# Exploring the Attentional Processes of Expert Performers and the Impact of Priming on Motor Skill Execution

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## Abstract

It is widely acknowledged that under situations of heightened pressure, many expert athletes suffer from performance decrements. This phenomenon has been termed ‘choking under pressure’ and has been the subject of extensive research in sport psychology. Despite this attention, gaps in the literature remain leaving opportunities for further advancements in knowledge about the phenomenon, particularly in relation to its underlying processes and the development of appropriate interventions that can be adopted in order to alleviate, or even prevent choking. The present programme of research, in general terms, aimed to develop and test the efficacy of an intervention tool, based on priming, to alleviate choking under pressure. It was acknowledged that such a tool should be matched to the mechanisms that underlie the choking process and although an abundance of research has provided valuable information about these mechanisms, it was identified that there still remains a lack of consensus regarding the most appropriate explanatory theory. Therefore the initial study in this thesis aimed to provide further insight into the processes that govern choking by examining accounts from elite international swimmers of their experiences of performing under high levels of pressure. The results provided further support for the postulation that choking under pressure occurs as a result of a combination of conscious processing hypothesis (Masters, 1992) and processing efficiency theory (Eysenck & Calvo, 1992) and that an optimum level of skill-focused attention is beneficial to performance. The following studies utilised this information as well as that of the existent theories of choking, to develop and examine an effective priming based intervention tool (a scrambled sentence task). Specifically, Studies 2, 3 and 4 examined the amount of residual working memory available after activation of the prime, the optimisation of the priming task and the efficacy of the tool in promoting performance under high pressure respectively. Results revealed support for the efficacy of the tool in reducing online skill-focused attention and promoting performance under both low- and high-pressure conditions. Finally, the general themes that emerged throughout the whole programme of study are discussed, as well as the limitations and recommendations for future research. Implications for coaches, athletes and practitioners are also presented.

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# Chapter 1: Introduction

## 1.1 Pressure and Performance in Sport

The opportunities for expert athletes to perform at their best, to put the long hours of training and preparation into effect and excel on the world stage are relatively limited in number and are often accompanied by high levels of perceived pressure. These conditions place extremely high demands on athletes and their ability to cope. A great performance often occurs as a result of an athlete managing the stress and appropriately allocating attention. Attention can be directed outwards towards the environment, crowds, equipment, opponents or inwards towards emotions, thoughts, feelings and skill execution. However, the extremely stressful, high-pressure conditions can also hinder the ability to cope and manage attention appropriately and unfortunately this is often reflected in suboptimal performance.

Some of the most spectacular and memorable moments in sports have been those that have resulted in devastating, sudden drops in performance in an instance where a win, or ultimate success, for a particular athlete has been thought a ‘sure thing’. You may be able to recall incidents in sporting events where a performer has performed suboptimally according to what they are capable of and their past performances. For example, the incident in the 1996 U.S. Master’s where Greg Norman had played brilliantly for the first three days of the tournament, taking a huge lead of six shots. But, throughout the final round, as the pressure built, his performance took a dive, until finally, there was an 11 shot difference between his score (78) and that of the winner, Nick Faldo (67). Consider also, the 1999 British Open, where Jean Van de Velde only needed a double-bogey to win; instead he scored a triple-bogey on the 18th hole and entered a play-off, which he lost. This phenomenon is not confined to golf; a further example comes from the performance of Matthew Emmons in the 50m rifle three positions event at the 2004 and 2008 Olympic Games. In the former he needed eight points to secure victory, he scored 8.1 but on his opponents target and in the latter having been averaging 9.8 points per shoot, and needing only 6.7 with his last to win gold, he scored a 4.4 and finished fourth. Additionally, recall the incident of Jana Novotna, who in the 1993 Wimbledon final was leading Steffi Graff 6-7 6-1 4-1 and at 40-30, Novotna double-faulted and a series of lost points followed. Not much more than 10 minutes later Graf had won 7-6 1-6 6-4. Finally, Pete Sampras has stated, “We all choke …. No matter who you are, you just feel pressure in the heat of the moment.” (Sampras, 2000, p. 68).

‘Choking under pressure’ is the colloquial term used to describe the events highlighted above and the current thesis stems from acknowledgement of the phenomenon. In particular, the questions, what do elite athletes experience under pressure that could lead to such poor performance, and from this, could an intervention tool based on priming be a successful theory-matched intervention in alleviating choking under pressure, form the central foci of the research.

## 1.2 Structure of the Thesis

The present chapter is followed by the Review of Literature, which introduces the key concepts at the core of the present programme of research and critically examines the extant research pertaining to the areas under investigation. It builds a broad and comprehensive foundation upon which the current programme of research was based.

Chapters 3-6 represent the four studies that comprise the programme of research. They each highlight areas that lack clarity and depth, thus the aim of each is make a significant contribution to knowledge. Specifically, in Chapter 3, accounts from elite athletes of their experiences of performing at high-pressure competitions were examined in order to shed light on the processes that are involved in choking. Across the three subsequent chapters, the efficacy of using scrambled sentence tasks as a form of priming to promote fluent and optimal motor skill execution was examined. Initial steps in the investigation of priming began in Chapter 4, which examined the influence that scrambled sentence tasks, based on the concept of priming, could have on performance of a motor skill and working memory activity. In Chapter 5, the possibility of optimising the previously used scrambled sentence task in order to enhance the effect of the prime, and reduce the time required to complete the task was examined. The final experimental chapter, Chapter 6, examined the efficacy of the most effective scrambled sentence task identified in Chapter 5, in alleviating self-focus in circumstances where a pressure manipulation was implemented.

Although interrelated, the chapters describing each of the four studies contain specific information regarding the explicit research question being addressed, and hence, were written as independent, stand-alone studies. Therefore, owing to the core themes entwined within the chapters, in some cases, literature and supplementary details provided to aid readability are repeated. The final chapter of the thesis, Chapter 7, provides a general discussion of the key findings of the programme of research, highlights emergent conceptual themes, research limitations, and implications for further research, athletes and practitioners.

# Chapter 2: Review of Literature

## 2.1 Introduction

The following review of literature aims to enable the reader to familiarise themselves with the body of knowledge that underpins the present programme of study. It will address the conceptual and methodological divergences that have emerged through the development of the concepts under investigation and provides a foundation on which the remaining chapters are based. Specifically, it will begin by examining the definition of choking followed by a discussion of the theories that have been proposed to explain the mechanisms and underlying processes of the phenomenon. Next, potential moderators of the choking process are discussed and some interventions designed to alleviate choking are also examined. Following the review of choking literature, a review addressing the utilisation of priming methods and their capacity to manipulate behaviour is presented. Finally, conclusions have been drawn that inform the rationale for the present program of research.

## 2.2 The Definition of Choking

The phenomenon commonly referred to as 'choking' has been defined as "performance decrements under pressure circumstances" (Baumeister, 1984, p. 610) where pressure is referred to as "any factor or combination of factors that increases the importance of performing well on a particular occasion" (Baumeister, 1984, p. 610). Building upon this, Baumeister has also provided an extended definition: "the occurrence of inferior performance, despite striving and incentives for superior performance" (Baumeister & Showers, 1986, p. 361). It is important to note that there is a distinct set of criteria that require fulfilment in order to classify an athlete as having choked. Unfortunately, it is not uncommon for the media or researchers to use the term 'choking' rather haphazardly to describe merely poor performance when a number of other factors could have influenced that performance. Therefore the definition is of paramount importance when researching and attempting to understand the phenomenon. It should differentiate between random fluctuations in performance that occur as a result of external factors or lack of effort and those which are an artefact of cognitive interference (Baumeister &

Showers, 1986). According to the presented definitions, to be considered a choke, the athlete must be motivated to achieve the goal they are in pursuit of, be capable of doing so, and regard the situation as important (Beilock & Gray, 2007). Therefore, choking is not any fluctuation in performance level, but a specific negative response to perceived pressure (Beilock & Gray, 2007).

The past 30 years has seen extensive research investigating the pressure-performance relationship and the underlying processes that cause choking. More recently, following such close investigation, researchers have called for the need to review the definition of choking (e.g., Gucciardi & Dimmock, 2008; Hill, Hanton, Fleming, & Matthews, 2009; Hill, Hanton, Matthews, & Fleming, 2010; Mesagno, Marchant, & Morris, 2008). It has been identified that the general deterioration in performance as suggested by Baumeister's definition does not accurately depict the dramatic deterioration in performance so often witnessed of top athletes on the world stage of performance sport. Gucciardi and Dimmock (2008) emphasised the inclusion of the word 'acute' therefore ensuring that reference is not just towards any inferior performance occurring under pressure. A number of other researchers have already included the word 'acute' when defining choking, for example, Clark, Tofler, and Lardon (2005) defined choking as "acute performance failure under perceived stress" (p. 962) and Wilson, Chattington, Marple-Horvat, and Smith (2007a) as "acute performance decrements despite the ability and incentives for good performance" (p. 439). The lack of consensus regarding the underlying processes that cause choking is discussed below, but worthy to note here is that Gucciardi and Dimmock have also suggested that this lack of consensus could be due to the way in which choking has been defined and subsequently observed in experimental research.

## 2.3 The Stress Process

Thus far the concept of choking has been introduced and it has been highlighted that choking is most likely to occur in stressful situations, it is therefore necessary to consider the concept of stress. Several models of stress have been proposed during the last two decades (e.g., Cerin, Szabo, Hunt, & Williams, 2000; Hardy, Mullen, & Jones, 1996; McGrath, 1970), yet the most comprehensive of those models is Lazarus and Folkman's (1984) Transactional Model of

Stress and Coping. The transactional model is based on the assumption that stress is affected by the transaction of the individual and environment (Cox, 2002), specifically, an individual's subjective judgment of demands and their own capability (resources) to cope with these demands. An event or situation is only deemed 'stressful' if the individual appraises it as threatening, harmful or taxing of available resources (Lazarus & Folkman, 1984).

According to the transactional model of stress (Lazarus & Folkman, 1984), two critical processes mediate the person-environment relationship: cognitive appraisal and coping. Lazarus and Folkman (1984) proposed that the process begins with the cognitive appraisal which is essentially, an evaluation process that determines why and to what extent a particular transaction between the person and environment is stressful and can be viewed as the process of categorising an encounter and its significant to one's well-being. It consists of three elements: a) the primary appraisal where the evaluation between perceived control of the situation and resources available to the individual takes place. In addition, it was suggested that primary appraisals can take 1 of 3 forms; harm/loss (i.e. damage the person has already sustained), threat (i.e., anticipated harms or losses), or challenge (i.e., events that hold potential for mastery or gain; b) secondary appraisal, this guides the use of specific coping strategies. The effectiveness of these coping strategies determines the individual's psychological adjustment as well as c) reappraisal, the final element. Reappraisal is a successive valuation that is based on new information obtained from the environment and/or person during the primary and secondary appraisal processes. The reappraisal differs from the primary appraisal only in that it follows an earlier cognitive evaluation and is determined by the effectiveness of the coping strategies guided by the secondary appraisals.

Coping is the second critical process that occurs and it is through this process that the individual manages the demands of the person-environment relationship and the ensuing emotion generated from the situation. Coping is defined as "constantly changing cognitive and behavioural efforts to manage specific external and internal demands that are appraised as taxing or exceeding the resources of the person" (Lazarus & Folkman, 1984, p. 141). Coping may take one of two general forms: emotion-focused or problem-focused. Emotion focused coping strategies are focused on internal emotional states rather than on external situations that trigger emotional responses (Lazarus, 1999). It is most likely to occur when an appraisal has been made that nothing can be done to modify the harmful, threatening or challenging environmental conditions, for example, in sport, avoidance may be employed following a bad refereeing decision. This form of coping is directed toward altering the individual's emotional response to the problem and includes strategies such as wishful thinking, minimisation, or, as highlighted in the example, avoidance. Contrastingly, problem-focused coping functions to alter the stressor by directing action towards the self (Lazarus, 1999), and might occur, for example, following an error such as after missing a shot which would then to lead to a slightly different approach for the next shot. This form of coping is more probable when conditions are appraised as amenable to change. Problem-focused strategies include learning new skills, finding alternative channels of gratification, or developing new standards of behaviour. Some coping strategies, such as seeking social support, may serve both emotion- and problem -focused functions simultaneously (Vitaliano, Maiuro, Russo, & Becker, 1987).

## 2.4 The Theories of Choking

Despite the relative uncertainty regarding an accurate definition of choking, a wealth of information has been gained through predominantly experimental research aimed at explaining the underlying mechanisms. Initially, drive theories (e.g., Spence & Spence, 1966) were considered to provide an explanation for the arousal-performance relationship, but these theories fail to provide a mechanistic explanation for why choking occurs. Thus, more recently, focus has been directed towards attentional theories where converging evidence has been provided for the implication of attentional focus as a significant mediator of performance (e.g., Beilock & colleagues, 2001, 2002a, 2002b, & 2004, Hardy, Mullen, & Martin, 2001, Masters & Maxwell, 2008; Wulf, McNevin, & Shea, 2001; Zachry, Wulf, Mercer, & Bezodis, 2005). Specifically, two seemingly contrasting attentional theories have shown promise as theoretical frameworks for explaining choking, namely: self-focus (Baumeister, 1984) and distraction (Carver & Scheier, 1981) with both having received support (e.g., self focus: Beilock, Carr, MacMahon, & Starkes, 2002; Gray, 2004; Jackson, Ashford, & Norsworthy, 2006; Lewis &

Linder, 1997; Masters, 1992; distraction: Beilock & Carr, 2005; Mullen, Hardy, & Tattersall, 2005). Finally, processing efficiency theory (PET; Eysenck & Calvo, 1992), an anxiety based hypothesis, which also has an attentional focus element, has received preliminary support. Due to these equivocal results, it has been suggested that choking may involve a combination of self-focus theories, particularly Conscious Processing Hypothesis (CPH; Masters, 1992) and PET, (Edwards, Kingston, Hardy, & Gould, 2002; Lam, Maxwell, & Masters, 2009; Liao & Masters, 2002; Wilson & colleagues, 2007a, 2007b). The following discussion considers drive theories, self-focus theories, distraction theories, and PET.

**2.3.1 Drive Theories**

Originally, drive theory demonstrated a linear relationship between arousal and performance however, developments resulted in a recognition that increased levels of arousal/drive produced by the desire to perform well under pressure could cause detrimental effects on performance (Spence & Spence, 1966). A further proposition based on drive theory provided a slightly differing account in describing the precise manner in which drive affects performance. Specifically, the Inverted-U Hypothesis (Yerkes & Dodson, 1908) was one of the earliest attempts cited to explain the arousal-performance relationship. This stated that increases in drive up to an optimal point would promote performance, but that low levels or levels past the optimal point would cause performance decrements. It was also identified that individual differences and the nature of the skill being performed affected the optimal arousal required. Hence it was suggested that every sporting skill had its own level of arousal, but that all traces follow the same invert-U pattern (Oxedien, 1970; Sonstroem & Bernado, 1982). When initially adopted within the context of motor skills, the inverted-U hypothesis received promising support (e.g., Martens & Landers, 1970; Sonstroem & Bernado, 1982).

Although these drive theories propose a plausible account for some types of performance failure under pressure, they do not provide a full explanation for a number for reasons. First, examples in sport where athletes have performed optimally under extremely high levels of drive as well as the instances where elite athletes have choked under pressure indicate that drive theories do not provide an explanation for all instances of choking (Baumeister &

Showers, 1986). Second, drive theory models are more descriptive that prescriptive and thus do not provide a full explanation of how arousal impacts performance (Beilock & Gray, 2007).

Further development of the conceptualisation of anxiety and the subsequent enhanced understanding of the arousal/anxiety-performance relationship led to the construction of the Multidimensional Anxiety Theory (MAT: Martens, Vealey, & Burton, 1990). MAT predicts that cognitive anxiety has a negative linear relationship with performance whereas somatic anxiety has an inverted-U shaped relationship, but it makes no specific predictions about the combined effects of cognitive and somatic anxiety. Research examining MAT has been inconclusive in that cognitively anxious performers have demonstrated significant improvements in performance during the days leading up to an important competition when somatic anxiety is low, but mixed positive and negative effects on the day of competition when somatic anxiety levels are elevated (see Hardy, 1996). Based on the above and the notions that anxiety does not always have a debilitative effect upon performance and that when suboptimal performance under pressure does occur, it drops dramatically, to very low levels, the Cusp Catastrophe Model (CCM: Hardy, 1996) was developed.

The CCM addresses the interactive effects of cognitive anxiety and physiological arousal upon performance. In short, increases in cognitive anxiety should lead to improved performance when physiological arousal remains low and stable, but disrupt performance when physiological arousal is high (Hardy 1999). Therefore, it predicts that high levels of both cognitive anxiety and physiological arousal can be catastrophic to performance (Hardy 1996), a prediction that reflects the acute performance decrements associated with choking. While CCM has made significant ground in providing an explanation for choking, as it stands, the applicability of the drive theories collectively to account for choking has received very limited support, therefore, involvement of such hypotheses in mechanistic explanations of choking warrant further research.

### 2.3.2 Distraction Theories

Whereas the drive theories are related to anxiety and arousal, the following two theories that propose further contradictory explanations for the processes that govern choking, namely distraction and self-focus, fall under the umbrella term of ‘attentional theories’. These theories offer an explanation that is differentially grounded by ones focus of attention and hence, the type of cognitive processing that one engages in.

The distraction theories maintain that stressful conditions can overload attentional capacity with task-irrelevant stimuli such as worry and self-doubt (see Beilock & Carr, 2001; Lewis & Linder, 1997; Wine, 1971). A dual-task paradigm is thus created where attentional resources are cognitively overloaded, creating an environment in the working memory where there is a competition for attention between performance of the skill and worry regarding the situation. Therefore, suboptimal performance occurs as a result of the cognitive deficit that arises when attention is diverted away from task.

Tasks most susceptible to choking, where distraction theories are concerned, have been those that rely heavily on storage and retrieval of information using working memory which is limited under the dual-task paradigm, for example, problem solving and mathematics (Ashcraft & Kirk, 2001; Beilock et al., 2004 respectively). It is probable that because most well-learned sporting skills are proceduralised, they are robust against the tenets of distraction theories and so lend themselves to self-focus related processes of choking (see below). Yet, the lack of empirical support for distraction theory in sport has been explained in accordance with the type of skills examined. Specifically, if sporting tasks requiring control structures susceptible to dual-task decrements, for example those involving decision making in team sports (see Kinrade, Jackson, Ashford, & Bishop, 2010) were to be tested, further support for distraction theories would be found (Beilock et al., 2004).

**2.3.3 Self-Focus Theories**

Self-focus theories (Baumeister, 1984; Beilock & Carr, 2001; Carver & Scheier, 1978; Masters, 1992) maintain that under heightened pressure, performers can think excessively about oneself and ones actions which inhibits performance and can lead to choking. Specifically, Baumeister argued that:

> Under pressure a person realises consciously that it is important to execute the behaviour correctly. Consciousness attempts to ensure the correctness of this execution

by monitoring the process of performance (e.g., the coordination and precision of muscle movements) but consciousness does not have the knowledge of these skills, so that it ironically reduces reliability and success of the performance when it attempts to control it (p.610).

In line with Baumeister (1984) and the propositions of Deikman (1969) who was the first to use the term ‘reinvest’, proposed the reinvestment theory, which has also been referred to as the conscious processing hypothesis (CPH: Hardy, Mullen, & Jones, 1996). Masters referred to adopted the term ‘reinvestment’ to explain the process where performance breakdown occurs due to reversal of learning progression (Fitts & Posner, 1967). The stages of learning model proposed by Fitts and Posner is widely accepted as an explanation for the learning process of motor skills. It predicts that a learner will pass from a cognitive phase, characterised by rule-based, explicit knowledge, where performance is slow, erratic and requires much effort, through an associative and to an autonomous phase where knowledge is implicit and non-verbalisable, and the skill is habituated resulting in performance being smooth, fluent, effortless and fast. In line with this, cognitive demands are relatively high in the cognitive phase and relatively low in the autonomous phase reflected of novice and expert performers respectively (Schneider, Dumais, & Shiffrin, 1984).

Reinvestment refers to the process when performers *dechunk* the motor program being utilised for a skill thus causing them to regress back to consciously controlling components of that skill in a step-by-step fashion, a characteristic of novice performers, in an attempt to maintain performance. In other words, conscious control of movement execution using explicit knowledge, instead of relying on automatic control processes for execution, causes performance breakdown (see Masters & Maxwell, 2008, for a review).

A number of studies aimed at examining the predictions of self-focus theories have been successful in finding support (e.g., Baumeister, 1984; Beilock & Carr, 2001; Beilock et al., 2002; Gray, 2004; Lewis & Linder, 1997; Liao & Masters, 2001; Masters, Polman, & Hammond, 1993). However, while in some studies pressure has been induced, in others, a skill-focus condition has been incorporated. Beilock et al. (2002) instructed expert football players to dribble a football through a slalom course whilst simultaneously performing either a secondary auditory task or a task aimed at inducing skill-focused attention. The time taken to complete the slalom course was recorded and results revealed that dribbling performance deteriorated in the skill-focused condition in comparison to the dual-task and baseline/control conditions. Gray (2004) instructed highly skilled baseball players to perform a batting task under two attentional conditions. The first condition required participants to identify a randomly presented tone as 'high' or 'low' in frequency whilst simultaneously performing the batting task. The second condition required the participants to perform the batting task whilst indicating whether their bat was headed 'upwards' or 'downwards' upon hearing a randomly presented tone. Results indicated that performance of the batting task was unaffected by the addition of the tone identifying task, whereas performance deteriorated in the skill-focused attention condition. Both sets of researchers concluded that the results were due to the fact that expert performers do not attend to the step-by-step mechanics of skill execution thus leaving attentional capacity available to perform a secondary task without disrupting the primary task. In addition, the skill-focused condition caused performers to attend to movement execution which interfered with performance.

Jackson et al. (2006) extended this work and reported analogous results under a pressure manipulation. Performance of a field hockey dribbling task deteriorated significantly in a skill-focused condition, in comparison to single-task and dual-task conditions. In addition, performance in the dual-task condition was unharmed by pressure. They suggested that the results indicated a conceptual distinction between explicitly monitoring skill execution and controlling it and concluded that explicit monitoring can have a general disruptive effect on performance but conscious control of skill through applying explicit rules in addition to monitoring execution will have additional negative implications.

Hardy et al. (2001) also demonstrated performance deterioration when participants were provoked to attend to movement execution. Performance of expert trampolinists deteriorated significantly when they were given explicit technical coaching cues under high state anxiety. They concluded that the combination of high anxiety and technical cues exceeded the athlete's attentional capacity and caused performance breakdown through a combination of CPH and distraction. Despite the relatively robust support for self-focus theories, recently, it has been suggested that where findings have been accepted as conclusive in support of self-focus, Processing Efficiency Theory (PET: Eysenck & Calvo, 1992) could also provide an explanation.

**2.3.4 Processing Efficiency Theory**

Before addressing the above stated issue and comparing the predictions of PET with CPH, it is necessary to first explore the tenets of PET and the research providing support for PET within choking. PET attempts to provide an explanation for the influence of state anxiety on performance. Within PET, it is assumed that trait anxiety and the perceived threat in any performance setting actively determines anxiety experienced by the performer. It further considers worry, the cognitive component of state anxiety, as the strongest influence on performance and describes it as the synthesis of concerns about evaluation, personal performance and self-preoccupation. The first effect of this is a reduction in the processing and storage capacity of working memory, and thus the resources available to complete the task at hand are reduced. The second effect sees an increase in motivation and on-task effort, which may partially or totally compensate for reduced performance effectiveness (Eysenck & Calvo, 1992).

According to PET there is a fundamental distinction between processing efficiency and performance effectiveness. Performance effectiveness is outcome related and refers to the quality of task performance, while processing efficiency refers to “the relationship between the effectiveness of performance and the effort or processing resources invested in performance” (Eysenck & Calvo, 1992, p.132).

In performance terms, the adverse effects of anxiety on performance effectiveness are often less than those on processing efficiency. Therefore, PET predicts that inefficient processing will affect performance, unless the athlete responds with increased effort or alternative strategies (Murray & Janelle, 2003; Wilson, 2008; Wilson, Smith, & Holmes, 2007b). However, significantly high levels of anxiety and/or the completion of cognitively demanding tasks under pressure is thought to overwhelm the working memory system and create a level of processing inefficiency that cannot be overcome by effort alone (Williams, Vickers, & Rodrigues, 2002). In this instance, choking will occur as a result (Smith, Bellamy, Collins, & Newell, 2001; Wilson et al., 2007a).

PET has been examined in a variety of sport settings, for example, golf-putting (Mullen & Hardy, 2000), table-tennis (Williams et al., 2002), and simulated rally-car driving (Murray & Janelle, 2003; Wilson, Smith, Chattington, Ford, & Marple-Horvat, 2006). Williams et al. provided evidence of increased effort, impaired processing efficiency, and impaired performance effectiveness when table tennis players were asked to perform in a high anxiety condition compared to a low anxiety condition. They also found evidence of changes in visual search patterns accompanying these changes. Murray and Janelle aimed to test the predictions of PET through examination of the relationship between anxiety and performance during a simulated motor racing task under low and high anxiety. Participants also performed a secondary task involving the identification of information in the periphery of the visual fields. In the high anxiety condition, peripheral task performance declined significantly despite maintained driving performance at a level similar to that shown in the low anxiety condition. Therefore, the predictions of PET were supported in that central task performance (lap time) was maintained at the expense of processing efficiency (visual fixation) in anxious individuals through the investment of additional effort.

Wilson et al. (2006) adopted a more process-oriented approach to investigate the affects of anxiety on the processing efficiency and performance effectiveness of a time-trial in a driving simulator. Car control was adopted as a process measure of performance in an attempt to differentiate between attention drawn from spare resources and attention drawn from the driving task. The study failed to provide conclusive support for PET; whilst the effort and processing efficiency data supported PET, increased levels of anxiety adversely affected performance, contrary to PET. The researchers concluded in agreement with others (e.g., Smith et al., 2001; Williams et al., 2002) who have tested the predictions of PET, that when resource demands of the task are too high, additional resources may not be sufficient to compensate for the negative effect of anxiety on performance.

Considering the limited empirical research that has been conducted and its relatively equivocal results, it is inconclusive at this stage whether PET solely accounts for the underlying process of the choking phenomenon. In addition, there are limitations to the suggestions that PET could be part of the process. First, although PET provides some explanation for the anxiety-performance relationship it does not provide a direct explanation for choking. Second, although PET was designed to have general applicability, it was predominantly developed with frameworks most relevant to cognitive-task performance, hence its transferability to motor skills is questionable. Finally, research into the role of PET in choking is limited due to the difficulty of measuring mental effort.

***2.3.4.1 Self-focus theories vs. processing efficiency theory.*** As previously mentioned, it has been suggested that where some results have been accepted as conclusive of self-focus, particularly CPH, PET could provide an alternative explanation, for example, Wilson and colleagues (2007a; b) argued further for the applicability of the predictions of PET to motor tasks and directly challenged the self-focus research (e.g., Beilock & Carr, 2001; Jackson et al, 2006; Mullen & Hardy, 2000). Wilson and colleagues stated that similar to predominately cognitive tasks, sensorimotor tasks, both during or before their completion, also require information to be stored and processed, and are therefore susceptible to anxiety effects.

In examining previous research where both skill-focused task and dual-task conditions are adopted, Wilson et al, (2007a) suggested that results could also be explained by PET. They stated that when the resource characteristics of the secondary tasks have not been assessed it is difficult to attribute differential effects to the type of attentional processing (distraction or skill-focused) involved. Therefore, PET could explain results such as those reported by Jackson et al. (2006), in that first, the skill-focused tasks used may simply have been more attentionally demanding than the distraction tasks, leaving fewer resources for the completion of the primary task. Second, as worry also places demands on attentional resources, this may explain why performance was most affected in the high-pressure condition.

In order to address the above mentioned conflicts, Wilson et al. (2007a) conducted a study designed to directly examine the opposing explanations of CPH and PET utilising a simulated driving task. Participants were instructed to perform the driving task as well as complete dual task and self-focus tasks, which were similar in attentional demands, and a control, drive-only condition. In addition, perceived mental effort was recorded. Each condition was completed under non-evaluative and evaluative instructional sets designed to manipulate anxiety. Results indicated that performance of the driving task was maintained in the distracting and self-focus pressurised conditions, which was identified as a consequence of the participants' raised effort. As such, the authors accepted the results to support PET over CPH yet acknowledged that CPH could explain the maintained driving performance in the high-pressure, secondary task condition, because the tone task would have primarily prevented drivers from explicitly monitoring their driving. While plausible accounts of the results were provided, it is worth mentioning that although cognitive state anxiety increased significantly from the low-pressure to the high-pressure condition, these levels may not have been high enough to provoke choking as such.

In a follow-up study, Wilson et al. (2007b) attempted to further test the tenets of PET against the CPH in a manner they deemed more ecologically valid by only manipulating the level of pressure the participants were exposed to during a putting task. Wilson et al. argued that due to the artificially contrived distraction and self-focus conditions used in previous studies, the single-task (or control condition) had offered the most realistic sporting setting. In general, the single task/control conditions had resulted in superior performance under high pressure (see Hill et al., 2010), which Wilson et al. stated could only be explained by PET. Wilson et al. measured golf putting performance in addition to effort levels of low and high trait anxious participants during performance, through analysis of self-report (Rating Scale for Mental Effort; Zijlstra, 1993), performance behaviour (time taken to initiate backswing and number of glances at hole) and psycho-physiological measures (heart rate variability, see Jorna, 1992, for a review). Overall, the results indicated that participants exerted more effort under pressure, which could be explained by either self-focus or PET. In addition, it was demonstrated that performance effectiveness was maintained at the expense of processing efficiency, which is supportive of the predictions of PET. However, when the high trait anxious golfers' performance was examined, it was evident that their performance was not maintained under high pressure. Considering that these golfers had reported significantly increased perceived effort, these results could be explained by either self-focus or PET. Therefore, Wilson et al. concluded with no decision as to whether self-focus or PET best explains the relationship between anxiety, effort and performance in motor tasks and suggested that it is reasonable to consider controlled processing as a direct function of the amount of mental effort invested.

