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**Can you feel the pressure? Examining the effects of anxiety in elite netball  
shooters.**

A thesis

submitted in partial fulfilment

of the requirements for the degree

of

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## Abstract

Netball is an increasingly popular sport for women in New Zealand, with the national league competition being fully professional. One important skill within netball is goal shooting, as the goal volume and accuracy ultimately decides the outcome of the game. Therefore, it is critical that shooters are able to perform this task well under pressure.

The first part of this thesis reviews the literature on the effects of anxiety on sport performance. The second part of this thesis includes two studies. The first study, *Study A* (Chapter 2), was an observational, retrospective analysis of performance of 15 shooters in the top New Zealand competition at different score-lines and time points throughout netball games. The analysis showed that when one and two goals ahead, as well as other specific time points such as first shot of the quarter, the shooters shot significantly worse than the individual mean accuracy, but when three or four goals ahead the opposite effect occurred, a performance decrease. The fluctuation in performance demonstrated the possible influence of anxiety and individual differences on performance under pressure, along with the need to examine performance under pressure in a controlled setting in elite netball shooters.

The second study, *Study B* (Chapter 3), was an experimental study designed to investigate the anxiety-performance relationship in elite netball athletes. Eleven elite netball shooters performed 100 shots at goal under four conditions: high-pressure defender present, high-pressure defender absent, low-pressure defender present, and low-pressure defender absent. Increased perceived anxiety, heart rate and task completion time occurred in the high-pressure conditions; however trait

anxiety, concentration disruption in particular, predicted performance under low-pressure but not high-pressure conditions. In conclusion, the outcomes of these studies demonstrate that performance fluctuation occurs under pressure and that there may be individual differences in performance under pressure. The need for greater investigation of anxiety induced by high-pressure in elite professional netballers is apparent.

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## **Publications Arising from this Thesis**

Tong, G., Driller, M., & Uiga, L. (under review). Do winning or losing score-lines affect the shot success in elite netballers? *New Zealand Journal of Sport and Exercise Science*.

Tong, G., Driller, M., & Uiga, L. (under review). The effects of anxiety on netball shooting performance in elite athletes. *The Journal of Applied Sport Psychology*.

# Thesis Organisation and Research Aims

## Thesis Organisation

This thesis is formatted to include four chapters; a literature review, two original studies and a concluding chapter. Chapter One contains a review of relevant literature with regards to the effects of anxiety on sport performance to introduce the reader to the topic and highlight the gaps present in the literature. Chapter Two analyses the performance of 15 elite netball shooters in the top New Zealand competition at different score-lines and time points throughout the games. Chapter Three is an original investigation evaluating the effect of state and trait anxiety on netball shooting performance in elite shooters. Chapter Four then summarises and discusses the findings of Chapter Two and Three as well as highlights areas for practical use and future research.

## Research Aims

The overall aims of this thesis were to investigate both the shooting performance of professional netballers within New Zealand and use these findings as foundation for an original investigation to explore the effect of anxiety on shooting performance. *Study A* (Chapter 2) aimed to understand the performance fluctuations that occur during competition at different time points and score-lines of games. *Study B* (Chapter 3) had three aims; 1) to induce psychological pressure in elite netballers in a controlled setting, 2) to examine shooting performance under low- and high-pressure conditions with defender absent and present, and 3) to investigate the association between competitive trait anxiety and performance under low- and high-pressure conditions.

# **Chapter 1: Literature Review**

## **Introduction**

Competition is frequent in everyday life, including in business, education, and sport. The competition for reward or to avoid retribution, to win or to avoid loss, along with other outcomes such as social evaluation, all prompt the desire and subsequent pressure to perform well. This perceived pressure can cause individuals to either excel or decline in performance. Instances of “choking” under pressure or “clutch” performances are not difficult to find in the archives of high-performance sport. Most famously in New Zealand netball, Maria Folau (nee Tutaia) successfully shot the winning goal for the Silver Ferns in the last second of double extra time to win the 2010 Commonwealth Games grand final against Australia. In contrast to this, the following year, the Silver Ferns had won two of the five matches in Constellation Cup series with Australia. In the final three matches, the Silver Ferns were leading in the first half and “choked” in the third quarter of each game, losing all matches by three or more goals, and with it, the overall series and number one world ranking.

## **Effects of Pressure on Motor Performance**

The competitive nature of sport in particular is one of the important reasons why pressure is induced, as players want to win over another team, the opposition or a starting position in the team. A common reward in competitive sport is that of medals and trophies, while in professional sport, it may be remuneration or monetary bonuses. All of these outcomes are considered important to an athlete, therefore the desire to perform at their best becomes necessary (Baumeister, 1984). Baumeister (1984) defined pressure as “any situation that causes an individual to believe that it is important to perform well” (p. 610). The effects of pressure on motor performance have been investigated extensively to show that acute changes

in performance occur when there is perceived incentive to perform well (Hill, Hanton, Matthews, & Fleming, 2010; Wilson, Smith, & Holmes, 2007).

### *Anxiety Theories*

Performance under pressure has been explained by both distraction (Derakshan & Eysenck, 2009; Eysenck & Derakshan, 2011; Eysenck, Derakshan, Santos, & Calvo, 2007) and self-focus theories (Baumeister, 1984; Masters, 1992; Masters & Maxwell, 2008), where either attention control or conscious movement processing are believed to affect the performance of motor tasks, respectively (Beilock, Kulp, Holt, & Carr, 2004; Masters & Maxwell, 2008; Williams & Crane, 2014). These performance decrements are particularly important when it comes to sports, especially at the elite level where performance determines team selection, remuneration for professional players, and most immediately, the outcome of the game. It may differ for individuals and between sports as to what causes the performance deterioration that is experienced, thus no single theory has been able to explain all instances.

### *Self-focus Theories*

The anxiety felt by athletes in high pressure situations demonstrates that optimal performance is important to them, and anxiety has been shown to increase investment or self-focus in automated tasks (Jackson, Ashford, & Norsworthy, 2006; Masters & Maxwell, 2008; Mesagno & Marchant, 2013; Williams & Crane, 2014; Wilson et al., 2007). In general, self-focus theories postulate that under pressure attention goes towards the self and this “over-thinking” of the motor task can disrupt motor movements (Baumeister, 1984; Beilock & Carr, 2001). Some individuals can be more susceptible to this due to increased trait self-consciousness (Hill et al., 2010; Hill, Hanton, Matthews, & Fleming, 2011) or propensity to



engage in conscious movement processing (Masters 1992; Masters & Maxwell, 2008). Fitts and Posner (1967) posited that there were three stages of learning: the cognitive stage, in which the skill is new, thus knowledge about the skill is explicit and prompted by external factors such as verbal learning; the associative stage, in which the skill is learned but still being consolidated, thus knowledge is moving from explicit to implicit; and the autonomous stage, in which the individual is an expert in the skill and knowledge about the skill is implicit in that the individual does not need to think about the specifics of the skill to perform it. The notion is that anxiety causes an individual to self-regulate a task which is usually completed without conscious processing, essentially shifting a task from late to early stages of motor skill acquisition (Fitts & Posner, 1967; Hardy, Mullen, & Jones, 1996; Hardy, Mullen, & Martin, 2001; Masters, 1992).

Performance decrements associated with conscious processing of a well-learned task can be explained by the theory of reinvestment (Masters, 1992; Masters & Maxwell, 2008). When an athlete has high state anxiety, it is predicted that they project their thoughts inwards to focus on the skill in which they are already an expert, using explicit knowledge regarding the skill and thereby disrupting the automaticity of performance (Hardy et al., 2001; Hill et al., 2010; Masters, 1992; Masters & Maxwell, 2008). Masters (1992) investigated novices at golf who participated in a study in which there were 5 different groups: implicit learning, explicit learning, implicit learning control, stressed control and non-stressed control. The participants underwent skill acquisition over four sessions in which they either received no instruction on how to putt and had to perform a random

letter generation task<sup>1</sup> (implicit learning or implicit learning control), detailed instructions on putting (explicit learning), or no instructions and no secondary task (stressed and non-stressed control groups). The groups then completed 100 putts in the testing phase, where the implicit learning, explicit learning and stressed control groups all were under stress (evaluation and financial incentive). Participants recorded what they felt were important aspects in performing a putt. The results showed that the implicit learning groups demonstrated low level of explicit knowledge and had no performance decrements under the stress condition in comparison to the explicit learning group, supporting that learning a skill without rule knowledge may cause less disruption due to not affecting the automaticity of the movement (Masters, 1992).

Otten (2009) used a basketball task to further examine personality, but more specifically in terms of whether individuals had a tendency to use explicit or implicit knowledge to perform when under pressure to try and explain why some individuals thrive and others crumble under pressure (Otten, 2009). The author required participants to perform fifteen free throws in low-pressure (no video recording) and high-pressure (video recording) conditions. Otten (2009) found that high-pressure created increased anxiety, which either increased self-focus, thus diminishing performance, or increased perceived control, thus improving performance (Otten, 2009). This finding demonstrates further that anxiety affects sport performance and that self-focus may be a contributing factor.

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<sup>1</sup> Secondary tasks are often used to engage working memory so that only limited attention can be drawn to primary task performance (Abernethy, 1988).

In accordance with the theory of reinvestment (Masters 1992; Masters & Maxwell, 2008), McNevin, Shea, and Wulf (2003) developed the constrained-action hypothesis. This hypothesis posits that inward focus of attention on the motor task being performed causes disruption in performance due to constraint on the automatic control of the task (McNevin et al., 2003; Wulf, McNevin, & Shea, 2001). Wulf et al (2001) tested this with 28 University students (majority female) who were required to learn a novel balance task. Specifically, the participants were required to balance on a stabilometer (i.e., wooden platform with a maximum of 30 degrees movement) and keep it as close to horizontal as possible. Participants kept their eyes ahead and were either in the internal or external focus group, where it was conveyed to focus on keeping feet or the markers on the stabilometer horizontal, respectively. Following practice, the participants were required to perform a 90-second balance task on the stabilometer while they performed a reaction time task (pressing a button in response to an auditory stimulus). The external focus group improved faster and had less movement (due to more postural adjustments) in the balance task, as well as demonstrated faster reaction times (indicating a decrease in attentional demands required for balance performance) than the internal focus group, supporting constrained action hypothesis (McNevin et al., 2003; Wulf et al., 2001).

Beilock and Carr (2001) further developed an explicit monitoring hypothesis. This hypothesis states that pressure leads to an individual explicitly focusing on the task being performed, and this precise attention control in skill acquisition is beneficial for novices, however, is detrimental to individuals once the skill is more practiced and automated (Beilock & Carr, 2001). Self-consciousness may be heightened during pressure situations leading to disruption of well-learned

skills, and this along with the anxiety to perform well causes performance breakdown (Beilock & Carr, 2001; Beilock, Carr, Macmahon, & Starkes, 2002; Beilock et al., 2004). Beilock and Carr (2001) examined this using golf putting, where a golf task was performed by novice participants under pressure, with or without self-consciousness training. They found that self-consciousness training abolished performance decrements under pressure, and dual-tasks (performing two tasks at once) increased susceptibility of performance deterioration under pressure (Beilock & Carr, 2001). This research demonstrates that explicit monitoring of a skill being performed can deteriorate performance.

