task evaluation. Four separate items were also included in the post-task questionnaire pack to assess how stressful participants found the acute psychological stress task, how difficult they found it, how well they felt they were able to cope during the task, and how much control they felt they had during the task. Ratings were all made on a 7-point Likert-type scale from 1 (*not at all*) to 7 (*extremely*) (Trotman, Williams, Quinton & Veldhuijzen van Zanten, 2018).

Imagery session evaluation. Five questions were given to the LSRT participants to assess their experiences during imagery intervention sessions. Four items asked how easy is was to see the images performed, how vivid and clear the images were, the level of emotion produced during each image, and the extent to which the imagery was confidence building in their ability to image. These items were assessed on a 7-point Likert-type scale from 1 (*very hard/not clear or vivid/no emotion/not at all*) to 7 (*very easy/very clear and vivid/strong emotion/extremely*). The last item asked how engaged participants were during the session time allocated to imagery on a scale from 0% to 100%.

Cardiovascular Measures

A semi-automatic blood pressure monitor (Omron HEM-705IT) with a cuff placed on the non-dominant arm was used to assess systolic and diastolic blood pressure (millimetres of mercury; mmHg) as well as pulse rate (beats per minute; bpm) every minute for six minutes during the baseline and the speech task in the pre-intervention and post-intervention visit.

Acute Psychological Stress Task

The psychological stress task used in this study was a public speaking task where participants were told they had to pretend they were either falsely accused of shoplifting a belt or falsely accused of cheating on their end of year exams (Bosch et al., 2009; McNair et al., 1982). This public speaking task has been shown to elicit both a psychological and physiological stress response (Baggett et al., 1996; Kothgassner et al., 2016). Each participant completed one scenario during the pre-intervention session and the other scenario during the post-intervention session. The order in which participants completed the tasks was counterbalanced across all participants. These two scenarios were chosen because they were relevant to the participant sample and are known to elicit a similar stress response in this population (Williams et al., 2017). Participants were given pre-recorded instructions outlining the topic of the speech and the five points that needed to be incorporated in the speech: (a) a description of the event, (b) what the security guard or invigilator did wrong, (c) what should happen to the security guard or the invigilator, (d) how the participant should be compensated, and (e) a summary of all these points. The participants were given two minutes to prepare for the speech and four minutes to deliver the speech, during which they were asked to speak for the entire four minutes. To increase stressfulness of the task, an evaluator was present for each speech. Additionally, participants were told their speech would be videotaped and later evaluated by a panel of experts. In reality this was only added to induce stress, as they were not video recorded or evaluated by a panel of experts. They were also told they would be asked to continue speaking if they failed to speak for the entire 4 minutes, and informed that the evaluator would not be able to ask questions or help with the speech.

Intervention Conditions

LSRT. Participants in the experimental condition attended four imagery training sessions in which they received LSRT (Cumming et al., 2016). Upon arrival participants were seated in a chair across from the experimenter. In the first training session they were given White and Hardy's (1998) definition of imagery, and descriptions and examples of internal visual imagery (first person perspective) and external visual imagery (third-person perspective), as well as kinaesthetic imagery and images of feelings and emotions. The researcher then ensured the participant understood what imagery was, as well as the different modalities and visual perspectives before proceeding. Participants were then introduced to the different stages of the LSRT process, and told this would be completed five times in the session. At the conclusion of each session participants completed the imagery session evaluation.

The number of training sessions was determined based on previous research that found four sessions to be adequate in increasing skill imagery ability scores (Williams, Cooley & Cumming, 2013). This training uses a layering approach to build images up in terms of vividness and detail, making them as realistic and lifelike as possible (Williams, Cooley & Cumming, 2013). The goal of the sessions was to use LSRT to help participants vividly and clearly image a stressful situation, but image their stress response to be facilitative. Specifically, it included imaging symptoms of anxiety such as elevations in heart rate, but to also feel confident and in control of the situation (Jones et al., 2009; Hanton, Mellalieu and Hall, 2004). Consequently, the main objective was for participants at the end of the intervention to be able to vividly and realistically image themselves successfully coping and performing well in a stressful situation despite experiencing physiological and psychological responses associated with stress.

During each LSRT session the participant would image a scenario they considered stress evoking for 30-60 seconds, the better they were at imaging the longer they were able to image (i.e., the image phase). After each image, participants would verbally recount and evaluate their imagery aloud. Specifically, they would explain the aspects they found vivid and clear as well as the aspects they found unclear or more difficult to image (i.e., reflect phase). Based on the information gathered, the participant and experimenter would discuss ways to develop the image further and the participant would then try and incorporate some of this into the next image (i.e., develop phase). Following the approach by Williams et al. (2013), participants performed the image, reflect, and develop cycle five times during each session. Participants chose the content they imaged based on what was most stressful to them from a list of scenarios, including an exam, a presentation, an interview, or an important competition. This was to ensure the imagery was personalized and meaningful, an important factor for effective imagery (Lang, 1979; Smith et al., 2007). If participants were more proficient in their imagery skills, they would image more than one event to practice their imagery.

An example of the image, reflect, and develop cycle would be a participant imaging taking an exam. The participant would try and image the scenario with as much detail as possible (e.g., seeing the exam paper on the desk in front of them, feeling their pen in their hand). The experimenter and participant would then reflect on how to develop upon or alter the image content, so that it felt more realistic and vivid to the participant, or more positive in nature (e.g., being aware of their heart beating in anticipation of opening their exam paper to answer the questions well). They would then image again and the cycle would continue. Prompts during the imagery sessions would include something similar to; "image your feelings of anxiety about the stressor and once these emotions feel real, consider that this anxiety is motivation to perform well, rather than an obstacle. Include feelings of control and confidence while you image performing the stressor with your new found motivation". This individualized approach made each session unique to the participant according to the speed in which their imagery ability improved and the ease in which they imaged.

Control Intervention. Participants in the control group also came to the laboratory four times following the pre-intervention visit. They were seated in front of a computer and asked to place their hands on the table in front of them.

During each session, instead of receiving LSRT, participants were shown videos of hand movements that were between three and five minutes long. The experimenter instructed them to vividly and realistically image their hands making the same movements as in the video, without actually moving their hands. They were instructed to watch the video in its entirety. At the conclusion of the video, they left the laboratory. The movements included spreading their fingers apart, moving one finger at a time, and moving different fingers while having a rubber band around their hand. The experimenter stayed in the room to ensure they were focusing on imaging the hand movement and not actually moving their hand. This condition was designed to compare the effectiveness of the LSRT to a motor based imagery intervention. Such a condition also enabled control group participants to feel like they were receiving imagery training as the study was advertised as an imagery intervention. For consistency, control group sessions were matched with the LSRT group sessions in terms of number, however the duration of time spent imaging in each session was shorter in the control group then the LSRT group. They were also told this imagery intervention was being tested for its ability to help in dealing with stress, similar to the LSRT group.

Data Reduction and Analysis

Three participants were excluded due to changes in eligibility at the pre-intervention laboratory visit (i.e., the participants no longer met the criteria for their respective PSS group), leaving a final sample size of 23 participants (control = 12, experimental = 11). Two further participants in the final sample had a score slightly below the cut-off (PSS = 14) for participants with high perceived stress. The data was analyzed both with and without the two participants and due to results being no different, they were included in the reporting of the results.

Data were analysed using SPSS (version 23). One-way ANOVAs were conducted to ensure there were no differences in age, mastery imagery ability, general anxiety, and PSS between the control and LSRT group at the beginning of the study. Separate 2 phase (baseline, task) × 2 group (Control, Experimental) mixed-design ANOVAs examined any differences between groups in SBP, DBP, and PR during visit 1 baseline and stress, and whether there were any differences in the cardiovascular responses to the stress task. To examine changes in imagery experiences as well as ensure participants had sufficient imagery ability during the LSRT training sessions, separate one-way repeated measures ANOVAs were run on the ratings given by the LSRT group of ease, vividness, engagement, emotion, and confidence imaging across the four imagery training sessions. Next, 2 Visit (Pre-intervention, Post-intervention) × 2 Group (Control, Experimental) mixed-design ANOVAs were run separately on PSS, Mastery Imagery Ability, and HADS anxiety to measure changes in both groups' general levels of perceived stress, imagery ability, and general anxiety from pre to post intervention.

2 Group (Control, Experimental) × 2 Visit (Pre-intervention, Post-intervention) repeated measures ANOVAs were carried out to explore differences between groups and from pre- to post-intervention in ratings of stressfulness and difficulty, cognitive and somatic anxiety intensity and interpretation, feelings of self-confidence, control and coping during the stress task. For cardiovascular measures, baseline measurements were averaged to give an overall baseline value for diastolic blood pressure (DBP), systolic blood pressure (SBP), and pulse rate (PR). Similarly, measurements taken during the preparation phase and speech task were averaged to give an overall stress phase value for DBP, SBP, and PR (Trotman et al., 2018). First, separate 2 Phases (Baseline, Stress) one-way repeated measures ANOVAs

examined whether the stress task elicited an increase in DBP, SBP and PR. Next, reactivity scores were calculated by subtracting the average baseline value from the average stress phase value. To determine the differences in DBP, SBP, and PR reactivity from the pre intervention to post intervention, three separate 2 Visit (Pre-intervention, Post-intervention) × 2 Groups (Control, Experimental) ANOVAs were conducted.

The mixed-design ANOVAs yielded low power (values between 0.053 and 0.287 for all interactions). This combined with the small sample size suggests that a large proportion of the results may have been underpowered. This is not surprising given that current study was designed to be a pilot study and one of the goals was to obtain data to detect sample size for future research. As such, paired sample t-tests were run as a follow-up analysis to further investigate any outcome variable changes in each group from pre intervention to post intervention. The t-tests compared assessments made before the intervention to assessments following the intervention and were run separately for the LSRT group and control group.

For ANOVAs including repeated measures, Greenhouse Geisser values were reported if Mauchly's test of sphericity was violated. All ANOVA effect sizes were reported as partial eta squared and significant effects were followed up with Bonferroni post hoc pairwise comparisons. The alpha level was set at .05 for all analysis conducted.