***2.3.4.2 A combination of CPH and PET.*** The concluding suggestions of Wilson et al. (2007a; b) fall in-line with propositions from numerous researchers (e.g., Edwards et al., 2002; Hardy et al., 1996; Hardy et al., 2001; Liao & Masters, 2002) that a combination of theories may well explain the processes of choking, due to the multifaceted and complex relationship between performance production, attention, and anxiety. In-line with both self-focus and PET, Hardy et al. (2001) observed performance deterioration when athletes with high state anxiety were exposed to a condition designed to increase their self-focus, for example, coaches calling out explicit cues. Although this appeared to support the self-focus theories, in-line with their prior conclusions (Hardy et al., 1996), Hardy et al. (2001) proposed that the combination of high anxiety with additional technical cues may have exceeded the athletes' attentional capacity, and caused choking through distraction or PET. A further research group (Edwards et al., 2002) provided a similar conclusion in that cognitively anxious performers maintained their performance through the compensatory mechanism of effort. Edwards et al. proposed that the notion of anxious individuals expending more effort in an attempt to improve performance could dovetail logically with self-focus theories in that increased expenditure of effort could lead to conscious processing and decrements in performance.

Additionally, in support of this proposition, Lam et al. (2009) reported better performance from individuals who learned a skill (a modified seating basketball free-throw) by analogy in comparison to those who learned through explicit rules. It was concluded that processing of explicit task knowledge is crucial to performance breakdown rather than simply the load on attention. Their results seemed consistent with CPH, although, in-line with their previous inferences (see Liao, & Masters, 2002), they also acknowledged that conscious control also places high demands on working memory resources and that a more appropriate explanation could be that performance breakdown is a result of both quantity of information processed in working memory, on-task effort, and type of information processed by the performer. Therefore, a merging of PET with CPH was suggested as a potential focus for future research.

It seems logical, that a combination of the predictions of self-focus theories, particularly that of CPH, and those of PET could underlie performance decrements under pressure. Referring to Eysenck's PET, greater expenditure of effort is associated with the allocation of additional processing resources. It may well be that in trying harder, anxious individuals transfer task control from lower order, automatic subsystems to higher order, controlled subsystems.

While a consensus does appear in sight, the ecological validity of most of the above mentioned research is questionable, where distraction and self-focus/skill-focus conditions have mostly been artificially contrived as too have the pressure manipulations. In addition, the wholly experimental approach of contemporary choking research does not fully reflect the complexity of the pressure-performance relationship. Therefore, a call for a more ecologically valid, qualitative approach has been made by researchers such as Bawden and Maynard (2001), Gucciardi and Dimmock (2008), Gucciardi, Long-bottom, Jackson, and Dimmock (2010), and Hill et al. (2009).

In addressing the above criticism in a recent study, Hill et al. (2009) gathered information from four individuals who they classified as 'expert' in the field of stress and anxiety and had extensive experience of working with athletes who had performed in highly stressful situations. The participants took part in a focus group and follow-up interviews that addressed the definitions of choking, the choking process, the consequences of choking, and the possible moderating factors of choking. The results indicated attentional disturbances as the prime mechanism of choking in sport and evidence was provided for both CPH and PET. Hill et al. concluded that in order to establish if either one or both processes are responsible, information from the performers themselves needs to be examined.

In line with this recommendation, Gucciardi et al. (2010) conducted focus groups and interviews in an attempt to explore the personal accounts of experienced golfers' choking incidents. The results provided support for both distraction and self-focus theories; Athlete accounts indicated that the pressure coupled with higher incentives to perform well distracted their attention away from task relevant thoughts and a focus on technical cues was often adopted in order to shift attentional focus back. In addition, the importance of perceived emotional control, fear of failure and perfectionism evolved as potential mediators of choking. Gucciardi et al. concluded that choking is a complex process that involves the interplay of several cognitive, attentional, emotional and situational factors and that a combination of those theories presented could be possible.

Given the advancements that have been achieved through the above mentioned qualitative approaches, it is clear that further ecologically valid research is required. Additional investigation into the understanding of which theory or combination of theories is most relevant to a competitors' experience when under high levels of performance pressure (Gould & Krane, 1992; Gucciardi & Dimmock, 2008; Hill et al., 2009) would be advantageous in order to provide a thorough explanation of the underlying processes that cause choking.

## 2.4 Potential Moderators of Choking

The examination of the choking process has resulted in the identification of a wide range of moderating variables and individual differences, such as self-consciousness (Baumeister, 1984), reinvestment (Masters, Polman, & Hammond, 1993), trait anxiety (Baumeister & Showers, 1986), self-confidence (Baumeister, Hamilton, & Tice, 1985), skill level (Beilock & Carr, 2001), audience effects (Wallace, Baumeister, & Vohs, 2005), stereotype threat (Chalabaev, Sarrazin, Stone, & Curry, 2008), public status (Jordet, 2009), coping strategies (Wang, Marchant, Morris, 2004a; Wang, Marchant, & Gibbs, 2004b), fear of failure and perfectionism (Gucciardi et al., 2010), although the extent to which these play a role remains unclear (see Beilock & Gray, 2007). Presented below is further discussion of the proposed moderators listed above.

### 2.4.1 Self-Consciousness

Self-consciousness is defined as the tendency to either direct attention inwards focusing on covert aspects of the self that are associated with ones inner thoughts and feelings (referred to as private self-consciousness) or outwards, focusing on aspects of the self that are most relevant to motives involving self-representations or self-portrayal (referred to as public self-consciousness) (Carver & Scheier, 1981). In addition, social anxiety is a facet of self-consciousness and represents an individual's reaction to being focused on by others.

Fenigstein, Scheier, and Buss (1975) developed the Self-Consciousness Scale (S-CS) to assess individual differences in the concept. The scale comprises three subscales; one for each of the three dimensions of self-consciousness: private self-consciousness, public-self-consciousness and social anxiety. Baumeister (1984) initially predicted that an athlete with high dispositional self-consciousness, indicated by the SCS, is less prone to choking because he or she is more accustomed to performing in a self-aware state than those who score low in self-consciousness. Therefore, the assumption is that the state of self-awareness may be most disruptive to persons who rarely experience it (Baumeister & Showers, 1986). This suggestion has been supported by numerous studies (e.g., Beilock & Carr, 2001; Lewis & Linder, 1997). However, more recently, contradictory evidence has emerged suggesting that highly self-conscious individuals are more prone to choking because they are more likely to engage in detrimental self-focus under pressure (Liao & Masters, 2002; Poolton, Maxwell, & Masters, 2004; Wang et al., 2004b). Further research is required to address the lack of consensus and to consider the possible influence of additional moderators, such as skill level and task properties.

### 2.4.2 Reinvestment

Masters et al. (1993) proposed 'reinvestment' as an individual difference in personality that reflects a propensity to reinvest and disrupt controlled processing under pressure. A series of investigations examining the theory of reinvestment subsequently lead to the development of the Reinvestment Scale which assesses an individual's propensity for reinvestment of controlled processing (Masters et al.). The reinvestment scale contains twenty items from the SCS (Fenigstein et al., 1975), the Emotional Control Questionnaire (Roger, Nesshover, 1987), and the Cognitive Failures Questionnaire (Broadbent, Cooper, Fitzgerald, & Parkes, 1982). Masters et al. found a significant correlation between Reinvestment Scale scores (RS-scores) and performance decrements under pressure in golf putting and also found a significant correlation with coach and team captain ratings of university tennis and squash players' tendency to choke under pressure. Further support was provided by Maxwell, Masters, and Eves (2000), who found a positive correlation between RS-scores and the number of reported explicit rules accrued during learning of a golf putting task and a negative correlation with overall putting performance for those in an explicit learning condition. Further investigation with skilled soccer players provided support for the predictive validity of the Reinvestment Scale with high reinvesters displaying a greater susceptibility to skill failure under pressure (Jackson et al., 2006).

**2.4.3 Trait Anxiety**

Trait anxiety reflects an individual’s predisposition to respond with state anxiety, a transitory emotion characterised by physiological arousal and consciously perceived feelings of apprehension, dread and tension, in the anticipation of threatening situations (Spielberger, 1966). Byrne and Eysenck (1995) suggested that high trait anxious individual perform poorly under pressure because they response to pressure situations with elevated state anxiety more frequently and/or more intensely than low trait anxious individuals. In addition, Baumeister and Showers (1986) proposed that chronic performance anxiety could harm performance a result of the frequent and intense state anxiety response that athlete’s with high trait anxiety experience whilst under pressure. While many studies have used pressure manipulations (e.g., Beilock et al., 2002; Hardy et al., 2001; Jackson et al., 2006; Lewis & Linder, 1997), limited research has been conducted to examine the extent to which trait anxiety directly predicts choking. In addressing the issue, Wang et al. (2004a) studied the free-throw performance of experienced basketball players under high and low pressure conditions and recorded anxiety and self-consciousness. They found that somatic trait anxiety predicted poor performance and suggested that this was because somatic trait anxiety may act as a trigger for greater self-focus.

**2.4.3 Self-Confidence**

Self-confidence is the belief that one has the internal resources to achieve success. There is little research considering the effects of self-confidence on performance under pressure and choking, yet it has been identified as a potential moderator. It has been suggested that individuals who expect success outperform those who expect to fail (Baumeister et al., 1985) and in-light of this suggestion Wallace and Baumeister (2002) conducted a study with a focus on narcissism. Wallace and Baumeister reported that participants who had high narcissism scores, performed better in a dart throwing task under pressure than those who possessed low scores. It is possible that narcissistic individuals, i.e., individuals who have high self-confidence and self-efficacy, are less susceptible to performance pressure because when faced with setbacks they tend to maintain confidence that their performance will yield the outcome they desire. Furthermore, in a qualitative investigation conducted by Hill et al. (2009), results indicated that low self-confidence was a key individual difference characteristic that may encourage choking.

**2.4.4 Skill Level**

Most evidence for performance failure under pressure has been found in highly skilled athletes, and thus it appears that monitoring and controlling skill processes does not cause skill failure in all variations of skill level. In studies where novices have been directed to attend to skill execution of baseball batting (Gray, 2004) and soccer dribbling (Beilock et al., 2002a) no evidence of performance decrements has been demonstrated in comparison to performance under normal circumstances. It has been suggested that this is due to the fact that, in accordance with the stages of learning (see Fitts & Posner, 1967), novices need to pay attention to skill execution in order to perform optimally, thus performance is not likely to be hindered in situations when skill focused attention is promoted (see Gray, 2004). In a study conducted by Beilock and Carr (2001), individuals considered to be absolute novices in golf were taught a golf putting task. Participants were asked to perform the putting task during the early stage of learning under a high pressure situation and again at a much later stage, when it was considered that the skill had been acquired substantially. Performance results indicated that during the early stage of skill acquisition, pressure facilitated performance, yet in the later stage, performance decrements occurred under pressure. Therefore it is possible that novices are not harmed by pressure in the same way as experts and that monitoring and controlling skill processes is likely to be the cause of skill failure under pressure only for well-learned and highly practiced sport skills.

### 2.4.5 Audience Effects

It is widely accepted that the presence of an audience poses as a moderator to choking, yet it the direction of those effects remain somewhat unclear. There is evidence for the home team advantage (e.g., Neville & Holder, 1999; Thomas, Reeves, & Bell, 2008) and the most probable explanation for the home advantage is that supportive audiences elicit better performances than unsupportive audiences. Yet, Baumeister and Steinhilber (1984) introduced the notion that supportive audiences could induce choking under pressure. Evidence for the home choke has been provided through the examinations of World Series baseball, national championship basketball (USA), championship golf and ice hockey (Baumeister & Steinhilber, 1984) but this evidence has not stood the test of time, with more recent championships of a similar nature to those mentioned above being won at home. Wallace et al. (2005) suggest that supportive audiences typically induce motivation in athletes, although when a performer's level of motivation is sufficient, the added pressure from the audience may cause choking.

### 2.4.5 Stereotype Threat

According to stereotype threat theory, when a negative stereotype about a group's ability is made relevant in a competitive situation, target individuals may fear being evaluated based on the stereotype (Beilock & McConnell, 2004). Despite the limited research examining the influence of stereotype threat on sporting performance, initial findings have demonstrated that it may cause some instances of choking. For example, racial stereotype threat was demonstrated in a study conducted by Stone, Lynch, Sjomeling and Darley (1999). Caucasian athletes choked under pressure when informed the task was an indication of natural athletic ability performance, and African American athletes choked when they were introduced to the task as being a test of sports intelligence. Further support for the effects of stereotype threat on motor skill performance was provided by another investigation on putting performance. Beilock, Jellison, Rydell, McConnell, and Carr (2006) introduced a putting task and told participants that "women actually tend to perform better than men on our putting task" (stereotype threat) or that "this research is investigating individual differences in golf putting performance" (control). Men in the control condition improved their performance between practice and test phases whereas test performance in the stereotype threat condition was worse than in the control condition. Beilock et al. interpreted their results to indicate the presence of stereotype threat and performance pressure as factors influencing cognitive processes that can subsequently lead to choking. Support for stereotype threat within sport does exist but full understanding of the mechanisms which underpin the process has not been established.

**2.4.6 Public Status**

Jordet (2009) conducted a thorough examination of penalty shoot out data from two major international tournaments (World Cup and European Championships). Public status of players was derived from assessing how many international club titles had been achieved and the international achievements of their fellow national team members. Results indicated that those players who were ranked highly in public status spent less time preparing for their shots and were less successful at the penalty shot than the players with lower public status. Jordet concluded that the high expectations players experience as a result of being on a certain team can lead to underachievement and possibly choking. In addition, players on teams with less expectation due to lower public status may excel in the same situations.

**2.4.7 Coping Strategies**

Wang et al. (2004a) examined the relationship between coping styles and choking susceptibility. Basketball players' completed the Coping Style Inventory for Athletes (CSIA: Anshel & Kaissidis, 1997) and performed free-throws under low- and high-pressure conditions. Correlation and hierarchical regression analyses revealed that approach coping style accounted for significant variance in performance under pressure and the high scores for approach coping predicted poor performance under pressure, whereas the avoidance coping style did not. The authors therefore accepted their hypothesis that approach coping can lead to performance decrements under pressure.

### 2.4.8 Fear of Failure and Perfectionism

Gucciardi et al. (2010) identified fear of failure and perfectionism as potential psychological constructs that may predispose or predict an individual's susceptibility to choking under pressure. In their study, the majority of golfers who recollected a choking experience expressed awareness of a fear of failure preceding the choke. Negatively perceived potential outcomes of the performance can be perceived as threatening because of the potential for failure and appraisals of threat are particularly applicable for goals or performances that are perceived as personally important (Lazarus, 1991). Gucciardi et al. identified relationships between fear of failure experienced before an event perceived as highly important, with perceptions of decreased motivation and self-belief leading to a choke as well as emotional distress experienced after the choke. Conversely, they recognised perfectionism as the compulsive pursuit of excessively high standards and a tendency to engage in harsh, overly critical self-evaluation, which supports suggestions from Flett and Hewitt (2005) in their review of perfectionism. Through examination of the athlete accounts, it was apparent that excessively high standards and critical evaluations were common surrounding a choke. Gucciardi and Dimmock (2008) further noted that experimental research is required to further examine the influences of both perfectionistic tendencies and fear of failure.

## 2.5 Methods Proposed to Alleviate/Prevent Choking

As you may note, a clear lack in consensus exists with regards to the numerous moderating variables that influence an individual's propensity to choke. Obtaining consensus regarding the underlying processes that cause choking is necessary in order to attempt to ascertain the extent to which each of the concepts highlighted above affect choking. Despite the extensive research conducted on choking over the past 2 decades, the lack of detailed knowledge and consensus regarding the underlying processes and moderators of choking is possibly the reason for the limited number of appropriate interventions, aimed at reducing or alleviating choking. Recently, Mesagno and colleagues (Mesagno et al., 2008; Mesagno, Marchant, & Morris, 2009; Mesagno & Mullane-Grant, 2010) have recognised the need to develop theory-based interventions and through a series of studies have investigated the efficacy of pre-performance routines. Prior to this the most notable interventions have been implicit learning (Masters, 1992), analogy learning (Lam et al., 2009; Liao, & Masters, 2002), process cues (Gucciardi & Dimmock, 2008), performing a secondary task (e.g., Lewis & Linder, 1997), and adaptation training (Beilock & Carr, 2001).

### 2.5.1 Implicit Learning

Through investigation into reinvestment theory (Masters, 1992), the notion of implicit learning was proposed. Masters suggested that if a skill was learnt in such a way that minimal or no explicit knowledge was obtained, when under pressure there would be very limited possibility of reinvestment as performer's self-focused attention increases. Although this method has been effective in maintaining performance in sport (for example, Mullen, Hardy, & Oldhan, 2007; Koedijker, Oudejans, & Beek, 2007) and medical domains (Masters, Lo, Maxwell, & Patil, 2008) under physical fatigue as well as psychological stress (Masters, Poolton, Maxwell, & Raab, 2008), the appropriateness of application in real-life sport as an intervention remains questionable.

First, the majority of studies aiming to test implicit learning have utilised a secondary, distracting, task during the skill learning phase to eliminate the development of explicit knowledge. The secondary tasks used have varied substantially from study to study, for example, random letter generation (Masters, 1992) and tone-counting (Maxwell et al., 2000), therefore replication of an optimal method in real-life sport is difficult. Second, implicit learning does not provide a helpful suggestion for athletes who have already learnt their skills in the more conventional way. In addition, according to Gentile (1972) the process of learning involves both implicit and explicit aspects and it has been proposed that implicit learning can prohibit athletes from developing self-correcting strategies (Bennett, 2000). Third, it is possible that once the implicit learning techniques are withdrawn, explicit knowledge will begin to accumulate. Although preliminary research has demonstrated that a short duration of implicit motor learning can be enough to retain the characteristic advantages associated with implicit learning despite accumulation of explicit knowledge (see Poolton, Masters, & Maxwell, 2005), further works is required in order to confirm the permanency of learning a skill through implicit methods. Finally, implicit learning methods take much longer than the more conventional approaches (see Maxwell et al.).

**2.5.2 Analogy Learning**

In response to some of the above concerns of implicit learning, Masters (2000) proposed analogy learning, which uses biomechanical metaphors to teach complex actions (e.g., hitting a table tennis backhand as if 'throwing a frisbee'. Lam et al. (2009) investigated analogy learning using a seated basketball free-throw. Participants were either given a series of explicit instructions, such as 'support ball with hand of your non-shooting arm', or just one analogy, 'shoot as if you are trying to put cookies into a cookie jar on a high shelf'. The group taught by analogy performed significantly better under pressure. This seems promising, yet there is no guarantee that it was the learning process, i.e., the prevention of acquiring explicit rules and not an appropriate guide during execution (through the analogy) that aided performance. Although some of the limitations of implicit learning are addressed with analogy learning there still remains the issue that analogy learning does not provide aid to those performers who have already developed their skills nor does it stop people acquiring explicit rule in the future.

**2.5.3 Process Cues**

There is limited research that specifically examines the effectiveness of specifically process cues, although one study in particular, conducted by Gucciardi and Dimmock (2008) examined the use of process cues to alleviate choking. They instructed elite golfers to perform a putting task whilst focusing on task-irrelevant thoughts, explicit rules or a single 'swing thought'. As predicted, under heightened pressure, putting performance in the explicit rules condition deteriorated, whereas performance in the swing-thought conditions improved. This method poses another applicable method in preventing choking, yet again, further applied research is required.

### 2.5.4 Secondary Tasks

The benefits associated with performing a concurrent, secondary task have been highlighted throughout the choking literature (e.g., Beilock et al, 2002; Jackson, et al., 2006; Lewis & Linder, 1997; Mullen & Hardy, 2000). Yet, Mullen et al. (2005) presented opposing findings when they required participants to perform a golf putt while simultaneously performing a tone counting task. Therefore, despite the majority of research being favourable, there is uncertainty regarding the efficacy of adopting a secondary task as a means to prevent choking. In addition, the ecological validity of this particular intervention must be questioned. It would be impossible to include a tone related secondary task during a competition and potentially, inappropriate for expert athletes to verbalise random letters during performance.
Therefore, it is unlikely that this method can be adopted in sporting skills.

### 2.5.5 Adaptation Training

Lewis and Linder (1997) investigated the effectiveness of adaptation training by requesting golfers to practice a putting task whilst being video-taped. The video-taping was used as self-awareness adaptation training and was designed to induce increased self-focused attention. Participants who had practiced under the self-awareness adaptations condition performed significantly better under high pressure than participants who had not experienced the self-awareness adaptation training. These results were replicated in a study conducted by Beilock and Carr (2001) where the same manipulation was adopted. Following training, golf putting performance improved from low pressure to high pressure. The concept of adaptation training is a plausible intervention to prevent choking from occurring, although it does not provide an immediate effect. In addition, the training required for positive results in real-life competitive performance is yet to be established.

### 2.5.6 Pre-Performance Routines

In the past couple of years, pre-performance routines have been investigated as a theory-matched intervention method of preventing choking (Mesagno & colleagues, 2008, 2010). Mesagno et al. (2008) developed a pre-performance routine (PPR) to alleviate choking in experienced ten-pin bowlers via the reduction of distraction. The authors indicated that

Boutcher's (1990) recommendations for PPR development were adhered to and that the PPR's included modification of optimal arousal levels, behavioural steps, attention control and cue words, however they provided no other details regarding the content of each PPR. The results revealed improved performance from high-pressure with no PPR, to high-pressure following PPR training. In a following study (Mesagno & Mullane-Grant, 2010) pre-performance routines designed to alleviated self-focused attention were investigated in the performance of experienced Australian football players. Participants were required to perform a kick into a scoring zone under low-pressure and high-pressure conditions using differing versions of a PPR. Results were positive and revealed improved performance from low-pressure to high-pressure after receiving PPR training. These proposed interventions of Mesagno and colleagues (2008, 2010) show potential yet still require further investigation.

## 2.6 Summation of Choking Literature

Two main points evolve from the above review of the choking literature that are relevant to the present body of research. The first concerns the methodological approaches to choking research. There is clearly a need to address the lack of ecological validity that exists within the almost exclusively experimental approach to choking. In addition, there is a lack of detailed understanding and consensus regarding the mechanisms and moderators of choking. The value of qualitative, idiographic methods have recently been acknowledged but are in their infancy in terms of adoption. The studies conducted by Gucciardi et al. (2010) and Hill et al. (2009), have provided some insight, as discussed previously, which would not have been uncovered through experimental approaches. However, further research of this nature could prove to be fruitful, particularly regarding enhancing understanding of the potential numerous inter-related moderators and the complex relationship between pressure and performance.

The second point that arises from the review concerns the lack of interventions designed specifically to alleviate choking that are appropriate in the applied setting, although some do show promise. There remains the need for an intervention tool that is appropriate for immediate use in a real-world competition that could be used alongside more long-term methods and potentially form part of a pre-performance routine. As mentioned above, further development of theory-matched interventions that focus on the expert athlete at the point of pressure are required. In seeking to develop an appropriate intervention to alleviate or even prevent choking in sport, the following section provides a review of the literature surrounding priming.

## 2.7 Introduction to priming

Priming research was originally adopted as a method to explore the cognitive representations and processes that mediate between environmental events and psychological reactions to them (Bargh & Chartrand, 2000). Such research eventually moved on to demonstrate that the residual effects of one's use of a representation in comprehending or acting on the world leaves a primed representation automatically associated with it. During the time that a primed representation remains active, a passive effect is exerted on the individual, one that if he or she is not aware of and does not attend to, is unlikely to be controlled (see Bargh, 1994; Bruner, 1957; Higgins, 1989, 1996). This primed representation creates internal readinesses that interact with future environmental information to produce perception, evaluations, and even motivations and social behaviours (see Bargh, 1997). Simply put, the term 'priming' is now used to refer to the effect of the recent use of a concept in one task on its probability of usage in a subsequent unrelated task (Segal & Cofer, 1960).

Most priming research is conducted within the domain of social psychology and a study conducted by Higgins, Rhodes and Jones (1977) provides a principle example to highlight the concept. Higgins et al. exposed participants to the synonyms of certain personality traits as part of a memory experiment. Next, in what participants believed to be an unrelated task, they read about a target person who behaved in ways ambiguously related to the primed traits, such as sailing across the ocean alone and preferring to study by himself. The results indicated that those participants who had been exposed to words such as 'adventurous' and 'independent' formed more positive impressions of the target person than did those participants who had been previously exposed to terms such as 'reckless' and 'aloof'. This research demonstrated that an individual's recent experience could affect, in a passive and unintended way, his or her perceptual interpretation of another person's behaviour.

## 2.8 Priming Techniques

The techniques used in priming research fall into three main categories, these are mindset priming, sequential priming and conceptual priming (Bargh, 2000), the latter being of most relevance to the present programme of study. Although they differ in the route to effect, all three methods examine unintended consequences of an environmental event or experience on subsequent thoughts, feelings, and behaviour.

### 2.8.1 Mindset Priming

Mindset priming concerns an initial active engagement in a goal-directed type of thought in one context and expects that particular mindset to be adopted in an unrelated context. Therefore, what is primed is a procedure or a purposive way of thinking about information or a situation. For example, Wilson and Capitman (1982) provided half of their male participants with a ‘boy meets girl’ story, implying the beginning of a loving relationship, while the other half received nothing. In a follow-up task, those participants who had read the story smiled more and generally behaved in a more friendly way towards a female experimenter in comparison to those who were not provided with such a story.

### 2.8.2 Sequential Priming

Unlike**,** mindset priming and conceptual priming, sequential priming is not adopted to examine the residual effects of a recent experience, rather it is used to test for **c**hronic connections between an attitude object and its evaluation or between two different concepts. Therefore, this method is adopted to explore the associative structure of the mind, specifically; it is used to examine memory structure and automaticity.

Sequential priming methods work based on associative network theory which holds that the activation of a concept will only spread if there is an associative link that has been formed, and the stronger the association, the faster the activation will spread across the interconnected nodes of memory to the related node. Early experiments on associative network theory showed that responses to a target item (e.g., nurse) were faster if an associated node (e.g., doctor) had just been activated (Meyer & Schvaneveldt, 1971).

### 2.8.3 Conceptual priming

Conceptual priming involves the activation of mental representations in one context and examines the passive, unintended, and non-aware influence in a subsequent un-related context. The priming task is typically far removed from the task, which is performed in order to measure the priming effect. Manipulations are used that activate the internal mental representation of interest in a first task, in such a way that the participant does not realise the relation between that activation event and the later influence. Conceptual priming can be induced supraliminally or subliminally.

***2.8.3.1 Supraliminal priming.*** In supraliminal priming methods, the individual is fully aware of the priming itself, but it not aware of the underlying pattern that it serves to prime. A frequently used method of supraliminal conceptual priming is the scrambled sentence task (Srull & Wyer, 1979). The task incorporates target words that are related to the construct to be primed. Typically, the task comprises a number of items with each item consisting of five words, four of which can be used to create a grammatically correct sentence. Instructions are to complete a 4 word grammatically correct sentence with any four of the words in each item. Participants completing the task are therefore exposed to the words embedded in the task. Although the priming method is supraliminal, it is believed to activate temporary cognitive representations at the preconscious level; the non-consciously primed concept then operates automatically, outside of awareness, to influence perception and behaviour in prime-consistent directions (see below for example).

*2.8.3.1.1 Scrambled sentence tasks.* Scrambled sentence tasks have been used to prime a variety of behaviours (e.g., Bargh, Chen, & Burrows, 1996; Krolak-Schwerdt, 2003; Srull & Wyer, 1979). Specifically, Bargh et al. used a scrambled sentence task to activate the concept of rudeness or politeness and then waited to see if a participant would interrupt a conversation in order to get directions for the next task from the experimenter. Those primed with the rude stimuli were more likely to interrupt (63%), than those primed with politeness (17%). This was replicated and extended by Krolak-Schwerdt (2003) who primed participants with extraversion and introversion and found corresponding behavioural effects.

Similarly, Srull and Wyer (1979) replicated the findings of Higgins et al, (1977) when they primed participants with the concept of hostility using scrambled sentence tasks. Following exposure to the prime, in an allegedly unrelated task, participants read a behavioural description of a person that was ambiguous regarding hostility and then rated the stimulus person on several trait dimensions. Results indicated that ratings of the stimulus person along the dimension of hostility were higher from those who were primed.

***2.8.3.2 Subliminal priming.*** Subliminal priming involves a very brief presentation of the prime and an immediate masking by another stimulus, followed by appropriate awareness checks. In addition to providing a way to examine the effects of nonconsciously perceived stimuli, subliminal priming can be adopted as a means to conclusively rule out alternative explanations for priming effects. For example, in an attempt to replicate the findings of Higgins et al. (1977) and Srull and Wyer, (1979), Bargh and Pietromonaco (1982) exposed participants to the concept of hostility by the use of a vigilance task. In the task, participants were required to respond as quickly as they could to flashes that appeared on the screen. These flashes were actually words, of which a certain number of them were related to hostility, and appeared for 100 ms so as not to appear long enough for the participants to be aware of the nature of the flashes. As in studies where a supraliminal priming method was adopted, a similar rating of a described ambiguous target person was reported following exposure to the prime.