### *Distractions Theories*

Distraction theories have attempted to rationalize why performance deteriorates under pressure with regards to the changes in attention that occur in high-pressure competitive situations (ACT; Eysenck & Calvo, 1992). The premise in general with distraction theories is that attention is misguided due to the anxiety or increased arousal of the individual (Eysenck et al., 2007; Hill et al., 2010). Specifically, an attention shift from task-relevant to task-irrelevant cues occurs, causing the athlete to have less attentional resources to process the appropriate information, which may be detrimental to performance (Eysenck & Calvo, 1992; Eysenck & Derakshan, 2011; Hill et al., 2010; Williams & Crane, 2014). According to the Processing Efficiency Theory (PET) worry about performing a task places demands on the working memory system and its resources and thereby affects processing efficiency and potentially performance effectiveness (Eysenck & Calvo, 1992; Hardy et al., 1996; Hill et al., 2010; Wilson et al., 2007). An individual's performance suffers when worry exhausts the resources of working memory (Eysenck & Calvo, 1992; Hardy et al., 1996; Hill et al., 2010; Wilson et al., 2007).

Not every athlete experiences this phenomenon, thus Attentional Control Theory (ACT; Eysenck et al., 2007), an extension of PET, was developed to better explain how some athletes are able to perform well under high-pressure (Derakshan & Eysenck, 2009; Eysenck et al., 2007). According to ACT, when anxiety causes processing efficiency to be compromised, this may not affect performance effectiveness (Eysenck & Derakshan, 2011). Occasionally, athletes can still overcome the negative effects of anxiety with increased attentional control to maintain performance (Derakshan & Eysenck, 2009; Eysenck & Derakshan, 2011; Eysenck et al., 2007; Williams & Crane, 2014). Eysenck et al. (2009) proposed that these attentional control changes were due to the balance and efficiency of the central executive working memory system (Derakshan & Eysenck, 2009; Eysenck et al., 2007; Wilson, Wood, & Vine, 2009). The central executive is thought to consist of two systems that are in balance with one another: the top-down or goal directed system and the bottom-up or stimulus driven system (Derakshan & Eysenck, 2009; Eysenck et al., 2007; Wilson et al., 2009). The top-down system refers to the goals being driven by the individual, for example on task relevant cues such as how far away the basketball hoop is. The bottom-up system is more driven by a stimulus, and high anxiety in pressure situations is understood to disrupt the balance between systems, thus increasing attention to stimulus-driven information and distractibility due to task-irrelevant cues (Derakshan & Eysenck, 2009; Eysenck et al., 2007).

Wilson and colleagues (2009) investigated the penalty kick performances of 14 experienced footballers while their gaze was monitored to determine eye fixations during the motor skill. Under high-pressure, footballers exhibited disrupted and faster eye movement patterns and these fixations were longer toward

the goalkeeper which led to decreased accuracy (Wilson et al., 2009). The researchers discussed this within the framework of ACT, explaining that those high in state anxiety were likely to be distracted by the goalkeeper. This distraction may be explained by the disruption in balance between the stimulus-driven and goal-driven attention control systems within the central executive, leading to increased distractibility and performance impairment (Eysenck & Derakshan, 2011; Wilson et al., 2009). Wood and Wilson (2010) investigated ACT further with 18 competitive level University footballers were required to complete penalty kicks under low-pressure and high-pressure (monetary incentive and social evaluation) conditions. A goal keeper was present and for half the shots in each condition the goal keeper would move their arms around in the pre-shot period (Wood & Wilson, 2010). The researchers found that a moving goalkeeper caused decreased accuracy and greater shots aimed toward the goalkeeper (centre of goal) regardless of condition. Furthermore, the penalty takers fixated on the goalkeeper for longer under the high-pressure condition, suggesting that the goalkeeper increased distractibility and disrupted attention for the penalty takers which led to performance decrements (Wood & Wilson, 2010).

### **Measuring Anxiety**

Competitive state anxiety is a common feeling described by athletes, especially at the high level, and is considered to be a normal part of competing; however, when this anxiety interrupts information processing it can be detrimental to sport performance (Ford, Ildefonso, Jones, & Arvinen-Barrow, 2017; Horikawa & Yagi, 2012; Patel, Omar, & Terry, 2010; Williams & Crane, 2014). Spielberger (1970) differentiated between state and trait anxiety; with state anxiety referring to how an individual feels about a situation currently, in comparison to trait anxiety which is

how the individual feels in general (Bernstein & Eveland, 1982; Horikawa & Yagi, 2012; Spielberger, Gorsuch, & Lushene, 1970). State anxiety results in symptoms with relation to both cognitive anxiety (e.g., worry, concentration disruption) and somatic anxiety (e.g., muscle tension, increased heart rate, nervous feelings in the stomach) and these symptoms can disrupt normal motor performance (Marten, Burton, Vealey, Bump, & Smith, 1990; Patel et al., 2010). State anxiety is an important variable to record as it can tell researchers if pressure is induced, or in a more applied setting, it can tell coaches why athletes may perform in a certain way (Patel et al., 2010). Trait anxiety is more related to stress in that it is a characteristic of an individual's personality and can influence their perception of and reaction to pressure once in a competitive setting (Franklin, Smith, & Holmes, 2015; Horikawa & Yagi, 2012; Meijer, 2001; Patel et al., 2010).

### ***Questionnaires and Scales for Measure Trait and State Anxiety***

Trait and state anxiety have been traditionally measured using different scales and questionnaires. For example, the State Trait Anxiety Inventory (STAI; Spielberger et al., 1970) was often used in earlier studies to differentiate between state and trait anxiety (Beilock & Gray, 2007; Bernstein & Eveland, 1982; Ferreira & Murray, 1983; Spielberger et al., 1970). For example, Ferreira and Murray (1983) showed that groups performing a balance task with an audience had significantly greater state anxiety when compared with both their own pre-test STAI scores as well as when compared with the no audience group. Perhaps, two of the most commonly used scales in sport performance include the Competitive State Anxiety Scale-2 (CSAI-2; Marten et al., 1990) and the Sport Anxiety Scale-2 (SAS-2; Smith, Smoll, & Schutz, 1990). These revised scales both separate cognitive and somatic anxiety into different subcomponents and are used to determine the performance anxiety

before, during and after competition, in other words, both scales can be used as state and trait anxiety scales (Hardy et al., 1996). The CSAI-2 discriminates between cognitive anxiety and somatic anxiety in addition to having a subscale of self-confidence (Marten et al., 1990). The SAS-2 does not include self-confidence, but instead breaks the cognitive anxiety subscale down into the two components of worry (e.g., about performing well) and concentration disruption (i.e., distractibility from the task at hand), in addition to having somatic anxiety as a subscale (Smith, Smoll, Cumming, & Grossbard, 2006).

Hanton, Mellalieu, and Hall (2002) examined 102 male football players currently in competition at Collegiate level to investigate the relationship between state and trait anxiety in a competitive setting. The participants completed the CSAI-2 within an hour of their competition, while the SAS-2 was completed in a non-competitive environment in between competitions to determine trait anxiety (Hanton et al., 2002). Hanton et al. (2002) found that individuals high in trait anxiety had high state anxiety before competition. Horikawa and Yagi (2012) further investigated state and trait anxiety in footballers to examine the reason why performance deteriorates under high-pressure penalty shoot-outs. The authors classed 59 University football players as either low or high in trait anxiety using the STAI and repeated the use of this scale just prior to testing. The participants completed 10 penalty shots and were randomly assigned to the control group, where they were free to shoot when ready, or the pressure group, where there was a high level of instructional pressure and communication about how others had done well that day to increase competitiveness (Horikawa & Yagi, 2012). It was found that performance deteriorated in the high-pressure condition and state anxiety was higher in those that were allocated to the high trait anxiety group prior to the study.



Wang, Marchant, Morris, and Gibbs (2004) examined trait self-consciousness and trait anxiety and whether these characteristics predicted the performance deterioration under pressure in free throw shooting in basketball (Wang et al., 2004). Players of all competitive levels were recruited and shot under low-pressure (researcher present only) and high-pressure (financial rewards, audience present and video recording). Before the task, the participants completed the Self-Consciousness Scale (SCS; Fenigstein, Scheier, & Buss, 1975) and SAS-2 to determine their level of the traits of self-consciousness and trait anxiety, and the CSAI-2 immediately prior to testing to determine state anxiety (Wang et al., 2004). The researchers found that high-anxious or self-conscious individuals were more susceptible to performance decrements under pressure, and the individuals high in both traits suffered the greatest, which was linked to interference of execution in automatic skills due to reinvestment (Masters & Maxwell, 2008; Wang et al., 2004). State and trait anxiety scales have been used in the literature to demonstrate that people high in trait anxiety also display high state anxiety and more often suffer from performance breakdown under pressure when compared with people with low trait anxiety (Ferreira & Murray, 1983; Hanton et al., 2002; Horikawa & Yagi, 2012; Smith et al., 2006).

### ***Other Methods for Measuring State Anxiety***

In addition to perceptual measures such as questionnaires, competitive state anxiety can more objectively be measured using physiological measures (Cooke et al., 2014; Williams & Crane, 2014; Wilson et al., 2007). Heart rate is an important measure of anxiety; where increased heart rate is related to heightened anxiety, and heart rate variability can provide assessment of cognitive resources (mental effort) utilised in a task (Cooke et al., 2014; Wilson et al., 2007). Cooke et al. (2014)

recorded cortical, cardiac, muscular and kinematic activity during a golf-putting task under pressure in 20 putters that were separated into expert and novice groups. The authors demonstrated that experts showed different heart-rate variability readings (greater decreases in high-alpha power) and decreased heart-rate under pressure when compared with novices, which was argued to be due to more resource allocation to maintain putting accuracy and coping better with pressure, respectively. It has been shown that increased mental effort is linked to high-anxiety states (Eysenck & Derakshan, 2011), and increased task completion time suggests that more effort has been utilised (Beilock, Bertenthal, Hoerger, & Carr, 2008; Derakshan & Eysenck, 2009; Eysenck et al., 2007; Mackay, 1982).

### **Netball Performance**

Most of the sports that have been investigated in terms of performance under pressure include skills that are closed, self-paced and easy to measure such as golf putting (Hill et al., 2011; Masters, 1992; Wilson et al., 2007), baseball batting (Castaneda & Gray, 2007), basketball free throws (Fryer, Tenenbaum, & Chow, 2018; Maher, Marchant, Morris, & Fazel, 2018; Otten, 2009; Toma, 2017; Zheng, Price, & Stone, 2011), and different penalty shots from Australian Football League (Mesagno & Mullane-Grant, 2010), rugby (Jackson, 2003; Jackson & Baker, 2001) and soccer (Beilock et al., 2002; Horikawa & Yagi, 2012; Navarro et al., 2012; Wilson et al., 2009). One sport that has had little attention in the literature is that of netball, the most played sport by females in Commonwealth countries that only recently became a professional sport in the late 1990s (NNZ, 2019).

Netball, although similar to basketball, has many restraints to the players in terms of where they are able to move on the court (Bruce, Brooks, & Woods, 2018; O'Donoghue, Mayes, Edwards, & Garland, 2008). Netball is a team sport by which

seven players can be on the court at one time, and each position has differing areas of the court they are allowed in. For example, the goal shooter can only be in one third of the court, including the shooting circle (Bruce et al., 2018). Only the goal shooter and goal attacker are able to shoot goals, and shooting more goals than the opposition is essentially how teams win, therefore significantly more pressure may be felt by the shooting positions than other positions on the court, making this team sport different to most others (Deutscher et al., 2018). The distance and angle differ almost every shot for a goal shooter, with a distracting defender present and sometimes over 50 shots at goal being attempted per game (NNZ, 2018). As the number one sport for females and the number one sport for all secondary school students in New Zealand, as well as having a television audience of 3.2-million in 2018 (NNZ, 2018), it is important to investigate different aspects of performance at the elite level.