Results

Participant Baseline Data

One-way ANOVAs confirmed there were no significant differences between the control and LSRT group at visit one in age (F [1, 22] = 1.38, p = .254, η_p^2 = .062), mastery imagery ability (F [1, 22] = 0.350, p = .561, η_p^2 = .016), perceived stress (F [1, 22] = 0.023, p = .881, η_p^2 = .001), or general anxiety (F [1, 22] = 0.315, p = .580, η_p^2 = .015) (See Table 3). The 2 phase (baseline, task) x 2 group (LSRT, control) mixed-design ANOVAs revealed significant main effects for phase, indicating that the stress task did elicit a stress response with significant increases from baseline to stress in measures of DBP (F [1, 21] = 96.56, $p <$ 0.01, $\eta_p^2 = .821$), SBP (: F [1, 21] = 105.91, $p < 0.01$, $\eta_p^2 = .835$), and PR (F [1, 21] = 62.48, $p < 0.01$, $\eta_p^2 = .748$). They showed no main effect for group in measures of DBP (F [1, 21] = 3.91, $p = .061$, $\eta_p^2 = .157$), SBP (F [1, 21] = 1.71, $p = .205$, $\eta_p^2 = .075$), or PR (F [1, 21] = .214, $p = .649$, $\eta_p^2 = .010$). Furthermore, there were no significant visit by group interactions in measures of DBP (F [1, 21] = 1.43, $p = .245$, $\eta_p^2 = .064$), SBP (F [1, 21] = 1.21, $p = .285$, $\eta_p^2 = .054$), PR (F [1, 21] = .740, $p = .399$, $\eta_p^2 = .034$).

Table 3.

Means and Standard Deviations For Pre-Intervention Variables.

	Pre-Intervention	
	Control	LSRT
Age	21.11 (1.35)	22.60 (4.19)
Mastery Imagery Ability (1-7)	4.42 (1.28)	4.12 (1.10)
Perceived Stress (0-40)	22.17 (5.15)	22.45 (3.83)
General Anxiety (0-21)	10.08 (3.85)	9.27 (2.97)
Baseline SBP (mmHg)	112.10 (11.09)	103.74 (8.39)
Baseline DBP (mmHg)	76.21 (8.87)	66.47 (8.11)
Baseline PR (bpm)	65.76 (8.04)	66.23 (11.13)
SBP (mmHg) Reactivity	16.69 (5.61)	20.68 (11.15)
DBP (mmHg) Reactivity	12.60 (5.57)	16.09 (8.28)
PR (bpm) Reactivity	14.73 (7.01)	18.33 (12.52)

Notes. Means and standard deviations for pre-intervention variables; SBP = systolic blood pressure; DBP = diastolic blood pressure; PR = pulse rate.

Imagery Evaluations

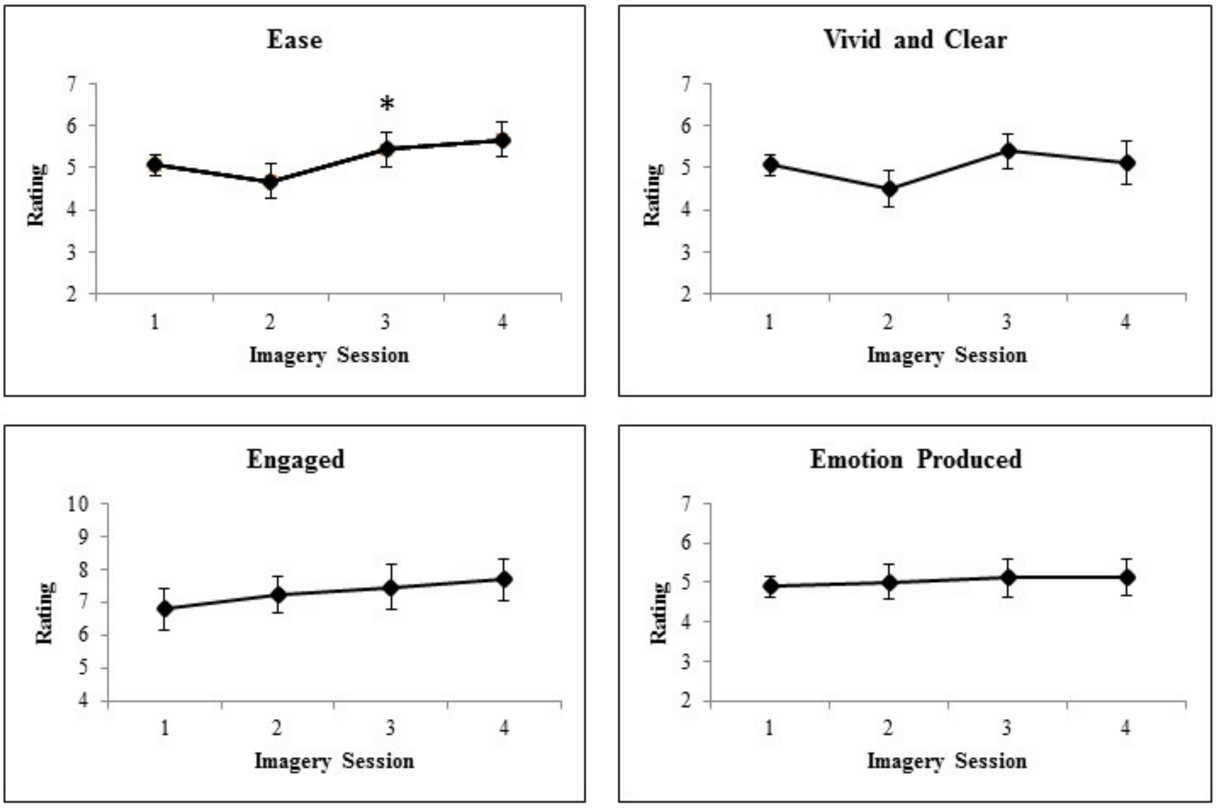

Figure 8. Mean and Standard Errors of LSRT group Imagery Session Evaluation. All questions were rated on a 7-point Likert scale, except the question on engagement, which was a 10-point scale; * $p < 0.05$.

Mean and standard errors of the imagery session evaluation items for the LSRT group only are displayed in Figure 2. Mean scores suggest that participants in the LSRT group were able to image the content with relative ease, vividness, and clarity. The mean scores also suggest they were sufficiently engaged in the imagery training (See Figure 8). The level of emotion produced also suggests the imagery was meaningful. Repeated measures ANOVAs revealed the only significant change was in ease of imaging (See Figure 8), which significantly increased from session 2 to session 3.

Mixed Design ANOVAs

The main effects for visit and group, and the visit by group interactions of the 2 visits (pre-intervention visit, post-intervention visit) × 2 groups (control, LSRT) mixed design

ANOVAs as well as the means and standard deviations for each variable are reported in Table 4 and Table 5.

Trait measures (PSS, HADS-A, Mastery imagery ability). There was a significant main effect for visit for perceived stress, anxiety, and mastery imagery ability. Perceived stress and general anxiety scores significantly decreased from the pre-intervention visit to the post-intervention visit. Mastery imagery ability significantly increased from the pre-intervention visit to the post-intervention visit. There were no other significant main effects or interactions.

Stressfulness and difficulty. Both ANOVAs revealed no significant main effect for visit or group, and no visit by group interaction. Participants in both groups found the task equally stressful and difficult in both visits (See table 4).

State anxiety intensity and interpretation (IAMS). There were no significant differences for cognitive and somatic anxiety intensity. However, there was a main effect of visit for both cognitive and somatic anxiety interpretation. Compared to the pre-intervention visit, interpretations of anxiety became significantly more facilitative during the post-intervention visit. There was also a significant group effect for somatic anxiety interpretation, the LSRT group interpreted their somatic anxiety significantly more facilitative compared to the control group (See table 4). No other significant main effects or interactions were found.

Confidence, control and coping. There were main effects for visit for self-confidence intensity. Self-confidence intensity was significantly lower during the pre-intervention visit compared to the post-intervention visit. There were also main effects for visit for control and coping. Feelings of control and coping were significantly higher during the post-intervention visit. There were no other significant main effects or interactions.

Cardiovascular reactivity. There were significant main effects of visit with DBP reactivity, SBP reactivity and PR reactivity all being significantly greater during the pre-intervention visit compared to the post-intervention visit. No other significant main effects or interactions were found.

Table 4.

Analysis of Variance (ANOVA) Between Experimental and Control Group from the Pre-Intervention Visit to Post-Intervention Visit

		Pre M (SD)	Post M (SD)	Main Effect for Visit F	p	η_p^2	Main Effect for Group F	p	η_p^2	Visit x Group Interaction F	p	η_p^2
Trait measures												
PSS	LSRT Control	22.45 (3.83) 22.17 (5.15)	19.36 (5.41) 18.83 (8.26)	6.78	**.017**	.244	.036	.851	.002	.010	.923	.000
HADS-A	LSRT Control	9.27 (2.97) 10.08 (3.85)	7.45 (3.96) 8.33 (5.37)	8.83	**.007**	.296	.270	.609	.013	.003	.955	.000
Mastery Imagery Ability	LSRT Control	4.12 (1.10) 4.42 (1.28)	4.91 (1.18) 4.75 (1.15)	7.08	**.015**	.252	.023	.880	.001	1.16	.293	.053
Task assessments												
Stressfulness	LSRT Control	4.45 (1.44) 4.58 (1.78)	3.91 (1.30) 4.58 (0.90)	.880	**.040**	.359	.636	**.029**	.434	.880	**.040**	.359
Difficulty	LSRT Control	4.27 (1.19) 4.75 (1.55)	4.00 (1.18) 4.25 (0.87)	2.05	.089	.167	.707	**.033**	.410	.177	**.008**	.678
State anxiety measures												
Cognitive Anxiety Intensity	LSRT Control	4.45 (1.21) 4.92 (1.38)	3.82 (1.17) 4.50 (1.38)	3.18	.160	.059	1.47	.066	.238	.174	**.008**	.681
Cognitive Anxiety Interpretation	LSRT Control	-1.36 (1.12) -1.64 (1.21)	0.27 (1.49) -1.00 (1.27)	11.12	.357	.003	3.31	.142	.084	2.15	.097	.158
Somatic Anxiety Intensity	LSRT Control	4.18 (0.98) 4.00 (1.86)	3.73 (1.35) 3.67 (1.78)	1.22	.055	.282	.051	**.002**	.824	.029	**.001**	.867
Somatic Anxiety Interpretation	LSRT Control	-1.45 (0.93) -1.90 (0.88)	0.00 (1.41) -1.20 (1.14)	8.43	.307	.009	6.80	.264	.017	1.03	.052	.322

Notes. Degrees of freedom (1,21) for all variables except Cognitive Anxiety Interpretation (1,20) and Somatic Anxiety Interpretation (1,19); Bold numbers indicate statistically significant values.

Table 5.