***2.8.3.3 Supraliminal vs. subliminal.*** The same effects have been obtained consistently using either supraliminal or subliminal priming, therefore awareness of the priming stimulus presentation is deemed to bare no significance. Although there are no studies to date that demonstrate the seemingly equal effects of supraliminal and subliminal prime methods alike, there is evidence in the studies conducted by Higgins et al. (1977), Srull and Wyer (1979), and Bargh and Pietromonaco (1982) as discussed above where the same behavioural effects were found using both methods.

## 2.9 Moderators of Priming Effects

It is beneficial at this point to consider the potential moderators of priming affects that have arisen from the priming research reviewed here. Conscious awareness of the prime material, conscious awareness of the potential effect of the prime, and the number of priming stimuli have emerged as aspects of priming methods that act as potential moderators in varying the strength of primed responses. The strength of a prime is understood to be reflected in the intensity of the primed behaviour as well as the duration of time that the primed behaviour is retained for (Higgins, Bargh, & Lombardi, 1985). In addition, the prime content has also been found to moderate the direction of the primed response.

### 2.9.1 Conscious Awareness of the Priming Material

Subliminal priming versus supraliminal priming has already been touched on in this review, and to recap, the same behavioural effects have resulted from both methods of priming. Bargh and Chartrand (2000) propose that as a general rule, ‘conscious’ priming tasks, where the individual is aware of the priming material and processes the prime material consciously, as in scrambled sentence tasks, result in stronger priming effects than does subliminal priming. The primed effect will therefore be stronger, because the stronger the activation of a concept, the greater its accessibility and likelihood of subsequent use (Higgins & King, 1981).

### 2.9.2 Conscious Awareness of the Possible Prime Influence

The individual’s awareness of the possible influence that a situation/prime may have can moderate the primed effect. As already discussed, it is likely for an individual to be affected unintentionally by the current environmental context (as in priming effects), but be able to counteract such effects on judgements or behaviour if they become aware of the potential influence (Strack & Hannover, 1996). It has always been the case that findings of ‘uncontrollable’ automatic effects refer not to uncontrollable responses but to uncontrollable internal activation events. Therefore, if an individual is not aware of the potential prime effects, biased judgements and even behaviour can be evident, but, if aware, he/she may be able to adjust for and control the effect. For example, Schwartz and Clore (1983) conducted telephone interviews where participants were either contacted on a rainy day or a sunny day and asked about their life satisfaction. When the experimenter did not mention the weather, participants who were contacted on a rainy day reported lower life satisfaction than those contacted on a sunny day. Conversely, if the experimenter did mention the weather, this effect disappeared.

### 2.9.3 The Number of Priming Stimuli

It has been suggested that the more priming stimuli presented, the stronger the obtained priming effects (Bargh & Chartrand, 2000). The sole study to date that has directly compared the number of priming stimuli was conducted by Srull and Wyer (1979). In the aforementioned 'hostility' study, Srull and Wyer also manipulated the number of items and the proportion of relevant primes in the scrambled sentence tasks. Participants completed tasks with either 30 or 60 items containing either 20% or 80% relevant primes of the total items. The results revealed that both number of items and percentage of prime items produced significant main effects. Thus, the longer tasks had stronger priming effects than the shorter tasks and the tasks that included a greater concentration of relevant primes had stronger priming effects than the tasks with fewer prime relevant items.

### 2.9.4 The Target of Prime Material

The priming research discussed thus far has resulted in behaviour in-line with the implications of the activated category or trait, for example, activation of the category 'elderly', resulted in participants walking slowly (Bargh et al., 1996), but not all priming research has demonstrated such an effect. Opposing, contrast effects, have also been reported. For example, Herr (1986) demonstrated that priming participants with the hostile exemplar of 'Hitler' lead participants to judge a stimulus person to be less hostile, rather than more as was demonstrated by Bargh and Pietromonaco, (1982), Higgins et al, (1977) and Srull and Wyer (1979), through activation of the general concept of hostility.

Further, research examining contrast and assimilation effects has been conducted by Dijksterhuis et al. (1998). They researched the notion that in considering judgements, priming a general category or trait resulted in assimilations effects, and activation of specific exemplars resulted in contrast effects. In the first of a series of experiments, participants were primed with categories of either college professors or supermodels or exemplars Albert Einstein/ Claudia Schiffer. As expected, those primed with the category professor outperformed those primed with supermodel traits in a series of general knowledge questions. Additionally, in-line with social judgement research, those primed with the exemplar Claudia Schiffer outperformed those primed with the exemplar Albert Einstein. Dijksterhuis et al. concluded that exemplars elicit judgemental contrast by evoking social comparisons. Further research conducted by Nelson and Norton (2005) has supported this notion where the activation of the category ‘superhero’ resulted in more helpful behaviour, whereas, activation of the exemplar ‘superman’ actually led to less helpful behaviour.

**2.10 Priming Effects on Motor Actions/Behaviour**

Most priming research has been conducted in the social/cognitive response and social behaviour domains, and thus far, these have been the topic of discussion in order to provide an in-depth understanding of the nature of priming. After considering the general research surrounding priming manipulations we return to the use of priming methods to activate a response or behavioural change in those primed that is relevant in the motor skill domain. As discussed, research has demonstrated that activated trait constructs not only affect judgements about others, but also affect participant’s overt behaviour. Activated traits bring behaviour in line with the particular trait (Bargh et al., 1996; Dijksterhuis & Van Knippenberg, 1998; see Dijksterhuis & Bargh, 2001, for a review) and although limited research examining primed effects on motor actions has been conducted, such effects have been demonstrated. Now follows, a discussion of the few studies that have demonstrated a primed effect in motor skill behaviour.

In their initial investigation into the unconsciousness of behaviour initiation, Bargh et al. (1996, experiment 2) were the first to report effects of category activation on motor behaviour. In their experiment, half of the participants were primed with the category of elderly, in the form of a sentence scrambling task and the other half were not. After completion of the sentence scrambling tasks, participants were advised that the experiment had been completed; however, the time it took for each participant to walk from the experimental room to the nearest elevator was recorded and formed the actually experiment. The data showed that participants primed with the elderly category walked significantly slower than the control participants. Hull, Stone, Meteyer and Matthews (2002) replicated the pattern demonstrated by Bargh et al. (1996) study.

In response to the findings of Bargh et al. (1996), Banfield, Pendry, Mewse, and Edwards (2003) queried the potential of such a prime to effect the entire execution of a simple motor skill such as walking. They suggested that, according to neuropsychological literature, simple skills such as walking are executed in a bottom-up manner and are therefore not usually susceptible to such primed effects as reported by Bargh et al. To test their theory they examined the effects of a prime on a reaching and grasping task because they felt that this task would allow for accurate identification of where the effects of the prime lay within the overall sequence of the action. Banfield et al. requested participants to perform the simple motor task of reaching and grabbing post exposure to an elderly stereotype prime. Results indicated that category activation did not change the overall speed of action but instead the prime caused the action to be executed more slowly because longer pauses were made between actions. It was concluded that the effect must lie elsewhere in the temporal execution of the overall action sequence. They suggested that simple visuomotor actions are dorsally driven and do not need much attentional input, making it unlikely that these actions are sensitive to activation or perceptual representations such as social categories. Motor preparation, on the other hand, is at least partly the result of prefrontal control and of the integration of various perceptual processes. This in turn, makes it more likely that more complex tasks can be affected by activated constructs. Therefore, it is possible that the impact of a prime on the performance of a motor task varies as a function of the action being carried out.

The findings of Banfield et al. (2003) in relation to simple motor actions seem plausible, yet they do not provide insight into more complex motor skills or instances where motor skill execution has increased as a result of a prime. The following studies have resulted in improvement of more complex motor skills. Bry, Meyer, Oberlé and Gherson (2009) investigated priming effects of cooperation versus individualism on baton changeover speed in a 4 x 100 m relay race. Ten teams of four adult beginner athletes were primed with either cooperation or individualism through sentence scrambling tasks. Participants performed a pre-test race followed by an experimental (primed) race three weeks later. For each race, the speed of the baton within a 20 m change-over box was recorded. The results revealed no difference between change-over speed between the pre-test race and the experimental race for the individualism prime. In the cooperation prime condition, changeover speed was faster in the experimental race than the pre-test race. Although it could not be inferred from these results that individual motor performance can be facilitated the results do support the use of sentence scrambling tasks in team motor skill execution.

Finally, in part 3 of a series of studies investigating the effects of motivation orientation, Hodgins, Yacko, and Gottlieb (2006) primed collegiate rowers with autonomy, control or impersonal motivation orientation. Performance was measured over a 2,000 m row and the results revealed significantly faster estimations of predicted performance as well as actual performance on a rowing ergometer.

It can be seen that in addition to the more traditional social and cognitive behaviours that have been subject to priming research both simple and complex motor actions can, potentially through differing mechanisms, be subject to priming manipulations. Therefore it would seem plausible that general motor skill execution could be manipulated by adopting the concept of supraliminal priming methods.

**2.10.1 Priming to Prevent Skill Breakdown under Pressure.**

In relation to the above, Ashford and Jackson (2010) adopted the scrambled sentence tool and developed three tasks; a negative task predicted to promote skill-focus, a positive task predicted to promote automatic execution and a neutral task deemed to have no effect on performance. The effects of the tasks were examined with a group of skilled field hockey players performing a dribbling task under high- and low- pressure. In two experiments, the positive prime based on words relating to automaticity resulted in significantly faster and / or more accurate performance than that attained under control (Experiments 1 and 2) and negative or neutral prime (Experiment 2) conditions. Conversely, the negative prime resulted in significantly slower performance than the neutral prime. Ashford and Jackson interpreted their results by appealing to attentional mediators of performance. In particular, they suggested that the positive and negative primes may have caused attention to be successfully directed away from and towards the mechanics of movement execution, respectively. This conclusion is plausible but cannot be confirmed without measuring changes in attentional processes resulting from priming. Ashford and Jackson’s study therefore provided preliminary support for the efficacy of priming in motor skills performed under pressure; however, further research regarding the effects of priming on attentional processes is warranted.

## 2.11 Rationale for the Present Programme of Study

The theories and literature referred to throughout this chapter facilitate understanding of the choking phenomenon and provide a frame of reference for further research. There are a number of studies that have examined the underlying mechanisms of choking (e.g., Beilock & Carr, 2001; Beilock et al., 2004; Gucciardi et al., 2010; Jackson et al., 1996; Masters, 1992; Gray, 2004; Smith et al., 2001; Williams & colleagues, 2007a, b), potential moderators of choking (e.g., Baumeister & colleagues, 1985, 1986; Beilock & Carr, 2001: Masters et al., 1993; Wang & colleagues, 2004a, b), and methods to alleviate choking (e.g., Gucciardi & Dimmock, 2008; Mesagno & colleagues, 2008, 2009, 2010, Masters, 1992; Lam et al., 2009; Lewis & Linder, 1997). Although, some progress has been made towards understanding the mechanisms of choking, these studies are primarily quantitative in nature and it is apparent that there still remains some uncertainty. Where self-focus theories have received the most support in the domain of motor skill execution under pressure, it remains a possibility that a combination of the proposed theories, including distraction theory and PET could provide a more comprehensive explanation of the processes that govern choking. Therefore in order to enhance understanding of the phenomenon and provide clarity, it is necessary to initially investigate the potential interaction of the above mentioned theories utilising a qualitative methodology prior to pursuing the further aims of the thesis.

In addition, the methods proposed to alleviate choking that exist at present are somewhat limited in their appropriateness for the applied context and/or do not necessarily provide a short-term answer. Therefore, it has become apparent that there is a need for the development of new theory-matched methods (Mesagno & colleagues, 2008, 2009, 2010) that can be adopted by expert athletes who have already acquired the skills they require to perform and that can be used in accompaniment to pre-performance routines.

The literature reviewed in relation to priming methods provides an understanding of the effects that differing priming manipulations can have. Predominantly used within social and cognitive research to examine responses and judgements, priming has also been used to observe behavioural changes in relation to motor skills (e.g. Bargh et al., 1996; Bry et al., 2009; Hodgins et al., 2006; Hull et al., 2002) and has been preliminarily tested, with positive results, in relation to its efficacy in maintaining performance under pressure (Ashford & Jackson, 2010). Therefore an intervention tool that reflects what is known thus far about the underlying mechanisms of choking and embraces the concept of priming stands as a plausible method that could be adopted to alleviate self-focused attention and prevent choking. It is clear that further examination and development of such a tool warrants attention.

Based on the issues herein, and the need for logical advancement of the research area, the four experimental chapters that comprise the research programme set out to: a) further investigate the underlying mechanisms of the choking process through a qualitative inductive approach; b) examine the effects of positive and negative priming based interventions on motor skill execution and attentional processes; c) investigate the potential to refine a tool based on priming that can be used to promote fluent motor skill execution; and finally, d) to establish if such a priming based tool can be employed effectively to alleviate and/or prevent choking from occurring.

# Chapter 3

## Study 1: A Qualitative Investigation into Choking Under Pressure with Elite Swimmers

### 3.1 Introduction

'Choking under pressure' is a frequently cited term used within sport and is defined as "the occurrence of inferior performance, despite striving and incentives for superior performance" (Baumeister & Showers, 1986, p.361). Accordingly, to be considered a choke, the athlete must be motivated to achieve the goal, capable of doing so, and regard the situation as important (Beilock & Gray, 2007). Therefore, choking is not a random fluctuation in skill level, but a specific negative response to perceived pressure (Beilock & Gray, 2007). To date, experimental studies into the breakdown of skill execution under pressure have provided converging evidence implicating attention as a significant mediator of performance (e.g., Beilock & colleagues, 2001, 2002a, 2002b, & 2004, Hardy, Mullen & Martin, 2001, Masters, 1992; Masters, Polman & Hammond, 1993; Masters & Maxwell, 2008; Wulf, McNevin & Shea, 2001; Wulf, Shea, & Park, 2001; Zachary, Wulf, Mercer, & Bezodis, 2005). Two contrasting attentional theories have shown promise as theoretical frameworks for examining performance under pressure: distraction (Carver & Scheier, 1981) and self-focus (Baumeister, 1984). Interestingly, support for both theories has been provided, with most support for the distraction theory in situations that load heavily on working memory, for example, mathematical problems (e.g., Beilock, Kulp, Holt & Car, 2004; Mullen, Hardy, & Tattersall, 2005) and support for self-focus theories in high-level motor skills such as golf putting (e.g., Beilock & Carr, 2001; Gray, 2004; Hardy, et al., 1996; Jackson, Ashford & Norsworthy, 2006; Masters, 1992; Masters et al., 1993). In addition, processing efficiency theory (PET; Eysenck & Calvo, 1992), an anxiety-based hypothesis, has also been proposed as an explanatory theory, which has received support in recent years (e.g., Williams, Vickers, & Rodrigues, 2002; Wilson, Smith, & Holmes, 2007; Wilson, Smith, Chattington, Ford & Marple-Horvat, 2006). Due to a lack in consensus and equivocal results, a number of researchers have explained their results through suggesting a combination of processes based on the theories that have been proposed (Edwards, Kingston, Hardy & Gould, 2002; Lam, Maxwell, & Masters, 2009; Liao & Masters, 2002; Wilson, &

colleagues, 2007a, 2007b). The lack in clarity surrounding the underlying mechanisms that cause choking are the focus of this study.

Distraction theories (Carver & Scheier, 1981; Wine, 1971), maintain that under perceived pressure, an athlete's attentional capacity can become overloaded with task-irrelevant stimuli pertaining to the circumstances, for example worry and self-doubt (See, Beilock & Carr, 2001; Lewis & Linder, 1997; Wine, 1971). This creates cognitive overload and thus impacts the capacity of working memory, creating a situation in which there is competition for attention between performance of the skill and worry regarding the situation. Thus, choking occurs as a result of the cognitive deficit that arises when attention is diverted away from the task.

Conversely, self-focus theories (Baumeister, 1984; Carver & Scheier, 1978) maintain that under heightened pressure, an increase in self-focused attention leads an expert to attend to the step-by-step motor components of performance. Masters (1992) postulated that performance breakdown occurs due to reversal of the learning progression (see Fitts & Posner, 1967) whereby performers 'reinvest' explicit knowledge, and engage in conscious control processes characteristic of novice performers in an attempt to maintain performance. This reinvestment in explicit knowledge disrupts automatic movement control (see Masters & Maxwell, 2008 for a review). In other words, conscious control of movement execution using explicit knowledge, instead of relying on automatic control processes for execution, causes performance breakdown. This process has also been described as Master's Conscious Processing Hypothesis (e.g., Hardy, Mullen, & Jones, 1996) and the explicit monitoring hypothesis (Beilock & Carr, 2001; Lewis & Linder, 1997).

PET (see Wilson, 2008 for a review), has typically been considered as an alternative explanation to the attention-based theories. It postulates that conscious control places high demands on working memory and it is this, which may lead to performance breakdown. In summary, PET proposes that the worry experienced when under pressure consumes the working memory, this can act as a motivational function resulting in the allocation of additional effort and resources or the initiation of alternative processing strategies, thus maintaining the processing efficiency of the cognitive system and hence, performance (Eysenck & Calvo, 1992).

Alternatively, an athlete suffering from extremely high levels of anxiety may be unable to overcome such processing inefficiency, through insufficient compensatory effort, resulting in negative effects on performance effectiveness, and thus ‘choking’ (Smith, Bellamy, Collins, & Newell, 2001; Wilson, et al, 2007b).

It is unsurprising that self-focus theories have acquired most support in the sporting domain, where the use of sensorimotor and well-learned, proceduralised skills are prevalent (Beilock and colleagues 2001, 2002a, 2002b, & 2004; Gray, 2004; Gucciardi, & Dimmock, 2008; Jackson, et al., 2006); while the distraction theory has gained support in studies using tasks that place significant demands on working memory, such as mathematical tasks (e.g., Beilock & Carr, 2001; Beilock et al., 2004; Mullen, et al., 2005). However, the lack of support for distraction theories might simply be due to the skills that have been investigated and were skills requiring higher levels of cognitive control to be investigated (i.e., decision making), potentially, more support would be found. In addition, it seems logical to propose that the mechanisms do not occur in isolation, with one being responsible in the sensorimotor domain and the other in the cognitive domain where skills require an increased cognitive load. There is evidence to support the idea of a combination of the processes explained in self-focus theories, distraction theories and PET working together to moderate performance under pressure (e.g., Edwards, et al., 2002; Hardy, Mullen, & Martin, 2001; Lam, et al., 2009; Liao & Masters, 2002; Wilson, & colleagues, 2007a, 2007b).

Wilson et al (2007a; 2007b) aimed to directly examine the seemingly conflicting predictions of CPH and PET. Performance of motor skill tasks (rally driving, 2007a; golf putting, 2007b) and self-reported effort were measured in an attempt to investigate the role of mental effort in influencing the effects of pressure on performance. The results from the rally driving study revealed maintained performance across pressure conditions at the expense of processing efficiency (i.e., increased effort) as predicted by PET, however, the authors could not rule out CPH completely because the secondary tone task would have primarily prevented drivers from explicitly monitoring their driving. Results of the golf putting revealed, in line with the predictions of PET, that self-reported increases in effort appeared to compensate for the negative influence of pressure on performance in low trait anxious individuals, yet, the decline in performance despite increased effort demonstrated by high trait anxiety individuals could be explained by either CPH or PET. CPH would propose that the increased effort was focused inwards in attempt to control their putting technique leading to detrimental reinvestment, whereas PET would propose that the compensatory effort was not sufficient to overcome the deficits in working memory. Wilson et al. (2007a) concluded that it is plausible to consider controlled processing as a direct function of the amount of mental effort invested and therefore both CPH and PET in combination provide promise as theoretical frameworks for examining the process of performance under pressure. Additionally, Edwards et al., (2002) predicted that maintained performance of cognitively anxious individuals could be achieved through added compensatory effort; yet, it was acknowledged that conscious processing could be a direct function of the amount of mental effort invested. Thus, excessive mental effort could cause engagement in detrimental conscious processing subsequently leading to performance decrements. Finally, in a review of the CPH/ PET debate Lam et al. (2009) recognised that research comparing CPH and PET had used within-subject designs and had not manipulated the amount of explicit knowledge available to participants. They subsequently concluded that performance breakdown could be a result of the quantity of information processed in working memory, on-task effort, and the quality of information processed by the performer.

In an attempt to provide some further clarity, Gucciardi, Longbottom, Jackson, and Dimmock (2010) adopted a qualitative methodology of focus groups and interviews to explore the personal accounts of experienced golfers’ choking incidents. Unsurprisingly, support was established for both distraction and self-focus theories. Athlete accounts indicated that pressure coupled with higher incentives to perform well distracted their attention away from task relevant thoughts and a focus on technical cues was often adopted in order to shift attentional focus back. In addition, the importance of perceived emotional control, fear of failure and perfectionism evolved as potential mediators of choking. Gucciardi et al. concluded that choking is a complex process that involves the interplay of several cognitive, attentional, emotional and situational factors and that a combination of those theories presented could be possible.

The present study sought to address the inconclusiveness regarding an explanation for the underlying mechanisms of choking by examining the experiences of elite athletes at high-pressure competitions more closely. Experimental designs have provided valuable insight into the processes that govern performance under pressure and credible theories have been proposed and supported (e.g., reinvestment, Masters 1992; conscious processing hypothesis: Hardy, et al. 1996; explicit monitoring hypothesis: Beilock & Carr, 2001; Lewis & Linder, 1997; distraction theories: Beilock & Carr, 2001; Lewis & Linder, 1997; processing efficiency theory: Eysenck & Calvo, 1992, Williams et al., 2007a, 2007b). However, these approaches have not fully reflected the complexity of the pressure-performance relationship and few have examined the potential interaction of multiple theories as an explanation. Qualitative methodology is particularly well suited for grasping the complexity of a phenomenon (Peshkin, 1993) and can be used to acquire and examine rich information regarding the mental qualities of expert performers as well as the genuinely complex nature of how they perform (Strean, 1998). Adopting an inductive approach to qualitative methodology can allow for themes to emerge and concepts to develop (Oliver, 1998). In recognition of the multifaceted and complex nature of the processes governing performance under pressure, and the relative inconclusiveness of the research to date, several researchers have highlighted the need for more qualitative research (e.g., Gould & Krane, 1992; Gucciardi & Dimmock, 2008; Hill, Hanton, Fleming, & Matthews, 2009). Where recent qualitative studies (for example, Hill et al., 2009; Gucciardi, et al., 2010) into the choking phenomenon have provided further insight it is clear that similar studies could uncover more. Ecologically valid research into the understanding of which theory or combination of theories is most relevant to a competitors' experience when under high levels of performance pressure is warranted (Gould & Krane, 1992; Gucciardi & Dimmock, 2008; Hill et al., 2009).

It was in light of the above that semi-structured interviews were conducted in the present study. In doing so, the aim was to obtain a rich, in-depth insight into the thought process, feelings and subsequent responses athletes experience immediately prior to and during performances at high-pressure competitions. Specifically, the present study aimed to examine the experiences of elite athletes at pressure competitions in order to develop a further understanding of the interacting nature of proposed choking theories.

## 3.2 Method

### 3.2.1 Participants

Nine (5 female; 4 male) elite international swimmers aged between 16 and 28 years (*M* = 22 years; *SD* = 4.15 years) participated in the present study. The participants' competitive experience ranged from 5 to18 years (*M* = 12 years; *SD* = 3.98 years) and all had competed internationally for at least 2 years (*M* = 5.22 years; *SD* = 2.53 years).

### 3.2.2 Procedure

Having gained institutional ethical approval, the participants' coach was approached to request his athletes' involvement. Having gained verbal consent, the athletes in his charge were invited to participate in the interviewing procedure. Upon receipt of written informed consent (see Appendix A), convenient times for two interviews per athletes were arranged; they took place at the main training venue for convenience and to ensure a comfortable environment. The interviews were recorded using a dictaphone and were transcribed verbatim.

***3.2.2.1 Interview guide.*** Each participant was taken through a standardised series of open-ended questions which were designed based on key characteristics of theories within the choking related literature. Preceding the interview participants were provided with a description of the type of competitions that were considered 'high-pressure' and were informed that these were the types of competitions that they would be asked to reflect upon. The interview began with a series of familiarisation questions regarding the participant's career and their experiences of high-pressure situations in general to encourage descriptive talk (Patton, 2002). The following questions focused on thoughts, feelings, and behaviours experienced at high-pressure competitions such as national selection meets and international competitions in comparison to low-pressure competitions.  Elaboration probes and secondary questions, in-line with recommendations from Strean (1998), were incorporated in the interview guide to encourage the participants to expand on their answers and to gain an in-depth understanding of their responses. Finally, the athletes were requested to relive a recent high-pressure race in as much detail as possible, starting from entering the call-room (approximately 30 minutes prior to the race) through to the end of the race.

Following completion of the first interview, second interviews took place. The content of the second interviews varied between participants. The second interview was conducted in order to elaborate on any aspects deemed necessary by the interviewer in light of initial evaluation of the content of the first interview. For example, one athlete had difficulty describing a recent high-pressure race, therefore, during the second interview the participant was encouraged to provide deeper responses using a range of clarification, elaboration and contrast probes (Patton, 2002). In closing, an ending question (Charmaz, 1990), for example, “how have you come to deal with pressure situations after having these experiences?” was asked in order to elicit information regarding any particular coping strategies and also in an attempt to close the interview on a positive note.

***3.2.2.2 Trustworthiness.*** According to Strauss and Corbin (1998), it is necessary to declare the working knowledge of the research team involved in the study prior to data analysis. The three individuals involved in the analysis process were knowledgeable in theories and research regarding choking under pressure, with one member also having extensive experience as an elite swimmer. The prior knowledge of choking under pressure, preconceived ideas, personal experiences, and values relevant to the present research held by the researchers was likely to have informed the construction of the interview guide and influenced the subsequent data analysis (Charmaz, 1990; Rees & Hardy, 2000). Yet, as discussed by Charmaz (1990), in order to create categories from the data, the researchers must have a firm grounding in the appropriate conceptual concepts relevant to the area of investigation. Therefore, care was taken to ensure that prior knowledge would be utilised appropriately and was deemed was facilitative in informing the interview guide, interpretation of the data as well as establishing rapport and making sense of the language employed by the participants.

### 3.2.3 Data Analysis

The author transcribed all the interviews verbatim in order to immerse herself thoroughly in the data. Prior to the hierarchical content analysis (Patton, 1990), all transcripts were read numerous times in order to gain thorough familiarization of the data.

Quotations that represented the performer's thoughts, feelings and behaviours at each stage of their performance in the high-pressure competitions were extracted from the transcripts and used as raw data for the analysis. Relevant quotes were separated after transcription into two temporal categories; pre-race (approximately 30 minutes before the race through to walking onto the poolside and standing behind the block) and during race. Hierarchical content analysis was conducted using inductive reasoning in order to allow emergence of themes and concepts from the data (Sparkes, 1999). Although conducted inductively, all raw data were initially allocated to primary themes dependant on the participant's emotional orientations, which were classified as being facilitative, debilitative or neutral. The raw data were then examined for their trigger (a label for the initiation of the behaviour), behaviour (the thought/ feeling/ action that was demonstrated) and function (the specific direction of the behaviour) and placed within an overarching category of similar themes. It was thought this would ensure the data were representative of their context and that this arrangement would facilitate the examination of emergent differences between theories. The objective at that point was to ensure that the category titles were accurate and that all those raw data falling into the category reflected the category title. The constant comparison method (Strauss & Corbin, 1998) was adopted to explore the emerging categories thoroughly through identification of various patterns within each category. Similarities and difference of the demonstrated behaviour within each category were compared and contrasted. Finally, through integration and sub-division of appropriate categories, concepts were formed. This was conducted a number of times, until optimum fit was achieved and the clear meaning of each concept was represented through the data contained within it. Again, the constant comparison method was utilised for the refinement of concept labels.

***3.2.3.1 Validation.*** In an attempt to achieve validation and credibility of the data, member checks (see Lincoln & Guba, 1985) were performed in two stages: following the first interview, an idiographic profile was developed; participants read this profile and discussed it with the author enabling clarification or alterations where necessary. Following the second interview, participants were provided with a complete transcription of both interviews and instructed to make any necessary alterations that would ensure that what they said had been recorded accurately. The participants were asked to sign the transcript to validate it as an accurate record accordingly. Further, all members of the research team engaged in frequent discussions similar to that described by Scanlan, Stein, and Ravizza (1991) and were involved in the analysis. Collaborative agreement was achieved for the allocation of all raw data to themes in order to achieve consensual validation. Finally, following recommendations made by Sparkes (1998) regarding authenticity, fidelity, and believability, exemplar quotes from the interviews have been provided to enable and encourage readers to judge the trustworthiness of the data and derive conclusions for themselves (Rees & Hardy, 2000).

## 3.3 Results

The analysis revealed 233 raw data categories, which were then examined for their trigger, behaviour, and function and subsequently allocated to a central concept. In total nine central concepts evolved. Accordingly, five central concepts are presented from the pre-race timeframe: expectations, physical condition/ability, fear of failure, physiological monitoring, and attentional focus and four from the during race timeframe: attentional focus, effort, striving for perfection, and physiological awareness. Each of the central concepts is discussed in the following section using reference to sub-concepts and verbatim quotes from participants. See Table 3.1 for weight of each central concept as per number of participants providing raw data for each in a negative, positive or neutral regard.