Research has been conducted on various statistics taken during an elite netball game in both the Australasian competition (ANZ Championship) and the British National Super League competition to understand the performance analysis of the three best netball performing nations in the world in the season that was analysed: New Zealand, Australia and England (Bruce et al., 2018; NNZ, 2018; O'Donoghue et al., 2008). These studies found that shooting volume, attempts and accuracy were key performance indicators in netball; however, the effect of pressure on shooting performance was not investigated (Bruce et al., 2018; O'Donoghue et al., 2008).

One study did evaluate elite netballers in pressure situations but with a ball handling skill instead of shooting (Stoker et al., 2017). Specifically, the authors examined 15 members of the English International squad directly after the

Commonwealth Games, where they performed a specific throwing accuracy drill they were all familiar with under four conditions: *demands* (moderate task difficulty as opposed to easy), *consequences* as derived from interviews prior to testing (judgement by the coach, forfeit for the worst where they were required to perform an embarrassing task in front of their teammates and financial reward for the best), *demands plus consequences*, and *control* (easy task difficulty). It was found that there was increase in perceived pressure and heart rate (i.e., cognitive and somatic anxiety) in both the *demands plus consequences* and *consequences* conditions, with the *consequences* condition having the biggest increase from control (Stoker et al., 2017). Performance accuracy decreased in the *demands* and *demands plus consequences* conditions, but surprisingly not in the *consequences* condition. These results display that the anxiety induced by increased pressure did not decrease performance effectiveness among the elite players during this particular netball task, however, increasing the cognitive and physical demands did decrease performance (Eysenck & Derakshan, 2011; Eysenck et al., 2007; Stoker et al., 2017).

Two studies have examined the effects of pressure on netball shooting among skilled athletes. Mesagno and Marchant (2013) investigated individuals to see whether being susceptible or resistant to performance decrements occurs in individuals and if it is possible to predict performance under pressure in netballers (Mesagno & Marchant, 2013). They recruited 46 netballers with at least five years of experience to shoot from a set distance away (2.44 metres) using a single case study design with qualitative interviews in addition to administering the SCS, SAS-2, CSAI-2 and the Coping Style Inventory for Athletes (CSIA-2) to assess self-consciousness, trait anxiety and coping styles. The researchers used these scales to

separate individuals into groups that were susceptible or resistant to performance failure under pressure. It was found that those predicted to be more susceptible to performance decrements performed worse, and those more resistant performed better in the pressure condition (Mesagno & Marchant, 2013). There were qualitative interviews after the experiment so the researchers were able to deduce that the coping resistant participants performed better due to superior coping strategies to manage pressure situations but did not talk to specifics of how performance breakdown may have occurred (Mesagno & Marchant, 2013). More recently, an observational netball shooting study in Sri Lanka investigated 30 school-aged netballers that were screened for competitive state anxiety using the CSAI-2 before a national competition (Rupasinghe, Perera, & Sriharan, 2015). It was found that cognitive anxiety impaired performance and somatic anxiety facilitated performance, but again, the specifics of how this may have occurred was not discussed in terms of a theoretical explanation behind anxiety's effect on netball shooting performance under pressure (Rupasinghe et al., 2015).

### **Literature Gaps**

It is clear that the literature is extensive in performance under pressure, however, there is a gap in the motor performance under pressure research in elite level netball shooting. It is also important to note that netball is a sport which is only played by females at the professional level, and many pressure studies have been in male basketball (Fryer et al., 2018; Maher et al., 2018; Otten, 2009; Zheng et al., 2011), football (Dohmen, 2008; Wilson et al., 2009; Wood & Wilson, 2010) or golf players (Beilock et al., 2008; Beilock & Carr, 2001; Beilock et al., 2002; Wilson et al., 2007). Under pressure there may be gender differences as women tend to be higher in self-consciousness, therefore females may respond to pressure differently to men

(Toma, 2017). In addition to this, the performance of elite netball shooters has not been examined and skill level has been shown to be a moderator under pressure, therefore highly skilled netball shooters may not follow common research trends in performance under pressure (Hill et al., 2010, 2011).

## **Chapter 2:**

### **Study A: Do winning or losing score-lines affect the shot success in elite netballers?**

This chapter appears in the same format as required for submission in the New Zealand Journal of Sport and Exercise Science.

**Citation:** Tong, G., Driller, M., & Uiga, L. (under review). Do winning or losing score-lines affect the shot success in elite netballers? *New Zealand Journal of Sport and Exercise Science*.

## **Abstract**

**Background:** Limited research has examined the performance of elite netball shooters. These athletes frequently perform in high-pressure situations as the outcome of the game depends largely on their performance. **Design:** A retrospective observational study design was employed on 15 of the top netball shooters (from both goal attacker and goal shooter) to examine fluctuations in shooting performance in the 2018 national premierships competition in New Zealand. **Methods:** Each shot for each player was analysed for success or failure across the whole 2018 season (n= 5,667 shots). The shots were then categorised under the following score-lines: draw, ahead or behind by the following margins: 1-2 points, 3-4 points, 5-6 points, and >6 points. The percentages of successful shots were calculated for each score-line and compared to each player's mean shooting accuracy over the season. **Results:** The results showed that when 1-2 goals ahead, the shooters shot significantly worse ( $p < 0.001$ ) than their mean overall accuracy, but when 3-4 goals ahead, the shooters shot significantly better ( $p = 0.01$ ). There was also a significantly lower shooting percentage for the first shot of quarter ( $p = 0.03$ ), last shot of quarter ( $p < 0.001$ ) and last shot of game ( $p < 0.001$ ) compared to mean overall accuracy. **Conclusion:** These results suggest that shooting accuracy fluctuates throughout the game, which might be associated with levels of anxiety experienced due to the added pressure of different score-lines.

**Keywords:** elite athletes, pressure, netball, accuracy



## **Introduction**

Netball is a team sport that requires seven players on the court at one time, with each of these players only being allowed to move in a specified area of the court. The game is won by the team that shoots the most goals. Importantly, however, the shots at goal can only be taken by two players: the goal attack and goal shoot positions (see NNZ, 2018, 2019). These two players are frequently placed under high-pressure, because the outcome of the game depends largely on their performance.

Pressure in sport is defined as an increase in the perception of importance of performing well and can cause some athletes to break down and some to excel (Baumeister, 1984; Beilock & Gray, 2007; Mesagno & Marchant, 2013; Otten, 2009; Williams & Crane, 2014). Pressure fluctuates throughout competitions and games as some points within the game may be perceived as more important than others, a notion that is commonly overlooked in controlled studies (Eysenck & Wilson, 2016). An example of this variation in importance of any given goal in netball is when the score is close (within two goals) the perceived importance of getting a goal would be much greater than when losing or winning by 20 goals. Pressure during competition also relies on the relationship between current and desired performance (how successful the athlete should be in comparison to how successful the athlete is currently), thus pressure and performance are related to each other bidirectionally (Eysenck & Wilson, 2016).

Performance analysis is a widely used method by coaches and performance analysts to understand performance in a competitive environment ; however, the sport of netball has gained only little research interest, with the current studies having mainly focused on the statistical trends across seasons for performance

indicators (Bruce et al., 2018; O'Donoghue, Mayes, Edwards, & Garland, 2008). For example, O'Donoghue et al. (2008) examined performance indicators of top half and bottom half teams determined by finishing position on points table of 59 British National Super League netball matches between 2005 and 2008. The authors found that top half teams attempted significantly more goals and at a higher percentage than bottom half teams. The overall average percentage for all teams across these four years was approx. 74%. Similarly, Bruce et al. (2018) analyzed the top Australian and New Zealand combined competition (ANZ Championship) matches over an 8-year period. The authors found that during each season the average attempts were approximately 250 shots at goal and the overall average shooting percentage was approximately 80%. To the best of our knowledge, however, no research has examined shooting performance within a game, at different score-lines and time-points.

The aim of this study was to investigate the shooting accuracy of elite netball players at different score-lines in a game throughout a season. Specifically, we calculated shooting accuracy for 15 of the top netball shooters in the 2018 ANZ Premiership. Each shot for each player was analysed for success or failure and categorised under the following score-lines: draw, ahead or behind by 1-2 , 3-4, 5-6 , and >6 point margins. The percentage of successful shots were calculated for each score-line and compared to each player's mean shooting accuracy over the season.

## **Method**

### ***Participants***

The shooting performance of 15 elite female netball shooters (9 goal attackers and 6 goal shooters) playing across the six ANZ Premiership teams in 2018 were analysed for this study. All players had been international representatives of their country during the last three years. The performance was analysed for shooters who had played at least 350 minutes across the season and attempted at least 150 goals. These inclusion criteria guaranteed that the performance of at least one goal shooter and one goal attacker<sup>2</sup> of each of the six ANZ Premiership teams was analysed. A combined total of 10,606 minutes were played and 5667 attempts at goal were shot between these 15 shooters in the 2018 season. The maximum amount of games played was 17 for the team that completed the regular season and participated in both the elimination and grand final.

### ***Procedure***

Each game of the 2018 ANZ Premiership season (47 games total including elimination final and grand final) was analysed using the Score Flow tab on the official ANZ Premiership statistics website ([https://mc.championdata.com/anz\\_premiership/](https://mc.championdata.com/anz_premiership/)) to record each goal with regards to who shot the goal and whether it was successful. A successful goal was displayed as “GOAL” on the statistics website and was defined as an attempt at goal where the ball passed through the middle of the netball hoop, whereas an unsuccessful goal was displayed as “MISS” and was defined as an attempt at goal where the ball

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<sup>2</sup> The performance of two goal attackers from three of the teams was analysed due to even distribution in the shot volume and minutes played.

did not pass through the hoop. Additional information recorded included the quarter being played, the shooter's name, and the score-line at the time of a shot.

Nine score-line categories were defined: losing by more than six goals (>6 goals behind), losing by five or six goals (5-6 goals behind), losing by three or four goals (3-4 goals behind), losing by one or two goals (1-2 goals behind), equal score-line (draw), winning by one or two goals (1-2 goals ahead), winning by three or four goals (3-4 goals ahead), winning by five or six goals (5-6 goals ahead), and winning by more than six goals (>6 goals ahead). The overall attempts and successful shots were used to calculate percentages for each shooter in each score-line category and the overall shooting percentage. Three out of the fifteen shooters had not taken any shots in the score-line category of losing by more than six goals, because the teams had not been in the situation of losing by that much. Each of the players had taken shots at goal in every other score-line category. Finally, the success of the first shot of the game, the first shot of each quarter, the last shot of each quarter, the last shot of the game, and the last shot of a close game (determined to be within two goals) was analyzed.

### ***Statistical Analysis***

First, we calculated the individual average for each player followed by the shooting accuracy for each score-line. We then looked at different time points within the game; such as the first shot of the game, the first shot of the quarter, the last shot of the quarter and the last shot of the game (for all games and close games specifically). Paired samples t-tests were conducted in the statistics software, Statistical Package for the Social Sciences (SPSS), to compare each of the different score-lines and time points with the mean shooting accuracy for each shooter as

well as to compare the categories with one another. Statistical significance was set at  $p < 0.05$ .