Analysis of Variance (ANOVA) Between Experimental and Control Group from the Pre-Intervention Visit to Post-Intervention Visit

		Pre M (SD)	Post M (SD)	Main Effect for Visit			Main Effect for Group			Visit x Group Interaction		
				F	*p*	η_p^2	*F*	*p*	η_p^2	*F*	*p*	η_p^2
Measures of self-confidence, control, and coping												
Self-Confidence Intensity	LSRT	3.18 (1.33)	4.55 (1.37)	7.27	**.013**	.257	2.03	.169	.088	1.56	.225	.069
	Control	3.08 (1.24)	3.58 (0.90)									
Control	LSRT	3.82 (0.75)	5.36 (1.03)	30.13	**< .001**	.589	3.46	.224	.070	.931	.346	.042
	Control	3.50 (1.57)	4.58 (1.24)									
Coping	LSRT	4.00 (1.55)	5.36 (1.43)	11.03	**.003**	.344	2.16	.156	.093	.930	.346	.042
	Control	3.67 (1.30)	4.42 (0.79)									
Cardiovascular reactivity measures												
DBP CVR	LSRT	16.09 (8.28)	10.03 (8.63)	8.23	**.009**	.281	.308	.585	.014	1.65	.213	.073
	Control	12.60 (5.57)	10.29 (8.44)									
SBP CVR	LSRT	20.68 (11.15)	13.52 (9.45)	8.91	**.007**	.298	.499	.488	.023	.757	.394	.035
	Control	16.69 (5.61)	12.76 (9.84)									
PR CVR	LSRT	18.33 (12.52)	13.37 (6.19)	11.55	**.003**	.355	1.59	.221	.070	.078	.783	.004
	Control	14.73 (7.01)	8.88 (7.33)									

Notes. Degrees of freedom for all variables was (1,21); M = mean; SD = standard deviation; DBP = diastolic blood pressure; SBP = systolic blood pressure; PR = pulse rate; CVR = cardiovascular reactivity; Bold numbers indicate statistically significant values.

T-tests

All mean scores, standard deviations, *p*-values, and t-values are displayed in table 6 and 7.

Trait measures (PSS, HADS-A, Mastery imagery ability). Perceived stress scores did not change for either group. General anxiety scores significantly decreased whereas mastery ability increased from the pre intervention to the post-intervention visit in the LSRT group. No such changes were seen in the control group.

State anxiety intensity and interpretation (IAMS). There were no significant changes in cognitive and somatic anxiety intensity for either group. However, compared to the pre-intervention session, cognitive anxiety interpretation became significantly more facilitative in the LSRT group during the post-intervention session, while the control group showed no differences. The LSRT group showed no differences in somatic anxiety interpretation, yet the control group showed a significantly more facilitative interpretation of somatic anxiety during the post-intervention visit.

Confidence, control and coping. Self-confidence intensity significantly increased from pre-intervention to the post-intervention visit for the LSRT group, but not the control group. Control significantly increased for both groups from pre-intervention to the post-intervention visit, while ratings of coping only significantly increased for the LSRT group and not the control group.

Cardiovascular reactivity. Compared to the pre-intervention stress test, the LSRT group displayed significantly lower diastolic and systolic blood pressure reactivity during the post-intervention stress test, but there was no change for the control group. The control group did experience significantly lower pulse rate reactivity during the post-intervention visit, but there was no change for the LSRT group.

Table 6.

Paired sample t-test results

	LSRT				Control			
	Pre-Intervention M (SD)	Post-Intervention M (SD)	*t*	*p*	Pre-Intervention M (SD)	Post-Intervention M (SD)	*t*	*p*
Trait measures								
PSS	22.45 (3.83)	19.36 (5.41)	1.82	.100	22.17 (5.15)	18.83 (8.26)	1.88	.087
HADS-A	9.27 (2.97)	7.45 (3.96)	2.43	**.036**	10.08 (3.85)	8.33 (5.37)	1.90	.084
Mastery Imagery	4.12 (1.10)	4.91 (1.18)	-2.24	**.049**	4.42 (1.28)	4.75 (1.15)	-1.37	.197
State anxiety measures								
Cognitive Anxiety Intensity	4.45 (1.21)	3.82 (1.17)	1.55	.152	4.92 (1.38)	4.50 (1.38)	1.24	.241
Cognitive Anxiety Interpretation	-1.36 (1.12)	0.27 (1.49)	-2.76	**.020**	-1.64 (1.21)	-1.00 (1.27)	-1.88	.089
Somatic Anxiety Intensity	4.18 (0.98)	3.73 (1.35)	.922	.378	4.00 (1.86)	3.67 (1.78)	.650	.529
Somatic Anxiety Interpretation	-1.45 (0.93)	0.00 (1.41)	2.19	.054	-1.90 (0.88)	-1.20 (1.14)	-2.69	**.025**

Notes. M = mean; SD = standard deviation.

Table 7.

Paired sample t-test results

	LSRT				Control			
	Pre-intervention M (SD)	Post-Intervention M (SD)	*t*	*p*	Pre-intervention M (SD)	Post-Intervention M (SD)	*t*	*p*
Measures of self-confidence, control, and coping								
Self-Confidence Intensity	3.18 (1.33)	4.55 (1.37)	-2.51	**.031**	3.08 (1.24)	3.58 (0.90)	-1.15	.275
Control	3.82 (0.75)	5.36 (1.03)	-5.49	< **.001**	3.50 (1.57)	4.58 (1.24)	-2.86	**.015**
Coping	4.00 (1.55)	5.36 (1.43)	-2.68	**.023**	3.67 (1.30)	4.42 (0.79)	-1.92	.082
Cardiovascular reactivity measures								
DBP CVR	16.09 (8.28)	10.03 (8.63)	3.01	**.013**	12.60 (5.57)	10.29 (8.44)	1.10	.294
SBP CVR	20.68 (11.15)	13.52 (9.45)	2.65	**.024**	16.69 (5.61)	12.76 (9.84)	1.54	.152
PR CVR	18.33 (12.52)	13.37 (6.19)	1.88	.089	14.73 (7.01)	8.88 (7.33)	3.15	**.009**

Notes. CVR = cardiovascular reactivity; SBP = systolic blood pressure; DBP = diastolic blood pressure; PR = pulse rate; M = mean; SD = standard deviation.

Discussion

The current pilot study explored the effects of a 2-week intervention aimed at improving mastery imagery ability on general levels of perceived stress and anxiety in individuals displaying high levels of perceived stress, as well as increasing feelings of confidence and control and decreasing cardiovascular activity during an acute psychological stress task. The intervention was successful in improving mastery imagery ability and decreasing levels of general anxiety. In addition, the intervention also induced increased feelings of self-confidence, control and coping, more positive interpretations of cognitive anxiety and lower cardiovascular reactivity in response to an acute psychological stress task.

Despite the positive findings regarding the within-group effects of the imagery intervention, it should be acknowledged that a comparison of the intervention with a control condition did not reveal significant overall group or group by time interaction effects. However, this is likely due to the small sample size, as is clear from the low power (values between 0.050 and 0.287), and small to medium effect sizes ($0.244 < \eta_p^2 < 0.589$). While the sample size of this pilot study was low, it was similar to previous LSRT research studies (Williams et al., 2013), further research is needed with a bigger sample to confirm the findings in this study. In order to investigate any potential changes in the variables of interest due to the imagery training in more detail, changes from pre- to post-intervention were analysed separately for the experimental and control groups. Employing the t-test analyses, both groups showed no changes in general levels of perceived stress at the conclusion of the study. However, results suggested the LSRT group, but not the control group, increased their mastery imagery ability. This is the first study to assess and demonstrate that LSRT was successful in increasing mastery imagery ability, as well as adding to previous research demonstrating LSRT's effectiveness in increasing movement related imagery ability (Williams, Cooley & Cumming, 2013; Weibull et al., 2015).

The present findings provide preliminary evidence for a different population with which LSRT appears to be effective. Previous research has demonstrated LSRT's effectiveness in athlete populations and found that it successfully facilitates visual and kinaesthetic motor imagery ability (Williams et al., 2013). LSRT has also proved to be effective in improving imagery ability in a population of sedentary women who wanted to increase their physical activity levels using only one session (Weibull, et al., 2015). However, this is the first study to examine LSRT's effectiveness in a group of highly stressed individuals. With further testing this could be used as an easy and inexpensive intervention to help individuals suffering with high levels of stress.

The LSRT group also experienced a significant decrease in general anxiety, while the control group did not show any differences pre- to post-intervention. This is in line with the results from Chapter 2, which demonstrate that greater mastery imagery ability was associated with lower levels of general anxiety. The t-test results in the present study extend the association found in Chapter 2 by suggesting a potential causal effect. Specifically, it appears that increasing a participant's mastery imagery ability (i.e., enabling them to more easily and vividly image themselves successfully coping with a stressful situation), lowered their general anxiety levels. Consequently, developing the ability to image mastery imagery content could be a technique used to reduce anxiety in individuals suffering from high levels of perceived stress.

Although Chapter 2 found that perceived stress mediated the relationship between mastery imagery ability and general anxiety, perceived stress was not lower after the LSRT intervention. One reason for no change in perceived stress could be because participants were still viewing day to day situations as stressful, but the increased mastery imagery ability was allowing them to feel more capable of coping with the stress, thus lowering their anxiety experienced as a result of the stress instead of lowering their perceived stress itself. Indeed, the goal of the LSRT sessions was to encourage individuals to feel more confident and in control during stressful situations as well as to view their stress as more facilitative rather than eliminating the stress itself. Therefore, it would seem logical that individuals continued to experience stress, but experienced less anxiety. Furthermore, the perceived stress scale measures stress levels over the past week, therefore may not be sensitive enough to pick up more subtle changes in stress and could be a factor in the lack of change in perceived stress scores after the imagery training. In future research perhaps choosing multiple measures of stress and including more immediate measures of stress could yield the detection of changes in stress.

The second study aim was to investigate how increasing mastery imagery ability would affect psychological and cardiovascular responses to an acute psychological stress task (i.e. public speaking). Both public speaking topics used elicited a stress response similar to previous literature (Baggett et al., 1996; Williams et al, 2017), which was a substantial stress response. Furthermore, there were no changes in the high ratings of stressfulness and difficulty between the pre-intervention and post-intervention visit, providing evidence that the acute psychological task was similarly stressful during both visits.

The t-test results showing significant changes in cognitive anxiety interpretation suggests that improving mastery imagery ability could facilitate more positive perceptions of cognitive anxiety. The findings are in line with previous works, which have shown that participants with higher levels of mastery imagery ability were more likely to interpret cognitive anxiety as facilitative rather than debilitative in response to a stress task (Quinton et al., 2018; Williams et al., 2018). Because cognitive anxiety is related to the mental component of anxiety, such as mental thoughts and concerns, it would be expected to change in the LSRT group due to the fact that the imagery training was focused on altering mental thoughts during stress.