### 3.3.1 Pre-race

The raw data associated with the time period leading up to the race, clearly indicated that a number of factors lead to a rise in cognitive anxiety. Each participant provided a number of raw data quotes that demonstrated experience of high cognitive anxiety in comparison to a regular (low-pressure) race. The following four central concepts: expectations, perceived physical condition/ability, fear of failure, physiological monitoring and attentional focus, represented triggers that caused an increase in cognitive anxiety.

***3.3.1.1 Expectations.*** In comparison to a low-pressure race, there were a vast number of references to experiencing an increased perception of pressure resulting from both internal (self-expectations) and external (expectations of others) sources, with almost every swimmer appraising the expectations as debilitative to performance. The following quote indicates the heightened pressure a participant experienced from external sources which increased the pressure he put on himself: “Maybe people are very like, “ah, I see you’re ranked second in the world, that must mean you’re going to do really well”, and all this kind of stuff and I think that added expectation from outside sources ... it was very difficult to play it down ... that made it very difficult”. Another participant discussed other external sources as a trigger for increased perceived pressure: “From other points of views there’s the pressure of national governing bodies having certain expectations, you know, it’s not just friends and family and people you know”. Another quote exemplifies the pressure coming from the self at times of high-pressure: “High pressure meets can cause you to get carried away with your own expectations”. The experience of increased, perceived pressure as a result of perceived expectations was regarded as negative to performance, the following quote supports this suggestion: “There’s been times when I’ve expected a really good performance and I’ve sat thinking about this really good performance that just didn’t happen ... maybe I had performed badly because I had been thinking about it for the last 6 hours or whatever”.

***3.3.1.2 Perceived physical condition/ability.*** It was apparent from the data that there was a tendency for the participants to make judgements regarding their own physical condition or ability, and all the raw data concerning this were provided in a negative perspective. The following quotes, from three participants, clearly exemplify such thoughts and support this: “I was just panicking going into the trials because I was thinking ‘I haven’t done enough work’, ‘I’m not in the best shape’, ‘these times are pretty hard’, stuff like that”; “I wasn’t really worried about other people in that [race]; it was just myself [capability] I was worried about”;

"Especially the longer distances I get much more worried, so I'm like, 'oh, this is an 800, how am I going to be able to do this?', 'am I going to be able to finish the race?', 'like I don't want to do this'". It was clear that the participants did not regard this as a positive thought process. Most often, it was noted that there was often no real evidence for such thoughts, and that it was purely the pressure of the situation that was causing them to question their own ability. Many of the experiences that were discussed were those related to international and Olympic finals in which they would have clearly demonstrated quite adequate ability in order to reach such an event.

***3.3.1.3 Fear of failure.*** With so much importance riding on the performances in question for the participants, they had put a great deal of work into preparation for the races. It was apparent that when the event was coming up, they realised this importance increasingly and in considering the possibilities of not doing as well as they had hoped, a fear of failure was an experience many shared and all those who felt this spoke of it from a negative perspective. The following quotes provide insight into the thoughts about fear of failure the participants expressed: "I don't know, it's like I usually have like a fear of failure almost like I see myself putting all the work in and stuff and not getting the results"; "I'll say to myself, 'Oh god, I really don't want to do this', coz I'm like so scared that I'll do bad, especially at big competitions, I have a fear of swimming bad, a fear of failure. I'm like, I don't like this feeling'. That's when I start talking to people, I'm like 'I can't be thinking like this, I've got to do something'"; "I was like so scared that I wasn't going to swim well and I ended up swimming really well. It's like, 'if I don't swim well here, what am I going to do in a couple of months time?' or 'if I don't swim well here, I'm not going to the Olympics'". One participant stated that her fear of failure lead her to consider: "'what ifs', 'what if I don't make the final?', I suppose just with regards to positioning, with regards to competitors [and] the actual outcome of the race because it's still an unknown. There are other ones like, 'what position am I going to come?', 'what if I come last?'… I have those thoughts all the time".

Letting people down and not performing well enough to receive financial support was also a concern and enhanced the fear of failure in some of the participants, for example, one participant stated: “It was just worrying, just thinking that ‘this could be the end of my swimming career because I can’t carry on if I don’t have any money’, that was a little bit of a worry”…“I thought that ‘if I don’t swim fast I might have to quit because I can’t afford to carry on’, that’s the only pressure that I’ve had but again that was put on by myself to perform, so I think it definitely comes from yourself”. Another participant stated: “Swimming is an expensive sport, you don’t get much money back so already there’s a big financial commitment, most people I know that still swim, even in their thirties; they’ve got some kind of financial backing from somebody, whether it’s parents, team or whoever and that’s a negative influence because that can never be positive because it’s only putting somebody’s invested in you therefore they’re expecting you to perform”. Having a fear of failure was regarded by the participants as negative to performance, particularly regarding the negativity of the thoughts and the increased cognitive anxiety they would experience as a result.

***3.3.1.4 Physiological monitoring.*** There was heavy reference to being more aware of physiological symptoms prior to a race perceived as high-pressure in comparisons to those of low pressure. The participants described using these symptoms as indicators of readiness (or not) and often looked for these symptoms through physiological monitoring. The raw data indicated that the result of such physiological monitoring could often leave the participants feeling lower or higher in self-efficacy. The following quotation highlights the physiological monitoring that takes place in order to search for the ‘readiness symptoms’: “I think a lot about whether I’m actually in a state where I’m actually ready to race, like in terms of warm-up and is my heart beating enough? Like a state of arousal, like, if I’m not sweating before a race then that’s when I start to have negative thoughts”. Another quote, exemplifies the cognitive anxiety that can result from the monitoring: “if I’m not getting the signals (of readiness) then I’m definitely going to be doubting my ability to perform in that race, definitely, because I know from experience that I’m not physically ready, and that, if you’re not confident in your physical readiness then, the best mind in the world will struggle to convince themselves that they’re ready if they’re not”. As well as increased physiological monitoring and awareness, there was reference to somatic anxiety at high-pressure events in comparison to those of a much lower standard. One participant expressed her physiological awareness in the following quote: "I'm quite nervous just before, like standing on the blocks I get a bit shaky, anticipation is kind of what's coming. Walking from the call room to the block I'm feeling quite tense, like do some arm swings to loosen up. I know I'm not tense and know I'm not rigid, I just feel a bit more because I'm nervous, tense a bit. I fidget quite a lot".

***3.3.1.5 Attentional focus.*** Due to the varying directions of the categories that fell under the central concept of attentional focus i.e., feeling distracted, self-focus, process oriented focus, and automaticity, they are discussed below independent of one another.

*3.3.1.5.1 Feeling distracted.* Participants referenced feeling distracted as a result of the pre-race concepts highlighted above and the resultant elevation in cognitive anxiety. This helps to explain why the concepts described above were considered as negative. One participant referred to worries when describing her feelings of distraction: "I'll have more worries at a high-pressure meet because I have more to deal with". There were also references from participants about the outcome of the race, and that this was distracting them away from facilitative thought processes, the following quotation exemplifies this: "[being] unable to shut off from thinking about different outcomes, so, and they'll replay in my mind, so there'll be an outcome where I'll win, and I'm like cheering 'yeah', and there'll be like outcomes where I might have not done well and I suppose the consequent outcomes from that outcome, it's a chain reaction after those". Another participant, described feeling distracted when they found themselves occupied with thoughts regarding expectations: "It would be really good to get something" …"Let's do this well so my mum will be proud"…"I'd say I have thought 'it would be really good to get something; good for the team', but I wouldn't dwell on it too much. It can be the case that I'm maybe day dreaming, sort of rather than helpful thoughts; you can just get a little bit carried away".

*3.3.1.5.2 Self-focus*. There were substantial references to increased self-focussed attention from all participants. The following quotes from four different participants explicitly demonstrate how they became aware of their heightened self-consciousness in the lead up to an important race. They also demonstrate that in addition to the physiological monitoring highlighted above, that self-focus, primarily in the form of self-regulation was experienced: “I guess at a bigger competition everyone’s into doing their own thing; you’re so much more focused on yourself…Just like aware of everything about me, like, what am I doing? Like, ‘oooh’, just much more self-conscious”; “I don’t really take in anything else, I’m so wrapped up in myself and how I’m going to race or whatever”; “I don’t really pay attention to anybody else to be honest”…“When there’s a lot of pressure I notice every single little thing, everything that’s wrong about me”; “They’ve started reading out the guys names so I’ll start taking my clothes off, it’s pretty much just me and my head from that point but I mean that’s only a couple of minutes worth it’s not like too tiring”. Another participant highlighted the intensity of the experience: “As soon as you arrive at the pool you start thinking about your race so from then on for two hours or whatever it might be, until your race you always analyse what’s going on and how you’re feeling”. It is evident here that the participants were engaging in self-monitoring, yet they did not cite this as being detrimental to their performance.

*3.3.1.5.3 Process oriented focus.* Several of the participants emphasised focussing on the process of the task at hand, i.e., the race and elements of the race, and this was regarded as generally facilitative to performance. The following quotes provide examples of the types of process oriented approaches the participants described: “Everything will be analysed at a bigger competition, like the race itself will be broken down to much more minute details, like, right first 50 just go out with everyone else, second 50, I usually drop off quite a lot on the second 50 so it’s like ‘don’t drop off, keep up the pace’, ‘just go out just a bit slower and then come back faster and like work, build on the race as it goes along’”; “By the time I get to the call room I’ll maybe have a little check list of things that I’m going to think about like if I’m going to be going out hard in the first 50 I’ll just remind myself of how I’m going to; my little race plan”; “Immediately prior to [the race] it’s thinking about technical elements of the race, something that I have to think about a lot”. Another participant, emphasised the importance of making the process focus, short and not to detailed: “I think about more as a kind of a brief sentence of what you’re going to do; ‘Don’t start to slow, don’t start too hard, make sure you stay relaxed, make sure you try and enjoy doing the race’, or just not all these things at once, but maybe one of these things, summarising instead of confusing myself with millions of things before". One participants' comment exemplifies how important focussing on the process prior to the race was in preparation for events that would occur during the race: "Beforehand I'll stand behind the block and I'll be like 'ok this is what I'm going to do, we're going to go out hard' and that's it, it's pretty simple"…"and because I know beforehand that's it, it's done, I don't need to think about it after that, I know what I'm going to do".

This process oriented approach adopted by the participants was often acknowledged as a coping strategy that was used to counteract the feeling of cognitive anxiety, and viewed as facilitative to performance; this is demonstrated by the following quote: "It's only when I start to get tight and worked up I'm like 'I know what I'm doing, this is what I'm doing' and then I go through it, at a high-pressure meet I'm that more tense a bit more nervous, that [means] I need to constantly reassure myself that I know what I'm doing and that's when I go through it ... I think like 'it's just a swim, you know what you're going to do', I think about my race plan and I can calm myself down quite easily doing that".

*3.3.1.5.4 Automaticity.* Contrary to the facilitative perspective the participants had of a process oriented focus of attention, evidence for a positive regard toward automatic processes of execution as also provided. One participant talked about not needing to focus on the process because: "At a high-pressure meet, there's no question of what I'm going to do". Another participant stated: "I know the races inside out, I don't, you know, I don't have to think about them and if I do think about them, then I shouldn't be because it's just a waste of energy" and "Personally, by then, there isn't a lot of thought, it's just a case of '(deep breath), alright this is it', it's more the realisation of 'right, this is now the time' rather than 'right, let's try and do this many strokes'". Another participant supported the notion of relying on a certain level of automaticity and viewed focussing too much on the elements of the performance in a negative light. She referred to a time when thinking too much about the process had led her to feel tense, she stated that now: "I'm not like getting all worked up about the things I have to remember before the race".

### 3.3.2 During Race

In the participants' discourse relating to during the performance, references relating to direction of attention was again evident. Similarly to the pre-race data, generally the participants acknowledged a heightened awareness of the process and what was required and adopted process oriented focus yet also favoured automatic processes to a certain extent. In addition increased effort and striving for perfection was evident as well as a high-level of physiological awareness.

***3.3.2.1 Attentional focus.*** Attentional focus represented the majority of raw data that the participants provided when referring to during race thoughts, feelings and behaviours. As in the pre-race results, here the categories of heightened awareness of skill execution and automaticity are discussed independent of one another.

*3.3.2.1.1 Heightened awareness of skill execution.* It was apparent that the participants indicated an attentional state of heightened awareness, i.e., that where conscious control of skill execution was implied, in a high-pressure race, due to the importance of the situation demonstrated by the following: "At the bigger meets, you think about it more … about technique or the smaller technical elements of the race that you wouldn't really think about at the smaller meets". It was evident that the participants viewed maintaining focus and concentration on skill execution and certain processes within the race as essential for optimal performance. Heightened awareness of skill execution was clearly evidenced from all of the participants and emphasis was on a number of elements, for example, technique, strategy, rhythm, and a general holistic process oriented approach. The following quotes provide examples of the types of process oriented cues the participants would use: "I have to be thinking about swimming 'forward' rather than down, instead of putting my arms down like that (gesture) but forward, thinking about 'forward, drive' or something"; "I was like, 'remember to kick underneath the water but don't like kick too hard, like really pull arms'... so that's what I focused on"; "Once I hit the water I thought about good streamline and good relaxed under water 4 kicks and start to pull in the start of the fourth kick, so fourth kick my arms goes down and starts to pull and breakout and then relax my shoulders as much as possible so they're not tense and make sure it's as fast first four strokes as possible without being hard, easy". The following quotes exemplify the rhythm focused thoughts: "So consciously I will have to think about getting into that rhythm straight away although I'm not necessarily conscious of what that rhythm is exactly" and from another participant: "Then I think about getting right back into a rhythm again of fast but still not hard, it can't be hard, if it's hard then, I know that I've had it because there's still too far to go".

*3.3.2.1.3 Automaticity.* Considerable evidence was provided to suggest that the participants not only saw engagement in conscious control as facilitative but necessary for performance, particularly in races of high-importance. That said, it was clear that the participants felt that there was a point where 'thinking too much' about elements of execution was an exercise that can be detrimental to performance. The following quotes demonstrate these views: "If I don't think about it [technique] too much then that's when I'm fastest rather than when I'm concentrating too much on little bits of the stroke; "for me in swimming breaststroke if I just get into my natural rhythm and not think about it too much … rather than when I'm concentrating too much … I can lose the overall feel of it. Another participant spoke from experience of focusing too much on elements of the race: "If I just think about a race too much, I'll just mess it up probably and that's something I've been trying to do not so often".

***3.3.2.2 Effort.*** An increase in mental effort, primarily in relation to elevating ones concentration on processes of the race was clearly emphasised by the participants, when comparing a high-pressure event with a low-pressure event. For example, the following quotes from three of the participants represent this behaviour: "I'm thinking about things so much more and I'm trying to do so much more to make myself swim faster "; "Just going into the wall thinking, 'right you're alright you're about right, just hit the wall come up and make sure you're quick'"; "Trying to work on the things that I knew were going to help me swim faster, trying not to snatch the water too much but trying to make sure that each stroke was actually moving forward not stopping me down". The outcome of such mental effort or concentration was often coupled with increased physical effort, exemplified in the following quotes from another three participants: "It's like putting more effort in, or wanting to put more effort in just to swim faster...‘ok, it’s the final, you’ve got to try harder, got to push myself a little bit more and put more effort in’”; “I think naturally that I always try harder at a more important meet”; “At the bigger meets you might push on a wee bit more or at least try to”. Another important sub-concept that arose under effort, was the recognition from the athletes that too much mental effort, can lead to an over emphasis on physical processes which in turn could be detrimental to execution: “It [being at a high-pressure meet] makes you more determined, more passionate, it’s not always a good thing, because sometimes you go right I’m having it and you totally lose like technique a little bit”.

***3.3.2.3 Striving for perfection.*** Although closely linked to effort and direction of attention, striving for perfection was a highly relevant concept discussed by the participants and was identified as being characteristic of performing at an event of high importance. In their discussion, it was clear that there was a huge emphasis placed on executing all elements of a race optimally. One participant said: “I think in a high-pressure situation I’m making even more sure that I’m doing the things perfectly” and in doing so the participants level of self-awareness was often raised: “You are definitely conscious of what you’re doing [technically] to try and perfect how you swim”. Throughout the raw data that feel under striving for perfection, none of the participants who provided data in this category stated a stance as to whether they felt this was helpful or unhelpful to their performance.

***3.3.2.4 Physiological awareness.*** There were sufficient examples to suggest that during a high-pressure race, participants engage in self-monitoring in order to gauge how they are feeling in physiological terms. For example, one participant said the following: “It’s more just the feel of going through the race that if you feel good, If you feel like this, if you feel like that, it’s all dependant on how you feel at that time”. Another participant highlighted this process: “There was a few points in there where I’ll be aware of how I’m actually feeling at that point, but sometimes there might be more or less of that than I expected, most of the time, it’s been a few times it’s happened where I get all the way to 75 meters and I just feel like I haven’t even done anything yet”. It was apparent that these processes were perceived as neutral in its effect on performance, yet one participant mentioned how physiological awareness can be both facilitative and debilitative to thought processes, she said: "'ok, crank it up a notch, start kicking more', you know like, 'make sure I'm more streamlined off the wall', like I can build on it if I feel well, but If I don't then I'm like struggling, I'm like, 'oh, I really, I think I'm struggling, aah, get your arms over' and then I start breathing more I'm like 'ooh'".

Table 3.1

*Frequency of participants citing raw data with a negative, positive, or neutral direction in each central concept.*

| Central concept | Category | Negative | Positive | Neutral |
|---|---|---|---|---|
| **Pre-Race** | | | | |
| Expectations | | 8 | 0 | 1 |
| Physical Condition/Ability | | 7 | 0 | 0 |
| Fear of Failure | | 6 | 0 | 0 |
| Physiological Monitoring | | 7 | 4 | 0 |
| | Feeling Distracted | 7 | 0 | 0 |
| Attentional Focus | Self-Focus | 2 | 1 | 3 |
| | Process-Oriented focus | 2 | 7 | 2 |
| | Automaticity | 1 | 4 | 3 |
| **During-Race** | | | | |
| Attentional Focus | Heightened Awareness | 2 | 9 | 0 |
| | Automaticity | 0 | 6 | 2 |
| Effort | | 1 | 6 | 4 |
| Striving for Perfection | | 0 | 0 | 5 |
| Physiological Awareness | | 2 | 2 | 2 |

## 3.4 Discussion

The aim of this study was to provide further insight into processes that govern choking. This was attempted by exploring the thought processes, feelings and subsequent responses athletes experience when competing at competition of perceived high-pressure.

The results support the proposition that performance under pressure involves a stress response, which is transactional in nature (Hill, et al., 2009), whereby athletes continually appraise their capability to meet the demands placed upon them within a given environment.

Specifically, evidence of a stress response was present with participant's accounts being consistent with the constituents of performance pressure (e.g., cognitive and somatic anxiety, Jones & Hardy, 1989; self-consciousness, Liao & Masters, 2002; and an increased desire to perform well, Baumeister, 1984). Participants also indicated that they maintained a continuous appraisal of the environment and their capability in the lead up to performance. In line with Hill et al (2009), it was noted that a decrement in performance, and in some cases an instance of choking, would prevail when individuals perceive themselves as unable to cope with the demands of the situations, however, if they responded with a positive appraisal of their emotional reactions, performance was likely to be maintained (Fletcher, Hanton, & Mellalieu, 2006). Results also indicated that in situations deemed to be important; an initial appraisal of incompetence could be overcome with a counteracting, cognitive restructuring strategy of attending to specific components of performance. While participants viewed the latter activity positively, it should be noted that it contradicts elements of the self-focus theories that have been developed thus far.

Overall, the results of this study provide support for a combination of distraction, PET and CPH in explaining performance under pressure (Edwards, et al., 2002; Lam, et al., 2009; Liao & Masters, 2002; Wilson, & colleagues, 2007a, 2007b). Support for distraction was found with participants providing references to feelings of distraction as a result of perceived pressure coupled with the added desire to perform optimally even when a choking experience did not occur.

PET states that an increase in effort can overcome the deficit in reduced processing capacity elicited by worry in order to maintain performance effectiveness; similar to Bawden and Maynard (2001) who reported the use of 'compensatory strategies', participants in this study provided evidence of engaging in performance oriented thought processes in an attempt to counteract the distractive thoughts. In addition, the participants provided evidence to suggest that the perceived importance and pressure of an important event elevated the emphasis they placed on perfect execution, and subsequently they invested more effort both physically and mentally in order to do so. Finally, support for CPH has been provided in that the participants clearly recognised the potential deleterious effects of focusing too much on skill execution during the performance, with many participants using examples from their own experience. These findings were again in-line with Bawden and Maynard's findings who reported that the bowlers engaged in 'conscious control' during their experience of the 'yips' and noted the importance of 'automaticity' that emerged from the bowler's recollections of good performances.

It has been considered that the seemingly contradictory predictions of PET and CPH do in fact dovetail in a complementary fashion (Hardy, et al., 1996). This study provides evidence of the two theories working mutually. It is clear that, at times, attention is directed to execution of the skill being performed, both prior to and during the performance. Not only did the participants perceive concentrating on execution of the task at hand as facilitative to performance, it was established that it occurred in situations of optimal performance. In addition, there was evidence to suggest that the added mental effort that was elicited enabled participants to overcome any reductions in processing efficiency and thus, it served to maintain performance. Therefore, it can be suggested that performance is potentially maintained through a combination of added effort and the recruitment of additional processing resources (in-line with PET), in the form of facilitative conscious control of performance execution. If this is the case, choking under pressure may result from two differing processes related to opposing levels of effort and engagement in conscious processing. In the first instance, an athlete does not increase effort enough in order to engage in appropriate conscious control. In the second instance, an athlete increases their effort expenditure to such a level that it leads to conscious processing and subsequently, performance decrements. Therefore, collectively, these findings are consistent with suggestions from Edwards et al., (2002) who proposed the notion combining PET and CPH, in that cognitively anxious performers maintain their performance through the compensatory mechanisms of effort. However their increased effort expenditure may lead to conscious processing and decrements in performance.

Consequently, the process that has been termed conscious control is actually common across good and poor performances indicating its facilitative as well as debilitative capacity. As suggested by Jackson and Beilock (2007) there are probably well-learned components of sport performance that still require a significant amount of attention and effort for optimal performance that may not be harmed when performers consciously monitor (see Jackson, et al., 2006) and attempt to control execution. It is therefore apparent that the term 'conscious control' does not allow for the different levels or modes of control that athletes operate under in order to produce an optimal performance in a particular skill (as demonstrated by the participants of the present study). Clearly, there is the need to identify the differences between the conscious control deemed to impede performance and conscious control that can aid performance. In order to address this ambiguity, we propose the notion of 'heightened awareness' to describe the control expert athletes engage in with reference to the technical and tactical elements of execution which do not disrupt, but ensure execution.

The level of heightened awareness required for optimal skill execution as well as the number of cues required to facilitate it may differ from skill to skill. The heightened awareness demonstrated by the participants varied across the board, from low-level cues related to rhythm to high levels cues related to mechanics of a breaststroke pull, for example. Some of these cues may have been more facilitative than others, however, in the context of this study it is not possible to identify whether this was the case or indeed, how many cues were required or adopted in the optimal performance situations described. The skill classification system could provide information as to the appropriate level of heightened awareness required for each skill, but due to the differing levels referenced in this study, it is impossible to hypothesise.

In light of the present findings, it is possible to comment on methods/strategies that could be successful in alleviating skill breakdown under pressure. In targeting the initial stress response, it is evident that athletes could benefit from the development and use of positive appraisals of capability. In addition, it is necessary to encourage an optimal level of heightened awareness. The use of process goals has been criticised as contradictory to the propositions of explicit monitoring theory, yet in the form of a technical, strategic, rhythmical and/or global/holistic cue (Jackson, et al., 2006), a process oriented focus would fit with the proposed notion of heightened awareness and prove beneficial. Therefore athletes can discuss with a coach and/or practitioner, cues that refer to elements of performance that are essential for optimal execution.

This study has highlighted the benefits of the examining athletes' personal experiences and perspectives to promote a more detailed understanding of particular performance contexts. More specifically, the value of qualitative research in an area dominated by experimental studies has been demonstrated allowing the multifaceted nature of choking to be explored and conclusions to be drawn about the interactive nature of the currently proposed explanatory theories.

While an invaluable step-forward has taken place with regard to understanding the processes of performing under pressure, there is a limitation that must be addressed. The study utilised retrospective accounts (Edwards et al., 2000) of high-pressure performances; recollections of events become degraded and distorted over time and thus, caution must be taken when basing inferences on such accounts. However, retrospective accounts, when unbiased and undiscerning, can provide valuable information thus, the study made every attempt to confirm the reliability of accounts using follow-up interviews and member-checks. Future research could aspire to collect immediate recollections of instances in which suboptimal performance and choking have been experienced in order to obtain most accurate information and validate the inferences from this study.

In conclusion, independent support for both PET and CPH has been demonstrated through the results of this study, yet overall, the findings support the notion that PET and CPH work interactively. In summary, increased effort through a heightened awareness of tactical, technical and strategic elements of performance is likely to overcome the negative effects that anxiety and worry can have, while too much effort can result in detrimental conscious control. The extent to which each theory plays a role in the process is most likely to be dependent on the type of skill being performed, yet this requires further examination. It is apparent that further research of a similar nature to the present study regarding choking experiences over a range of different performance domains is necessary in order to further facilitate understanding of the phenomenon and the complex attentional processes that are at play.

# Chapter 4

## Study 2: The Efficacy of Priming to Promote Fluent Motor Skill Execution

### 4.1 Introduction

Research into the breakdown of skill execution under pressure (commonly referred to as choking, see Baumeister, 1984) has provided converging evidence identifying focus of attention as a significant mediator of performance (e.g., Beilock & colleagues, 2001, 2002a, 2002b, & 2004, Hardy, Mullen & Martin, 2001, Masters & Maxwell, 2008; Wulf, McNevin & Shea, 2001; Zachry, Wulf, Mercer & Bezodis, 2005). The notion that conscious control of skill execution, emanating from the desire to maintain performance under pressure, can lead to performance decrements is well supported (e.g., Beilock, Carr, MacMahon, & Starkes, 2002a; Beilock & Carr, 2001; Hardy, Mullen, & Jones, 1996; Jackson, Ashford, & Norsworthy, 2006; Masters, 1992; Masters & Maxwell, 2004; Gray, 2004). Although performance decrements resulting from skill-focused attention have been widely demonstrated, there are limitations associated with methods proposed to alleviate skill failure under pressure. The use of secondary tasks to prevent reinvestment (Lewis & Linder, 1997) and adopting methods that promote implicit motor learning (Masters, 1992) have proved effective in maintaining performance under heightened pressure in sport and medical domains (Masters, Lo, Maxwell, & Patil, 2008) and under physical fatigue as well as psychological stress (Masters, Poolton & Maxwell, 2008). Nonetheless, the extent to which these methods can readily be applied has been questioned; for example, it may be impractical to use audible or visual prompts in a competitive environment. With respect to modifying instruction protocols, there are issues with preventing learners from accumulating explicit knowledge over extended periods, although using visual analogies or 'biomechanical metaphors' may offer an alternative in this regard (Liao & Masters, 2001). At present, it remains a challenge for researchers and practitioners to provide practical solutions that aid performers either by suppressing the tendency to reinvest explicit knowledge or by promoting desirable characteristics of automaticity, such as fluent, effortless performance.

### 4.1.1 Priming

The term ‘priming’ is used to describe “the influence a stimulus has on subsequent performance of the processing system” (Baddeley, 1997, p. 352). Through the activation of specific contexts, traits, stereotypes, goals and related constructs, priming is hypothesised to stimulate the representations of behaviours that influence a general behavioural change in line with those representations (Bargh, Chen, & Burrows, 1996; Chen, & Bargh, 1997; Dijksterhuis & Van Knippenberg, 1998). The mere awareness or perception of a behaviour is sufficient to activate the corresponding motor representations (Dijksterhuis, Chatrand, & Aarts, 2007; Grezes & Decety, 2001; Jeannerod, 1999; Perani, Cappa, Schnur, Tettamanti, Collina, Rosa, & Fazio, 1999) resulting in changed perception, evaluations, motivations and/or social behaviour (Wheeler, DeMarree, & Petty, 2007).

The few studies reporting priming effects in motor behaviour predominantly concern walking speeds, for example, Aarts and Dijksterhuis (2002) primed participants with words associated with fast animals (cheetah, antelope) or slow animals (snail, turtle) and found that participants subsequently walked faster or slower, respectively. Bargh et al., (1996) and Hausdorff, Levy, and Wei (1999) reported that priming participants with an elderly stereotype resulted in slower walking in both elderly and young college students. Finally, MaCrae, et al., (1998) demonstrated that priming participants with the notion of a world champion racing driver resulted in faster walking. In addition to walking speed, a limited number of studies have reported other motor behaviour modifications resulting from priming. In relation to overall performance of a sport skill, Stone, Lynch, Sjomeling, and Darley (1999) reported decrements in golfing performance in response to activation of a racial stereotype prime, while faster relay change-over times in beginner athletes through cooperation priming have been reported (Bry, Meyer, Oberlé, & Gherson, 2009). Although the latter study can be questioned as performance improvement could have been due to the improvement of novices rather than effects of the prime.