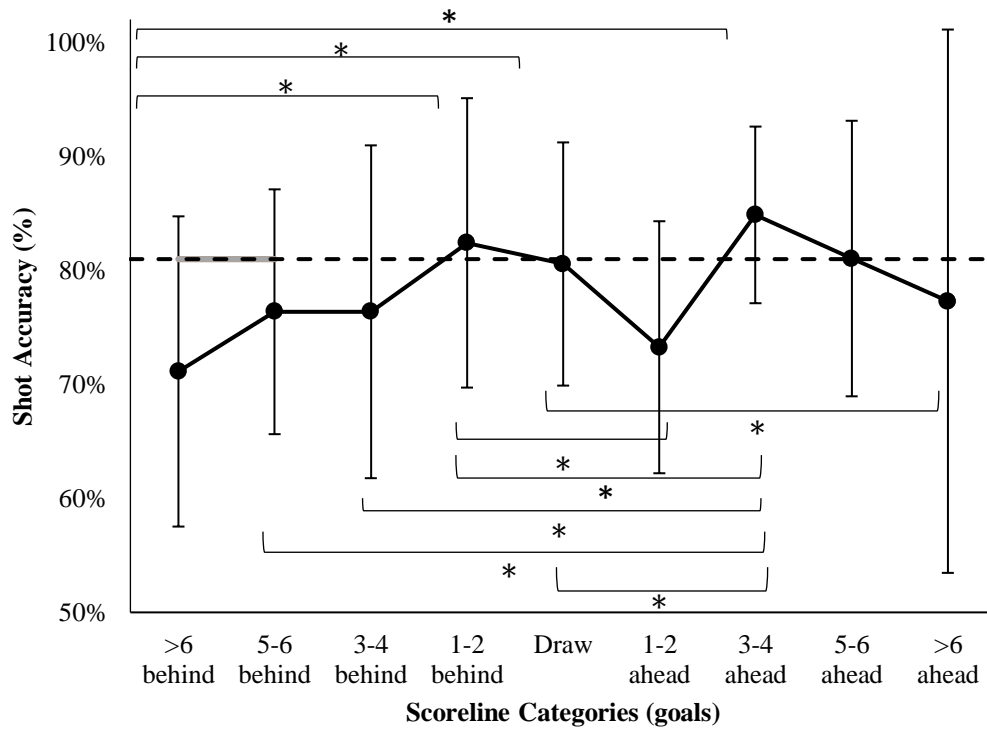
## **Results**

The overall shooting accuracy for all shooters across the whole 2018 ANZ Premiership competition was 80.15% ( $SD = 7.18\%$ ; range 64.98% - 92.08%). The mean accuracy and shot volume are presented in Table 1. The most accurate shots were taken when the team was leading by 3-4 goals ( $M = 84.86\%$ ) and when behind by 1-2 goals ( $M = 82.41\%$ ). The least accurate shots were taken when the team was behind by more than 6 goals ( $M = 71.13\%$ ) or when ahead by 1-2 goals ( $M = 73.25\%$ ). Compared to each player's average shooting percentage over the competition, shot accuracy was significantly lower at >6 goals behind,  $M_{(diff)} = 9.02\%$ , 95% CI [3.22 to 14.82],  $t(11) = 3.42$ ,  $p < .01$ , and at 1-2 goals ahead,  $M_{(diff)} = 7.73\%$ , 95% CI [3.51 to 11.94],  $t(14) = 3.93$ ,  $p < .001$ . However, shot accuracy was significantly higher at 3-4 goals ahead,  $M_{(diff)} = 3.88\%$ , 95% CI [1.00 to 6.76],  $t(14) = 2.89$ ,  $p = .01$ . There were no significant differences for any other score-line categories.

**Table 1.** Percentage of mean (SD) accuracy and shot volume for all shooters across the season, where \* represents significant difference ( $p < 0.05$ ) compared to mean overall shooting accuracy (80.15% )

Score-line Categories	Mean Accuracy (%)	Attempted Shot Volume (goals)
>6 behind	71.1 (13.6)*	640
5-6 goals behind	76.4 (10.7)	310
3-4 goals behind	76.4 (14.6)	571
1-2 goals behind	82.4 (12.7)	1142
Draw	80.6 (10.7)	479
1-2 goals ahead	73.3 (11.1)*	530
3-4 goals ahead	84.9 (7.8)*	648
5-6 goals ahead	81.0 (12.1)	444
6 goals ahead	77.3 (23.8)	903

Figure 1 displays the comparisons in shot accuracy between the nine score-line categories.

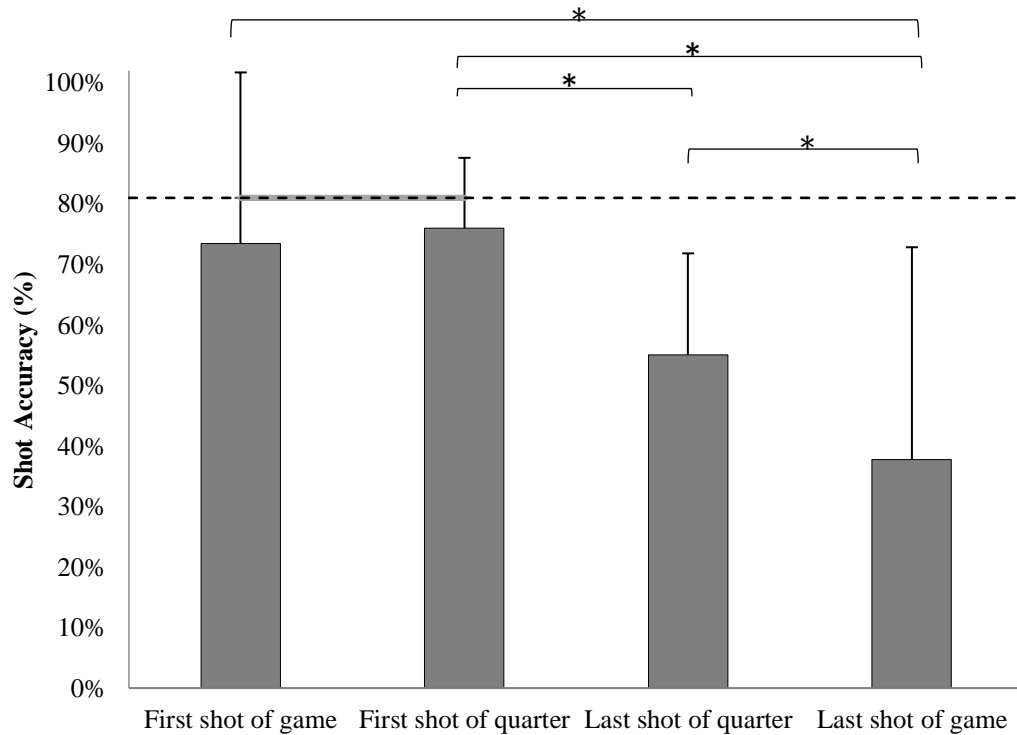


**Figure 1.** Percentage mean accuracy (SD) for each score-line category. \* represents statistical significance of  $p < 0.05$  between categories, the dashed line represents the mean overall accuracy (80.15%).

Figure 2 displays the mean percentages for the first shot of the game, first shot of each quarter, last shot of the quarter as well as last shot of the game. There was no significant difference between the average shooting accuracy and the first shot of the game,  $M = 71.44\%$ ,  $SD = 28.23\%$ ;  $M_{(diff)} = 9.54\%$ , 95% CI [-4.73 to 23.80],  $t(14) = 1.43$ ,  $p = .17$ . However, there was a significant difference for the first shot of the quarter,  $M = 75.98\%$ ,  $SD = 11.62\%$ ;  $M_{(diff)} = 5.00\%$ , 95% CI [0.74 to 9.26],  $t(14) = 2.52$ ,  $p = .03$ , for the last shot of the quarter,  $M = 55.10\%$ ,  $SD = 16.86\%$ ;  $M_{(diff)} = 25.88\%$ , 95% CI [17.18 to 34.59],  $t(14) = 6.38$ ,  $p < .001$ , and for the last shot of the game,  $M = 37.78\%$ ,  $SD = 35.05\%$ ;  $M_{(diff)} = 43.20\%$ , 95% CI [24.12 to 61.29],  $t(14) = 5.12$ ,  $p < .001$ . There was no significant difference for the last shot

of close games (within two goals behind or ahead),  $M = 67.60\%$ ,  $SD = 36.48\%$ ;

$M_{(diff)} = 14.52\%$ , 95% CI [-5.59 to 34.63],  $t(13) = 1.56$ ,  $p = 0.14$ .



**Figure 2.** Percentage mean shot accuracy (SD) for first and last shot of each quarter, and first and last shot of each game across the whole season, where \* represents statistical significance of  $p < 0.05$  and the dashed line represents the mean overall accuracy (80.15%).



## **Discussion**

This study aimed to investigate the shooting accuracy at different score-lines in 15 elite netball shooters in the top New Zealand domestic competition and determine if there were differences in performance at different score-lines and time points within the game. The mean shooting accuracy across the 2018 ANZ Championship was 80.15% (range = 64.98 – 92.08%), in comparison to four years analysed of the British National Super League of 74.38% (O'Donoghue, Mayes, Edwards, & Garland, 2008), and similarly to eight years analysed of the ANZ Championship of approximately 80% (Bruce, Brooks, & Woods, 2018). The main finding of the current study was that performance accuracy fluctuates throughout the game, such that the shooting accuracy was significantly lower at one or two points ahead, and shooting accuracy was significantly higher at three or four points ahead compared to the mean overall accuracy.

This study has demonstrated that different score-lines lead to significant differences in terms of shooting accuracy, which could be explained by fluctuating levels of pressure at different points of game (Harris et al., 2019). The performance when winning by one or two goals was significantly worse than the individual mean performance. It may be that when only just in the lead the pressure is high to induce anxiety and affect performance as more is at stake and pressure has been predicted to be higher when mistakes could be at more cost to the athlete (Harris et al., 2019). This pressure may affect performance via worry felt by an individual to perform well (Beilock & Gray, 2007; Eysenck & Calvo, 1992; Hill et al., 2010; Marten, Burton, Vealey, Bump, & Smith, 1990). Research has shown that worry can lead to changes in attention control, and distraction from the task an individual performs can cause changes in performance (Derakshan & Eysenck, 2009; Eysenck &

Derakshan, 2011; Eysenck, Derakshan, Santos, & Calvo, 2007). According to Attentional Control Theory (ACT; Eysenck et al., 2007), those higher in state anxiety put more mental effort in certain tasks. When between one and two goals in the lead there was a decrease in performance, which may be due to athletes no longer feeling the need to put in the effort due to being in the lead, they perceive less pressure, thus have lower state anxiety (Derakshan & Eysenck, 2009; Eysenck, et al., 2007; Wilson et al., 2009). This may also explain the significant increase in accuracy seen when winning by three or four goals as once more in the lead, motivation increases along with confidence, so more effort is invested in the task (Horikawa & Yagi, 2012; Wilson et al., 2007).

Compared to mean accuracy, shooting performance was significantly worse for the first shot of the quarter, last shot of the quarter and last shot of the game. For the first shot of each quarter, shooters have just been given feedback based on the game of what they should do and have had time on the sideline to think about their performance, which may increase the amount of information they are thinking about. This may require more attention resources, which could lead to distraction from the task at hand – shooting (Eysenck & Calvo, 1992; Eysenck & Derakshan, 2011; Eysenck et al., 2007), or to self-focused attention (Masters, 1992; Masters & Maxwell, 2008). Last shot of the quarter and last shot of the game may be more specifically related to time pressure. Pressure has been argued to be greater when time is a variable (Harris et al., 2019). For example, it has been shown that free-throw shooting accuracy in basketball was decreased when there was less than a minute left in close games (Harris et al., 2019; Zheng et al., 2011). This may explain the decrease in performance seen in the last shot of the quarter and game, however; we cannot be sure this is due to time pressure and not how important these are to

the athletes. For example, the lower accuracy towards the latter stages of play could be because the team is winning or losing by many goals, thus there is no motivation to perform well.