As hypothesized, there were no changes in cognitive or somatic anxiety intensity in either the experimental or control group. Contrary to the present results, Quinton et al. (2018), and Williams and Cumming (2015) found that mastery imagery ability is related to lower levels of cognitive and somatic anxiety intensity. An explanation for the present study findings is likely due to the LSRT aiming to change the appraisal of the responses such as anxiety rather than decreasing the intensity of the responses. As such, the present study findings are more in line with findings from studies using mastery type imagery to change the interpretation rather than the intensity of the anxiety experienced (e.g., Williams et al., 2017; Williams et al., 2018).

Compared to before the intervention, the LSRT group also displayed significantly higher self-confidence, control, and coping during the post-intervention stress task compared to the pre-intervention stress task, suggesting that the LSRT helped them feel more confident and in control during stress. These greater levels of confidence and control could potentially be a mechanism leading to more positive perceptions of anxiety (Hanton, Mellalieu & Hall, 2004; Jones & Swain, 1992). These findings also support literature suggesting increased mastery imagery ability and imagery use leads to more adaptive responses to and appraisals of stress (Williams & Cumming, 2012; Williams et al., 2017; Vadoa, Hall & Moritz, 1997; Quinton et al., 2018).

Finally, during the post-intervention visit the LSRT group had significantly lower DBP and SBP reactivity in response to the stress task compared to the pre-intervention visit stress task. It could be possible that improving mastery imagery ability reduces blood pressure reactivity during stress. This may be due to the fact that increasing mastery imagery ability increased feelings of control and self-confidence, these changes caused them to have a more moderate reactivity to the stress task post-intervention because they were confident in their ability to cope. If this is indeed the case, developing mastery imagery ability could have the potential to reduce some of the health risks posed by exaggerated cardiovascular reactivity to stress, such as hypertension and cardiovascular disease (Carroll et al., 2012; Cohen, Gianaros, & Manuck, 2016; Ginty, Kraynak, Fisher, & Gianaros, 2017). Further studies are needed to determine the relationship between increasing mastery imagery ability and changes in cardiovascular reactivity.

The results of this pilot study should be considered with caution. Despite the majority of t-tests supporting the study hypotheses, the control group did experience some changes that were not predicted. These included significantly more facilitative interpretations of somatic anxiety, higher ratings of control, and lower PR reactivity during the post-intervention stress task compared to the stress task during the pre-intervention visit. Although these changes were fewer and less consistent than those experienced in the LSRT group, they still need to be taken into consideration. Perhaps due to already being exposed to the experimental room and conditions for the stress task, individuals in the control group viewed their physical symptoms of anxiety (somatic anxiety) as more facilitative and felt more in control of the outcome of the task. Furthermore, the pre-exposure and knowing the experimenter by this point could have caused their pulse rate reactivity to be lower during the post intervention visit. Additionally, as noted, the sample size in the current study was small. Consequently, while the findings suggest that mastery imagery ability has potential, the results presented here are preliminary and present the need for future research to replicate this study on a larger scale to examine in more detail whether LSRT targeting mastery imagery ability is as effective as some of the results suggest.

If future research can replicate the present findings, this would provide rationale to use imagery in clinical populations that suffer with negative images, such as clinically anxious or depressed patients (Holmes & Mathews, 2010; Lebois et al., 2016; Reiss et al., 2018). The current results suggest that LSRT may be a useful tool to help these individuals improve their mastery imagery ability and thus alter their negative imagery to more positive (motivating/empowering) content. Future research should examine the effectiveness of LSRT on different clinical populations.

While it is important to replicate the present study, the pilot nature of the work means that some alterations to the protocol could likely be made based on research reflection and informal feedback from participants. For example, based on participant feedback, it was mentioned it would be worth trying fewer in-person sessions to increase participant retention rates. Instead of 4 sessions there could be 2 or 3 that require them to attend in person, and in place of the remaining sessions participants could practice the imagery on their own with a recorded set of instructions to keep them on task. This way they would not feel the pressure of finding time in their busy schedules to come in person for all training sessions and can do it on their own once they have been guided through it a few times. While practicing imagery on their own they could draw from current circumstances that are causing them stress. Despite this, attendance to the imagery training sessions was very good, demonstrating the feasibility of this type of intervention.

Another adjustment to consider would be to include past high stress experiences that the participant has undergone and use those as situations to practice imaging during the training sessions and make it more personalized. They could then practice dealing with the scenario in a different way and getting a better outcome. Similar to previous research, individuals expressed the importance of imaging situations relevant to them, in order to produce realistic images and be fully engaged in the imagery (Lang, 1979; Cumming et al., 2016). Lang's (1979) bio-informational theory highlights this importance of individualized training for an effective increase in imagery ability and imagery use. Future studies should aim to individualize all imagery training where possible, in order to test whether it enhances the effects.

The present study investigated the effectiveness of LSRT in increasing mastery imagery ability. These pilot data results revealed that as well as increasing mastery imagery ability, the LSRT altered cognitive anxiety interpretation to be more facilitative, increased feelings of confidence, control, and coping, as well as decreased cardiovascular reactivity in response to acute psychological stress within the LSRT group in accordance with the hypotheses. The current study suggests LSRT as a likely effective stress management technique when working with individuals displaying high levels of perceived stress and suggests meaningful future implications for therapies and treatment of individuals with high stress. If the present study results can be replicated in future research it could open the door for a new therapy technique to improve how individuals cope and address the demands of stressful life events.

Chapter 4

General Discussion

General Discussion

The overall aim of the current thesis was to first establish a relationship between mastery imagery ability and stress, general anxiety, and immediate anxiety intensity and interpretation. Next, we tested a layered imagery training technique on its ability to increase mastery imagery ability, and alter both general stress and anxiety levels, as well as the responses and appraisals of acute psychological stress. Chapter 1 revealed significant relationships between mastery imagery ability and perceived stress, immediate cognitive anxiety measures, and general anxiety in a large sample of participants. Chapter 2 then showed evidence that a two-week LSRT program appeared to increase mastery imagery ability as well as lower general anxiety, and elicit more positive psychological appraisals and cardiovascular responses to acute psychological stress. However, the programme did not prove to change general stress levels.

The evidence of a relationship between mastery imagery ability and perceptions of and responses to acute psychological stress adds to the growing body of work demonstrating that mastery imagery is related to positive coping strategies (Williams et al., 2017). Furthermore, the relationship between mastery imagery ability and immediate cognitive anxiety as well as general anxiety adds to the already existing research on mastery imagery ability and anxiety (Quinton et al., 2018). In the present thesis, mastery imagery ability had a negative association with general anxiety levels, which until now has only been shown in athlete anxiety context. Building on the findings of Chapter 1, Chapter 2 showed that by increasing mastery imagery ability, general anxiety levels decreased significantly and cognitive anxiety was viewed as more facilitative in the context of acute mental stress. Chapter 1 also showed a negative relationship exists between an individual's mastery imagery ability and their general levels of stress and anxiety. Chapter 1 was the first study to confirm the relationship between mastery imagery ability and general levels of perceived stress, and that perceived stress mediates the relationship between mastery imagery ability and anxiety. The results of Chapter 3 hint at a cause and effect relationship between some of the associations established in Chapter 2. For example, altering mastery imagery ability in Chapter 2 also altered perceptions of cognitive anxiety and general anxiety levels, suggesting that maybe higher mastery imagery ability is the cause of more facilitative interpretations of cognitive anxiety and lower general anxiety. These pieces of evidence present new relationships and further confirm mastery imagery ability's role in levels of general stress and anxiety, as well as how increasing mastery imagery ability can help regulate immediate anxiety in response to stress.

A likely explanation for the observed altered stress and anxiety levels in relation to mastery imagery ability could be due to changes in perceived control and coping. Chapter 2 showed that in relation to an acute psychological stress task, after a two-week layered imagery training technique, individuals with increased mastery imagery ability displayed increased feelings of control and coping. These increased feelings of control and coping could be the mechanism through which people with higher mastery imagery ability have lower levels of general stress and anxiety, as well as lower intensity and more facilitative interpretations of immediate cognitive anxiety. For example, Tetrick and LaRocco (1987) confirmed a significant direct relationship between perceived control and stress, with higher levels of stress being related to lower control. Furthermore, studies have shown confidence and control to be associated with lower and more facilitative anxiety (Hanton & Connaughton, 2002; Hanton, Mellalieu & Hall, 2004). Although the study in chapter 2 did not measure control and coping, future studies should examine whether this is the reason for the relationships between mastery imagery ability, stress, and anxiety.

In addition to the novel contributions to the stress and anxiety literature, extending the imagery field, this thesis is the first to demonstrate LSRT's ability to increase imagery ability beyond movement content (Williams, Cooley & Cumming, 2013), and the effectiveness this can have on general anxiety levels, cognitive anxiety interpretation, and cardiovascular responses to acute psychological stress. Results from Chapter 2 showed that mastery imagery ability could be increased after only 4 bouts of imagery training. This is similar to work that has demonstrated only 4 bouts are needed to increase movement imagery ability (Williams et al., 2013). In the present thesis, training to increase mastery imagery ability was accompanied by a decrease in general anxiety levels. But in contrast to the hypothesis, the LSRT did not decrease levels of stress. However, stress levels may have remained due to the LSRT helping participants re-appraise and cope with the stress rather than reducing the actual perceptions of experiencing stress. This is further supported by the fact that mastery imagery ability reflects content associated with stress but successfully coping in these difficult situations.

Results of Chapter 3 suggest that individuals who received LSRT training may experience more moderate blood pressure reactivity to acute psychological stress after the intervention. Previously, Williams et al. (2017) has shown that imaging mastery based content (which the authors termed challenge imagery) elicited significantly lower heart rate, more positive anxiety, and greater confidence during a stressful situation in comparison to imaging threat imagery. The present thesis showed that increasing mastery imagery ability can decrease blood pressure reactivity during a stressful situation, and elicit more positive anxiety, and higher confidence. The findings in chapter 2 suggest that individuals with higher mastery imagery ability have lower stress and general anxiety. Therefore, these individuals may also have lower resting BP. Because resting blood pressure was not measured in the first study (Chapter 2), it would be interesting for future research to examine resting blood pressure in relation to mastery imagery ability to see whether mastery imagery ability (like it’s association with anxiety) is also associated with general blood pressure and not just blood pressure reactivity in response to acute psychological stress.