### 4.1.2 Priming to Promote Fluent Motor Skill Execution

Recently, it has been suggested that priming could promote automatic motor skill execution through preventing detrimental skill-focused attention. Ashford and Jackson (2010) investigated the effect of priming in a group of skilled field hockey players performing a dribbling task under low- and -high pressure. In two experiments, a positive prime based on words relating to automaticity resulted in significantly faster and / or more accurate performance than that attained under control (Studies 1 & 2) and negative or neutral prime (Study 2) conditions. Conversely, the negative prime resulted in significantly slower performance than the neutral prime. Ashford and Jackson interpreted their results by appealing to attentional mediators of performance. In particular, they suggested that, in-line with self focus theories (e.g., Baumeister, 1985; Masters, 1992), the positive and negative primes may have successfully directed attention away from and towards the mechanics of movement execution, respectively. This conclusion is plausible but cannot be confirmed without measuring changes in attentional processes resulting from priming. Ashford and Jackson's study therefore provides support for the efficacy of priming in motor skills performed under pressure; however, further research regarding the effects of priming on attentional processes is warranted.

### 4.1.3 The Retention of Primed Behaviours

A number of studies indicate that behavioural effects stemming from cognitive priming are strongest immediately following exposure (Bargh & Gollwitzer, 1994; Bargh, 1997) and significantly attenuate after 4 to 5 minutes (e.g., Bargh, Lombardi, & Higgins, 1988; Higgins, Bargh, & Lombardi, 1985; Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001). Bargh et al., (2001) explored this attenuation by priming individuals with high-performance goal-related stimuli, through a word-search task. In a subsequent impression formation task, primed participants considered a target person to be a higher achiever than did control participants. The impression formation task was repeated five minutes after exposure whereupon the behavioural effect had significantly reduced. Unfortunately, no baseline measure of impression formation was taken prior to exposure to the prime; therefore, it is hard to conclude whether the primed behaviour had in fact completely diminished.

In contrast, Merikle and Daneman (1998) have suggested that the impact of unconsciously perceived information can last for 24 hours, and that the effects may last considerably longer if the information is personally relevant. For example, Nelson and Norton (2005) found that participants demonstrated an increased willingness to do volunteer work three months after priming the category ‘superhero’ (participants were requested to list ten traits of superheroes). One possibility, raised by Bargh et al. (2005), is that effects exceeding the 4 to 5 minute timeframe result indirectly from psychological mediators rather than directly from the priming intervention, for example, increased willingness to volunteer (Nelson & Norton, 2005) may have been mediated by the satisfaction gained through the act of helping in the first instance. With relatively limited evidence, more work is required to investigate the retention of primed behaviours, particularly in relation to those of a motor skill nature given the varying nature and duration of sporting skills and events.

#### 4.1.4 The Present Study

The present study addressed three specific aims in investigating the efficacy of priming as a means of modifying motor behaviour. First, we aimed to replicate the findings of Ashford and Jackson (2010), who reported content-related changes to motor performance following fluency priming and skill-focus priming interventions. Our second aim was to investigate the attentional demands associated with motor performance under the different conditions. In movement-related research, probe-reaction time (P-RT) tasks have been used to assess the ‘mental workload’ imposed on the performer by any particular set of task conditions (Abernethy, 1988). P-RT task performance is considered to be a reflection of residual processing capacity, with performance being proportional to the size of the remaining ‘free’ attentional space (Wulf et al., 2001). Faster responses to the secondary P-RT task are interpreted to indicate that less on-line attention was utilised for primary task performance. In the present study, inclusion of the P-RT task allowed for assessment of the relative automaticity of motor skill execution as a function of the priming conditions.

Based on the premise that the priming interventions promote or disrupt automatic motor processes through reducing or increasing conscious control, we hypothesised that the fluency-based prime would yield faster P-RTs than the skill-focus prime, neutral prime and a no-prime control. Accordingly, we hypothesised that the skill-focus prime would yield slower P-RT's than the fluency prime, neutral prime and control conditions. In light of the equivocal findings from research on the retention period of primed behaviours and owing to varying lengths of sport competitions (i.e., 2 x 45 minutes for a football match; 4 x 12 minutes for a basketball game; 4 -5 hrs for a round of golf), our third aim was to investigate retention of any priming effects over a 30-minute and one-hour period. These periods were chosen in considering the potential for using priming as a method for promoting fluency and alleviating skill breakdown under pressure in sport tasks. We hypothesised that priming effects would be retained over one hour but would gradually dissipate such that they would be greater after 30 minutes than after one hour.

## 4.2 Method

### 4.2.1 Participants

Having gained institutional ethical approval, 24 skilled male soccer players, aged between 18 and 21 years ($M$ = 19.2; $SD$ = 0.9), provided informed consent to participate (see Appendix A). Participants were members of a university first and second team, currently competing in university league matches and reported a mean of 12.8 years ($SD$ = 2.9 years) of involvement in organised, competitive soccer.

### 4.2.2 Apparatus and Task

The primary task required participants to dribble a standard size soccer ball in and out of a series of six cones spaced at 1.5 m intervals using the in-step and out-step of their dominant foot (Beilock et al., 2002; Jackson et al., 2006). Participants were instructed to complete the trials as quickly and accurately as possible and were informed that task completion time and the accuracy of their dribbling would be recorded on each trial. Newtest Power Timer 1.0 photoelectric cells were placed at the start and finish to record trial completion time to the nearest millisecond. As a measure of consistency of dribbling around the cones, lateral displacement of the ball from the midline of the course was measured using a reference grid marked on the floor. A digital video camera (Panasonic NVDS65B) hidden from view, was used to record each trial. Subsequently, a mean lateral displacement score for each condition was calculated using the recordings.

P-RT was assessed using a technique similar to that of Gray (2004). In addition to the primary task, participants were instructed to respond as quickly and as accurately as possible to an auditory stimulus of 80 ms duration. The tone was either 250 Hz or 500 Hz and participants identified it as “low” or “high”, respectively. Tone frequency was randomly assigned in each trial and presented, again randomly, at either one, two, three, or four seconds into the trial. Sound was recorded by an Olympus digital voice recorder (model DS-50); reaction time and response accuracy were subsequently determined from a visual representation of the amplitude and frequency of the tone and vocal response using Wavelab 6.1.1.

**4.2.3 Conditions**

All three priming conditions (fluency, skill-focus, and neutral) took the form of a scrambled sentence task (Bargh et al., 1996; Hull, Stone, Meteyer, & Matthews, 2002; Srull & Wyer, 1979). The scrambled sentence priming task comprised 30 items, each consisting of five words presented in a random order. Participants were instructed to use four of the five words to form a grammatically correct sentence. The target words in the priming conditions were a slightly modified version of those used by Ashford and Jackson (2010),

***4.2.3.1 Fluency prime.*** The target words in the fluency prime condition were based on literature relating to the concepts of automaticity, optimal performance, and flow; for example, ‘movements seemed to flow’ (presented as: ‘movements very flow to seemed’) (for a full list of items see Appendix B). The items were assessed for face-validity by two experts in the field of choking.

***4.2.3.2 Skill-focused prime.*** The target words in the skill-focused prime condition were drawn from research on attentional focus and conscious control and directed the performer to the execution of the skill; for example, ‘concerned about my technique’ (presented as: ‘concerned the technique my about’) (for a full list of items see Appendix C). The items were assessed for face-validity by the same two experts as above.

***4.2.3.3 Neutral prime.*** The aim of the neutral prime condition was to prime neither fluency nor skill-focus, therefore, target words had no relation to performance; for example, 'chickens can lay eggs' (presented as: 'lay can chickens some eggs') (for a full list of items see Appendix D). The items were assessed for face-validity by the same two experts as above.

***4.2.3.4 Control.*** In the control condition, participants were simply instructed to "complete the dribbling task as quickly and accurately as possible and, secondly, respond to the auditory stimulus as quickly and accurately as possible".

**4.2.4 Procedure**

A repeated measures design was employed and conditions were counterbalanced. Prior to the test trials, participants performed 10 familiarisation trials. A total of six blocks (priming n = 3; control (no-prime) n = 1; retention n = 2) of five test trials followed. During four of the five trials in each block, a single auditory stimulus was presented. Prior to commencing each of the three blocks of priming trials, participants completed a scrambled sentence task appropriate to the particular condition. In line with Hull et al. (2002), participants were advised that this grammatical task was part of an unrelated research project and were asked if they could complete it during their rest period. After each block of trials, participants were given a short rest period during which they were requested to repeat aloud the five times table backwards to engage working memory and prevent rumination concerning previous performance.

Each participant completed the first retention block of trials (R1) after a 30 minute break and the second retention block of trials (R2) after an additional 30 minute break. During these breaks, the participant was asked not to discuss the study with anyone and to refrain from soccer dribbling. Upon completion of the experiment, each participant was informed of the camera presence to record ball displacement and asked for their consent to use the video footage for this purpose. All participants agreed. Finally, each participant was thanked for their time/participation, debriefed about the nature and purpose of the study and requested not to discuss the details of the study with other potential participants.

**4.2.5 Data Analysis**

Prior to analysis, all data were screened for outliers using standardized scores ($Z \pm 3.29$) and Mahalanobis' distance test. In order to explore any potential interactions and main effects that were not predicted by the *a priori* hypothesis, one-way repeated measures ANOVAs with bonferroni adjustments were conducted for the performance data from the first four blocks of trials; mean task completion time, mean lateral displacement score and mean P-RT served as the dependent variables. Planned contrasts were then conducted in order to test the *a priori* hypothesised differences between prime conditions. To compare the completion time of trials with and without the P-RT task, a 2 (with/without P-RT) x 4 (prime condition) repeated measures ANOVA was conducted.

To analyse the retention data, participants were grouped according to the last condition they completed. Since it had been predicted that the prime effects would start to wear off immediately, and for the sake of increasing statistical power, the participants were divided in to two groups of 12, a control group and an experimental prime group. The control group was formed by amalgamating the participants who completed the neutral prime condition last with those who completed the control condition last. The participants who completed the fluency prime condition last were grouped with those who completed the skill focus condition last to form an experimental prime group. Scores were then rebased for each participant using scores from the control condition in order to factor out potential individual group differences. In order to synchronise the data between those who completed the fluency prime last and those who completed the skill-focus prime condition last, the scores for the participants who completed the skill focus condition last were reversed. Finally, in order to explore any potential interactions and main effects that were not accounted for by the *a priori* hypothesis, one-way repeated measures ANOVAs were conducted for each of the dependent variables (completion time, PRT and displacement). The performance data recorded for condition 4 represented a baseline measure of the primed behaviour for each condition. Planned contrasts were then conducted in order to test the *a priori* hypothesised differences over the three time points.

## 4.3 Results

### 4.3.1 Data Screening

Data screening revealed no univariate or multivariate outliers.

### 4.3.2 Initial Effects of Prime

***4.3.2.1 Task completion time.*** A repeated measures one-way ANOVA for task completion time revealed a significant main effect of priming condition, $F$ (2, 41) = 22.02, $p <$ .001, $\eta_p^2$ = .49 (see Figure 4.1). Planned contrasts revealed task completion time to be significantly faster in the fluency prime condition than the skill-focus prime, $F$ (1, 23) = 77.61, $p <$ .001, $\eta_p^2$ = .77, neutral prime, $F$ (1, 23) = 29.80, $p <$ .001, $\eta_p^2$ = .56, and control, $F$ (1, 23) = 5.95, $p <$ .05, $\eta_p^2$ = .21, conditions. Additionally, task completion time in the skill-focused prime condition was significantly slower than in the neutral prime, $F$ (1, 23) = 38.76, $p <$ .001, $\eta_p^2$ = .63, and control conditions, $F$ (1, 23) = 28.31, $p <$ .0.001, $\eta_p^2$ = .55. As expected, there was a non-significant difference between the neutral prime and control conditions, $F$ (1, 23) = .020, $p >$ .05, $\eta_p^2$ = .001 (see Figure 4.1 for graphical representation).

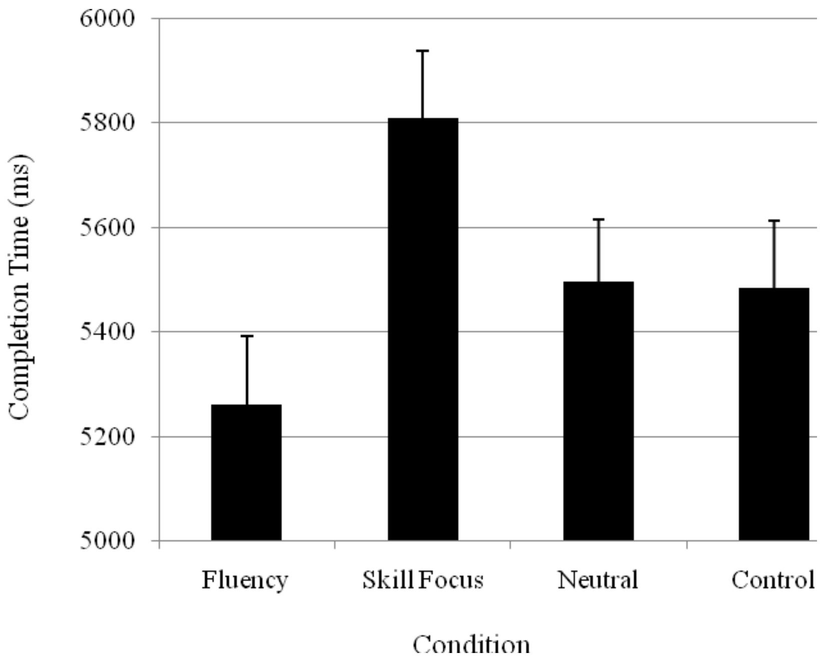


*Figure 4.1.* Mean (± SE) trial completion time under the priming and control conditions.

***4.3.2.2 Lateral Displacement.*** A repeated measures one-way ANOVA for lateral displacement revealed a non-significant main effect of prime condition, $F$ (3, 69) = 1.17, $p$ > .05, $\eta_p^2$ = .05 (see Figure 4.2). Planned contrasts revealed no significant differences between any of the conditions. The results of the planned contrasts are as follows: between the fluency prime and neutral prime, $F$ (1, 23) = .08, $p$ = .78, $\eta_p^2$ = .004, the fluency prime and the control, $F$ (1, 23) = 1.38, $p$ = .25, $\eta_p^2$ = .06, the fluency prime and the skill-focus prime, $F$ (1, 23) = .66, $p$ = .42, $\eta_p^2$ = .0, the skill focus prime and the neutral prime, $F$ (1, 23) = .3.69, $p$ = .07, $\eta_p^2$ = .14, the skill-focus prime and the control, $F$ (1, 23) = 1.6, $p$ = .69, $\eta_p^2$ = .007, and finally the neutral prime and the control, $F$ (1, 23) = 2.82, $p$ = .11, $\eta_p^2$ = .11(see Figure 4.2 for graphical representation).

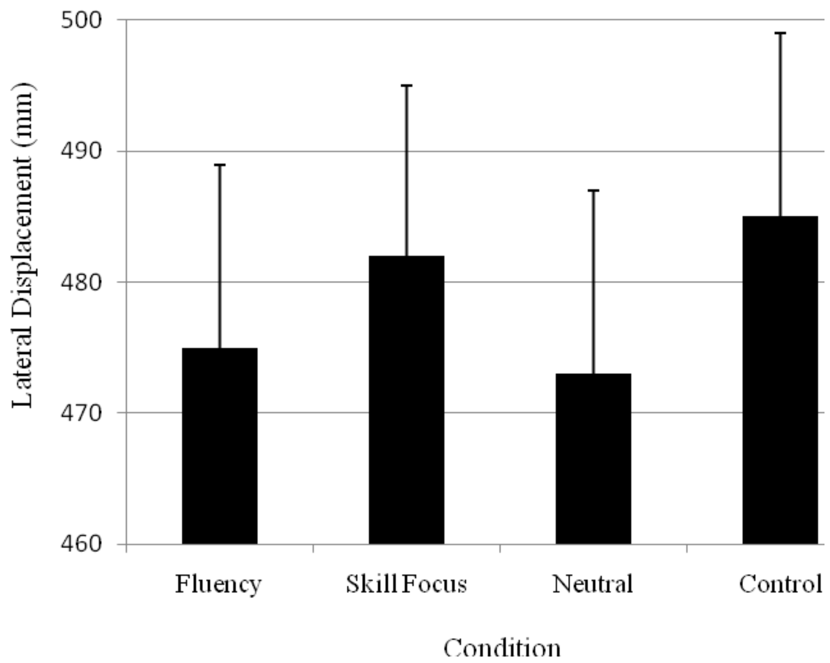


*Figure 4.2.* Mean (± SE) lateral displacement under the priming and control conditions.

***4.3.2.3 P-RT.*** A repeated measures one-way ANOVA for P-RT revealed a significant main effect of prime condition, $F$ (2, 46) = 5.64, $p$ < .01, $\eta_p^2$ = .20 (see Figure 4.3). Planned contrasts revealed P-RT to be significantly faster in the fluency prime condition than in the skill-focus prime condition, $F$ (1, 23) = 10.50, $p < .05$, $\eta_p^2 = .31$, neutral prime condition, $F$ (1, 23) = 7.66, $p < .005$, $\eta_p^2 = .25$, and control condition, $F$ (1, 23) = 5.25, $p < .01$, $\eta_p^2 = .19$. Additionally, P-RT in the skill-focus prime condition was significantly slower than in the neutral prime, $F$ (1, 23) = 3.94, $p = .05$, $\eta_p^2 = .15$, and control prime conditions, $F$ (1, 23) = 4.51, $p < .05$, $\eta_p^2 = .16$. There was no significant difference in P-RT between the neutral prime and control conditions, $F$ (1, 23) = .13, $p > .05$, $\eta_p^2 = .01$ (see figure 4.3 for graphical representation).

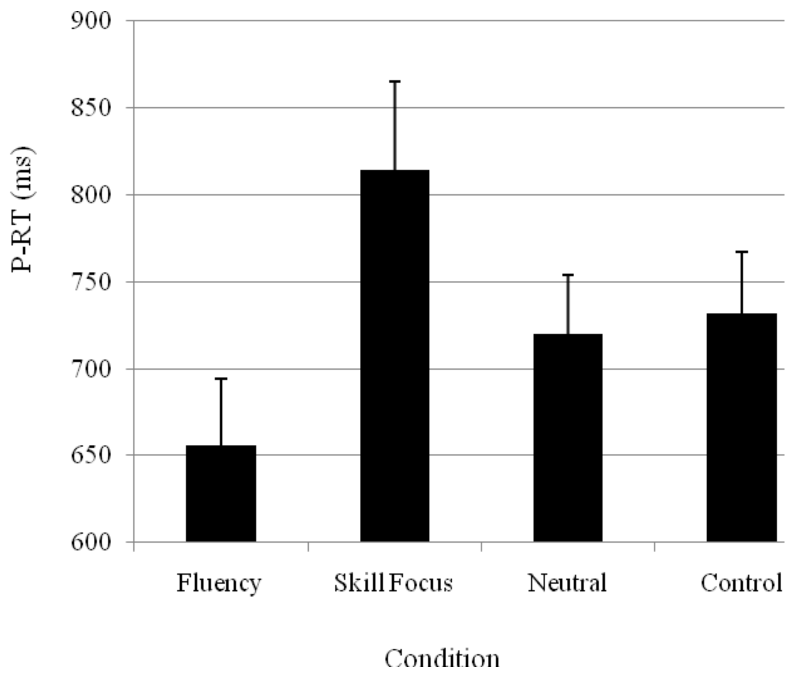


*Figure 4.3.* Mean (± SE) probe-reaction time (P-RT) under the priming and control conditions.

***4.3.2.4 Completion time for trials with P-RT task vs. trials without P-RT task.*** A 2 (with P-RT task/without P-RT task) x 4 (fluency/skill-focus/neutral/control) repeated measures ANOVA revealed a non-significant main effect for P-RT, $F$ (1, 23) = .06, $p > .05$, $\eta_p^2 = .003$, and a non-significant P-RT x condition interaction, $F$ (3, 69) = 1.39, p > .05, $\eta_p^2 = .06$, indicating that completion time was not affected by completion of the secondary P-RT task in any of the conditions.

### 4.3.3 Retention of Primed Behaviours

***4.3.3.1 Task completion time.*** A 2 (condition: experimental prime/control) x 3(time: baseline/R1/R2) repeated measures ANOVA revealed a non-significant main effect for time, $F$ (2, 44) = .34, $p$ > .05, $\eta_p^2$ = .02, a non-significant main effect for condition, $F$ (1, 22) = .63, $p$ > .05, $\eta_p^2$ = .02, and a non-significant time x condition interaction, $F$ (2, 44) = 1.05, $p$ > .05, $\eta_p^2$ =.05 (see Figure 4.4 for graphical representation). These results indicate that the effect of the prime on dribbling completion time was maintained throughout the duration of the experiment.

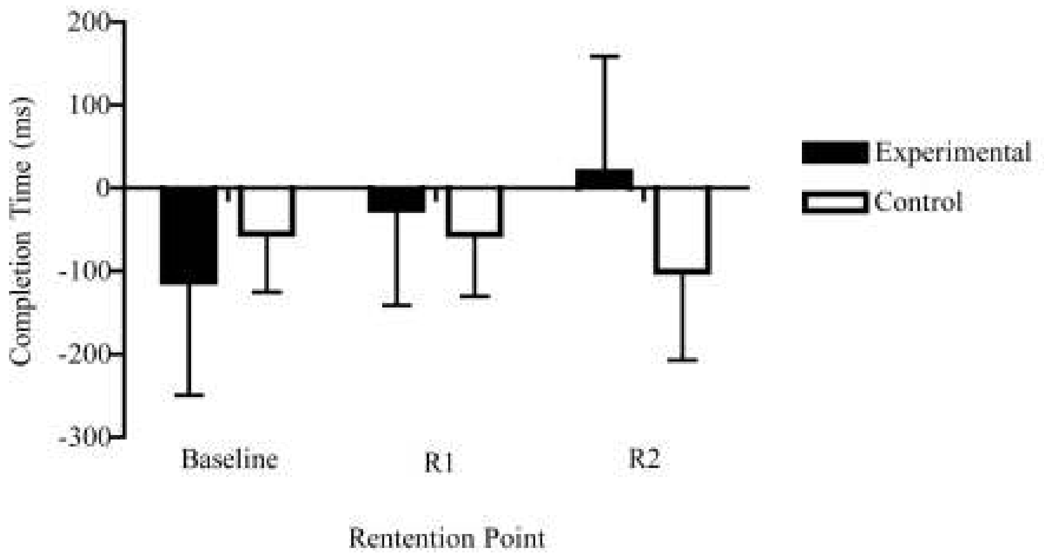


*Figure 4.4*. Mean (± SE) trial completion time under experimental prime and control conditions across retention period. *Note:* In-line with section 4.2.5 negative means occurred as a result of the manipulation imposed on the data in order to conduct the analysis.

***4.3.3.2 Lateral displacement.*** A 2 (condition: experimental prime/control) x 3 (time: baseline/R1/R2) repeated measures ANOVA revealed a non-significant main effect for time, $F$ (1.38, 30.42) = 3.87, $p$ > .05, $\eta_p^2$ = .15, a non-significant main effect for condition $F$ (1, 22) = 1.28 $p$ > .05, $\eta_p^2$ = .06, and a non-significant time x condition interaction, $F$ (1.38, 30.42) = .50, $p$ >.05, $\eta_p^2$ = .02. These results indicate that there was no change in performance in relation to lateral displacement across time.

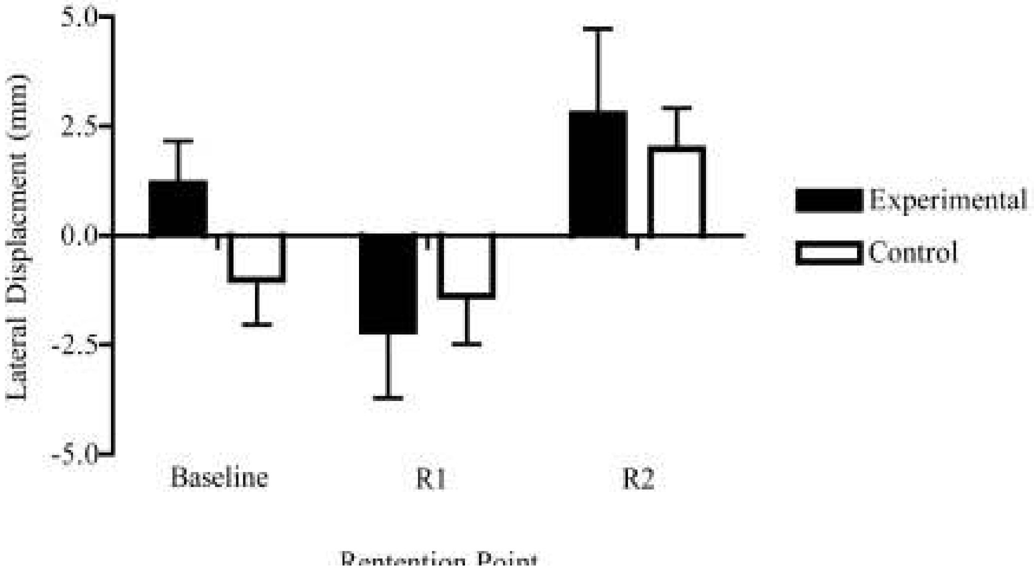


*Figure 4.5*. Mean (± SE) lateral displacement under experimental prime and control conditions across retention period. *Note:* In-line with section 4.2.5, negative means occurred as a result of the manipulation imposed on the data in order to conduct the analysis.

***4.3.3.3 P-RT.*** A 2 (condition: experimental prime/control) x 3 (time: baseline/R1/R2) repeated measures ANOVA revealed a significant main effect for time $F$ (2, 44) = 3.47, $p < .05$, $\eta_p^2 = .14$, a non-significant main effect for condition $F$ (1, 22) = 2.70, p > .05, $\eta_p^2 = .11$, and a non-significant time x condition interaction, $F$ (2, 44) = 1.81, $p = .78$, $\eta_p^2 = .08$.

One way ANOVAs for the experimental condition and the control condition over the three time periods (baseline, 30 minutes and one hour) were conducted to explore the *a priori* hypotheses. Results revealed a significant difference for the experimental prime group, $F$ (2, 22) = 6.23, $p = .007$, $\eta_p^2 = .36$, but not the control group, $F$ (2, 22) = .14, $p = .87$, $\eta_p^2 = .01$. Planned contrasts for the prime group revealed a significant increase in P-RT between baseline and 1 hour, $F$ (1, 11) = 15.36, $p = .002$, $\eta_p^2 = .58$, but not between baseline and 30 minutes, $F$ (1, 11) = 3.03, $p = .11$, $\eta_p^2 = .22$, and time 30 minutes and 1 hour, $F$ (1, 11) = 2.65, $p = .13$, $\eta_p^2 = .19$. These results indicate that the primed effects on P-RT had worn off significantly over the duration of the retention period.

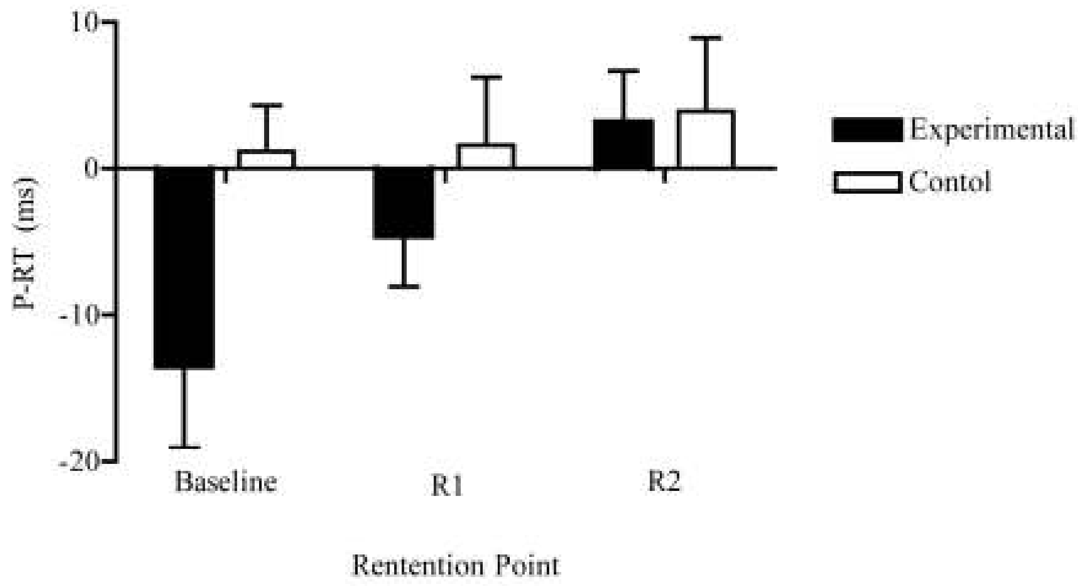


*Figure 4.6*. Mean (± SE) probe-reaction time (P-RT) under experimental prime and control conditions across retention period. *Note:* In-line with section 4.2.5, negative means occurred as a result of the manipulation imposed on the data in order to conduct the analysis.

**4.4 Discussion**

The aim of the present study was to further evaluate the efficacy of priming to promote fluent, automatic execution of a proceduralised motor skill. Specifically, speed and accuracy of the execution of a dribbling task were observed in order to investigate the efficacy of priming to manipulate motor skill performance. In addition, a secondary P-RT task was used to measure attentional processes during primary task performance. Finally, the retention of priming effects was measured over a period of 30 minutes and one hour.