It is important to note that the levels of anxiety felt by athletes throughout the game were not measured here, therefore we can only infer that pressure may have been the reason for impaired performance. Future studies should examine how pressure affects shooters in a more controlled setting as pressure felt by athletes in games can change in a moment and it is hard to monitor how much pressure is felt. Measuring trait anxiety may also be important as it may predict how an athlete is able to cope under pressure, as those high in trait anxiety have been shown to suffer from higher competitive state anxiety under pressure (Hanton, Mellalieu, & Hall, 2002; Horikawa & Yagi, 2012; Meijer, 2001; Wang, Marchant, Morris, & Gibbs, 2004). In addition to this, netball is a complex team sport with many components, therefore an experimental study could better extract the effect of pressure on performance from other confounding variables such as fatigue (Hill & Shaw, 2013; Rupasinghe, Perera, & Sriharan, 2015). Nevertheless, the results of the current study demonstrate that shooting performance in elite netball shooters fluctuates during the game, which could potentially be explained by different levels of pressure felt at different time-points.

## **Chapter 3:**

### **Study B: The effects of anxiety on netball shooting performance in elite athletes**

This chapter appears in the same format as required for submission for publication in the *Journal of Applied Psychology*.

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## Chapter Link

The results of *Study A* (Chapter 2) suggest that netball shooting performance might fluctuate throughout the game due to different levels of anxiety felt at various time points. However, given the observational nature of *Study A*, it was not possible to more specifically measure levels of anxiety felt by athletes. *Study B* (Chapter 3) was therefore conducted to examine the role of state and trait anxiety on shooting performance of elite netball players in a more controlled environment.

## Abstract

**Background:** A plethora of research has investigated the anxiety-performance relationship in athletes. However, little is known how anxiety affects performance of netball shooters, who frequently perform under high-pressure conditions as the outcome of the game largely depends on their performance. **Design:** Using a counter-balanced, controlled crossover design, this study examined the effects of anxiety on goal shooting performance in elite netball athletes. **Methods:** Eleven elite female netball shooters were required to complete 100 shots at goal under four different conditions held across two sessions: high-pressure with and without defender and low-pressure with and without defender. Performance accuracy was recorded as an outcome variable. Furthermore, trait anxiety was measured to predict performance under the four conditions. **Results:** The shooters felt increased anxiety and took longer to perform the task under the high-pressure conditions; however, they were able to maintain their performance accuracy regardless. Furthermore, trait anxiety, concentration disruption in particular, was found to predict

performance under low but not high-pressure conditions. **Conclusion:** These findings are discussed within the framework of Attentional Control Theory, which suggests that anxiety serves both attentional and motivational role and level of performance can be maintained at the expense of processing efficiency.

**Keywords:** anxiety, netball, attention, processing efficiency

## **Introduction**

Netball is a fast-paced team sport that requires rapid decision making and fine motor skills. It is a seven aside game played across four quarters of 15 minutes each in specified positions that are bound by different thirds of the court. As opposed to a similar sport, basketball, what makes netball stand out, is that shots at goal can only be taken by two players: by the goal attacker and the goal shooter. These players have to constantly perform under high-pressure conditions as the outcome of the game often depends on the shooting volume and accuracy. Only a limited number of studies have investigated the influence of anxiety on shooting performance (Mesagno & Marchant, 2013; Rupasinghe et al., 2015) and to the best of our knowledge, none of the studies have included elite netball goal shooters. Therefore, the present study will add to anxiety-performance literature and investigate goal shooting by elite athletes.

Anxiety is considered as an emotional state experienced by athletes at all levels (Ford et al., 2017) and is often characterized by negative affect that can impair motor performance (Eysenck, 1996; Wilson et al., 2007). Several frameworks have been proposed to explain the anxiety-performance relationship, with self-focus (Beilock et al., 2002; Masters, 1992) and distraction (Eysenck & Calvo, 1992; Eysenck et al., 2007; Sarason, 1988) theories being the most dominant ones. Distraction and self-focus theories postulate contrasting predictions in regards to the mechanisms responsible for inferior performance under pressure, yet supportive evidence has accumulated for both explanations (Beilock et al., 2004). Distraction theories propose that anxiety triggers changes in attention, which cause skill-relevant information to be processed alongside with irrelevant information, such as worry and self-doubt (Sarason, 1988). Attentional Control Theory (ACT;

(Eysenck et al., 2007), an extension of Processing Efficiency Theory (Eysenck & Calvo, 1992), for example, predicts that processing task-irrelevant threat-related information (e.g., worrisome thoughts) reduces the attention resources available to process the current task, thereby increasing the susceptibility to performance breakdown. However, anxiety does not always impair performance. ACT, therefore, distinguishes between performance effectiveness and processing efficiency arguing that anxiety affects processing efficiency to a greater extent than performance effectiveness. The adverse effects of anxiety can be reduced by increasing effort or processing resources invested (Eysenck & Calvo, 1992). However, the greater the task demands the more difficult, if not impossible, it is to compensate for processing inefficiency through increased effort and the use of processing resources.

Self-focus theories, in comparison, suggest that anxiety increases performer's self-consciousness and causes attention to be focused inwards (Baumeister, 1984; Beilock & Carr, 2001; Masters, 1992). Baumeister (1984), for example, argued that performers try to consciously control their skills, however "consciousness does not contain the knowledge of these skills, so that it ironically reduces the reliability and success of the performance" (p. 610-611). Similarly, the theory of reinvestment (Masters, 1992; Masters & Maxwell, 2008) proposes that conscious movement processing (through utilization of previously acquired declarative knowledge of the skill) disrupts the automatic control processes and increases the susceptibility to performance breakdown. In line with the theory of reinvestment, Beilock et al. (2002) demonstrated that golf putting performance of skilled athletes was disrupted when the players solely focused on their swing than when they were required to perform a concurrent secondary task. Similarly,



Castaneda and Gray (2007) showed that college level baseball players made more swing errors when they were required to focus on their swing than when they were not required to do that.

Performance under pressure can be easily measured for closed, self-paced skills such as golf putting (Hardy et al., 2001; Hill et al., 2011; Masters, 1992; Wilson et al., 2007), baseball batting (Castaneda & Gray, 2007), basketball free throws (Czech, Ploszay, & Burke, 2004; Maher et al., 2018; Toma, 2015), and football penalties (Horikawa & Yagi, 2012; Navarro et al., 2012; Wilson et al., 2009). Similarly, goal shooting in netball, which is considered as one of the main performance indicators of the game (O'Donoghue et al., 2008; Rupasinghe et al., 2015; Stoker et al., 2017), has gained some research interest. Rupasinghe et al. (2015), for example, investigated the relationship between competitive state anxiety and shooting accuracy in 30 school level netball shooters aged 10-14 years. Specifically, players were required to complete the Competitive State Anxiety Inventory-2 (Marten et al., 1990), which measures cognitive anxiety, somatic anxiety and self-confidence, prior to performing in a national competition. The authors found that cognitive anxiety had a debilitating effect on performance, while somatic anxiety facilitated performance. The authors, however, failed to interpret these findings and the specific role that anxiety, cognitive anxiety in particular, has on netball shooting performance remains unclear.

Mesagno and Marchant (2013) screened experienced netball players for self-consciousness, trait anxiety and coping style, and subsequently distinguished between players who were either resistant or susceptible to performance decrements under pressure. The players were then required to shoot under low and high-pressure conditions and take part in follow-up interviews. Using a single-case

research design, it was found that players who were identified as susceptible to performance decrements used emotion-focused coping style and showed performance decrements under pressure, whereas, players identified as resistant to performance decrements used task-focused coping style and improved their performance under pressure. The authors themselves, however, argued that single-case designs are susceptible to many confounding variables and the results should be interpreted with caution. Further research that examines the influence of anxiety on netball shooting performance in a controlled environment is therefore imperative.

***Present Study:***

The main objective of this study was to extend the previous research and examine the effects of state and trait anxiety on the performance of elite netball goal shooters. More specifically, we aimed to a) induce psychological pressure in a controlled environment in elite netballers, b) investigate shooting accuracy under low and high-pressure conditions when the defender was present or not present, and c) examine the association between the multidimensional sport competition trait anxiety, as measured using the Sport-Anxiety Scale-2 (SAS-2), and performance under low and high-pressure conditions when the defender was present or not present. The SAS-2 measures somatic anxiety, worry and concentration disruption, which all relate to the multi-variable sport of netball (Mesagno & Marchant, 2013; Smith, Smoll, Cumming, & Grossbard, 2006; Smith, Smoll, & Schutz, 1990). As defenders play an important role in netball shooting, both conditions, with and without defender, were included. We were interested in the effect of having a defender present on levels of anxiety and performance outcomes. We predicted that when using a simple shooting task, elite goal shooters would report increased levels

of anxiety under high-pressure conditions compared to low-pressure conditions, yet they would be able to maintain their level of performance even when the defender was present. We further predicted that trait anxiety, especially worry and concentration disruption, would predict performance outcomes under high-pressure conditions, as cognitive anxiety has previously been shown to be negatively associated with performance in sports like football, golf and netball (Derakshan & Eysenck, 2009; Hill et al., 2011; Rupasinghe et al., 2015; Smith et al., 2006).

## **Methods**

### ***Participants***

Eleven elite female netball shooters currently playing at least regional representative netball<sup>3</sup> in New Zealand (Mean  $\pm$  SD; age: 21  $\pm$  3 years) were recruited for the study via netball channels and word of mouth. The participants were all netballers in a shooting position. Both goal attacks and goal shooters were represented evenly in the study, and all of the participants reported that they could play both of these positions. Ethics approval was granted from the institutional ethics committee and each participant provided written informed consent prior to the commencement of the study.

### ***Task***

Participants were required to attend two experimental sessions separated by 6 days on average (range = 4 – 7 days): lo-pressure and high-pressure sessions (order counterbalanced). Each session included two conditions, one in which defender was present and one in which defender was not present (order counterbalanced). For each

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<sup>3</sup> 140,000 New Zealanders were affiliated to Netball New Zealand in 2018, making it New Zealand's most participated sport for females, therefore becoming a regional representative is a hard task and considered elite level (NNZ. (2018). *2018 Netball New Zealand Annual Report*. Auckland: NZ

condition, participants attempted 100 shots at goal from predetermined positions of 2.5 meters from the netball post. This distance has been determined to be moderately challenging for skilled netball players (Champion, 2018; Mesagno & Marchant, 2013). Twenty shots were taken from five areas: right-hand side baseline, right-hand side 45 degrees to baseline, front, left-hand side 45 degrees to baseline, and left-hand side baseline. The shooting spots alternated after each shot to ensure that the shooters did not become accustomed to one shooting spot. The scores from each spot were summed together in subsequent data analysis. There were no time constraints on each shot.

### ***Measures***

#### *Trait Anxiety*

The multidimensional sport competition trait anxiety was assessed using the Sport Anxiety Scale-2 (Smith et al., 2006; Smith et al., 1990), which comprises three subscales: worry, somatic anxiety, and concentration disruption. The Sport Anxiety Scale (SAS-2) was developed by Smith, Scholl and Schutz in 1990 to examine the somatic and cognitive anxiety specific to sport. The SAS-2 has 15 items, which are rated on a 4-point Likert-type scale ranging from *not at all* (1) to *very much* (4). Total scores range from 15 to 60 and for each subscale (i.e., worry, somatic anxiety, and concentration disruption) from 5 to 20, with higher scores on the scale associated with high trait anxiety. The SAS-2 was chosen instead of the widely used Competitive Sport Anxiety Inventory-2 (Marten et al., 1990) as it separates worry from concentration disruption instead of simply having cognitive anxiety more broadly. This separation is more relevant for team sports and would better able the researcher to determine if distraction was a factor in performance (Beilock & Gray,

2007; Hardy et al., 1996; Mesagno & Marchant, 2013; Smith et al., 2006; Williams & Crane, 2014).