While specific strengths and limitations of each study have been mentioned in previous chapters, a more general limitation regarding this thesis is that ease of imagery was used as the measure of imagery ability despite other dimensions such as vividness, accuracy, and controllability being important indicators of imagery ability (Morris, Spittle & Watt, 2005). Ease of imagery was selected as it is thought to be a more encompassing characteristic that is reflective of an individual’s ability to not only generate/form an image, but to also maintain, and transform an image (Williams & Cumming, 2011; Hall & Martin, 1997; Kosslyn, 1994). Dimensions such as vividness and controllability, while still important are thought to reflect the ability to generate and transform an image respectively (Kosslyn, 1994; Williams & Cumming, 2011). Although research demonstrates that there is considerable overlap between ease of imaging and vividness (Roberts et al., 2008; Williams & Cumming, 2011), conceptually they are distinct characteristics (Morris et al., 2005). Therefore, while arguably the most comprehensive self-report measure of imagery ability was selected in the present thesis, it is important for future work to establish how other dimensions of imagery ability, such as vividness relate to confidence, control, anxiety intensity, and anxiety interpretation, and the extent to which LSRT can improve vividness.

From a practical point of view, there were also some anecdotal reports made by participants that should be considered in future research. For example, participants suggested having the location of the imagery training in a room with minimal distractions and plenty of space to be comfortable. This is important because participants are able to stay focused during the imagery training, instead of having intermediate pauses due to outside noise. Individuals that experienced two separate experiment rooms, mentioned they felt their imagery was easier and more focused when in a location with minimal distractions and lots of space to get comfortable. They also mentioned that imaging experiences relevant to them resulted in more vivid and realistic images, so it would be beneficial for future researchers to ask the participate to image a scenario that has stressed them out in the past and use that scenario to build and alter their images, in order to have more relevant results. In addition, asking participants to use scenarios that are currently causing them stress gives them practice in using the imagery technique for current stressors in their life.

Finally, although participants with high levels of perceived stress were chosen, they were otherwise fairly healthy, which means the findings are only generalizable to non-clinical populations. The sample also had relatively high imagery ability to begin with, so it is not generalizable to individuals with low imagery ability. However, these studies were conducted as a first step to understanding the relationships between the selected measures. Future research could investigate recruiting individuals with low imagery ability versus high imagery ability, to see if those with low imagery ability benefit more from the LSRT. It would also be noteworthy to compare a non-clinical sample to a sample of individuals with clinical anxiety or stress disorders to test whether the relationships in chapter 2 can be replicated in a clinical population, and whether LSRT is more effective for these individuals.

Despite the limitations, there were many strengths to this body of work. One being the implementation of different research designs in a progressive manor to answer the posed research questions. Chapter 1 was a cross-sectional study, which used a large sample to establish associations between the variables of interest. Using an experimental design, Chapter 2 then built on this to examine whether cause and effect could be determined, by implementing an intervention to improve mastery imagery ability and examining the influence this had on the associated variables. This allowed for a very in-depth analysis of the variables examined and how these appear to relate and impact one another. Furthermore, this study utilized a multi-session training method compared to some of the previous research that have only used one-time training methods. Additionally, the current thesis was interdisciplinary in assessing stress, using a combination of self-report and physiological responses in order to get a more comprehensive assessment of responses to stress.

Overall, the results of this thesis provide evidence of the association between mastery imagery ability, stress, general anxiety, and immediate cognitive anxiety intensity and interpretation. It also provided a possible mechanism (i.e., perceived stress) through which mastery imagery ability affects general anxiety and immediate anxiety levels. Finally, this thesis provided evidence of an imagery training technique (LSRT) that can increase mastery imagery ability and subsequently alter psychological and physiological responses to acute psychological stress. These findings provide evidence of a technique that has the potential to be used as an inexpensive and non-invasive therapy technique to help individuals have a healthier and more adaptive response to everyday stress.

References

Abma, C. L., Fry, M. D., Li, Y. & Reylea, G. (2002). Differences in imagery content and imagery ability between high and low confident track and field athletes. *Journal of Applied Sport Psychology, 14,* 67-75.

Afshar, M., Mohsenzadeh, A., Gilasi, H., & Sadeghi-Gandomani, H. (2018). The effects of guided imagery on state and trait anxiety and sleep quality among patients receiving hemodialysis: A randomized controlled trial. *Complementary Therapies in Medicine,40*, 37-41.

American Psychological Association, APA Working Group on Stress and Health Disparities. (2017). *Stress and health disparities: Contexts, mechanisms, and interventions among racial/ethnic minority and low-socioeconomic status populations*. Retrieved from http://www.apa.org/pi/health-disparities/resources/stress-report.aspx

Anuar, N., Cumming, J., & Williams, S. E. (2016). Effects of Applying the PETTLEP Model on Vividness and Ease of Imaging Movement. *Journal of Applied Sport Psychology,28*(2), 185-198.

Armstrong, K. A., & Khawaja, N. G. (2002). Gender Differences in Anxiety: An Investigation of The Symptoms, Cognitions, And Sensitivity Towards Anxiety In A Nonclinical Population. *Behavioural and Cognitive Psychotherapy,30*(02), 227-231.

Arntz, A. (2012). Imagery Rescripting as a Therapeutic Technique: Review of Clinical Trials, Basic Studies, and Research Agenda. *Journal of Experimental Psychopathology,3*(2).

Baggett, H. L., Saab, P. G., & Carver, C. S. (1996). Appraisal, Coping, Task Performance, and Cardiovascular Responses During the Evaluated Speaking Task. *Personality and Social Psychology Bulletin, 22*(5), 483-494.

Baumeister, R. F., Campell, J. D., Krueger, J. I., Vohs, K. D. (2003) Does high self-esteem cause better performance, interpersonal success, happiness, or healthier lifestyles?

Psychol. Sci. Public Interest, 4, 1-24.

Baron, R. M. and Kenny, D. A. 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*: 1173–1182.

Bigham, E., Mcdannel, L., Luciano, I., & Salgado-Lopez, G. (2014). Effect of a Brief Guided Imagery on Stress. *Biofeedback,42*(1), 28-35.

Bjelland, I., Dahl, A. A., Haug, T. T., & Neckelmann, D. (2002). The validity of the Hospital Anxiety and Depression Scale: An updated literature review. *Journal of Psychosomatic Research, 52*(2), 69-77.

Bosch, J. A., Geus, E. J., Carroll, D., Goedhart, A. D., Anane, L. A., Zanten, J. J., . . . Edwards, K. M. (2009). A General Enhancement of Autonomic and Cortisol Responses During Social Evaluative Threat. *Psychosomatic Medicine, 71*(8), 877-885.

Buss, A. H., Wiener, M., Durkee, A., & Baer, M. (1955). The measurement of anxiety in clinical situations. *Journal of Consulting Psychology, 19*(2), 125-129.

Brosschot, J. F., Gerin, W., & Thayer, J. F. (2006). The perseverative cognition hypothesis: A review of worry, prolonged stress-related physiological activation, and health. *Journal of Psychosomatic Research, 60*(2), 113-124.

Campos, A. (2014). Gender differences in imagery. *Personality and Individual Differences,59*, 107-111.

Carrier, C., Higson, V., Klimoski, V., & Peterson, E. (1984). The Effects of Facilitative and Debilitative Achievement Anxiety on Notetaking. *The Journal of Educational Research, 77*(3), 133-138.

Carrillo, E., Moya-Albiol, L., González-Bono, E., Salvador, A., Ricarte, J., & Gómez-Amor, J. (2001). Gender differences in cardiovascular and electrodermal responses to public speaking task: The role of anxiety and mood states. *International Journal of Psychophysiology,42*(3), 253-264.

Carroll, D., Ginty, A. T., Der, G., Hunt, K., Benzeval, M., & Phillips, A. C. (2012). Increased blood pressure reactions to acute mental stress are associated with 16-year cardiovascular disease mortality. *Psychophysiology, 49*(10), 1444-1448.

Carroll, D., Lovallo, W. R., & Phillips, A. C. (2009). Are Large Physiological Reactions to Acute Psychological Stress Always Bad for Health? *Social and Personality Psychology Compass,3*(5), 725-743.

Carroll, D., Phillips, A. C., & Der, G. (2008). Body Mass Index, Abdominal Adiposity, Obesity, and Cardiovascular Reactions to Psychological Stress in a Large Community Sample. *Psychosomatic Medicine,70*(6), 653-660.

Carroll, D., Phillips, A. C., Ring, C., Der, G., & Hunt, K. (2005). Life events and hemodynamic stress reactivity in the middle-aged and elderly. *Psychophysiology,42*(3), 269-276.

Chamberlain, S. T., & Hale, B. D. (2007). Competitive state anxiety and self-confidence: Intensity and direction as relative predictors of performance on a golf putting task. *Anxiety, Stress, & Coping, 20*(2), 197-207.

Charalambous, A., Giannakopoulou, M., Bozas, E., & Paikousis, L. (2015). A Randomized Controlled Trial for the Effectiveness of Progressive Muscle Relaxation and Guided Imagery as Anxiety Reducing Interventions in Breast and Prostate Cancer Patients Undergoing Chemotherapy. *Evidence-Based Complementary and Alternative Medicine, 2015*, 1-10.

Chida, Y., & Steptoe, A. (2010). Greater Cardiovascular Responses to Laboratory Mental Stress Are Associated With Poor Subsequent Cardiovascular Risk Status: A Meta-Analysis of Prospective Evidence. *Hypertension, 55*(4), 1026-1032.

Christenfeld, N. J., Sloan, R. P., Carroll, D., & Greenland, S. (2004). Risk factors, confounding, and the illusion of statistical control. *Psychosomatic Medicine*, *66*(6), 868-75.

Clay, R. A. (2011). Stressed in America. *PsycEXTRA Dataset, 42*(1), 60.

Cohen, S., Gianaros, P. J., & Manuck, S. B. (2016). A Stage Model of Stress and Disease. *Perspectives on Psychological Science, 11*(4), 456-463.

Cohen, S., Kamarck, T., & Mermelstein, R. (1994). Perceived stress scale. *Measuring stress: A guide for health and social scientists*, 235-283.

Cohen, S., Kamarck, T., Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385-96.

Cohen, S*., &* G. Williamson*.* 1988*.* Perceived Stress in a Probability Sample of the United States*. In* The Social Psychology of Health*, eds.* S. Spacapan *and* S. Oskamp*.* Newbury Park, CA*: Sage Publishers.*

Connor, K. M., Vaishnavi, S., Davidson, J. R., Sheehan, D. V., & Sheehan, K. H. (2007). Perceived stress in anxiety disorders and the general population: A study of the Sheehan stress vulnerability scale. *Psychiatry Research, 151*(3), 249-254.

Coryell W., Noyes R., Hause J.D. (1986) Mortality among outpatients with anxiety disorders. *Am J Psychiatry*, 143, 508-510.

Cumming, J., Cooley, S. J., Anuar, N., Kosteli, M. C., Quinton, M. L., Weibull, F., & Williams, S. E. (2017). Developing imagery ability effectively: A guide to layered stimulus response training. *Journal of Sport Psychology in Action*, *8*, 23–33.