Researchers have reported that, for skilled athletes performing a self-paced, discrete or serial skill, a skill-focused direction of attention in the form of attending to components of the skill is often detrimental to overall performance (e.g., Beilock et al, 2002a, Jackson et al, 2006; Maxwell, Masters, & Eves, 2000). In an investigation of hitting kinematics of baseball players, Gray (2004) concluded that sequencing and timing are affected by attentional processes when an individual is placed under pressure. In addition, greater spare attentional capacity to perform a secondary task has been demonstrated as a characteristic of automatic and optimal execution of a primary motor task in expert performers (Abernethy, 1988). Recent research examining the effectiveness of priming in motor skills has been successful in both enhancing and deteriorating performance, potentially through influencing attentional processes (Ashford & Jackson, 2010). Therefore, in the present study, it was anticipated that the fluency prime would result in less online attention directed to skill execution and subsequently, faster P-RT performance and faster, more fluent, dribbling performance would be demonstrated in comparison to the skill-focus prime, the neutral prime and the no-prime control. Conversely, we expected the skill-focus prime to work in opposition to that of the fluency prime. Specifically, the skill-focus prime was proposed to direct attention to skill execution, thus increasing attentional demands and resulting in slower P-RT and slower, skill execution. In addition, we anticipated any priming effect to decline immediately after initial demonstration of such behaviours.

**4.4.1 Motor Skill Execution**

The speed with which the dribbling task was performed was consistent with the results reported by Ashford and Jackson (2010) and Beilock and Carr (2001) and confirmed our hypotheses. In particular, in-line with self-focus theories, the fluency prime resulted in significantly faster performance in comparison to the skill-focus prime, neutral prime and control conditions while the skill-focus prime resulted in slower performance than the neutral prime and control conditions.

The changes in performance speed were not the result of a trade-off with accuracy: non-significant differences in lateral displacement were evident across conditions. This finding differs slightly from the results of Ashford and Jackson (2010) who found that both performance speed and accuracy were affected. Of course, it remains possible that other elements of movement execution were affected such as movement fluency (Beilock & Carr, 2001, Collins, Jones, Fairweather, Doolan, & Priestly, 2001, see Gray, 2004, as mentioned above). Alternatively, it is possible that the displacement measure adopted in this study was not sensitive to those variations in execution that have been identified as susceptible to change as a function of attentional control. One way to assess this would be to analyse elements of the movement kinematics associated with performance under different priming (cf., Gray, 2004; Pijpers et al., 2005).

### 4.4.2 Attentional Processes

Examination of the P-RT task data revealed significant effects of the fluency and skill-focus primes on attentional processes. As predicted, the fluency prime resulted in significantly faster P-RT task performance than the skill-focus prime, neutral prime and control conditions, consistent with attention being directed away from the mechanics of skill execution. According to Abernethy (1988), these results can be interpreted to indicate that less on-line attention was utilised for performance of the dribbling task. Therefore, we can infer that the fluency prime was successful in promoting more automatic control processes concerned with execution of the dribbling task. Also, as predicted, the skill-focus prime resulted in significantly slower performance in the P-RT task than the fluency prime, neutral prime and control conditions, indicating that on-line attentional capacity was utilised to a greater extent. Therefore, it is possible to infer that attention was directed to execution of the skill and that conscious processing was promoted (Abernethy, 1988).

### 4.4.3 Behavioural Effects of the Primes

The results suggest that the fluency and skill-focus primes modified motor behaviour via changes in the degree of on-line attention control or explicit monitoring of the step-by-step processes governing skill execution. Modifying behaviour through priming is reliant on a relation, or contextual overlap (Bruce, Carson, Burton, & Ellis, 2000) between the prime and the self-concept of the individual. This relation leads to a subconscious comparison process that brings about a change in behaviour modification (Hull et al., 2002). The skill-focus and fluency primes were developed to have the necessary qualities to cause those processes mentioned above. Conversely, the neutral prime bore no relation to the context of the desired change in behaviour. The positive and negative effects on performance observed from the fluency and skill-focus primes respectively in addition to the lack of change in behaviour in the neutral condition, confirms the effectiveness of the prime itself in causing the change in behaviour and not the mere completion of a cognitive task prior to dribbling. Ultimately, considering the combination of results concerning the speed of dribbling performance and the P-RT task performance, it is clear that the priming method adopted herein was effective in priming motor skill behaviour, through manipulating the attentional processes associated with performance.

**4.4.4 Retention of the Primed Behaviours**

The non-significant differences in dribbling completion time over the period of retention observation suggest that priming remained effective on motor skill behaviour up to one hour after initial exposure to the prime. These results are contrary to the research that has generally demonstrated priming effects to have completely diminished after several minutes in the absence of reactivation (see Bargh et al., 1988; Bargh et al., 2001; Higgins et al., 1985). Despite most priming research observing an immediate reduction in primed effects, there are examples of priming effects lasting up to twenty-four hours (e.g., Nelson & Norton, 2005), although it has been suggested that these effects are most likely due to other psychological mediators (e.g., Bargh et al., 2005).

In this study, the players were not made aware of their performance results, therefore it is possible that the prolonged behavioural effects were a direct result of the prime rather than the influence of other psychological mediators. Hull et al (2002) have found that people are more sensitive to self-relevant primes, and that the effects of self-relevant primes are sometimes easier to obtain and would therefore be retained for longer. The players used in this study were likely to possess a strong identity with football and so it is likely that the primes used were highly self-relevant to the participants, which could explain the seemingly longer retention period of the priming effect.

Alternatively, a cognitive mediator, in the form of internal feedback, may have been influential in maintaining the primed behaviours. To consider this, it is necessary to refer to the two original groups that were amalgamated to form the experimental prime condition in order to examine retention: fluency prime group and skill focus prime group. A potential explanation involving internal feedback would mean slightly differing processes acting to maintain the differing primed effects. The maintenance of good performance of the fluency prime group could have been due to participants gaining satisfaction through internal feedback regarding the positive change in their performance. This in turn could have lead to stronger goal-directed behaviour that helped maintain performance. As already discussed in relation to the initial behavioural effects of the prime, it is likely that the participants in the skill-focus prime group were already engaging in detrimental conscious control of skill execution. Therefore, it is possible that the maintained negative performance over time could have been a result of added effort in response to internal feedback indicating performance had declined. This added effort may have maintained engagement in conscious control in the attempt to improve performance but paradoxically, and in line with self-focus theories, it was actually detrimental.

In order to explore this suggestion further, the groups were separated back into the four original conditions and mean data trends over time were examined. It is worthy to note here that there was a slight declining trend in performance over time, from baseline to one hour, revealed by the fluency group (5550 ms – 5620 ms), and a slightly more obvious improvement revealed by the skill-focus group (5961 ms – 5704 ms). Although not a strong enough change to infer that the effects of the primes were diminishing, it would be interesting to explore whether over a longer period of time, that this might have been the case.

The non-significant interaction between the experimental prime group and the control group is somewhat problematic as it suggests that both groups were getting slower in P-RT no matter if they were primed or not. A possible explanation for this could be that the participants were experiencing fatigue or monotony, although it cannot be said for certain. Potentially using a larger sample size, and/or adopting a matched-pairs or between-subjects design would have been advantageous. That said, further analysis of simple effects revealed that there was a significant change in performance over time for the experimental prime group and not the control group. This suggests that the factors stated above may not have come into play and that the strength of the prime was diminishing.

### 4.4.5 Applied Implications and Future Research

The results of the present study provide support for priming as a method for promoting fluent motor skill execution. Completing a sentence scrambling task prior to a game or competition could help maintain or even enhance performance. In addition, the preliminary evidence of retention of the primed behaviour from this study has significant potential considering the varied duration of sporting events.

In considering priming as a method to prevent skill disruption under pressure, some limitations of the present study need to be acknowledged and recommendations made for future research. The first limitation concerns that lack of a pressure manipulation. It appeared necessary to further examine the effects of priming on motor skill execution in the absence of pressure allowing further understanding of the effects and the underlying processes of such a priming method on motor skill behaviour to be gained. Therefore, in order to confirm its efficacy as a psychometric tool, further research is required conducted in a high-pressure environment is warranted. Additionally, concern for the ecological validity of the current research warrants attention; the fact that the dribbling task was completed in a laboratory setting brings about the question of its effectiveness in a real world sporting environment. The football dribbling task was chosen for this research because it was considered to be representative of a skill-based element that would be demonstrated in a game situation however, assessing this task or alternative tasks in an ecologically valid setting would be beneficial.

With the ultimate aim of developing a tool that can be used to alleviate choking under pressure, development and refinement of the priming method is warranted Specifically, from an applied perspective, the time it took participants to complete the sentence scrambling task (approximately 10 minutes) might render it inappropriate for use prior to competition. Therefore, modification of the priming task is required to reduce completion time whilst ensuring it brings about the desired change in performance. Previous research has provided initial support for reducing the number of items in the task; Bry et al. (2009) used a 16-item scrambled sentence task, comprising 12 sentences specifically referring to the prime concept (cooperation), successfully improving relay race change-over speed in beginner athletes who were primed compared with those primed with words relating to individualism. In addition, Nelson and Norton reported increased helping behaviour in participants who had been primed using a 10-item scrambled sentence task of which only three items were prime-relevant, however further exploration is required.

With respect to retention, the analysis revealed that primed effects on motor skill execution were maintained up to one hour after exposure to the prime. Due to the equivocal nature of the research on retention, some predicting immediate dissipation of a primed effect (e.g., Bargh, Lombardi, & Higgins, 1988; Higgins, Bargh, & Lombardi, 1985; Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001), others suggesting a lasting effects of up to 24 hours (Merikle & Daneman, 1998; Nelson & Norton, 2005), further research is required both to establish the durability of priming effects in motor behaviour and to understand the processes underlying retention. Future studies might also consider adding measures that target potential mediators of priming effects, particularly those that influence the retention period; Banfield et al., (2003) used a 3D motion analysis system to measure the effects of priming the category of the elderly on a grasping task. They were able to identify if any particular points in the movement were affected more than others, and if so, where in the movement the changes was occurring. At a theoretical level, this would help identify whether there are different processes underpinning the effect of priming and, at a practical level, would provide critical information regarding priming in the real-world sporting arena.

**4.4.6 Conclusions**

The present study has demonstrated the efficacy of priming in manipulating the attentional processes which are said to govern skill execution. Specifically, fluency priming resulted in greater working memory capacity and improved motor skill execution in comparison to a skill focus prime, a neutral prime and a control condition, suggesting that motor skill execution was taking place under optimal and automatic control processes. Therefore, the efficacy of priming to promote superior skill execution has been demonstrated and the potential of its use to alleviate choking is a strong avenue for future investigation.

# Chapter 5

## Study 3: Optimisation of a Priming Task to Promote Fluent Motor Skill Execution

### 5.1 Introduction

'Choking under pressure' is the term commonly used to refer to "the occurrence of inferior performance, despite striving and incentives for superior performance" (Baumeister & Showers, 1986, p.361). Choking is a frequently cited phenomenon in the sporting world, and to date, extensive research has focused on the underlying processes that cause it (e.g., Beilock and Colleagues, 2001, 2002a, 2002b, & 2004; Edwards, et al., 2002; Gray, 2004; Gucciardi, & Dimmock, 2008; Jackson, et al., 2006; Liao & Masters, 2002; Masters, 1992; Masters, Polman, & Hammond, 1993; Mullen, et al., 2005) and it has been proposed as a consequence of attentional disturbances caused by heightened anxiety (Hill, Hanton, Fleming, & Matthews, 2009) (for a review see Beilock & Gray, 2007). Recently, Mesagno and colleagues (Mesagno, Marchant, & Morris, 2008; Mesagno, Marchant & Morris, 2009; Mesagno & Mullane-Grant, 2010) recognised that the current challenge for researchers is to convert existing theoretical explanations into evidence-based treatments suitable for application with athletes. They suggest that researchers should focus on developing theory-matched interventions to assist athletes in reducing choking effects. Thus far, potential strategies suggested such as secondary tasks (Lewis & Linder, 1997) and implicit learning (Masters, 1992) lack suitability for application in real-world settings. In addition, adaptation training (Beilock & Carr, 2001) does not yield immediate effects. Therefore, a more appropriate, ecologically valid and immediate method to mediate direction of attention and alleviate skill breakdown under pressure is warranted.

Divergent theories relating to attentional processes propose explanations for the process of choking. Self-focus theories (conscious processing hypothesis, CPH; Masters, 1992; explicit monitoring, Beilock & Carr, 2001) propose that reinvesting in explicit technical information and consciously controlling a skill that would normally be performed automatically is detrimental to performance. In addition, athlete reports of peak performances have contained little reference to conscious control (Ravizza, 1984) suggesting that successful performances occur under more automatic control processes, providing further support for conscious processing. The seemingly contrasting distraction theory (Carver, & Scheier, 1981) maintains that under stressful conditions, task-irrelevant stimuli such as worry and self-doubt can overload an athlete's attentional capacity, resulting in performance decrements. Processing efficiency theory (PET; Eysenck & Calvo, 1992) has also been considered as an explanation for choking. According to PET, a performer can increase effort in order to compensate for performance worry but performance breakdown will occur if the compensatory effort is insufficient.

More recently, a combination of those theories proposed has been suggested. Beilock and McConnell (2004) proposed a combination of self-focus theories and distraction theory dependant on the skill being performed and the control processes required to perform that skill. They suggested, for example, that cognitive tasks such as problem-solving may be susceptible to working memory constraints because they require the manipulation of sequential steps and the maintenance of a large amount of information in working memory as the skill is executed, and that high-level proceduralised motor skills such as golf putting are thought to run largely outside of working memory without conscious attentional control and thus, are more likely to be harmed when too much attention is prompted to skill execution, rather than too little because (Beilock et al.). Edwards, Kingston, Hardy, and Gould (2002) have proposed an explanation combining CPH and PET in that increased effort (acknowledged in PET) is facilitative up until a point where it induced self-focus and lead to detrimental conscious processing and subsequently, performance decrements. From a slightly different perspective, Lam, Masters and Maxwell's (2009) articulation of the merged CPH and PET theories suggests that performance breakdown under pressure is caused by both quantity and content of information processed in working memory and on-task effort. Further, Mesagno et al. (2008) have provided qualitative support for the notion of a coexistence of distraction and self-focus theories. Despite the ongoing attempts to clarify the processes of choking and the recent suggestions of a combination of those theories proposed, self-focus is the most widely accepted explanation.

In recognition of the causal processes that cause choking, Mesagno and colleagues (2008, 2009, & 2010) attempted to transfer this knowledge into the development of a theory-matched intervention. They examined the effectiveness of pre-performance routines (PPR) designed to aid performers in maintaining appropriate attentional control. The results indicated improved performance under pressure when PPRs were used in comparison to performance under pressure where no PPR was used. Taking a slightly different approach, Mesagno et al, (2009) proposed that listening to music and thus promoting a dual-task environment would divert attention away from the increased self-focus experienced under pressure. Again, results were positive with basketball free-throw performance being superior under pressure after listening to music in comparison to performance under pressure without music.

Priming is another method that has been suggested to address the criticisms levied at previous choking prevention strategies. Through the influence of an unrelated stimulus or concept, a prime effects subsequent performance of the processing system and thus its probability of usage in a subsequent, unrelated task (See Segal & Cofer, 1960; Baddeley, 1997). It is a method that has been utilised to increase walking speed (MaCrae, Bodenhausen, Milne, Castelli, Schloerscheidt, & Greco, 1998; Aarts and Dijksterhuis, 2002), decrease walking speed (Aarts & Dijksterhuis, 2002; Bargh, et al., 1996; Hausdorff, Levy, & Wei, 1999), and promote faster relay change-overs in beginner athletes (Bry, Meyer, Oberlé, & Gherson, 2009). It therefore seems logical to predict that priming could be successful in promoting automaticity in motor skill execution, and thus, alleviating or preventing the conscious processing that can ultimately cause choking. Primary support for this proposal (utilising scrambled sentence tasks; Bargh et al., 1996; Hull et al., 2002; Srull & Wyer, 1979) has been demonstrated in terms of improved performance (Ashford & Jackson, 2010; Study 2 of the present research programme). Further, in Study 2, residual working memory activity was examined in an attempt to find out if the performance effect that had previously been observed in the study conducted by Ashford and Jackson were associated with changes in attentional processes. To do so, performance of a probe-reaction time (P-RT) task in addition to performance speed of a football dribbling task, under a fluency prime and a skill-focus prime were examined. The results indicated significantly faster performance times in the fluency prime condition and slower performance times in the skill-focus condition compared to the control condition. To compliment this behavioural effect, P-RT's were significantly faster in the fluency condition and significantly slower in the skill-focus condition, thus, indicating that more residual working memory capacity was available as a result of less online attention being directed to the dribbling task in the fluency condition. This was accepted to indicate that a more automatic execution of the skill was taking place. It was concluded that the fluency prime was successful in promoting automatic execution of soccer dribbling and had the potential to be utilised as an effective intervention.

Before any application or intervention can take place in an applied sense it must be fully validated in an experimental context. The scrambled sentence tasks highlighted above have taken the first steps in the validation process. While preliminary results (Ashford & Jackson, 2010; Study 2) regarding the scrambled sentence technique in a motor context have been positive, it became apparent that the task could be optimised by increasing contextual overlap and reducing the amount of time required to complete the task.

Contextual overlap within a prime is an essential requisite in optimising the task. In order for a behavioural effect to result from a prime, the individual in question must experience a link between the prime and their self-concept. Subsequently, the individual engages in a comparison process, resulting in behaviour modification (Hull et al., 2002). The success of previous priming research is thought to be the result of adequate contextual overlap between the prime, the task, and the desired response (Bruce, Carson, Burton, & Ellis, 2000). Previously, the scrambled sentence items have included key words based on optimum performance and fluency placed in a generic context, for example, ‘movements seemed to flow’ (presented as: ‘movements very flow to seemed’) rather than making reference to the impending skill performance. Therefore, it can be suggested that through increasing the applicability of the prime, by placing target words in s contextually relevant sentence, the resultant behavioural modification will potentially be stronger.

In Study 2 it was noted that individuals took up to 15 minutes to complete the 30-item task. Thus, reducing the time needed for completion would result in a more appropriate and applicable method. Nelson and Norton (2005) provided support for the use of a shorter scrambled sentence task in an investigation of priming superman related tendencies to elicit helping behaviour. The task comprised 10 items of which only 3 were related to the desired behaviour (helping) and resulted in significant assimilation effect on behaviour resulting in increased engagement in helping. Additionally, Bry, Meyer, and Oberlé (2009) reported a significant improvement in relay change-over speed in beginner athletes after exposure to a priming condition using a 16-item scrambled sentence task. The sole study to date that considered a direct comparison of the number of items comprising the scrambled sentence task compared 30 and 60 items (Srull & Wyer, 1979). Results indicated that although the longer task resulted in stronger behavioural changes, both tasks resulted in significant effects. Therefore, creating a task that has fewer items could still result in behaviour modification similar to that reported in the previous studies (Ashford & Jackson, 2010; Study 2) and thus be more applicable to the applied context.

The overarching aim of the present study was to seek optimisation of the scrambled sentence task (the priming method) used in previous research (Ashford & Jackson, 2010; Study 2). Specifically, two aspects of the priming task (contextual overlap and length) were targeted. Modifications in content and length were made to the original 30-item task resulting in four versions; universal (long), universal (short), sport-specific (long), and sport-specific (short). It was hypothesised that due to the high level of contextual overlap between the prime, the task, and the desired outcome, the sport-specific prime would result in improved performance on a putting task compared with the universal primes. In addition, it was hypothesised the shortened version of the scrambled sentence task would result in behaviour modification but to a lesser extent than that of the longer task.

## 5.2 Method

### 5.2.1 Participants

Having gained institutional ethical approval, 24 skilled male golf players (M Age: 19.4 years, SD = 1.1) who were all members of a scholarship golf programme associated with a British university, provided informed consent to participate (see Appendix A). The initial aim was to recruit participants with a handicap of 10 or below, however, having collated the demographic data it became apparent that all but one participant recorded a handicap of 5 or below. Therefore, in order to examine a more homogenous 'expert' sample the participant whose handicap was 7 was excluded resulting in a mean handicap of .83 (*SD* = 2.62) for the remaining 23 participants.

### 5.2.2 Apparatus and Task

The task required participants to perform a golf putt as accurately as possible, with the aim of landing the ball in the centre of a circular target 108 mm in diameter, equal to the size of a regulation hole, marked on an indoor carpeted putting surface, located two meters away. Participants were instructed to perform the putt as accurately as possible and advised that the result of the putt would be recorded by measuring the distance from the centre of the target at which the ball stopped. To perform the task, participants used their own putters and standard size golf balls were provided.

### 5.2.3 Design

A 2 (prime: universal/sport-specific) x 2 (task length: 30 items (long) / 15 items (short)) within group repeated measures design was adopted. The experiment consisted of a familiarisation phase and an experimental phase. The familiarisation phase consisted of 20 practice trials; the experimental phase consisted of 60 putts and took the form of an A-B-A design (control 1- prime conditions - control 2). Participants completed 10 putts in each of the control trials and 10 putts in each of the four prime conditions. The primed trials were fully counterbalanced in order to prevent order effects.

### 5.2.4 Conditions

In all four priming conditions; universal (long), universal (short), sport-specific (long), and sport-specific (short), the priming manipulation took the form of a scrambled sentence task (Bargh et al., 1996). The scrambled sentence task comprised either 30 (long) or 15 (short) items made up of five words presented in a random order. Prior to completing the putting trials, participants were instructed to complete the scrambled sentence task by using four of the five words in each item to form a grammatically correct sentence.

***5.2.4.1 Universal prime.*** The aim of the universal prime was to prime aspects of automatic, fluent and optimum performance with no sport-specific contextual overlap with the golfing task. The items were a slight adaptation of those used in Study 2 and by Ashford and Jackson (2010) and were based on literature related to automatic, optimum performance and flow. For example, 'movements very flow to seemed' could be arranged to form the sentence 'movements seemed to flow' (a full list of the items in the long and short tasks can be found in Appendices F & G respectively). The first author selected the target words and created items that were then assessed for face validity by two researchers in the field of choking

***5.2.4.2 Sport-specific prime.*** The aim of the sport-specific prime was to prime aspects of automatic, fluent and optimum performance including contextual overlap with the specific sporting task. Target words were the same as those used in the universal task; however, items were constructed, as highlighted above, using the context of golf, for example, 'flowed of the putt automatically' could be arranged to form the sentence 'the putt flowed automatically' (a full list of the items in the long and short tasks can be found in Appendices F & G respectively). The items were assessed as above.

***5.2.4.3 Control.*** In the control condition no priming task was completed. Participants were simply instructed to putt as accurately as possible.

### 5.2.5 Measures

Two performance measures (horizontal error and vertical error) were recorded for each putt based on the distance from the centre of the target to the centre of the ball as it landed. These two raw measures were used to calculate absolute error, that is, the unsigned distance from the hole. The performance score for each trial was calculated and subsequently, averaged over all trials to provide a score for each condition for each participant.

### 5.2.6 Procedure

Initially, the manager of the golf programme was approached to request the participation of athletes who were registered on the program. Following the manager's verbal consent, athletes were asked to volunteer. Upon arrival at the laboratory, participants read through the standardised information and provided their informed consent.

Prior to the experimental trials, participants completed an initial familiarisation block comprising 20 trials. They then completed 10 control trials, 10 trials in each of the four prime conditions and a further 10 control trials, generating a total of 80 trials. Prior to each block of prime trials, participants completed a condition-relevant scrambled sentence task. In order to prevent rumination regarding previous performances, participants were instructed to repeat aloud the twelve times table backwards (As adopted by Ashford & Jackson, 2010) during a short rest period after each block of trials. Upon completion of the experimental trials, all participants were thanked and fully debriefed regarding the nature of the study.

### 5.2.7 Data Analysis

Data screening using standardised scores ($Z \pm 3.29$) and Mahalanobis' distance test were conducted on absolute error data. A 2 (prime) x 2 (task length) repeated measures ANOVA was conducted to examine the effect of prime conditions that were not accounted for in the *a priori* hypotheses, and planned contrasts were conducted in order to test the specific *a priori* hypotheses. Mean absolute error served as the dependent variable. Finally, in line with the hypothesis, paired samples *t*-tests were conducted, to examine the various prime conditions against the control.

## 5.3 Results

### 5.3.1 Data Screening

Data screening revealed no univariate or multivariate outliers.

### 5.3.2 Control Data

A *t*-test was conducted between the two control conditions to ensure that there was no cumulative effect of the prime across conditions. The *t*-test revealed that there was a non-significant difference between the mean scores of the two control conditions (Control 1: $M = 18.32$, $SD = 4.61$; Control 2: $M = 17.24$, $SD = 4.21$), $t(23) = 1.07$, $p > .05$; therefore, the data for the control conditions of each participant was amalgamated.

### 5.3.3 Putting Performance

Results of the repeated measures ANOVA revealed a non-significant prime x length interaction, $F(1, 22) = .59$, $p > .05$, $\eta_p^2 = .03$. A significant main effect for prime was revealed,

$F(1, 22) = 11.04$, $p < .01$, $\eta_p^2 = .33$, but not for length $F(1, 22) = 1.59$, $p > .05$, $\eta_p^2 = .07$, indicating that the effects of the prime were comparable across the two different prime lengths. Planned contrasts examining the differences in performance as a result of the content of the prime revealed that the sport-specific prime was more effective than the universal prime, $F(1, 22) = 11.04$, $p < .01$, $\eta_p^2 = .33$.

Results of the paired *t*-tests revealed non-significant differences between the universal (long) prime condition and the control condition $t(23) = .67$, $p = .84$, 95% CI = -1.82 - 3.57 and the universal (short) prime condition and the control condition, $t(23) = -1.07$, $p = .48$, 95% CI = -3.28 – 1.06.

In both cases, the sport-specific conditions revealed lower absolute error than in the control condition. A significant difference was revealed between the sport-specific (long) prime and the control condition, $t(23) = 3.15$, $p = .003$, 95% CI = .92 – 4.48 and the sport-specific (short) prime and the control condition, $t(23) = .2.83$, $p = .01$, 95% CI = .60 – 3.93 (see Figure 5.1 for graphical representation).

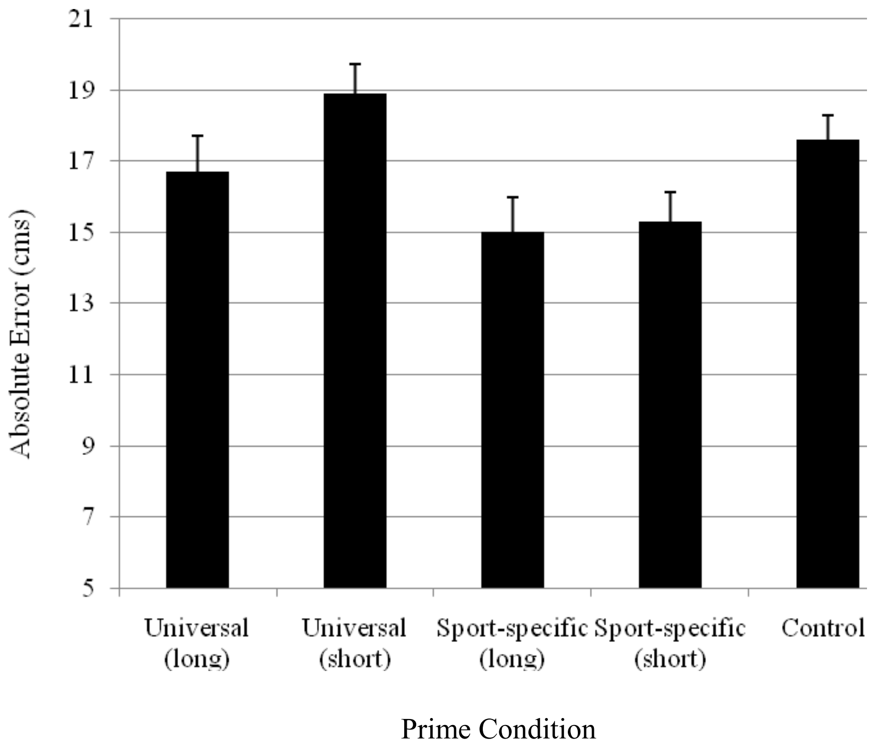


*Figure 5.1.* Mean (± SE) absolute error under the priming and control conditions.

## 5.4 Discussion

The main aim of the present study was to seek optimisation of a priming task previously found to be effective in promoting fluent motor skill execution. Specifically, modified versions of the original 30-item, universal scrambled sentence task (Ashford & Jackson, 2010; Study 2) were created with variations in content and length, resulting in four versions: universal (long), universal (short), sport-specific (long), and sport-specific (short). Putting performance of skilled golfers was then measured as a function of the differing priming tasks. It was hypothesised that the sport-specific tasks would prove more effective than the universal tasks and that the shorter tasks would be effective, but not as effective as the longer tasks. As hypothesised, the sport-specific primes resulted in lower putting error and therefore superior performance than the universal primes. This supports the theories proposed by Bruce, Carson, Burton, and Ellis, (2000) and Hull et al. (2002) in that a greater contextual overlap resulted in a stronger primed behaviour. In this study the contextual overlap was enhanced by encasing the key word for each item in a golf specific sentence. Specific care was taken to heighten the contextual overlap without directing the performer to the step-by-step mechanics of skill execution, which has been demonstrated to be detrimental to performance (e.g., Beilock & Carr, 2001; Masters, 1992). Further, it has been identified that a skill-focused prime can result in a decline in performance in comparison to a control condition (Ashford & Jackson, in 2010; Study 2). Thus, it appears that the sport-specific prime used herein was sensitive enough to facilitate automatic processing therefore discouraging conscious control, as performance was significantly better in both sport-specific prime conditions in comparison to the control condition.