### *State Anxiety*

State anxiety was measured using a visual analogue scale (VAS; Stubbs, 1979), a short state anxiety questionnaire, heart rate, and task completion time. The VAS used in this study was a 100-mm line with descriptors at each end. For estimating state anxiety, participants were asked how much pressure they currently felt, with descriptors at 0 mm “none at all” and 100 mm “maximal”. Participants were required to draw a vertical line on the scale to indicate their response

Three, slightly modified questions from SAS-2 were used to further measure state anxiety. We asked participants to rate on a scale *not at all* (1) to *very much* (4) the following items: for worry, “I worry that I will mess up during the game”; for somatic anxiety, “My body feels tense”; and for concentration disruption, “It is hard to concentrate on the task of shooting”.

Heart rate was measured using a Polar RS800CX heart rate monitor (Polar Electro, Kempele, Finland). The heart rate monitor was started and stopped by the researcher directly before the first shot and immediately after the final shot. The average heart rate for each condition was recoded.

Performance time for each condition was administrated by starting the time immediately prior to the first shot and stopping the time immediately after the last shot.

### *Performance*

Performance was measured in terms of shooting accuracy. The total number of successful shots (i.e., the ball passed through the ring) was recorded and percentage accuracy was calculated for each condition. A video recorder was placed directly underneath the hoop and subsequent video analysis was conducted to determine whether a shot was successful or not.

### *Set-up and Procedure*

Prior to attending the first experimental session, participants were asked complete an online survey, which asked for their basic demographic information and included the SAS-2.

During the low-pressure condition, each participant was tested independently without anyone else being present besides the participant and the researcher. Participants completed the short questionnaire along with the VAS for perceived state anxiety. They were given five minutes for a warm up prior to performing 200 shots in total; 100 shots with the defender and 100 shots with no defender (order counterbalanced between participants). In the defender condition, the same defender (height 182 centimeters) stood at a specified distance away (0.9-metres based on netball rules of obstruction) from each of the five shooting positions. This defender was also the rebounder for all conditions. Each successful shot was worth one point and performance scores ranged from 0-100 for each condition.

The high-pressure condition was identical to the low-pressure condition with the exception that there were 10 spectators (~50% male) watching the participant from the moment they entered the room (Mesagno & Marchant, 2013;

Mesagno & Mullane-Grant, 2010). The spectators were not known by the participant, and during the shootout, the spectators were positioned to face the participants, approximately 5m away. Spectators were instructed to use an expressionless face, not say anything and not to encourage or discourage (Mesagno & Marchant, 2013; Mesagno & Mullane-Grant, 2010; Stoker et al., 2017). To further increase pressure, one of the spectators following each shot commented out loud how many shots the shooter had successfully completed out of the attempts they had made.

### *Statistical Analysis*

Paired samples t-tests were conducted to compare the levels of state anxiety (i.e., VAS and the short state anxiety questionnaire) between low- and high-pressure conditions. 2 (Pressure condition: low pressure, high pressure) x 2 (Defender condition: defender, no defender) repeated measures Analyses of Variance were conducted separately for heart rate, performance accuracy and performance time to examine the differences between high- and low-pressure conditions when the defender was present or not present. Finally, separate multiple linear regression analyses were conducted for high- and low-pressure conditions when the defender was present or not present to determine the independent contribution of the three subscales of SAS-2 (i.e., worry, somatic anxiety, and concentration disruption) to performance accuracy. Data were checked for normality, linearity, homoscedasticity, and multicollinearity. To account for multiple comparisons, the Benjamini-Hochberg procedure was employed, with the false discovery rate set at the 5% level. The level of significance was set at  $p = .05$ .

## Results

Table 2 presents the mean state anxiety and performance measures for low- and high-pressure conditions.

**Table 2.** Mean (SD) state anxiety and performance measures across all conditions.

Variables	Low pressure		High pressure	
	Defender	No defender	Defender	No defender
<b>State anxiety</b>				
VAS (mm)	28.14 (17.18)		42.18 (18.30)	
Worry	1.91 (0.54)		2.18 (0.75)	
Somatic anxiety	1.36 (0.51)		1.45 (0.52)	
Concentration disruption	1.45 (0.52)		2.05 (0.57)	
Heart rate (bpm)	126.61 (11.63)	131.84 (11.94)	140.36 (12.18)	138.82 (16.47)
Performance time (s)	493.64 (39.30)	462.18 (43.54)	537.09 (48.04)	533.00 (87.07)
<b>Performance</b>				
Accuracy (%)	73.55 (10.09)	75.00 (10.57)	71.36 (10.05)	73.73 (9.46)

Note. VAS = Visual Analogue Scale



### ***Pressure Manipulation***

The results revealed a significant difference between low and high-pressure conditions for VAS scores,  $t(10) = 3.36$ ,  $p = .007$ , with participants feeling significantly more pressure under high-pressure condition ( $M = 42.2\text{mm}$ ,  $SD = 18.3\text{mm}$ ) than low-pressure condition ( $M = 28.1\text{mm}$ ,  $SD = 17.2\text{mm}$ ).

When adjusting for multiple comparisons, no significant difference between high- and low-pressure conditions were found for worry,  $t(10) = 1.94$ ,  $p = .082$ , and somatic anxiety,  $t(10) = 0.56$ ,  $p = .588$ , items of the short state anxiety questionnaire. However, a significant difference was found for concentration disruption,  $t(10) = 2.45$ ,  $p = .034$ , suggesting that participants thought it would be more difficult to concentrate on shooting under high-pressure compared to low-pressure conditions.

For mean heart rate, the results revealed no significant main effect of Defender,  $F(1, 7) = 0.49$ ,  $p = .506$ ,  $\eta^2 = 0.07$ , or an interaction effect,  $F(1, 7) = 2.27$ ,  $p = .176$ ,  $\eta^2 = 0.25$ . However, the results revealed a significant main effect of Pressure,  $F(1, 7) = 9.26$ ,  $p = .019$ ,  $\eta^2 = 0.57$ , demonstrating that the average heart rate was significantly higher under high-pressure condition ( $M = 143.2$  bpm) than low-pressure condition ( $M = 132.1$  bpm).

For performance time, the results revealed no significant main effect of Defender,  $F(1, 10) = 0.90$ ,  $p = .365$ ,  $\eta^2 = 0.08$ , or an interaction effect,  $F(1, 10) = 0.77$ ,  $p = .400$ ,  $\eta^2 = 0.07$ . However, the results revealed a significant main effect of Pressure,  $F(1, 10) = 15.00$ ,  $p = .003$ ,  $\eta^2 = 0.60$ , demonstrating that the average

time taken to perform the task was significantly longer under high-pressure condition ( $M = 535.1$  sec) than low-pressure condition ( $M = 477.9$  sec).

### ***Performance***

For performance accuracy, the results revealed no significant main effect of Pressure,  $F(1, 10) = 0.50$ ,  $p = .497$ ,  $\eta^2 = 0.05$ , or Defender,  $F(1, 10) = 3.50$ ,  $p = .091$ ,  $\eta^2 = 0.26$ . Furthermore, there was no significant interaction between the Pressure and Defender conditions,  $F(1, 10) = 0.10$ ,  $p = .758$ ,  $\eta^2 = 0.01$ .

### ***Self-reported Trait Anxiety (SAS-2)***

Multiple linear regression analyses were conducted to predict performance accuracy under low- and high-pressure conditions when the defender was present or not present from the three subscales of SAS-2: worry, somatic anxiety, and concentration disruption.

For performance under low pressure, the regression model significantly predicted performance accuracy when the defender was present,  $F(3, 7) = 6.12$ ,  $p = .023$ ,  $\text{adj. } R^2 = .61$ , and when the defender was not present,  $F(3, 7) = 8.72$ ,  $p = .009$ ,  $\text{adj. } R^2 = .70$ . Only concentration disruption subscale added significantly to the prediction, with higher scores on the scale associated with worse performance (see Table 3.).

For performance under high pressure, nonsignificant models were found for performance accuracy when the defender was present,  $F(3, 7) = 1.01$ ,  $p = .444$ ,  $\text{adj. } R^2 = .01$ , and when not present,  $F(3, 7) = 1.50$ ,  $p = .297$ ,  $\text{adj. } R^2 = .13$ .

**Table 3.** Summary of Multiple Regression Analyses

Variable	B	SEB	$\beta$	<i>p</i>
Low pressure, defender				
Worry	3.45	3.57	0.24	.367
Somatic anxiety	4.59	5.01	0.22	.390
Concentration disruption	-26.51	6.19	-0.95	.004
Low pressure, no defender				
Worry	0.59	3.27	0.04	.862
Somatic anxiety	4.27	4.59	0.20	.384
Concentration disruption	-28.03	5.67	-0.96	.002
High pressure, defender				
Worry	-2.60	5.66	-0.18	.660
Somatic anxiety	3.83	7.94	0.19	.645
Concentration disruption	-14.59	9.80	-0.52	.180
High pressure, no defender				
Worry	-0.26	4.97	-0.02	.960
Somatic anxiety	4.73	6.98	0.25	.520
Concentration disruption	-17.64	8.61	-0.67	.080

Note. B = unstandardized regression coefficient; SEB = standard error of the coefficient;  $\beta$  = standardized coefficient

## **Discussion**

Little is known about the effects of psychological pressure on the shooting performance of elite netball goal shooters. Therefore, the current study aimed to a) induce psychological pressure in a controlled environment in elite netball players, b) examine shooting performance, and c) determine the contribution of trait anxiety on shooting performance under low and high-pressure conditions. We successfully increased pressure; however, participants were able to maintain their level of performance. Trait anxiety, concentration disruption in particular, predicted performance in the low- but not high-pressure conditions, with higher trait anxiety associated with worse performance.

### ***Pressure Manipulation***

The data of this study supports the effectiveness of the anxiety manipulation in a controlled environment. Specifically, the participants reported feeling more pressure and difficulties in concentrating on shooting prior to performing under the high-pressure conditions than low-pressure conditions. Furthermore, the average heart rate of the participants was significantly higher during the performance under high-pressure conditions than low-pressure conditions. Heart rate is a known physiological indicator of stress and anxiety, and has shown to be higher under high-pressure condition compared to low-pressure (Cooke et al., 2014; Moore, Vine, Cooke, Ring, & Wilson, 2012). We also found that participants took longer to shoot under high-pressure condition than low-pressure condition. This is in agreement with previous research, which has shown task completion time to be lower in low-anxiety as opposed to high-anxiety conditions (Murray & Janelle, 2003). Together, these findings suggest that the pressure manipulation was

successful, and our participants felt increased levels of anxiety when shooting under high-pressure conditions.

Having the defender present did not have an effect on state anxiety. We believe that our elite players are accustomed to playing with defenders against them in every training and game and therefore did not feel elevated anxiety. The effect of having a defender present might be different for less experienced athletes, who might find the defender threatening and/or distracting.

### ***Pressure Effects***

The anxiety manipulation in our study increased the levels of perceived pressure and heart rate; however, it did not disrupt shooting accuracy. Participants displayed similar levels of performance under the low and high-pressure conditions. According to the Attentional Control Theory (ACT), under high-anxiety conditions the level of performance can be maintained by compensatory increases in effort and processing resources (Derakshan & Eysenck, 2009; Eysenck & Calvo, 1992; Eysenck et al., 2007; Hardy et al., 1996; Murray & Janelle, 2003). In other words, anxiety affects performance efficiency to a greater extent than performance effectiveness. In accordance with ACT, our participants maintained their performance, but took longer to complete the task under high-pressure than low-pressure condition, suggesting that processing efficiency was disrupted. Indeed, previous research has shown that performance time reflects the effort or supplementary resources that are allocated to task performance (Beilock & Gray, 2007; Beilock et al., 2008; Eysenck et al., 2007). Similarly, elevated heart rate has been argued to reflect increased task engagement or supplementary resources invested in the task at hand (Derks, Scheepers, Van Laar, & Ellemers, 2011; Moore et al., 2012). The average heart rate of our participants was higher under high-

pressure than low-pressure condition, suggesting greater levels of task engagement. Although we did not directly measure mental effort, the increases in both task completion time and heart rate suggest that the elite shooters in our study were able to maintain performance effectiveness by investing supplementary processing resources.