Cumming, J., Olphin, T., & Law, M. (2007). Self-reported psychological states and physiological responses to different types of motivational general imagery. *Journal of Sport & Exercise Psychology*, *29*, 629-644.

Cumming, J., & Williams, S. E. (2012). Imagery: The role of imagery in performance. In S.

Murphy (Ed.), Handbook of sport and performance psychology (pp. 213-232). New York, NY: Oxford University Press.

Cumming, J., & Williams, S. E. (2013). Introducing the revised applied model of deliberate imagery use for sport, dance, exercise, and rehabilitation. *Movement & Sport Sciences - Science & Motricité,*(82), 69-81.

Debnam, D. (2017). Huge Rise in Global Employee Depression, Stress, and Anxiety Since 2012. Retrieved from https://www.huffingtonpost.com/dean-debnam/huge-rise-in-global-employee_b_8923252.html

Diehl, M., & Hay, E. L. (2010). Risk and resilience factors in coping with daily stress in adulthood: The role of age, self-concept incoherence, and personal control. *Developmental Psychology*, *46*(5), 1132-1146.

Dimsdale, J. E., MD. (2008) Psychological Stress and Cardiovascular Disease. *Journal of the American College of Cardiology, 51*(13), 1237-1246.

Doron, J., Trouillet, R., Maneveau, A., Ninot, G., & Neveu, D. (2015). Coping profiles, perceived stress and health-related behaviors: A cluster analysis approach. *Health Promotion International, 30*(1), 88-100.

Eaves, D. L., Riach, M., Holmes, P. S., & Wright, D. J. (2016). Motor Imagery during Action Observation: A Brief Review of Evidence, Theory and Future Research Opportunities. *Frontiers in Neuroscience,10*.

Edwards T. C., & Hardy L. (1996) The interactive effects of intensity and direction of cognitive and somatic anxiety and self-confidence upon performance. *Journal of Sport and Exercise Psychology*, *18*, 296–312.

Evans, L., Jones, L., & Mullen, R. (2004). An Imagery Intervention during the Competitive Season with an Elite Rugby Union Player. *The Sport Psychologist, 18*(3), 252-271.

Facts & Statistics. (2017). Retrieved August 15, 2017, from https://adaa.org/about-adaa/press-room/facts-statistics.

Feltz, D. L. (1984). Self-efficacy as a cognitive mediator of athletic performance. In W.F. Straub, & J.M. Williams (Eds.), *Cognitive sport psychology* (1st ed, pp. 191-198). Lansing, NY: Sport Science Associates.

Fineberg, N., Haddad, P., Carpenter, L., Gannon, B., Sharpe, R., Young, A., Joyce, E., Rowe, J., Wellsted, D., Nutt, D. and Sahakian, B. (2013). The size, burden and cost of disorders of the brain in the UK. *Journal of Psychopharmacology*, *27*(9), 761-770.

Gaab, J., Rohleder, N., Nater, U., & Ehlert, U. (2005). Psychological determinants of the cortisol stress response: The role of anticipatory cognitive appraisal. *Psychoneuroendocrinology*, *30*(6), 599-610.

Gerin, W., Litt, M. D., Deich, J., & Pickering, T. G. (1995). Self-Efficacy as a Moderator of Perceived Control Effects on Cardiovascular Reactivity. *Psychosomatic Medicine*, *57*(4), 390-397.

Ginty, A. T., & Conklin, S. M. (2011). High perceived stress in relation to life events is associated with blunted cardiac reactivity. *Biological Psychology,86*(3), 383-385.

Ginty, A. T., Kraynak, T. E., Fisher, J. P., & Gianaros, P. J. (2017). Cardiovascular and autonomic reactivity to psychological stress: Neurophysiological substrates and links to cardiovascular disease. *Autonomic Neuroscience, 207*, 2-9.

Goette, L., Bendahan, S., Thoresen, J., Hollis, F., & Sandi, C. (2015). Stress pulls us apart: Anxiety leads to differences in competitive confidence under stress. *Psychoneuroendocrinology*, *54*, 115-123.

Greenwood, D. C., Muir, K. R., Packham, C. J., & Madeley, R. J. (1996). Coronary heart disease: A review of the role of psychosocial stress and social support. *Journal of Public Health Medicine,18*(2), 221-231.

Gregg, M., Hall, C., Mcgowan, E., & Hall, N. (2011). The relationship between imagery ability and imagery use among athletes. *Journal of Applied Sport Psychology,23*(2), 129-141.

Hagenaars, M. A., & Arntz, A. (2012). Reduced intrusion development after post-trauma imagery rescripting; an experimental study. *Journal of Behavior Therapy and Experimental Psychiatry,43*(2), 808-814.

Hanton, S.M. (1996). *An examination of debilitative and facilitative competitive anxiety* (Doctoral dissertation). Retrieved from Loughborough University Institutional Repository. (https://dspace.lboro.ac.uk/2134/7221).

Hanton, S., & Connaughton, D. (2002). Perceived Control of Anxiety and its Relationship to Self-Confidence and Performance. *Research Quarterly for Exercise and Sport*, *73*(1), 87-97.

Hanton, S., & Jones, G. (1997). Antecedents of intensity and direction dimensions of competitive anxiety as a function of skill. *Psychological Reports*, *81*, 1139–1147.

Hanton, S., & Jones, G. (1999). The Effects of a Multimodal Intervention Program on Performers: II. Training the Butterflies to Fly in Formation. *The Sport Psychologist, 13*(1), 22-41.

Hanton, S., Mellalieu, S. D., & Hall, R. (2004). Self-Confidence and Anxiety Interpretation: A Qualitative Investigation. *Psychology of Sport and Exercise*, *5*, 477-495.

Hanton, S., Neil, R., & Mellalieu, S. D. (2008). Recent developments in competitive anxiety direction and competition stress research. *International Review of Sport and Exercise Psychology, 1*(1), 45-57.

Hanton, S., Thomas, O., & Maynard, I. (2004). Competitive anxiety responses in the week leading up to competition: the role of intensity, direction and frequency dimensions. *Psychology of Sport and Exercise, 5*(2), 169-181.

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical Mediation Analysis in the New

Millennium. *Communication Monographs, 76*(4), 408-420.

Hayes, A. F. (2013). Introduction to mediation, moderation, and conditional process analysis: a regression-based approach. New York: The Guilford Press.

Henry, J. P., Stephens, P. M., & Santisteban, G. A. (1975). A model of psychosocial hypertension showing reversibility and progression of cardiovascular complications. *Circulation Research,36*(1), 156-164.

Herrmann, C. (1997). International experiences with the Hospital Anxiety and Depression Scale-A review of validation data and clinical results. *Journal of Psychosomatic Research, 42*(1), 17-41.

Heslop, P., Smith, G. D., Carroll, D., Macleod, J., Hyland, F., & Hart, C. (2001). Perceived stress and coronary heart disease risk factors: The contribution of socio-economic position. *British Journal of Health Psychology, 6*(2), 167-178.

Hirsch, C., Holmes, E. (2007). Mental imagery in anxiety disorders. *Psychiatry, 6*(4), 161-165.

Hollandsworth, J. G., Glazeski, R. C., Kirkland, K., Jones, G. E., & Norman, L. R. (1979). An analysis of the nature and effects of test anxiety: Cognitive, behavioral, and physiological components. *Cognitive Therapy and Research, 3*(2), 165-180.

Holmes, E. A., Arntz, A., & Smucker, M. R. (2007). Imagery rescripting in cognitive behaviour therapy: Images, treatment techniques and outcomes. *Journal of Behavior Therapy and Experimental Psychiatry,38*(4), 297-305.

Holmes, P. S., & Collins, D. J. (2001). The PETTLEP Approach to Motor Imagery: A Functional Equivalence Model for Sport Psychologists. *Journal of Applied Sport Psychology,13*(1), 60-83.

Holmes, E. A., & Mathews, A. (2005). Mental Imagery and Emotion: A Special Relationship? *Emotion, 5*(4), 489-497.

Holmes, E. A., & Mathews, A. (2010). Mental imagery in emotion and emotional disorders. *Clinical Psychology Review, 30*(3), 349-362.

Holmes, E. A., Mathews, A., Dalgleish, T., & Mackintosh, B. (2006). Positive Interpretation Training: Effects of Mental Imagery Versus Verbal Training on Positive Mood. *Behavior Therapy, 37*(3), 237-247.

IBM Corp. Released 2013. IBM SPSS Statistics for Macintosh, Version 23.0. Armonk, NY: IBM Corp.

Jamieson, J. P., Nock, M. K., & Mendes, W. B. (2012). Mind over matter: Reappraising arousal improves cardiovascular and cognitive responses to stress. *Journal of Experimental Psychology: General, 141*(3), 417-422.

Jerusalem, M., & Schwarzer, R. (1992). Self-efficacy as a resource factor in stress appraisal processes. In R. Schwarzer (Ed.), Self-efficacy: Thought control of action (pp. 195-213). Washington, DC, US: Hemisphere Publishing Corp.

Ji, J. L., Holmes, E. A., & Blackwell, S. E. (2017). Seeing light at the end of the tunnel: Positive prospective mental imagery and optimism in depression. *Psychiatry Research, 247*, 155-162.

Jing, X., Wu, P., Liu, F., Wu, B., & Miao, D. (2011). Guided Imagery, Anxiety, Heart Rate, and Heart Rate Variability During Centrifuge Training. *Aviation, Space, and Environmental Medicine, 82*(2), 92-96.

John-Henderson, N. A., Rheinschmidt, M. L., & Mendoza-Denton, R. (2015). Cytokine responses and math performance: The role of stereotype threat and anxiety reappraisals. *Journal of Experimental Social Psychology,56*, 203-206.

Jones, G. (1995). More than just a game: Research developments and issues in competitive anxiety in sport. *British Journal of Psychology, 86*(4), 449-478.

Jones, G., & Hanton, S. (2001). Pre-competitive feeling states and directional anxiety interpretations. *Journal of Sports Sciences, 19*(6), 385-395.

Jones, G., Hanton, S. & Connaughton, D. (2002). What Is This Thing Called Mental Toughness? An Investigation of Elite Sport Performers. *Journal of Applied Sport Psychology, 14*(3), 205-218.

Jones, M. M. V, Mace, R. D. R., Bray, S. R. S., MacRae, A. W., & Stockbridge, C. (2002). The impact of motivational imagery on the emotional state and self-efficacy levels of novice climbers. *Journal of Sport Behavior*, *25*(1), 57-73.

Jones, M., Meijen, C., McCarthy, P. J., & Sheffield, D. (2009). A Theory of Challenge and Threat States in Athletes. *International Review of Sport and Exercise Psychology, 2*(2), 161-180.