With regards to the length of the priming tasks, the results revealed a non-significant difference in prime task length, suggesting that the length of the task had no effect on the strength of the primed behaviour. This supports research conducted by Bry et al, (2009) and Nelson and Norton (2005) who reported significant behaviour modification from just 16 and 10 items respectively. Therefore, it can be concluded that shorter priming tasks, in comparison to the traditional 30 item task, are still effective. That said, the group mean scores highlighted that there was a slight trend indicating the long priming tasks to have resulted in a slightly lower absolute error than the short priming tasks in both the universal and sport-specific conditions. These results are in-line with our hypothesis and are similar to those results reported by Srull and Wyer (1979), where a higher number of relevant items in the scrambled sentence task lead to modified behaviour that indicated a stronger prime.

Looking at this further, a comparison of the sport-specific prime conditions with the no-prime control condition indicated that the sport-specific (long) prime resulted in significantly superior performance and the sport-specific (short) prime. Interestingly, this suggests that the long version was slightly more effective than the short version despite there being no significant difference in relation to overall task length. These results lend further support for the efficacy of a sport-specific prime in promoting enhanced motor skill performance. Although, the long version may well have resulted in a slightly increased strength of primed behaviour, due to the reduced amount of time required to complete the short version it is a more appropriate task to complete prior to performance and thus is a method that could be used to promote optimum performance under pressure.

Unexpectedly, the universal (long) priming task did not result in enhanced performance in comparison to the control condition. The 30-item universal priming task used herein has previously resulted in significant behaviour modification in field hockey dribbling (Ashford & Jackson, 2010) and soccer dribbling (Study 2) in comparison to the same control condition used in this study, therefore, it is uncertain why this priming task did not result in behaviour modification as demonstrated in previous studies. One explanation could be due to the skill level of the participants.

While the field hockey and soccer players were highly skilled, they were only competing at university level, thus, the place at which athletes fall on the highly skilled continuum may have a differential impact on their susceptibility to priming effects. It could be suggested that a stronger, more relevant, prime is required in order to see a behaviour modification in those who possess a higher standard of skill. This tentative suggestion is supported by the results of this study in that both the sport-specific priming tasks resulted in significantly improved performance in relation to the control condition. Therefore, the efficacy of universal scrambled sentence tasks versus sport-specific tasks in relation to skill level is an area worthy of future research.

Optimisation of the 30-item scrambled sentence task was the primary aim of the present study with development of a method to manipulate attentional focus the definitive endeavour. The improved putting performance demonstrated in this study provides further support for the efficacy of priming in promoting the performance of motor skills. The findings highlight the potential for such a method to be used prior to competition, for example, golfers could complete a short scrambled sentence task prior to a round of golf, and with the validation of the task demonstrated herein, potentially prior to each hole. However, before the priming method used herein is adopted in an applied sense, demonstration of the promotion of motor skill performance under pressure and in more ecologically valid settings (i.e., in the field). In addition, the effectiveness of the sport-specific primes in relation to the universal primes indicates that sport-specific scrambled sentence tasks could be created for any number of disciplines to be utilised prior to performance for an immediate effect and these warrant development and validation.

# Chapter 6
# Study 4: The Efficacy of Sport-Specific Priming to Alleviate Motor Skill Breakdown under Pressure

## 6.1 Introduction

'Choking under pressure' is a frequently cited term used within sport and is defined as "the occurrence of inferior performance, despite striving and incentives for superior performance" (Baumeister & Showers, 1986, p.361). Accordingly, to be considered a choke, the athlete must be motivated to achieve the goal, capable of doing so, and regard the situation as important (Beilock & Gray, 2007). Therefore, choking is not a random fluctuation in skill level, but a specific negative response to perceived pressure (Beilock & Gray, 2007). Extensive research into the underlying process/es causing choking has yielded two explanatory theories: distraction (Carver, & Scheier, 1981) and self-focus (conscious processing hypothesis, CPH; Masters, 1992; explicit monitoring, Beilock & Carr, 2001). In addition, processing efficiency theory (PET; Eysenck & Calvo, 1990) has been suggested as a likely explanation for the performance-pressure relationship. However, increasingly, researchers are leaning towards a merging of those theories proposed (for example, Edwards, Kingston, Hardy & Gould, 2002). In light of the advancement in understanding the processes that cause choking, Mesagno and colleagues (Mesagno, Marchant, & Morris, 2008; Mesagno, Marchant & Morris, 2009; Mesagno & Mullane-Grant, 2010) have made a call for researchers to develop theory-matched interventions aimed at alleviating choking.

Distraction theories (Carver & Scheier, 1981; Wine, 1971), maintain that under perceived pressure, an athlete's attentional capacity can become overloaded with task-irrelevant stimuli pertaining to the circumstances, for example worry and self-doubt (See, Beilock & Carr, 2001; Lewis & Linder, 1997; Wine, 1971). This creates cognitive overload and thus impacts the capacity of working memory, creating a situation in which there is competition for attention between performance of the skill and worry regarding the situation. Thus, choking occurs as a result of the cognitive deficit that arises when attention is diverted away from the task. Alternatively, according to the self-focus theories (CPH & explicit monitoring theory), increased desire to do well heightens self-focus, leading to conscious attention being directed towards explicit technical information resulting in engagement in conscious control of the skill (Baumeister & Showers, 1986; Beilock & Carr, 2001; Masters, 1992). Subsequently, what would normally be performed automatically is interrupted and skill breakdown occurs. In addition, according to PET (Eysenck & Calvo, 1990), a performer can increase effort in order to compensate for performance worry but choking will occur if the compensatory effort is insufficient.

Researchers have recently suggested the merging of the above mentioned theories. Beilock and McConnell (2004) proposed a combination of self-focus theories and distraction theory, dependant on the skill being performed. They suggest that due to the differing control processes required for performance, cognitive skills are more susceptible due to demands on working memory and proceduralised motor skills are more likely to fail when too much attention is engaged in skill execution addition, as opposed to too little. In a slightly different take, Edwards, Kingston, Hardy, and Gould (2002) provided an explanation combining CPH and PET in that increased effort (acknowledged in PET) is facilitative to performance until too much effort causes detrimental conscious processing and subsequently, performance decrements. Further, Lam, Masters and Maxwell (2009) have suggested that performance breakdown under pressure is caused by both the quantity and type of information processed in working memory, as well as on-task effort. Finally, Hill et al. (2009) provided qualitative support for the notion of a coexistence of distraction and self-focus theories.

Despite a lack in consensus regarding the theories of choking, the self-focus model poses as the most prominent within the motor skill domain. Support for self-focus has been provided from research that has demonstrated degradation in performance when attention has been directed towards movements through the introduction of a skill-focused task (e.g., Ashford, Jackson & Norsworthy, 2006; Beilock, Carr, MacMahon, & Starkes, 2002; Gray, 2004). It has also been shown that experts possess the ability to perform a secondary task concurrently without causing a detrimental effect on primary motor skill performance (e.g., Beilock et al., 2002; Gray, 2004). Further, studies conducted by Masters and colleagues (1992;

1993; Maxwell & Masters, 2003; Maxwell, Masters, & Eves, 2000) have demonstrated that skills acquired in ways that minimise explicit knowledge about how to perform the skill are more robust under pressure. In addition to the extensive body of research providing support for self-focus as the leading underlying process that causes choking, reports of peak performances have little reference to conscious control (Ravizza, 1984) indicating further that successful performances occur under automatic control processes.

To date, a number of techniques that aim to prevent choking have been presented, such as secondary tasks (Maxwell, Masters, & Eves, 2000), implicit learning (Masters, 1992) and adaptation training (Lewis & Linder, 1997; Beilock & Carr, 2001). Although these methods have proven successful they lack ecological validity and/or immediate effects. It is not likely that a secondary task, for example, verbalizing tones (Beilock et al., 2002) or numbers (Lewis & Linder, 1997), can be effectively utilized when an athlete is performing in a competition. In relation to implicit learning, once a performer has reached a certain level (i.e. that of the autonomous stage of learning, see Fitts & Posner, 1967) there is no certainty that explicit knowledge has not been accumulated and will not be acquired in the future. Finally, adaptation training can be onerous and does not provide an immediate result. Therefore, a more appropriate, ecologically valid and immediate method to mediate direction of attention and alleviate skill breakdown under pressure is warranted.

Recently Mesagno and colleagues (2008, 2009, & 2010) made a call for researchers to convert the proposed theoretical explanations of choking into further evidence-based treatments and theory-matched interventions suitable for application with athletes in real competition settings. Mesagno and colleagues (2008, 2009 & 2010) conducted a series of studies addressing the issue by testing corresponding intervention strategies. Mesagno et al. (2008) developed a pre-performance routine (PPR) to alleviate choking in experienced ten-pin bowlers. Results revealed improved performance under high-pressure PPR training. In a following study (Mesagno et al., 2009), self-focus theories were considered in the development of an intervention utilising music to alleviate detrimental self-focussing. Experienced basketball players performed free-throw shots under pressure with and without music. Only three participants were included in this study, but all three experienced an improvement in performance after the music intervention. In a third study (Mesagno & Mullane-Grant, 2010), pre-performance routines were investigated with regard to the performance of experienced Australian football players. Participants were required to perform a kick into a scoring zone under low-pressure and high-pressure conditions using differing versions of a PPR. Results were positive and revealed improved performance from low-pressure to high-pressure after receiving PPR training. These proposed interventions of Mesagno and colleagues (2008, 2009 & 2010) show potential, although it is worth noting that participant numbers were small and specifically in relation to the 2009 study, listening to music during performance is often unacceptable in competition.

The aim of the present study is to address the issue of the limited number of appropriate methods to alleviate choking in the applied setting of performance sport. Recently, priming has been suggested as a method that could be used effectively to alleviate choking (Ashford & Jackson, 2010). Priming is defined as the influence of an unrelated stimulus or concept and its probability of usage in a subsequent, unrelated task (see Segal & Cofer, 1960; Baddeley, 1997). Through the activation of specific contexts, traits, stereotypes, goals and related constructs, priming is hypothesised to stimulate the representations of behaviours that influence a general behavioural change in line with those representations (Bargh, Chen, & Burrows, 1996; Chen, & Bargh, 1997; Dijksterhuis & Van Knippenberg, 1998). The use of scrambled sentence tasks (see, Srull & Wyer, 1979) as a method of priming has proven effective in manipulating behaviour related to motor skill execution. For example, Bry, Meyer, Oberlé, and Gherson (2009) reported faster relay take-overs after completion of a cooperation focused scrambled sentence task, and Aarts and Dijksterhuis (2002) observed decreased walking speed of both elderly and student aged participants following exposure to target words related to the elderly. Improved performance in field hockey dribbling under both low-pressure and high-pressure (Ashford & Jackson, 2010), soccer dribbling (Study 2) and golf putting (Study 3) under no-pressure has also been reported. In Study 2, working memory activity and football dribbling was examined a function of differing priming conditions and demonstrated that priming effects can be seen in working memory activity. The results indicated improvement in dribbling speed and reduced working memory activity in association with fluency priming compared to slower dribbling and increased working memory usage in the skill focus prime.

In appraising these studies (Ashford & Jackson, 2010; Studies 2 & 3), it was identified that the previously used 30-item 'universal' scrambled sentence task that had no relation to the sporting task in question could be optimised. Specifically, in Study 3 the aim of the study was to optimise the universal task in allowing for a shorter task which would require less time to complete and thus increasing the possibility of effective use both prior to and during competition/performances. Optimisation was achieved via two means; 1) increasing the contextual overlap of the items in the scrambled sentence task with the sporting task. This was achieved by including target words related to fluency, automaticity and optimum performance with specific reference to golf putting whilst taking care not to promote conscious control, 2) reducing the priming task from 30 to 15 items. Professional golfers were tested on their putting ability after completing each of the four different versions of the scrambled sentence task: universal (short), universal (long), sport-specific (short) and sport-specific (long).

The results revealed superior golf putting performance after the golfers had been primed with sport-specific primes in comparison to universal primes and a no prime control condition, indicating that the sport-specific task was most effective and sensitive enough not to cause conscious control. Additionally, no difference in performance was revealed between the 15-item task and the 30-item task conditions, indicating that the short task was just as effective as the long task in causing behaviour medication. The authors concluded that a sport-specific version of the scrambled sentence task was most effective when attempting to prime highly skilled athletes and that the shorter 15-item task was most appropriate considering the considerably shorter time required for completion.

Having developed a sport-specific tool that can promote performance in low-pressure conditions, it was deemed necessary to test the efficacy of this task under pressure. Thus, the purpose of the current study was to investigate whether a sport-specific scrambled sentence priming task could alleviate or prevent choking. It was hypothesised that the priming task would reduce or at least buffer choking effects under high-pressure. Specifically, it was predicted that the sport-specific prime would result in superior performance under no-pressure and high-pressure conditions in comparison to neutral prime and no-prime control conditions. In addition, the neutral prime would not lead to any behavioural modification and therefore would result in a performance congruous with the control condition.

## 6.2 Method

### 6.2.1 Participants

Having gained institutional ethical approval, 24 skilled golf players (male = 21, female = 3) who were all members of an established golf programme provided informed consent to participate (see Appendix A). The participants reported a mean age of 26 years (*SD* = 4.96 years). All golfers reported their status as professional and therefore a registered a handicap of ‘scratch’ (0).

### 6.2.2 Apparatus and Task

The task required participants to perform a golf putt towards a target equal to the size of a regulation hole (108 mm in diameter), two meters away, on an indoor Huxley modular putting green. Participants were instructed to perform the putt as accurately as possible, aiming to land the ball on or as close to the centre of the target as possible and were advised that the result of the putt would be recorded by measuring the distance from the centre of the target at which the ball stopped. To perform the task, participants used their own putters and standard size golf balls were provided.

### 6.2.3 Design

A 2 x 3 (pressure level: low/high x prime: sport-specific/ neutral/ control) within group repeated measures design was adopted. The experiment comprised a familiarisation phase and an experimental phase; the familiarisation phase consisted of 20 trials and each experimental condition consisted of 10 trials. Half of the participants completed the low-pressure trials first and the remaining half performed the high-pressure trials first, this was determined via random allocation. The experimental trials within each pressure condition were fully counterbalanced.

### 6.2.4 Conditions

The priming conditions, sport-specific and neutral, took the form of scrambled sentence tasks similar to that used by Bargh, Chen, and Burrows (1996). The scrambled sentence task consisted of 15 items comprising five-words presented in a random order. Prior to completing the putting trials, participants were instructed to complete the sentence scrambling tasks by using four of the five words presented in every item to form a grammatically correct sentence.

***6.2.4.1 Sport-specific prime.*** The aim of the sport-specific prime was to prime aspects of automatic, fluent and optimum performance. The task was a replication of that used by in Study 3 where words for each item were selected on the basis of criteria associated with autonomous performance (e.g., automatically, effortless, smooth). Items were then constructed around these target words using the context of golf. An example item was as follows: ‘flowed of the putt automatically’ would form the sentence: ‘the putt flowed automatically’ (for a full list of items see Appendix F). The items were assessed for face-validity by two experts in the field of choking.

***6.2.4.2 Neutral prime.*** In order to support the notion that primes need to be contextually relevant to promote a behavioural change and that performance changes were not simply an artefact of engaging working memory (completing a cognitive task) prior to performing a neutral scrambled sentence task was included. Therefore, the aim of the neutral prime was to implicitly prime no behaviour and thus, elicit a performance that was predicted to be parallel to that found in the control condition. The items adopted were a replication of those used by Ashford and Jackson (2010) and this used in Study 2 where target words were selected on the basis of criteria associated with neutral words unrelated to the present context (e.g., table, green, sky). Items were developed around the target words and were validated by the same two experts as above. An example item was as follows: ‘now legs have four tables’ would form the sentence: ‘tables have four legs’ (for a full list of items see Appendix F). The items were assessed for face-validity by the same two experts as above.

***6.2.4.3 Control.*** In the control condition no priming task was completed. Participants were simply instructed to putt as accurately as possible.

### 6.2.5 Pressure Manipulation

The conditions highlighted above were performed under low-pressure and high-pressure. In-line with previous studies (e.g., Beilock & Carr, 2005) pressure was induced from two angles. Firstly, a video-camera was introduced for the pressure condition; Participants were told that the recordings would be viewed by the manager of the golf program to which they were all registered and exemplar techniques would be identified and shared with others on the golf program. In addition, participants were advised that their scores would be submitted into a competition between all participants, and that the results would be published to all the members of the golf program.

### 6.2.6 Measures

***6.2.6.1 Competitive state anxiety.*** State anxiety, commonly assumed to reflect perceived performance pressure (Mullen, et al., 2005), was assessed using the cognitive and somatic anxiety subscales of the revised CSAI-2 (CSAI-2R; Cox, Martens, & Russell, 2003). This measure has been used previously to examine how anxious participants feel before taking part in performance conditions, of both low-pressure and high-pressure (e.g., Gucciardi & Dimmock, 2008; Liao & Masters, 2002; Mesagno, et al., 2008). The CSAI-2R has been shown to be a valid and reliable measure of cognitive and somatic anxiety, with high internal consistency, $\alpha = .83$ and $\alpha = .88$ respectively (Cox et al., 2003). Participants rated anxiety intensity on a 4-point scale anchored by 1 (*not at all*) and 4 (*very much so*) and anxiety directions on a 7-point scale from –3 (very debilitative) to +3 (very facilitative) (see Appendices I and J for the full CASI-2R and score sheet respectively).

In addition to the CSAI-2R, participants completed a pressure rating scale where they were asked to respond to the question “How much pressure did you feel that you were under during the trials you have just completed?” using a 7-point Likert-type scale anchored by 1 (“no pressure”) and 7 (“extreme pressure”). This item was used based on face-value alone.

***6.2.6.2 Putting performance.*** Two performance measures, horizontal error and vertical error, were recorded for each putt based on the distance from the centre of the target to the centre of the ball as it landed. As in Study 3, two raw measures (vertical error and horizontal error) were used to calculate the absolute distance (error) from the hole. The performance score for each trial was calculated and subsequently, averaged over all trials to provide a score for each condition for each participant.

**6.2.7 Procedure**

Initially, the manager of the golf program was approached to request the participation of athletes who were registered on the program. Following the manager's verbal consent, athletes were asked to volunteer. Upon arrival at the laboratory, participants read through the standardised information and provided their informed consent.

Participants completed an initial familiarization block comprising 20 trials followed by 10 trials in each of the six experimental conditions, generating a total of 80 trials. The experimental conditions comprised three conditions (sport-specific, neutral, control) completed under low-pressure conditions and high-pressure.

Prior to each block of primed trials, participants completed a condition relevant sentence scrambling task. After each block of trials, they were given a short rest period in which they were required to repeat aloud the twelve times table backwards in order to prevent rumination regarding on previous performances and carryover of previous primed effects to future trials.

Before the set of high-pressure trials began, participants were advised of the presence of the camera and that the next thirty putts would be videotaped. They were also introduced to the competition scenario and told that their following 30 trials would be used to calculate a score that would be entered into the competition.

In order to establish that the pressure manipulation was successful, the direction and intensity elements of both the cognitive and somatic subscales of the CSAI-2R were administered prior to the sets of no-pressure and high-pressure trials. In addition, following completion of each set of pressure trials, participants were requested to complete the pressure rating scale. Finally, upon completion of the experimental trials, all participants were fully debriefed regarding the nature of the study and thanked for their participation.

### 6.2.8 Data Analysis

Data screening using standardised scores (z ± 3.29) and Mahalanobis' distance test methods were conducted on all data. In order to test the effectiveness of the pressure manipulation, data from the cognitive and somatic anxiety subscales of the CSAI-2R were entered into a repeated measures MANOVA with cognitive and somatic serving as the dependent variables. In addition, a paired samples t-test was used to assess the pressure rating scale data. Finally, a 2 x 3 repeated measures ANOVA was conducted with repeated measures on the pressure and prime condition factors. Mean absolute putting error served as the dependent variable.

## 6.3 Results

### 6.3.1 Data Screening

Data screening revealed no univariate or multivariate outliers.

### 6.3.2 Manipulation Checks

***6.3.2.1 Competitive-state anxiety.*** Results of the repeated measures MANOVA revealed a significant main effect for pressure, Wilks' $\lambda = .50$, $F = 5.18$, $p < .01$, $\eta_p^2 = .50$. Follow-up univariate results revealed significant increases in somatic anxiety intensity, $F(1, 24) = 9.61$, $p < .01$, $\eta_p^2 = .29$ and cognitive anxiety intensity, $F(1, 24) = 17.23$, $p < .01$, $\eta_p^2 = .42$, from the low-pressure to the high-pressure condition. With regard to direction, results revealed a significant difference for somatic anxiety, $F(1, 24) = 5.83$, $p < .05$, $\eta_p^2 = .20$, with participants perceiving it to be more facilitative in high-pressure. A non-significant result was revealed for cognitive anxiety, $F(1, 24) = 1.82$, $p > .05$, $\eta_p^2 = .07$. (See Table 6.1 for descriptive statistics).

Table 6.1

*Descriptive Statistics for Anxiety Intensity and Direction as Measured by the CSAI-2R*

| | Pressure | *M* | *SD* |
|---|---|---|---|
| Cognitive Anxiety Intensity | Low | 15.36 | 5.15 |
| | High | 20.32 | 6.01 |
| Cognitive Anxiety Direction | Low | 4.80 | 12.50 |
| | High | 1.36 | 12.47 |
| Somatic Anxiety Intensity | Low | 12.46 | 2.69 |
| | High | 15.49 | 4.75 |
| Somatic Anxiety Direction | Low | 11.54 | 11.26 |
| | High | 5.89 | 11.96 |

***6.3.2.2 Perceived pressure.*** The paired-samples *t*-test revealed that there was a significant difference in perceived pressure, $t\ (24) = -7.31$, $p < .001$, 95% CI: -1.80 – -1, between the pressure conditions. Mean scores indicated an increase in perceived pressure from the low-pressure condition ($M = 1.92$, $SD = .91$) to the high-pressure condition ($M = 3.32$, $SD = 1.22$).

**6.3.3 Putting Performance**

Results of the repeated measures ANOVA revealed a non-significant pressure x prime interaction, $F(2, 48) = 2.34$, $p > .05$, $\eta_p^2 = .09$. A significant main effect for prime $F(2, 48) = 5.81$, $p < .01$, $\eta_p^2 = .20$, but not pressure, $F(1, 24) = 3.08$, $p > .05$, $\eta_p^2 = .11$, was revealed, indicating that the effect of the prime and of the controls was comparable across both pressure conditions. Pairwise comparisons for the prime condition revealed that the sport-specific prime resulted in significantly more accurate putting performance than the neutral prime and control conditions. A non-significant result was revealed between the neutral prime and the control conditions. (See Figure 6.1 for graphical representation).

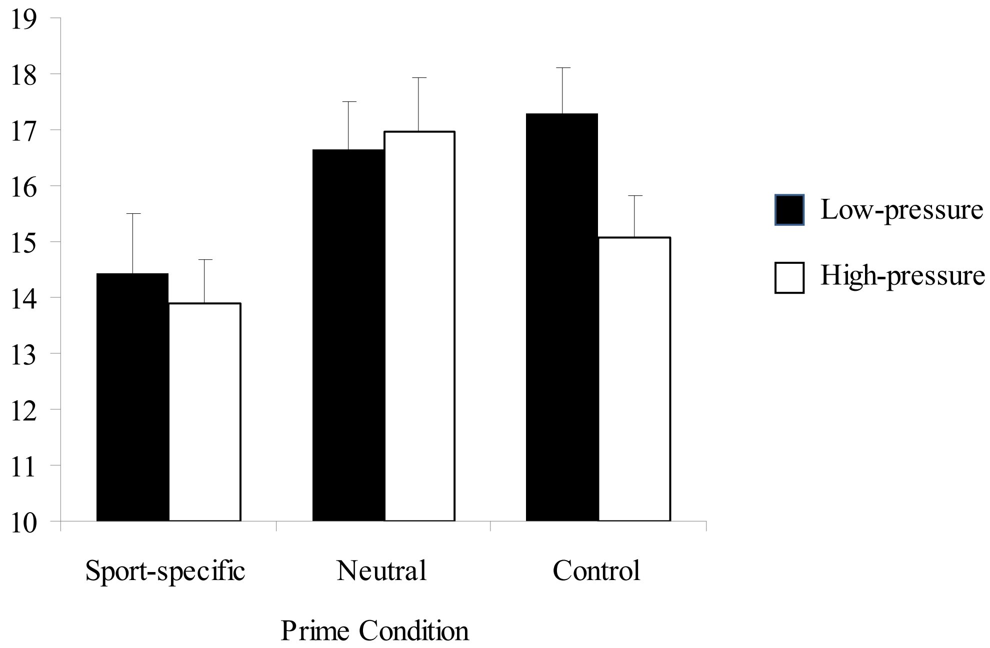


*Figure 6.1.* Mean (± SE) absolute error under the priming and control conditions.

**6.4 Discussion**

The primary aim of the present study was to examine whether a sport-specific (short) scrambled sentence task could alleviate or even prevent choking in a situation where professional golfers were subject to high-pressure. Previous research (see Studies 2 & 3) has demonstrated that priming, by use of scrambled sentence tasks incorporating key words related to fluency and automatic execution specific to the sporting skill in question, can be effective in promoting performance in the absence of competitive pressure. Hence, it was hypothesised that the sport-specific prime used in the present study would influence attentional focus and subsequently maintain putting performance would be maintained both under low-pressure and high-pressure conditions.

The results of the present study indicated a strong effect of the prime condition with the sport-specific prime resulting in significantly superior performance in comparison to the neutral prime and control conditions. These results provide further support for the efficacy of priming in general but more importantly, of sport-specific priming in promoting performance. As demonstrated in Study 2 where a universal scrambled sentence task lead to more available working memory capacity during skill execution, it seems logical to propose that the scrambled sentence task used herein had the same effect, ultimately preventing (or at least alleviating) detrimental skill focus. These results are similar to those presented in previous research where participants have performed a secondary task concurrently with skill execution and performance under pressure has been maintained (Beilock, et al., 2002; Jackson, et al., 2006; Maxwell, et al., 2000).

In developing the sport-specific scrambled sentence task, care was taken to ensure that completing the task would not promote skill-focused attention. Research has indicted the detrimental effects of skill-focussed attention (e.g., Beilock et al., 2002; Gray 2004; Jackson, et al., 2006; Masters, 1992), in addition, utilising a 'skill-focus' prime has resulted in conscious control and depreciated performance (Ashford & Jackson, 2010; Study 2). Therefore, it was possible that if the putting related items in the sport-specific priming task were of such a level that skill-focus attention could be caused, a detrimental effect on performance could also occur. In the present study, the sport-specific task clearly did not lead to conscious control as putting performance was more accurate in the sport-specific conditions than the neutral and control.

Examination of the means in the control conditions across pressure indicates superior putting performance in the high-pressure condition with mean absolute error decreasing by 2.23 cm (see Figure 6.1). While a significant increase in pressure was observed, this was perceived by the participants as facilitative to performance. Therefore, it is possible that the pressure elicited by the competition did cause the golfers to increase their effort to perform well. This increased effort could have resulted in appropriate skill monitoring or utilisation of appropriate skill relevant cues in relation to execution similar to that discussed by Ashford, Jackson, & Norsworthy (2006). This inference is in-line with the predictions of PET in that increased pressure can lead to the allocation of additional processing resources, or initiation of alternative processing strategies (Eysenck & Calvo, 1992) which can result in maintained performance. The data collected within this study is not enough to confirm these inferences, therefore, future research of a similar nature to that of the present, could utilise other performance measures that examine effort, process measures of performance and working memory activity in exploring this proposition. In addition, the results indicate that the neutral prime may have prevented engagement in the appropriate skill focused attention mentioned above (see Figure 6.1). This is a plausible outcome, particularly considering the lack in contextual overlap of the neutral prime and the golf putting tasks and the higher error in the neutral prime condition in comparison to that of the control condition under high-pressure.

The positive effects of the prime shown in the present study are reassuring regarding the elevated levels of performance in the sport-specific prime condition compared to that in the control condition. Yet, we cannot confidently conclude that the task will be effective in preventing choking due to the non-significant main effect of pressure. Although the pressure manipulation was effective in significantly raising cognitive and somatic anxiety as well as pressure ratings from the low-pressure condition to the high-pressure condition, it is clear that in this study, the pressure perceived did not evoke a choking response. Further, while an increase in perceived pressure was present in the high-pressure condition, only a moderate response was reported (i.e., 3 out of 7). Nevertheless, despite the fact that choking did not occur in the present study, it is still important to acknowledge the point that performance was superior in the sport-specific condition than the neutral and control conditions both under low-pressure and high-pressure. Due to the above mentioned issue related to the level of pressure manipulated in the high-pressure condition, it is necessary to investigate the effectiveness of the sport-specific prime in a more applied context, such as a real golf competition. This will allow for the method to be tested in a more ecologically valid setting and therefore in a situation where levels of perceived pressure are more likely to match those where a choke often occurs. It would also be fruitful to test the method with a group of participants who show a high propensity to choke within a real competition through the use of the reinvestment scale (Masters, Polman, & Hammond, 1993).

Based on the results of the present study suggestions could be offered to applied sport psychologists who are working with choking susceptible athletes and/or developing tools for athletes to be used in pressure situations. Specifically, the sport-specific prime utilised herein could be adopted to facilitate golfers' performance in pressure competitions. The task could be completed prior to a round of golf and possibly, time permitting, prior to each hole. In the meantime, whilst other sport-specific primes are developed and tested within other sports, the universal prime that has yielded positive results in previous research (Ashford & Jackson, 2010; Studies 2 & 3) could be adopted in a similar format to that mentioned for use in golf. The scrambled sentence tasks can also be used in combination with other methods proposed to alleviate choking, such as analogy learning (Lam et al., 2009; Liao, & Masters, 2002), process cues (Gucciardi & Dimmock, 2008) and adaptation training (Beilock & Carr, 2001) and could form part of the pre-performance routines recently investigated by Mesagno and colleagues (2008, 2009, & 2010).