Perhaps surprisingly, we found that trait anxiety, and concentration disruption in particular, significantly predicted performance under the low-pressure but not high-pressure conditions. ACT argues that anxiety not only serves an attentional role, but might also serve a motivational role, especially in individuals high in trait anxiety (Eysenck et al., 2007; Hirsch & Mathews, 2012; Hoshino & Tanno, 2017; Wilson et al., 2007). Under high-pressure conditions, highly anxious individuals are more likely to attempt to compensate for the adverse effects of anxiety by allocating more effort or attentional resources to the task they are completing (Eysenck & Derakshan, 2011; Hoshino & Tanno, 2017). Under low-pressure condition, however, anxious individuals do not feel the need to do that and their performance is disrupted by the distracting influence of trait anxiety. It is, therefore, possible that the concern over sub-optimal performance in front of an audience motivated the more anxious shooters in our study to employ additional processing resources in order to maintain performance under high-pressure condition. Thus, the SAS-2 was able to predict performance under the low-pressure but not under the high-pressure condition.

According to ACT, anxiety impairs functioning of the goal-directed attentional system and increases the influence of stimulus-driven attentional system (Derakshan & Eysenck, 2009). In other words, anxiety causes distractibility (i.e., concentration disruption) by threat-related stimuli, such as worry about

performance, spectators, and defender. The results of this study showed that only concentration disruption, but not worry and somatic anxiety, uniquely contributed to performance outcome under the low-pressure conditions. Furthermore, the shooters thought that it would be more difficult to concentrate on the task under high-pressure conditions. Netball shooting, similar to basketball shooting, is characterized by tight temporal and spatial demands and high accuracy requirements. As the shooters must be able to fully concentrate on the task, it is perhaps not surprising that concentration disruption impairs performance. However, employing additional cognitive resources may have diminished the negative impact of stimulus-driven attentional system under high-pressure conditions.

#### ***Limitations and Future Directions***

This study is not without limitations. As we aimed to recruit only elite netball shooters, the sample size of this study is relatively small, and the results should be interpreted with caution. Our performance measure was adapted from previous research (Mesagno & Marchant, 2013; Rupasinghe et al., 2015) and is representative of the shooting distance used in an actual game. However, it is not representative of an actual game situation itself, in which other factors such as other players, fatigue, and rapid decision-making play a role. Future studies should investigate the performance of the shooters in a more ecologically valid setting. It is possible, that in our study trait anxiety did not predict performance under high-pressure condition because the shooters employed additional cognitive resources to compensate for the negative impact of anxiety. However, as the cognitive resources that can be employed are limited, under more demanding task situations (e.g., more complex task, multitasking) trait anxiety might have negative impact on

performance under high-pressure conditions. Alternatively, recruiting additional cognitive resources to maintain performance might lead to conscious control of movements, which is detrimental to performance (Beilock & Carr, 2001; Masters & Maxwell, 2008). Furthermore, the addition of psychophysiological and psychobiological measures, such as electromyography, heart rate variability and cortisol readings, can provide a more objective assessment of anxiety and cognitive resources invested in task performance (Cooke et al., 2014).

### ***Conclusion***

In the current study, we were successful in inducing pressure experienced by elite netball shooters in a controlled environment; however, that did not affect performance outcomes. Furthermore, trait anxiety, concentration disruption in particular, significantly contributed to performance outcomes under low-pressure conditions, but not under high-pressure conditions. Within the framework of Attentional Control Theory, we have argued that anxiety serves an attentional role as well as a motivational role and performance effectiveness in elite netball shooters can be maintained at the expense of processing efficiency.



## **Chapter 4: Conclusions, Limitations and Future Directions**

The aims of this thesis were to add to current literature relating to performance under pressure, particularly in elite female netball athletes. *Study A* (Chapter 2) as an observational retrospective study aimed to investigate performance fluctuations that occur in an applied setting, analysing shooting performance for shooters in the top New Zealand netball competition across a whole season. *Study A* found that there were variations in shooting accuracy at different score-line categories which are likely driven by fluctuations in anxiety levels. Subsequently, *Study B* (Chapter 3) aimed to more specifically examine the influences of state and trait anxiety on shooting performance by elite netball shooters in a controlled environment. *Study B* showed that anxiety was successfully induced; however, shooting accuracy was maintained as compared to a low-pressure condition. Interestingly, concentration disruption as a component of trait anxiety predicted shooting performance under low-pressure but not high-pressure in the way that individuals with higher trait anxiety performed worse than individuals with low trait anxiety.

### **Anxiety and Performance**

Our findings are in line with the framework of Attentional Control Theory (ACT) as posited by Eysenck et al. (2007). ACT postulates that induced anxiety leads to changes in attentional control in that task-relevant information is less attended to in the place of task-irrelevant information such as worry and self-doubt (Eysenck, Derakshan, Santos, & Calvo, 2007; Sarason, 1988). However, level of performance can be maintained by increasing effort or processing resources invested (Derakshan & Eysenck, 2009; Eysenck et al., 2007; Hardy, Mullen, & Martin, 2001; Murray & Janelle, 2003). We have demonstrated (*Study B*) that elite athletes are able to maintain performance under pressure by investing additional processing resources as indexed by increased task completion time and heart rate. Indeed, previous

research has shown that both increased performance time (Beilock & Gray, 2007; Beilock, Bertenthal, Hoerger, & Carr, 2008; Eysenck et al., 2007) and elevated heart rate (Derks, Scheepers, Van Laar, & Ellemers, 2011; Moore et al., 2012) reflect the effort or supplementary resources that are allocated to task performance. In line with ACT, anxiety in our study seemed to impair performance efficiency rather than performance effectiveness (Eysenck & Calvo, 1992; Murray & Janelle, 2003). However, as the cognitive resources that can be employed are limited, higher levels of anxiety or more demanding task requirements can have negative impact on performance (Eysenck et al., 2007; Sarason, 1988). Indirect support is offered by *Study A*, which demonstrated that shooting performance was significantly lower when the team was leading only by one or two goals – a situation that is potentially highly anxiety provoking and cannot be compensated by employing additional cognitive resources.

Alternatively, recruiting additional cognitive resources to maintain performance might lead to conscious control of movements, which has been shown to be detrimental to performance (Beilock & Carr, 2001; Masters & Maxwell, 2008). Indeed, the anxiety felt in high-pressure situations may lead to increased self-consciousness and self-focus on the task being executed, which can cause disruption in motor skills and may be why performance decrements were seen in some instances (Beilock & Carr, 2001; Masters & Maxwell, 2008; Williams & Crane, 2014). Self-focus theories (e.g., Beilock & Carr, 2001; Masters & Maxwell, 2008) may therefore explain the findings from *Study A*, which showed that the first shot of the quarter was significantly worse than overall mean shooting accuracy. This may be because shooters have just received a lot of information from their coaches during the quarter breaks. As well as tactical information, shooters may be

given tips on the movement mechanics of their shot, which could increase the use of explicit knowledge and thereby harm performance (Masters, 1992; Masters & Maxwell, 2008).

Individual differences in performance with response to anxiety were shown in *Study A* (Chapter 2), which revealed a relatively large range in shooting accuracy across the season (range = 64.98% - 92.08%). One trait that is a point of difference for individuals is that of self-consciousness, where individuals have been shown to have a tendency to use either explicit or implicit knowledge in skill execution (Otten, 2009). Self-consciousness along with trait anxiety have been shown to be predictors of performance in sport and lead to susceptibility or resistance to performance deterioration under pressure (Hill, Hanton, Matthews, & Fleming, 2010, 2011; Mesagno & Marchant, 2013; Wang, Marchant, Morris, & Gibbs, 2004). Motivation, as a moderator of performance under pressure, is another aspect that may explain the performance variation found in *Study A* (Chapter 2) (Hill et al., 2010). As shooters just got into the position of leading there may have been an acute drop in motivation, therefore less effort was applied and anxiety may have had a negative effect on performance (Eysenck & Derakshan, 2011; Hill & Shaw, 2013; Hoshino & Tanno, 2017; Williams & Crane, 2014). However, when leading by three or four goals, this had led to increased confidence due to being on a “winning streak”, thus the motivation to put effort in was high, leading to a significant increase in shooting accuracy.

When examining state anxiety in *Study B* (Chapter 3), the concentration disruption sub-scale of SAS-2, predicted performance under low-pressure conditions in *Study B* (Chapter 3). These findings are in line with ACT (Eysenck et al., 2007), which postulated that individuals high in trait anxiety can use anxiety in

a motivational way to recruit more attentional resources under high-pressure conditions (Eysenck & Derakshan, 2011). Under low-pressure conditions, however, the motivation to increase effort is absent and participants may have been distracted by the trait anxiety (Eysenck et al., 2007; Hirsch & Mathews, 2012; Hoshino & Tanno, 2017; Wilson, Smith, & Holmes, 2007), which could explain why shooters with high trait anxiety performed worse under low-pressure conditions than shooters with low trait anxiety.

Pressure-induced anxiety does not cause performance decrements in all instances; however, which was shown in our high-pressure condition in *Study B* (Chapter 3). The pressure manipulation may have only induced mild anxiety and may have caused decreases in processing efficiency; however, since shooting accuracy was maintained under high-pressure, attentional demands must have not exceeded attentional resources (Derakshan & Eysenck, 2009; Eysenck & Derakshan, 2011; Eysenck, Derakshan, Santos, & Calvo, 2007; Wood & Wilson, 2010). *Study A* (Chapter 2) supports this finding in that there were variations in performance across games, which may be because there are only some parts of the game for shooters in which performance effectiveness was affected by decreased processing efficiency (Derakshan & Eysenck, 2009). These fluctuations also included increases in shooting accuracy at some points in the game, which agrees with some elite athlete literature where elite athletes have been shown to perform better under pressure situations, specifically those who are experts in a skill such as golf (Deutscher et al., 2018).

When more than six goals behind in *Study A* (Chapter 2), there was a statistically significant decrease seen in accuracy which may be explained by self-confidence (Bleichrodt, L'haridon, & Van Ass, 2018; Craft, Magyar, Becker, &

Feltz, 2003; Hays, Thomas, Maynard, & Bawden, 2009). When the team is losing by more than six goals, the shooters may lack confidence in themselves (due to missed goals) or in the team to win, and low self-confidence has been shown to be linked with inferior performance in other sports (Hays et al., 2009; Mesagno & Marchant, 2013; Otten, 2009). Self-confidence has also been shown to have the opposite effect, where being ‘on a roll’ either as a team or individually can lead to increased confidence and better performance (Gernigon, Briki, & Eykens, 2010). This was seen in *Study A* (Chapter 2) results with a statistically significant increase in shooting accuracy when the lead was by three or four goals. Confidence also increases optimism which has been shown to be linked to increased success in sports performance (Bleichrodt et al., 2018). However, this is hypothesized and should be further examined as we did not measure self-confidence.