Jones, G., & Swain, A. (1992). Intensity and Direction as Dimensions of Competitive State Anxiety and Relationships with Competitiveness. *Perceptual and Motor Skills, 74*(2), 467-472.

Jones G., Swain A.B.J. (1995) Predispositions to experience debilitative and facilitative anxiety in elite and non-elite performers. *The Sport Psychologist*, *9*, 201-211.

Jones, G., Swain, A., & Hardy, L. (1993). Intensity and direction dimensions of competitive state anxiety and relationships with performance. *Journal of Sports Sciences, 11*(6), 525-532.

Kawachi, I., Sparrow, D., Vokonas, P. S., & Weiss, S. T. (1994). Symptoms of anxiety and risk of coronary heart disease. The Normative Aging Study. *Circulation, 90*(5), 2225-2229.

Keller, A., Litzelman, K., Wisk, L. E., Maddox, T., Cheng, E. R., Creswell, P. D., & Witt, W. P. (2012). Does the Perception that Stress Affects Health Matter? The Association with Health and Mortality. *Health Psychology,31*(5), 677-684.

Khalili, R., Nir, M. S., Ebadi, A., Tavallai, A., & Habibi, M. (2017). Validity and reliability of the Cohen 10-item Perceived Stress Scale in patients with chronic headache: Persian version. *Asian Journal of Psychiatry, 26*, 136-140.

Kibler, J. L., & Ma, M. (2004). Depressive symptoms and cardiovascular reactivity to laboratory behavioral stress. *International Journal of Behavioural Medicine*, 11, 81–87.

Koehn, S. (2013). Effects of confidence and anxiety on flow state in competition. *European Journal of Sport Science, 13*(5), 543-550.

Kosslyn, S. M. (1994). *Image and brain: The resolution of the imagery debate*. Cambridge, MA: MIT Press.

Kothgassner, O. D., Felnhofer, A., Hlavacs, H., Beutl, L., Palme, R., Kryspin-Exner, I., & Glenk, L. M. (2016). Salivary cortisol and cardiovascular reactivity to a public speaking task in a virtual and real-life environment. *Computers in Human Behavior, 62*, 124-135.

Kroenke, K., Spitzer, R. L., Williams, J. B., Monahan, P. O., & Löwe, B. (2007). Anxiety Disorders in Primary Care: Prevalence, Impairment, Comorbidity, and Detection. *Annals of Internal Medicine, 146*(5), 317-325.

Laborde, S., Lautenbach, F., Allen, M. S., Herbert, C., & Achtzehn, S. (2014). The role of trait emotional intelligence in emotion regulation and performance under pressure. *Personality and Individual Differences, 57*, 43-47.

Lagraauw, H. M., Kuiper, J., & Bot, I. (2015). Acute and chronic psychological stress as risk factors for cardiovascular disease: Insights gained from epidemiological, clinical and experimental studies. *Brain, Behavior, and Immunity,50*, 18-30.

Lang, P. J. (1977). Imagery in therapy: An information processing analysis of fear. *Behavior Therapy*, *8*, 862–886.

Lang, P. J. (1979). A Bio-Informational Theory of Emotional Imagery. *Psychophysiology,* *16*(6), 495-512.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer.

Lebois, L. A., Hertzog, C., Slavich, G. M., Barrett, L. F., & Barsalou, L. W. (2016). Establishing the situated features associated with perceived stress. *Acta Psychologica, 169*, 119-132.

Lee, M. H., Kim, D., & Yu, H. S. (2013). The Effect of Guided Imagery on Stress and Fatigue in Patients with Thyroid Cancer Undergoing Radioactive Iodine Therapy. *Evidence-Based Complementary and Alternative Medicine,2013*, 1-8.

Lee, S. W., & Kwon, J. (2013). The efficacy of Imagery Rescripting (IR) for social phobia: A randomized controlled trial. *Journal of Behavior Therapy and Experimental Psychiatry,44*(4), 351-360.

Lyubomirsky, S., Tkach, C., DiMatteo, R. M. (2006). What are the differences between happiness and self-esteem. *Social Indicators Research, 78*(3), 363-404.

Mamassis, G., & Doganis, G. (2004). The Effects of a Mental Training Program on Juniors Pre-Competitive Anxiety, Self-Confidence, and Tennis Performance. *Journal of Applied Sport Psychology,16*(2), 118-137.

Martin, K. A., Moritz, S. E., & Hall, C. (1999). Imagery use in sport: A literature review and applied model. *The Sport Psychologist, 13,* 245-268.

Mascarenhas & Smith. (2011). “Developing the Performance Brain: Decision Making Under Pressure” Collins, D., Button, A., Richards, H., & Robinson, A. (2011). *Performance psychology a practionners guide*. Edinburgh: Churchill Livingstone Elsevier.

Matud, M. (2004). Gender differences in stress and coping styles. *Personality and Individual Differences,37*(7), 1401-1415.

Mayo Clinic Staff. (2016, April 21). Chronic stress puts your health at risk. Retrieved from https://www.mayoclinic.org/healthy-lifestyle/stress-management/in-depth/stress/art-

20046037

McKenzie, A. D., & Howe, B. L. (1997). The effect of imagery on self-efficacy for a motor skill. *International Journal of Sport Psychology,28*(2), 196-210.

McNair, D. M., Frankenthaler, L. M., Czerlinsky, T., White, T. W., Sasson, S., & Fisher, S. (1982). Simulated public speaking as a model of clinical anxiety. *Psychopharmacology, 77*(1), 7-10.

Mellalieu, S. D., Hanton, S., & Obrien, M. (2004). Intensity and direction of competitive anxiety as a function of sport type and experience. *Scandinavian Journal of Medicine and Science in Sports, 14*(5), 326-334.

Mellalieu, S. D., Neil, R., & Hanton, S. (2006). Self-Confidence as a Mediator of the Relationship Between Competitive Anxiety Intensity and Interpretation. *Research Quarterly for Exercise and Sport, 77*(2), 263-270.

Mental health statistics: Stress. (2018, May 13). Retrieved from https://www.mentalhealth.org.uk/statistics/mental-health-statistics-stress

Moore, L. J., Vine, S. J., Wilson, M. R., & Freeman, P. (2012). The effect of challenge and threat states on performance: An examination of potential mechanisms. *Psychophysiology, 49*(10), 1417-1425.

Morina, N., Deeprose, C., Pusowski, C., Schmid, M., & Holmes, E. A. (2011). Prospective mental imagery in patients with major depressive disorder or anxiety disorders. *Journal of Anxiety Disorders, 25*(8), 1032-1037.

Morris, T., Spittle, M., & Watt, A. P. (2005). *Imagery in Sport*. Champaign, IL: Human Kinetics.

Moscovitch, D. A., Chiupka, C. A., & Gavric, D. L. (2013). Within the minds eye: Negative mental imagery activates different emotion regulation strategies in high versus low socially anxious individuals. *Journal of Behavior Therapy and Experimental*

Psychiatry, 44(4), 426-432.

Munroe-Chandler, K., Hall, C., & Fishburne, G. (2008). Playing with confidence: The relationship between imagery use and self-confidence and self-efficacy in youth soccer players. *Journal of Sports Sciences, 26*(14), 1539-1546.

Neil, R., Mellalieu, S. D., & Hanton, S. (2006). Psychological Skills Usage and the Competitive Anxiety Response as a Function of Skill Level in Rugby Union. *Journal of Sports Science and Medicine, 5*(3), 415-423.

Neil, R., Wilson, K., Mellalieu, S. D., Hanton, S., & Taylor, J. (2012). Competitive anxiety intensity and interpretation: A two-study investigation into their relationship with performance. *International Journal of Sport and Exercise Psychology, 10*(2), 96-111.

Nepon, J., Belik, S., Bolton, J., & Sareen, J. (2010). The relationship between anxiety disorders and suicide attempts: Findings from the National Epidemiologic Survey on Alcohol and Related Conditions. *Depression and Anxiety, 27*(9), 791-798.

Ng, D. M., & Jeffery, R. W. (2003). Relationships Between Perceived Stress and Health Behaviors in a Sample of Working Adults. *Health Psychology, 22*(6), 638-642.

NHS Digital. (2016, September 29). Adult Psychiatric Morbidity Survey: Mental Health and Wellbeing, England, 2014. Retrieved from https://www.gov.uk/government/statistics/adult-psychiatric-morbidity-survey-mental-health-and-wellbeing-england-2014

Ntoumanis, N., & Biddle, S. J. (2000). Relationship of Intensity and Direction of Competitive Anxiety with Coping Strategies. *The Sport Psychologist,14*(4), 360-371.

O'Donnell, K., Brydon, L., Wright, C. E., & Steptoe, A. (2008). Self-esteem levels and cardiovascular and inflammatory responses to acute stress. *Brain, Behavior, and Immunity, 22*(8), 1241-1247.

Parker, G., Roy, K., Wilhelm, K., & Mitchell, P. (2000). 'Acting out' and 'acting in' behavioural stress responses: the relevance of anxiety and personality style. *Journal of Affective Disorders, 57*(1-3), 173-177.

Peters, M. L., Godaert, G. L., Ballieux, R. E., Vliet, M. V., Willemsen, J. J., Sweep, F. C., & Heijnen, C. J. (1998). Cardiovascular and endocrine responses to experimental stress: Effects of mental effort and controllability. *Psychoneuroendocrinology, 23*(1), 1-17.

Peterson, R. A. (1994). A Meta-analysis of Cronbach's Coefficient Alpha. *Journal of Consumer Research,21*(2), 381-391.

Phillips, A. C., Ginty, A. T., & Hughes, B. M. (2013). The other side of the coin: Blunted cardiovascular and cortisol reactivity are associated with negative health outcomes. *International Journal of Psychophysiology,90*(1), 1-7.

Poirat, L., Gaye, B., Perier, M., Thomas, F., Guibout, C., Climie, R., . . . Empana, J. (2018). Perceived stress is inversely related to ideal cardiovascular health: The Paris Prospective Study III. *International Journal of Cardiology*.

Quinton, M. L., Cumming, J., & Williams, S. E. (2018). Investigating the mediating role of positive and negative mastery imagery ability. *Psychology of Sport and Exercise, 35*, 1-9.

Racic, M., Todorovic, R., Ivkovic, N., Masic, S., Joksimovic, B., & Kulic, M. (2017). Self-perceived stress in relation to anxiety, depression and health-related quality of life among health professions students: A cross-sectional study from Bosnia and Herzegovina. *Slovenian Journal of Public Health, 56*(4), 251-259.

Raffety, B. D., Smith, R. E., & Ptacek, J. T. (1997). Facilitating and debilitating trait anxiety, situational anxiety, and coping with an anticipated stressor: A process analysis. *Journal of Personality and Social Psychology, 72*(4), 892-906.

Ree, M. J., French, D., Macleod, C., & Locke, V. (2008). Distinguishing Cognitive and Somatic Dimensions of State and Trait Anxiety: Development and Validation of the

State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA). *Behavioural and Cognitive Psychotherapy, 36*(03), 313-332.

Reiss, N., Warnecke, I., Tibubos, A. N., Tolgou, T., Luka-Krausgrill, U., & Rohrmann, S. (2018). Effects of cognitive-behavioral therapy with relaxation vs. imagery rescripting on psychophysiological stress responses of students with test anxiety in a randomized controlled trial. *Psychotherapy Research,* 1-12.

Roberti, J. W., Harrington, L. N., & Storch, E. A. (2006). Further Psychometric Support for the 10-Item Version of the Perceived Stress Scale. *Journal of College Counseling,9*(2), 135-147.

Roberts, R., Callow, N., Hardy, L., Markland, D., & Bringer, J. (2008). Movement Imagery Ability: Development and Assessment of a Revised Version of the Vividness of Movement Imagery Questionnaire. *Journal of Sport and Exercise Psychology,30*(2), 200-221.

Robin, N., Dominique, L., Toussaint, L., Blandin, Y., Guillot, A., & Her, M. L. (2007). Effects of motor imagery training on service return accuracy in tennis: The role of imagery ability. *International Journal of Sport and Exercise Psychology,5*(2), 175-186.

Rod, N. H., Grønbaek, M., Schnohr, P., Prescott, E., & Kristensen, T. S. (2009). Perceived stress as a risk factor for changes in health behaviour and cardiac risk profile: A longitudinal study. *Journal of Internal Medicine, 266*(5), 467-475.

Rosiek, A., Rosiek-Kryszewska, A., Leksowski, Ł, & Leksowski, K. (2016). Chronic Stress and Suicidal Thinking Among Medical Students. *International Journal of Environmental Research and Public Health*, *13*(2), 212.

Schwartz, A. R., Gerin, W., Davidson, K. W., Pickering, T. G., Brosschot, J. F., Thayer, J. F., . . . Linden, W. (2003). Toward a Causal Model of Cardiovascular Responses to

Stress and the Development of Cardiovascular Disease. *Psychosomatic Medicine,65*(1), 22-35.

Seery, M. D. (2011). Challenge or threat? Cardiovascular indexes of resilience and vulnerability to potential stress in humans. *Neuroscience & Biobehavioral Reviews, 35*(7), 1603-10.

Selye H. (1956). The Stress of Life. New York: McGraw-Hill.

Shekhar, A., Truitt, W., Rainnie, D., & Sajdyk, T. (2005). Role of stress, corticotrophin releasing factor (CRF) and amygdala plasticity in chronic anxiety. *Stress, 8*(4), 209-219.

Simonsmeier, B. A., & Buecker, S. (2017). Interrelations of Imagery Use, Imagery Ability, and Performance in Young Athletes. *Journal of Applied Sport Psychology,29*(1), 32-43.

Skodzik, T., Leopold, A., & Ehring, T. (2017). Effects of a training in mental imagery on worry: A proof-of-principle study. *Journal of Anxiety Disorders,45*, 24-33.

Smeeton, N. J., Hibbert, J. R., Stevenson, K., Cumming, J., & Williams, A. M. (2013). Can imagery facilitate improvements in anticipation behavior? *Psychology of Sport and Exercise,14*(2), 200-210.

Smith, D., Wright, C., Allsopp, A., & Westhead, H. (2007). Its All in the Mind: PETTLEP-Based Imagery and Sports Performance. *Journal of Applied Sport Psychology, 19*(1), 80-92.

Spielberger, C. D. (1966). Theory and research on anxiety. Anxiety and behavior. New York: Academic press.

Steptoe, A., & Kearsley, N. (1990). Cognitive and somatic anxiety. *Behaviour Research and Therapy, 28*(1), 75-81.

Suter, P., Maire, R., Holtz, D., & Vetter, W. (1997). Relationship between self-perceived stress and blood pressure. *Journal of Human Hypertension, 11*(3), 171-176.

Tetrick, L. E., & LaRocco, J. M. (1987). Understanding, prediction, and control as moderators of the relationships between perceived stress, satisfaction, and psychological well-being. *Journal of Applied Psychology, 72*(4), 538-543.

Thomas, O., Hanton, S., & Jones, G. (2002). An alternative approach to short-form self-report assessment of competitive anxiety. *International Journal of Sport Psychology, 33*, 325-336.

Tolgou, T., Rohrmann, S., Stockhausen, C., Krampen, D., Warnecke, I., & Reiss, N. (2017). Physiological and psychological effects of imagery techniques on health anxiety. *Psychophysiology, 55*(2).

Trotman, G. P., Williams, S. E., Quinton, M. L., & Zanten, J. J. (2018). Challenge and threat states: Examining cardiovascular, cognitive and affective responses to two distinct laboratory stress tasks. *International Journal of Psychophysiology, 126*, 42-51.

Vadoa, E. A., Hall, C. R., & Moritz, S. E. (1997). The relationship between competitive anxiety and imagery use. *Journal of Applied Sport Psychology, 9*(2), 241-253.

Van Eck, M., Berkhof, H., Nicolson, N., & Sulon, J. (1996). The Effects of Perceived Stress, Traits, Mood States, and Stressful Daily Events on Salivary Cortisol. *Psychosomatic Medicine, 58*(5), 447-458.

Van Praag, H. M. (1996). Faulty cortisol/serotonin interplay. Psychopathological and biological characterisation of a new, hypothetical depression subtype (SeCA depression). *Psychiatry Research, 65*(3), 143-157.

Vine, S. J., Freeman, P., Moore, L. J., Chandra-Ramanan, R., & Wilson, M. R. (2013). Evaluating stress as a challenge is associated with superior attentional control and motor skill performance: Testing the predictions of the biopsychosocial model of challenge and threat. *Journal of Experimental Psychology: Applied, 19*(3), 185-194.

Watson, D. (1988). Intraindividual and interindividual analyses of positive and negative affect: Their relation to health complaints, perceived stress, and daily activities. *Journal of Personality and Social Psychology, 54*(6), 1020-1030.

Weger, M., & Sandi, C. (2018). High anxiety trait: A vulnerable phenotype for stress-induced depression. *Neuroscience & Biobehavioral Reviews, 87*, 27-37.

Weibull, F., Cumming, J., Cooley, S. J., Williams, S. E., & Burns, V. E. (2017). Examining the feasibility of a short intervention for improving exercise imagery ability. *Journal of Imagery Research in Sport and Physical Activity*, *12*(1).

Weibull, F., Cumming, J., Cooley, S. J., Williams, S. E., & Burns, V. E. (2015). Walk this Way: A Brief Exercise Imagery Intervention Increases Barrier Self-Efficacy in Women. *Current Psychology, 34*(2), 477-490.

Wenzel, L., Glanz, K., & Lerman, C. (2002). Stress, coping and health behavior. In K. Glanz, B. K. Rimer, & F. M. Lewis (Eds*.), Health behavior and health education: Theory research and practice* (pp. 210–239). San Francisco, CA: Jossey-Bass.

White, A., & Hardy, L. (1998). An in-depth analysis of the uses of imagery by high-level slalom canoeists and artistic gymnasts. *The Sport Psychologist*, *12*, 387 – 403.

Wiegner, L., Hange, D., Björkelund, C., & Ahlborg, G. (2015). Prevalence of perceived stress and associations to symptoms of exhaustion, depression and anxiety in a working age population seeking primary care - an observational study. *BMC Family Practice, 16*(1).

Williams, S. E., Carroll, D., Zanten, J. J., & Ginty, A. T. (2016). Anxiety symptom interpretation: A potential mechanism explaining the cardiorespiratory fitness–anxiety relationship. *Journal of Affective Disorders,193*, 151-156.

Williams, S. E., Cooley, S. J., & Cumming, J. (2013). Layered Stimulus Response Training Improves Motor Imagery Ability and Movement Execution. *Journal of Sport and*

Exercise Psychology, 35(1), 60-71.

Williams, S. E., & Cumming, J. (2011). Measuring Athlete Imagery Ability: The Sport Imagery Ability Questionnaire. *Journal of Sport and Exercise Psychology, 33*(3), 416-440.

Williams, S. E. & Cumming, J. (2012a). Challenge vs. threat: Investigating the effect of using imagery to manipulate stress appraisal of a dart throwing task. *Sport & Exercise Psychology Review, 8,* 4-21.

Williams, S. E., & Cumming, J. (2012b). Sport imagery ability predicts trait confidence, and challenge and threat appraisal tendencies. *European Journal of Sport Science, 12*(6), 499-508.

Williams, S. E., & Cumming, J. (2015). Athlete imagery ability: A predictor of confidence and anxiety intensity and direction. *International Journal of Sport and Exercise Psychology, 14*(3), 268-280.

Williams, S. E., Cumming, J., & Balanos, G. M. (2010). The Use of Imagery to Manipulate Challenge and Threat Appraisal States in Athletes. *Journal of Sport and Exercise Psychology, 32*(3), 339-358.

Williams, S., Cumming, J., & Edwards, M. G. (2011). The Functional Equivalence Between Movement Imagery, Observation, and Execution Influences Imagery Ability. *Research Quarterly for Exercise and Sport,82*(3), 555-564.

Williams, S. E., Quinton, M. L., Veldhuijzen van Zanten, J. J., Davies, J., Möller, C., Trotman, G. P., & Ginty, A. T. (2018). The Benefits of Mastery Imagery Ability During Acute Psychological Stress. *Manuscript submitted for publication*.

Williams, S. E., Zanten, J. J., Trotman, G. P., Quinton, M. L., & Ginty, A. T. (2017). Challenge and threat imagery manipulates heart rate and anxiety responses to stress. *International Journal of Psychophysiology, 117*, 111-118.

World Health Organization. (2008). *Social determinants of health*. Retrieved from http://www.who.int/social_determinants/en/

Workplace Stress. (2018, January 12). Retrieved from https://www.stress.org/workplace-stress/

Wright, D. J., Williams, J., & Holmes, P. S. (2014). Combined action observation and imagery facilitates corticospinal excitability. *Frontiers in Human Neuroscience, 8*.

Yijing, Z., Xiaoping, D., Fang, L., Xiaolu, J., & Bin, W. (2015). The Effects of Guided Imagery on Heart Rate Variability in Simulated Spaceflight Emergency Tasks Performers. *BioMed Research International, 2015*, 1-8.

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica, 67*(6), 361-370.