### **Limitations and Future Research**

The small sample size was a limitation to *Study B* (Chapter 3); however, all participants were elite netballers, so the total pool in which we were recruiting from was limited. Small sample sizes have been discussed within sport science research as a crucial problem with studying elite athlete populations (Bernards, Sato, Haff & Bazyler, 2017) . Another limitation of *Study B* to consider is that of self-report bias with perceptual measures, as participants had to be truthful and honest about their anxiety and perceived mental pressure in all conditions, it is possible that some may have felt that due to their playing level they should not feel pressure and answer accordingly. As trait anxiety did not predict performance under high-pressure, cognitive coping strategies may have been adopted thus qualitative methods may benefit a future study in a mixed methods design (Beilock & Gray, 2007; Hill et al., 2011; Mesagno & Marchant, 2013; Williams & Crane, 2014; Wilson et al., 2007).

Qualitative methods such as interviews could be used to understand the thought processes, coping strategies and potential causes for performance deterioration under pressure. The performance measure needs to be considered also, as the test-retest reliability was not measured prior to the study; yet it can be seen as an ecologically valid way to measure shooting performance of a netball shooter and has been used in other studies (Mesagno & Marchant, 2013; Rupasinghe et al., 2015). Perhaps to increase the ecological validity further and be able to extrapolate results to game play scenarios as well as shooting accuracy, a more dynamic environment would be beneficial where decisions have to be made rapidly.

Although we were successful in inducing pressure in *Study B* (Chapter 3), there was no significant decrease in performance on average from low- to high-pressure as opposed to the fluctuation in performance seen in *Study A* (Chapter 2) analysis. This pressure we induced therefore may not be the same kind of pressure felt in the game as there are different variables to consider along with crowd and evaluative pressure that accompany and are pertinent to professional team sport including fatigue, team-mates, opposition and umpires (Hill & Shaw, 2013; Rupasinghe et al., 2015). Thus, pressure induced in laboratory conditions is not exactly comparable to the pressure that athletes feel in actual games, which may be why a difference was not observed. Fatigue was not induced in this study or other netball shooting studies in controlled settings and would make the study more ecologically valid and perhaps additional performance decrements would be seen (Mesagno & Marchant, 2013; O'Donoghue, Mayes, Edwards, & Garland, 2008; Stoker et al., 2017). Mental effort could be a good variable to measure rather than inferring this from task completion time. Mental effort could be used to determine the amount of processing efficiency being used to avoid attentional distractions

caused by pressure (Cooke et al., 2014; Moran, 1996; Wilson et al., 2007). The addition of psychophysiological and psychobiological measures, such as electromyography, heart rate variability and cortisol readings would provide more objective assessment of anxiety and cognitive resources invested in task performance (Cooke et al., 2014).

### **Practical Applications**

Our findings have suggested, along with the literature, that there might be individual differences in the ability to cope with pressure with regards to traits such as self-consciousness and trait anxiety. Thus, this may affect the ability to perform in high-pressure situations. The following practical implications can be made based on the findings of the studies that comprise this thesis:

- The data collection methodology used in *Study A* could be a team or opposition performance analysis tool to track shooters across seasons and find out where they are weakest. This performance analysis could then be used to identify and target which shooters perform inadequately under pressure and who may have problems coping with high anxiety (Beilock & Gray, 2007; Hill, Hanton, Matthews, & Fleming, 2011; Mesagno & Marchant, 2013; Williams & Crane, 2014; Wilson et al., 2007).
- The SAS-2 has been shown to be a trait anxiety scale that predicted performance under low-pressure so could be used to identify those high in trait anxiety. These athletes may benefit from techniques such as mental imagery (imagining skill execution to increase performance outcomes), or pre-performance routines (set of behaviours and thoughts to help execution of a closed skill) in order to cope with perceived pressure and the anxiety that is induced (Cotterill, 2010; Guillot, Nadrowska, & Collet, 2009; Hill et



al., 2011; Jackson & Baker, 2001; Mesagno, Marchant, & Morris, 2008; Mesagno & Mullane-Grant, 2010).

- The pressure manipulation in *Study B* (Chapter 3) was shown to successfully induce pressure and but performance outcomes did not change under high-pressure. Furthermore, this can be used by coaches in a training setting to induce pressure on shooters that need practice under pressure, as it has been shown that training under mild anxiety may prevent performance impairment under high levels of anxiety (Oudejans & Pijpers, 2010).
- Training under mild anxiety may be used along with incorporating decision making or fatigue as well to make the task more ecologically valid to the team sport (Hill & Shaw, 2013; Rupasinghe, Perera, & Sriharan, 2015), or by adding coach evaluation (Beilock & Gray, 2007) or reward (Cohen-Zada, Krumer, Rosenboim, & Shapir, 2017; Dohmen, 2008) to increase pressure to closer to what is experienced in game play scenarios.
- As task completion time has been used to deduce the processing efficiency an individual has, this could be used as a measure at elite level, as perhaps under fatigue or in a game situation a decrease in performance may be seen (Eysenck et al., 2007).

## **Summary**

This thesis adds to the current literature in elite athlete performance under pressure by analysing professional netball shooters in a real-world applied setting of a game, and subsequently, in a controlled experimental setting. Our results from *Study A* (Chapter 2) and *Study B* (Chapter 3) demonstrate that there are performance fluctuations that occur in pressure situations that may be caused by anxiety. Individual differences are evident in our results with variable performances under

pressure, and this may be an important factor for coaches to understand and work with their shooters to improve their performance, potentially leading to better team outcomes.

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## **Appendices**

## Appendix 1 – Ethics approval

The University of Waikato  
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Gate 1, Knighton Road  
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Human Research Ethics Committee  
Karsten Zegwaard  
Telephone: +64 7 838 4892  
Email: [humanethics@waikato.ac.nz](mailto:humanethics@waikato.ac.nz)



3-8-2018

Georgia Tong  
By email: [gtt2@students.waikato.ac.nz](mailto:gtt2@students.waikato.ac.nz)

Dear Georgia

**UoW HREC(Health) 2018#53 : The effect of pressure on netball goal shooting accuracy in elite netballers**

Thank you for submitting your amended application HREC(Health) 2018#53 for ethical approval.

We are now pleased to provide formal approval for your project within the parameters outlined within your application.

If you need to make any changes to the elements approved within the application that requires ethical approval, please contact with committee [humanethics@waikato.ac.nz](mailto:humanethics@waikato.ac.nz), quoting the approval number, and seek an amendment to your application. Any minor changes or additions to the approved research activities can be handled outside the monthly application cycle.

We wish you all the best with your research.

Regards,



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**Karsten Zegwaard PhD**  
Chairperson  
University of Waikato Human Research Ethics Committee

## **Appendix 2 – Participant Information Sheet and Consent Form**

### **Project Title**

The effect of pressure on netball goal shooting accuracy in elite netballers

### **Purpose**

To determine the effect of pressure on netball goal shooting accuracy in elite netballers and understand the relationship between reported sport anxiety states and goal shooting accuracy under pressure situations.

### **What will you have to do and how long will it take?**

Firstly, you will be asked to fill out a Sport Anxiety Scale-2 questionnaire online. Only the researcher and supervisor will be able to access this data, your identity will be kept anonymous in the outputs of the data collection.

Following this, you will be asked to come in for two separate shooting sessions at your convenience which will be randomized in order.

#### **1. No pressure**

- a. No defender:* you will shoot 100 shots total between 5 different marked spots with goal shooting percentage recorded.
- b. Defender:* the researcher will stand a marked distance away from you and you will shoot 100 shots at the same spots while goal percentage is recorded.

#### **2. Pressure**

- a. No defender:* as 1a, but there will be University staff and students (up to 20 people) present to watch your shots, and someone will tell you how many goals are successful out of how many attempts following each attempt.
- b. Defender:* as 1b but with the same pressure as in 2a.

The visits should take about 30 minutes including set up time as it is only 200 shots.

### **What will happen to the information collected?**

It is possible that published journal articles and oral presentations will be the outcome of the research. This work will also be used in a Masters thesis. Only the researcher and supervisor will be privy to the individual data related to the Sport Anxiety Scale and all experimental trials. No participants will be named in the publications and every effort will be made to disguise their identity. The individual data will be destroyed after 5 years.



## **Declaration to participants**

If you take part in the study, you have the right to:

- Refuse to answer any particular question, and to withdraw from the study before analysis has commenced on the data, at any time.
- Ask any further questions about the study that occurs to you during your participation, at any time.
- Be given access to a summary of findings from the study when it is concluded.

## **Who's responsible?**

If you have any questions or concerns about the project, either now or in the future, please feel free to contact either:

Georgia Tong

Masters Student

66 Ascot Road, Chartwell

Hamilton 3210

[Georgia.tong@live.com](mailto:Georgia.tong@live.com)

*Supervisor's name and contact information*

Dr Matthew Driller

Senior Lecturer – Senior Lecturer, Masters Programme Lead

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*The effect of pressure on netball goal shooting accuracy in elite netballers*

**Consent Form for Participants**

- I have read the Participant Information Sheet for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I also understand that:

- I am free to withdraw from the study at any time, or to decline to answer any particular questions in the study. I understand I can withdraw any information I have provided up until 3 weeks following participation
- I agree to provide information to the researchers under the conditions of confidentiality set out on the Participant Information Sheet.
- I agree to participate in this study under the conditions set out in the Participant Information Sheet.

Signed: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

*Researcher's name and contact information*

Georgia Tong

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*Supervisor's name and contact information*

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### Appendix 3 – Sport Anxiety Scale-2

#### REACTION TO PLAYING SPORTS

Many athletes get tense or nervous before or during games, meets or matches. This happens even to pro athletes. Please read each question. Then, circle the number that says how you USUALLY feel before or while you compete in sports. There are no right or wrong answers. Please be as truthful as you can.

	Not At All	A Little Bit	Pretty Much	Very Much
<u>Before or while I compete in sports:</u>				
1. It is hard to concentrate on the game.	1	2	3	4
2. My body feels tense.	1	2	3	4
3. I worry that I will not play well.	1	2	3	4
4. It is hard for me to focus on what I am supposed to do.	1	2	3	4
5. I worry that I will let others down.	1	2	3	4
<u>Before or while I compete in sports:</u>				
	Not At All	A Little Bit	Pretty Much	Very Much
6. I feel tense in my stomach.	1	2	3	4
7. I lose focus on the game.	1	2	3	4
8. I worry that I will not play my best.	1	2	3	4
9. I worry that I will play badly.	1	2	3	4
10. My muscles feels shaky.	1	2	3	4
<u>Before or while I compete in sports:</u>				
	Not At All	A Little Bit	Pretty Much	Very Much
11. I worry that I will mess up during the game.	1	2	3	4
12. My stomach feels upset.	1	2	3	4
13. I cannot think clearly during the game.	1	2	3	4
14. My muscles feel tight because I am nervous.	1	2	3	4
15. I have a hard time focusing on what my coach tells me to do.	1	2	3	4

*Scoring Key:* Somatic: Items 2, 6, 10, 12, 14; Worry: Items 3, 5, 8, 9, 11; Concentration Disruption: Items 1, 4, 7, 13, 15

### Appendix 3 – Short State Anxiety Questionnaire

*Circle one in each question*

**Before you complete the 100 shots in this condition...**

1. It will be hard to concentrate on the task of shooting

Not at all	A little bit	Pretty much	Very much
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2. My body feels tense

Not at all	A little bit	Pretty much	Very much
------------	--------------	-------------	-----------

3. I worry that I will not shoot well

Not at all	A little bit	Pretty much	Very much
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## **Appendix 4 – Visual Analogue Scale**

### **Subjective Mental Ratings**

How much mental pressure do you currently feel? (Please draw a vertical line on the horizontal line to indicate)

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**None at all    Small    Moderate    Large    Maximal**