Other avenues for research into the efficacy of priming as a means of alleviating choking have been identified. In addition to future examination of the scrambled sentence task used herein under further pressure manipulations including those of real-life competitions, examination of other performance measures such as the kinematics of the golf swing could provide interesting information in respect of how priming works. Further, in previous research (Studies 2 & 3) differences in priming effects have been noticed in relation to the content of the priming task and the skill level of the athletes. A universal priming task was effective in improving the performance of university level field hockey (Ashford & Jackson, 2010) and soccer (Study 2) players, yet the same task was not effective with professional standard golfers (Study 3). Although it is not certain, the effect was attributed to the requirement of a stronger, more relevant prime needed to see a behaviour modification in athletes of an incredibly high standard. Choking research has also identified potential differences in the effects of skill-focus attention depending on skill level (see Jackson & Beilock, 2007). Thus, further research examining the differing effects of priming on performance with varying levels of standard through examining the efficacy of prime as a function of differing skill levels within the population of those athletes entitled 'expert' is warranted.

In addition, further research aimed at examining the effectiveness of the scrambled sentence task on performance under high-pressure could adopt a more robust measure of anxiety. While obtaining perceived anxiety intensity and interpretation scores provided insightful information, it may well have been useful to have collected data in relation to frequency. Hanton et al. (2004) have suggested that the frequency of reported perceptions and symptoms also contribute to the development of affective states.

A limitation of this study that warrants some attention relates to the impact the pressure manipulation had on performance. Although, as stated above, the pressure felt by the participants increased, it clearly was not strong enough to elicit the detrimental effects that were anticipated, therefore, a lack of ecological validity must be acknowledged. It has been suggested that other manipulations may be effective in inducing pressure and/or detrimental skill-focused attention and therefore could be adopted in future research of this nature. For example, performing in front of a mirror (Carver, 1974,1975; Scheier, 1976), when the individual can hear their own voice (Ickes, Wicklund, & Ferris, 1973), adapted/novel equipment (such as the funny putter used by Beilock & Carr, 2001), and monetary incentives (Masters, Polman, & Hammond, 1993). Furthermore, Masters and Maxwell (2008) highlighted certain contingencies in addition to psychological pressure that can influence reinvestment such as rewards, boredom, too much or too little time in which to execute a skill, praise, process goals, unexpected events, and the need to adapt for different conditions (similar to that of adapted/novel equipment such as the funny putter used by Beilock and Carr, 2001, or even a particularly taxing putting green).

In conclusion, the present study further strengthens the body of support provided for the efficacy of priming tasks in promoting automatic performance, specifically that of sport-specific priming tasks. Therefore, the potential for its usage as a tool to prevent skill breakdown under pressure is clearly a possibility. Further research in a more realistic setting, where competitive pressure is likely to match that of the situations where athletes are subject to instances of choking, is required, to provide a true reflection of the efficacy/applicability of the priming task.

# Chapter 7: General Discussion

## 7.1 Introduction

The present chapter addresses three main aims: a) to summarise the main findings of each of the studies presented in the preceding chapters and highlight the conceptual themes that have emerged throughout the research programme as a whole; b) to consider the implications of the main findings for research in the area of attentional allocation and choking, and the development of theory-matched interventions based on priming to promote performance and alleviate choking under pressure; c) to highlight the research limitations, d) to present possible future research directions; and finally, e) applied implications for practitioners and coaches;

## 7.2 Summary of Research Findings

The original idea for the present line of research came from the desire to explore the underlying mechanisms of choking through adopting a qualitative approach, and the efficacy of priming as a theory-matched intervention to alleviate this phenomenon in highly skills athletes. The hypothesis that, based on the predictions of self-focus theories, a method based around priming research could prevent or at least alleviate choking, stemmed from research conducted by Ashford and Jackson (2010).

### 7.2.1 Study 1: A Qualitative Investigation into Choking Under Pressure

Despite a proliferation of research concerning the performance-pressure relationship, there is a lack of consensus regarding the underlying process/es that cause choking. In recognition of the multifaceted and complex nature of the processes governing performance under pressure, Study 1was conducted to gain real-world insight to performers' thoughts whilst performing in high-pressure circumstances. Specifically, through semi-structured, in-depth interviews, individual perceptions and causal beliefs regarding anxiety, self-focus and attentional direction under situations of heightened pressure were collated from nine international swimmers. Data were examined using a predominantly inductive approach therefore allowing themes to emerge from the athletes' responses.

Eleven central concepts were generated from two race phases: five from the pre-race phase (expectations, perceived physical condition/ability, fear of failure, physiological monitoring, and attentional focus) and four from the during race phase (attentional focus, effort, striving for perfection and physiological awareness). The emerging dominant themes indicated that performers commonly engaged in a skill-focused direction of attention when performing at 'high pressure' competitions. However, contrary to the choking literature (Beilock & Carr, 2001; Gray, 2004; Masters, 1992) this skill-focused attention did not always lead to performance decrements. This provides further support for the suggestion that varying levels of conscious control exist, where a certain level can be tolerated and an optimal level may even aid performance under pressure without causing choking (Jackson et al., 2006). Overall, the results provided further support for the postulation that choking under pressure occurs as a result of a combination of previously proposed theories. Specifically, the swimmers did recognise the detrimental effects of thinking too much about skill execution during performance in line with Master's (1992) conscious processing hypothesis and also cited experience of increased worry and concern for the outcome as well as increased effort to perform optimally, consistent with the predictions of processing efficiency theory (Eysenck & Calvo, 1992). In the aim to develop a theory-matched intervention that could alleviate choking under pressure, the findings of this chapter, in addition to existing theories proposed to explain the underlying mechanisms of choking, informed the development, optimisation and examination of such an intervention in the following three studies.

### 7.2.2 Study 2: The efficacy of Priming to Promote Fluent Motor Skill Execution

In light of the research conducted by Ashford and Jackson (2010) and the findings of Study 1, it appeared that a tool based on priming could be appropriate to alleviate choking, through promoting appropriate attentional processes and avoiding worry and detrimental skill focussed attention. To test this proposition, motor skill (soccer dribbling) performance and attentional processes were examined as a function of different prime conditions. In addition, in light of the equivocal findings from research on the retention period of primed behaviours and owing to varying lengths of sport competitions (i.e., 2 x 45 minutes for a football match; 4 x 12 minutes for a basketball game; 4 -5 hrs for a round of golf) the retention of any priming effects were assessed over a one hour period.

In-line with previous research (Ashford & Jackson, 2010), the results indicated that the fluency prime yielded significantly faster dribbling times compared to the skill-focus prime, neutral prime and control conditions and the skill-focus prime significantly slower performance times in comparison to the other three conditions. Additionally, as expected, the P-RT results reflected that of the dribbling times, in that the fluency prime condition yielded faster P-RT's than the other three conditions, and the skill-focus prime condition revealed slower P-RT's. There were no significant differences in lateral displacement across the three conditions. These results were interpreted to indicate that the fluency prime was successful in promoting automatic skill execution thus, freeing working memory and enabling participants to response quickly and accurately to a secondary task (PRT). In addition, the retention data revealed that primed dribbling performance was maintained over a one hour period although the primed effects on P-RT had started to dissipate. The results of this study not only provided further support for the efficacy of priming but also initial evidence of concurrent changes in attentional demands, consistent with promoting or disrupting automatic skill execution.

The results of Study 2, therefore, provided indication that such a priming tool could stand as a theory-matched intervention, based on self-focus theories and those underlying processes of choking identified in Study 1, to alleviate choking. It was concluded that further research aimed at optimising the priming method (i.e., shortening the priming task and reducing completion time) and evaluating its effectiveness in alleviating skill failure under stress was warranted.

**7.2.3 Study 3: Optimisation of a Priming Tool to Promote Fluent Motor Skill Execution**

Following the positive results of Study 2, and in acknowledgement of the need to further develop the priming task, Study 3 was conducted. It was deemed necessary to make the task shorter so as not to require so much time for completion and to increase the effectiveness of the task by increasing the contextual overlap, an element deemed essential for creating an effective prime (Bruce et al., 2000; Hull et al., 2002), between the priming task and the sporting task. Therefore, a shorter scrambled sentence task was developed based on research that has demonstrated behavioural effects from scrambled sentences tasks comprising less than 30 items (e.g., Bry, Meyer, & Oberlé, 2009; Nelson & Norton, 2005). In addition, contextual overlap was increased by making the items in the scrambled sentence task context specific to the sporting skill. This process was informed by the research findings from Study 1, where it was identified that expert performers utilise an optimum level of skill focused attention in a facilitative manner. Therefore, contextual overlap was heightened by using target words that were reflective of the positive skill monitoring (heightened awareness) reported by the swimmers in Study 1 and transformed to fit the context of golf.

In addition to the aim of enhancement of the priming task, a further aim was to test the efficacy of the priming tool with another skill. Four versions of the scrambled sentence task were administered to expert golfers: universal (long), universal (short), sport-specific (long), and sport-specific (short), the universal long being the task that was used in Study 2. Following exposure to each of the primes as well as a no-prime (control) condition, putting performance was assessed as a function of the differing priming tasks. As expected, significant differences in putting performance could be identified between the sport-specific prime and the universal prime conditions, with the sport-specific prime resulting in superior putting performance. Thus, in-line with theories proposed by Bruce et al. (2000) and Hull et al. (2002) results indicated that greater contextual overlap elicited a stronger primed behaviour. Interestingly, a non-significant difference in performance was revealed between the long tasks and the short tasks signifying parallel effectiveness of the tasks.

Unexpectedly, the universal (long) prime, which had yielded positive results in Study 2, was not so effective with the golfers and did not result in a significantly superior performance in comparison to the control condition. It was suggested that potentially these results could be explained by differing skill levels. Although both groups were considered expert, the football players were only competing at university levels whereas the golfers were professional or amateurs of professional standard. Thus, it was further suggested that, potentially, a prime with higher contextual overlap is required for those of a high standard.

Overall, the results were accepted to indicate that, in addition to football dribbling, performance of a golf putting task is another motor-skill that can be optimised through the concept of priming. In addition, it was concluded that the most appropriate task for further examination under pressure, would be the sport-specific (short task) as this yielded optimum behavioural change and required minimal completion time prior to performance. Therefore, it was acknowledged that following the proven efficacy of the sport-specific (short) prime used herein to promote an improvement in putting performance, the next step would be to test the efficacy of the tool to alleviate choking in a pressure manipulated setting.

**7.2.4 Study 4: The Efficacy of Priming to Alleviate Choking**

Given the successful results following exposure to the sport-specific (short) prime in Study 3, the aim of Study 4 was to examine the efficacy of the task to alleviate choking under pressure in expert golfers' putting performance. Putting performance was examined following exposure to the sport-specific (short) prime, the neutral prime used in study two and a control (no prime) condition.

As anticipated, the pressure manipulation was successful in producing an elevation in state anxiety and perception of pressure. Yet, despite the significant increase in pressure in the high-pressure condition, perception of pressure was regarded facilitative to performance and the performance measures indicated that putting was superior to that of the low-pressure condition. This was accepted to signify that the pressure was not enough to induce choking but was enough to raise effort in a positive fashion.

Most importantly, and in-line with the hypothesis, improvement in putting performance was observed from the control and neutral prime conditions to the sport-specific prime condition in both pressure conditions. Unfortunately, given these results, it is not possible to conclude the efficacy of the priming tool in alleviating choking. That said, the positive results are encouraging and indicate the potential of this method as an effective tool to promote optimum attentional control for skill execution.

## 7.3 Emergent Conceptual Themes

As a result of the present programme of research, salient themes have emerged regarding processes underlying performance and the effects of completing a scrambled sentence task on expert motor skill performance. This section addresses the overall findings and highlights the implications they may have for expert performance.

### 7.3.1 The Effects of Skill-Focused Attention vs. Automatic Control Processes on Execution

The detrimental effects of skill focussed attention in the form of conscious processing and the facilitative effects of relying on automatic control processes has been demonstrated throughout the choking literature (e.g., Beilock & Carr, 2001; Beilock et al., 2003; Jackson, et al., 2006; Lewis & Linder, 1997; Masters, 1992; Masters et al., 1993) and the present research programme has provided results in-line with this notion. Support for the detrimental effects of conscious processing was demonstrated when a priming condition designed to promote harmful skill-focused attention was associated with overloaded attentional capacity and degraded performance, in-line with the skill-focused conditions that have demonstrated similar results in previous research (e.g., Beilock et al., 2002; Gray, 2004; Jackson, et al., 2006). In addition, the accounts of elite athletes indicated that too much attention directed to skill execution both prior to and during a performance could be detrimental to the outcome. Furthermore, the priming conditions throughout the research programme designed to promote fluent, automatic skill execution were associated with clearer attentional capacity and improved performance. Also, the swimmers also provided anecdotal evidence in support for the positive effects of automatic control processes.

Given the support for both the detrimental effects of conscious processing and the facilitative effects of automatic control processes on expert motor skill execution, one would believe that an athlete's apparent ability to neglect or reject all focus on skill execution would lead to optimal performance. However what was also apparent throughout this programme of research was that combining the two approaches and creating a diluted version of a reliance on automatic control processes with some focus on skill execution (heightened awareness) would potentially provide the optimum focus of attention for performance. This was evident in the swimmer's recollections of optimum performances under pressure and the positive performance effects in association with a priming task that utilised the notion of heightened awareness and used target words related to elements of the skill to be performed.

**7.3.2 Effectiveness of Priming**

Across the three final studies, the efficacy of a scrambled sentence task based on the concept of priming, using key words signifying aspects of fluent, automatic and optimum performance has been demonstrated. Where behavioural effects from priming have been demonstrated throughout different aspects of social psychology (e.g., Bargh, Chen, & Burrows, 1996; Krolak-Schwerdt, 2003; Srull & Wyer, 1979), the studies in the present programme of research have provided evidence that motor behaviour can also be influenced, both positively and negatively, through targeting attentional processes. The results of Study 2, which demonstrated the attentional affects of the priming manipulation, combined with the results of Studies 3 and 4 which demonstrated performance improvements, indicate that there is potential for the tool to be effective in alleviating choking.

**7.4 Research Limitations**

The overall aim of the present research was to provide further insight into the underlying mechanisms of choking and, using this insight in addition to the existing theories, develop and test a theory-matched tool, based on priming, which could prevent or at least alleviate choking under pressure. Prior to the development and examination of the priming tool, further investigation into performance under pressure was conducted in order to provide further insight into cognitive processes and experiences of expert sport performers. In the process of addressing these aims, a number of limitations were identified, which are discussed below.

**7.4.1 Pressure**

There are two areas in which the discussion of limitations surrounding issues related to pressure that need addressing. First, the priming tool was only tested in one instance under pressure. The second limitation is in relation to the retrospective accounts of pressure situations and the artificial pressure manipulation adopted. These are discussed in more detail below.

***7.4.1.1 Limited examination of pressure.*** The priming tools examined in Studies 2 and 3 were not subject to a pressure manipulation. Although, it was deemed necessary to test the efficacy of the tool without the added element of pressure, results from a pressure condition would have been relevant to the programme of study. That said, it was deemed of higher importance to address each specific aim of these studies in order to gain further understanding of the effects of priming and to develop the tool effectively before pressure was added to the equation.

***7.4.1.2 Perceptions of pressure***. Due to the retrospective accounts used in Study 1 and the pressure manipulation used to examine performance under pressure in Study 4, the situations of high pressure referred to in these instances might not be a true reflection of what was experienced or that might be expected in real life respectively

Although the swimmers participating in Study 1 were instructed to recollect performances under pressure that were experienced in the past season, and were therefore relatively fresh in their minds, these instances were still retrospective. Such retrospective recall could have lead to a degraded perception of the pressure that was experienced. Therefore, care was taken in the collection of the swimmer's accounts to encourage the swimmer to relive the experience in as much detail as possible. Retrospective recall provides valuable information for research and has been used successfully in previous studies examining pressure (e.g., Edwards et al., 2000), yet due to the potential degradation and distortion of such recollections caution was taken when inferences were being made. Future research of a similar nature could collect accounts from athletes immediately after performance or as soon as possible following cool-down and coach debrief if necessary.

The manipulation used in Study 4 was designed to create a situation similar to that of a real tournament or competition and while it was effective in elevating levels of anxiety, the levels that were achieved were moderate and were not extensive enough to induce a choking experience. In fact, participants' performance actually improved. There are arguably many factors which can increase the perceived importance of performance (Rushall & Sherman, 1987) but unfortunately, it is extremely unlikely that the pressure re-created in laboratory settings is ever likely to be comparable to that experienced by professional golfers or other athletes in the critical moment of a tournament. Therefore, ecologically valid research is warranted in order to really test the validity and reliability of the priming tool.

**7.4.2 Generalisation of Results**

There are two main areas in which the generalisation of the results needs to be demonstrated. First, it needs to be demonstrated that the results generalise to the real equivalent sporting tasks, i.e., football dribbling and golf putting. Second, it needs to be demonstrated that the results generalise across the domain of sport.

***7.4.2.1 Generalisation of the type of skill.*** Although across Studies 2, 3 and 4 the efficacy of priming to promote performance in soccer dribbling and golf putting was demonstrated, it is possible to argue that the tasks adopted for examination were taken out of context and did not provide a true reflection of the skill. Therefore, owing to the nature of the experimental setting, the ecological validity and generalisation of the results were diminished.

In defence, a football dribbling task (Study 2) was adopted which required the participants to dribble in and out of a series of cones, a skill-based task that is often undertaken in training. In addition, although not exactly mimicking a skill that would be performed in a match situation, it was a slight adaptation of such, in that players are quite often required to dribble around the opposition in a match and therefore it was deemed an appropriate task that could be examined quantitatively in a laboratory based setting.

Studies 3 and 4 examined putting performance again in a laboratory setting. Although the putting task was unlike putting on a golf course and did not require the participants to 'hole' a putt, but to land a putt as close to a clearly marked target on the putting green, the task did require participants to make a number of judgements characteristic of a 'real life' golf putt. Specifically, participants were required to judge the speed and length of the putt and, owing to the nature of the scoring system, adapt the 'weight'. However, it should be acknowledged that the target method allowed considerably higher vertical error in comparison to that which would occur in an actual golf putt and thus, quite often a putt that may have resulted in a ball being holed in a real putting task, rolled beyond the target in the task used herein. Therefore, it could be argued that the task was not a true test of putting ability.

While the putting task may not have reflected a 'real' putt, the adapted task was employed in order to have a dependent measure sensitive enough to reveal slight disruptions in performance. Previous studies have used large numbers of trials to address the limited sensitivity of using a 'real' putt (Masters, 1992; MacMahon et al., 1997) however, this would have been problematic in the present research studies due to the sheer number of putts that would have been required, which could have lead to boredom and even fatigue. The adapted task has in fact been successfully adopted in previous research of a similar nature (e.g., Beilock, Bennett, Bertenthal, McCoy, & Carr, 2004) and when expert golfers were asked for their opinions on the task in question; they stated that putting toward a target is an exercise often practiced in order to increase putting ability.

***7.4.2.2 Generalisation of results across the sporting population.*** Although an attempt was made to examine a variety of sports throughout the programme of study, it can be argued that the results from specific studies included do not transfer across the board. Having acknowledged this, it can be suggested that while there are direct implications for the sports employed, there are a number of sports that comprise similar skill characteristics, and thus, the findings could be used tentatively as a basis on which to predict the effects of self-focus and priming. For example, the findings of Study 1 could be employed to loosely predict the processes of the performance-pressure relationship, in sports of a similar nature, such as running, rowing, climbing and cycling. In relation to the latter studies, it can be inferred that the scrambled sentence task would be effective in promoting performance in such skills as a drive in golf, a basketball free-throw, a penalty shoot and many other closed skills.

### 7.4.3 Research Methods

***7.4.3.1 Triangulation.*** Although an attempt was made to adopt both qualitative and quantitative research methods within the present programme of study, it is possible that adopting qualitative methods to complement the quantitative data in Studies 2-4 may have been advantageous. One limitation in particular relates to the lack of awareness tests regarding the primes following completion of experiments. Specifically, participants may have become aware that the target words in blocks of sentences were unidirectional, particularly in the sport-specific conditions, which could have subsequently compromised the effectiveness of the prime. Therefore, in hind-sight, it would have been advantageous to question the participants regarding their awareness of the prime content following their participation and prior to their debriefing of the nature of scrambled sentence tasks.

Exercising triangulation could also have been beneficial through collecting questionnaire data in Study 1 and further questionnaire data in Study 4 (e.g., Reinvestment Scale: Masters, 1992). In Study 1 this could have provided more insight into the individual experiences of those who rate high in reinvestment in comparison to those who score low in reinvestment, providing more information about the differing cognitive processes that are engaged in when under pressure. Further, in Study 4, scores could have been used to differentiate between high and low reinvesters to find out if there were differential performance effects as a result of the pressure and the priming manipulation.

***Design.*** A within group design was adopted throughout Studies 2-4 and thus there was an increased possibility of a cross-over of the primed effect from condition to condition. When considering the results, the filler-task and the counterbalancing included in an attempt to avoid a cross-over appear to have been effective. However, a replication of this study with a between groups design might be advantageous.

## 7.5 Future Recommendations for Research

### 7.5.1 Processes of Choking

The present studies, in particular Study 1, highlight the need for further investigation of the potential interactive relationship between PET and self-focus theories (specifically CPH). Examination of the direct comparisons of the two proposed theories has been attempted (Wilson et al., 2007a; b), but more recent work (e.g., Edwards, et al. 2002; Hill et al., 2009; Lam et al., 2009) and the present research suggests rather than competing models they are actually complimentary. Thus, in order to progress and develop further understanding in this area, it would be of benefit to conduct additional qualitative research, ultimately, immediately following performance. Research conducted in such as way could allow further evidence to obtained in relation to the consequences of pressure experienced by elite athletes.

Another area that has not been explored adequately in this programme of research is related to facilitative skill-focused attention, termed heightened awareness, that was evident from the athletes who participated in Study 1and of which the notion was utilised to develop the sport-specific scrambled sentence priming task. Further understanding regarding this level of facilitative conscious control could shed light on the entire process as well as providing further options for potential aids in promoting performance under pressure. This could be achieved through further qualitative research examining the cognitive process and attentional cues used by elite performance athletes.

**7.5.2 Priming**

With the successful results of the studies related to priming throughout the present programme of research there are further research steps that can be made to strengthen the case for priming and to extend support for its utilisation in an applied context. First, a natural progression from Study 4 would be to develop and test the efficacy of the sport-specific priming tool on the performance of other skills within golf, such as the drive. This would provide information as to whether priming effects vary across skills within the same sport. Second, while universal primes could be tentatively used at present within sports and skills other than the golf putt, it is clear that development and examination of sport-specific priming tasks for other sports are warranted. Third, despite the contribution to knowledge provided by the experimental chapters, the mechanisms that are associated with the effects of priming on motor skill execution remain relatively unknown. Therefore, another area worthy of future examination would be to investigate the effects of priming on motor skill execution more closely. For example, motion analysis technology and/or drive analysis launch monitor software, such as TrackMan™, could be used to obtain specific performance measures (e.g., joint angles, swing velocity, launch angle, initial ball velocity, direction and distance), similar to the data collected on baseball hitting kinematics by Gray (2004). These measures might provide further information on the effects of the prime and potentially identify if there are any particular elements of a skill that are most affected as a result of the prime.

Further, while examination of the efficacy of the sport-specific priming task under high-pressure was addressed in the present programme of research, further examination is necessary. Specifically, it is necessary for this research to be conducted in a more ecologically valid setting. Whereas experimental laboratory based experiments are vital in proving an initial understanding of tools such as the one used herein, as already discussed, it is difficult to match the levels of pressure that are experienced in high stakes competitive environments in the library. Therefore, an additional avenue for future research could test the effects of priming task under the same pressures that golfers would experience in high stakes point in tournaments, such as real-life competitions.

Finally, although the scrambled sentence tasks have proven relatively successful throughout this research programme, there is still relatively little known about the long-term effects of such a prime. In addition, one may question the efficacy of long term use; it is likely that following repeated trials athletes will become aware of the purpose of the scrambled sentence task or at least question it. Therefore, an exploration of the effectiveness of this technique when athletes are aware of its purpose along with development of an arsenal of priming methods would be beneficial for coaches and thus warrants attention in future research.

### 7.6 Summation of Applied Implications

The results of the priming studies have provided support for the efficacy of priming as a means to promote performance under very little pressure and in situations where pressure had been increased slightly. Although there are logical pathways for future research in order to increase the support for such methods, there are some implications for coaches and practitioners working with elite athletes.

These individuals should be aware of the concept of self-focus and the impact that differential levels may have. Specifically, they need to be aware of the negative impact of conscious processing and the detrimental effects excessive processing can have, as well as the potentially facilitative nature of skill focus, termed ‘heightened awareness’.

Given the positive results regarding the efficacy of the sport-specific priming task on putting performance under increased pressure in Study 4, it is possible to tentatively recommend the utilisation of such a priming tool for all aspects of the game, for example, a scrambled sentence task could be completed prior to a round of golf. It is possible that a priming task completed prior to a round could lead to effects lasting the entire round. Yet, due to the retention period observations in Study 2, and the acknowledged requirement for further research into the retention of behavioural effects (see Study 2), it is likely that completing additional tasks throughout a round would be required. As demonstrated in Study 2, primed behaviours were retained for at least 60 minutes, and considering that the British Open (2010) winner, Louis Oosthuizen, completed his four rounds on average in four hours and 36 minutes (Round 1: 4hrs, 52mins; Round 2: 4hrs, 37mins; Round 3: 4hrs, 37mins; Round 4: 4 hrs, 29 mins, www.telegraph.co.uk), five tasks could be required. This is a reasonable suggestion given that recent results from the PGA tour have indicated that some Par 5 holes are reachable in 3 strokes, and some Par 4 holes in 2 strokes, which means it is common for golfers to have small periods of time where they are waiting on the Tee for the green to be clear. Therefore, this time could be utilised to complete a short priming task.

In relation to the positive results associated with the universal prime (see Study 2) and whilst specific primes for other sports are being developed and examined, the universal task could be deemed appropriate for use in other sports, It can be cautiously suggested that participants engaging in sports with similar skill characteristics, for example, basketball, could be equally responsive to these primes.

### 7.7 Conclusion

The aim of the present programme of research was to add to the present body of knowledge regarding the performance-pressure relationship and the underlying mechanisms of choking. The second aim was to utilise the knowledge of the processes governing choking, to develop a theory-matched tool based on priming, refine it and ensure that, under heightened pressure, it remained effective. Initially, further support was found for the notion of a combination of the predictions of self-focus theories (particularly CPH) and PET as a reasonable explanation for the mechanisms underlying choking. In addition, it was found that not all skill-focused attention is detrimental to expert skill execution and that elite athletes engage in a facilitative mode of skill-focused attention, termed 'heightened awareness' in this thesis. Further, it was demonstrated that a scrambled sentence task based on priming was effective in promoting performance of motor skills such as football dribbling and golf putting, under low-pressure and high-pressure. Specifically, examination of variations of the priming task revealed that the effects in skill execution were associated with the attentional processes that are linked to performance execution and provided further support for its efficacy to prevent choking.

As a result of the present programme of research, a number of avenues for further enquiry have been identified. In relation to obtaining further understanding of performance under pressure, future research should address the potential combination of theories in explaining the choking process, in addition to the concept of heightened awareness. Further, the effects of priming on motor skill execution should be considered with regard to the type of skill being performed, the level of pressure being experienced, and the duration of the primed effect, using additional performance measures (e.g., kinematic analysis). It is anticipated that findings from such research will advance our knowledge within the framework of performance under pressure and the priming of motor skill behaviour. Consequently, it is anticipated that the emergent line of investigation will provide a significant contribution to the literature coupled with clear recommendations for athletes who experience performance decrements under pressure.

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# Appendices

## Appendix A

## Participant Information and Informed Consent

### Participant Information

This research will require you to attend 1 session lasting approximately 1 hour. You will perform 7 blocks of a golf putting task, 3 of which will be part of a competition involving all participants in the study. The purpose of this study is to examine the accuracy of your putting.

You will also be completing sentence scrambling tasks as part of an additional research project into sentence construction.

Any information or data will be kept confidential and your identity will remain anonymous in any presentation of material unless consent has been given to do so.

There are no known risks or any discomfort associated with your participation in this study.

You are encouraged to ask any questions regarding the procedures of the study which are to be directed to the researchers, either Danielle Adams (Danielle.Adams@Brunel.ac.uk Tel: 07919 623387), Dr Kelly Ashford (Kelly.Ashford@Brunel.ac.uk) or Dr Robin Jackson (Robin.Jackson@Brunel.ac.uk).

You are free to withdraw from any part of the study at any time without penalty.

### Declaration of Informed Consent

1. I have been informed that the general purpose of this study is to assess my performance in a putting task.
2. I have been informed that my participation in this study will involve me attending 1 session, lasting approximately 1 hour.
3. I have been informed that any information or data I provide will be kept confidential and that my identity will be kept anonymous in any presentation of this material unless I have given my consent to do so.
4. I have been informed that there is no known discomfort or any risk expected as a result of my participation in this study.
5. I have been informed that the researchers will answer any questions regarding the procedures in this study at any stage.
6. I have been informed that I am free to withdraw from any part of the study at any time without penalty.
7. I understand that if I have any concerns about this project I can contact Danielle Adams, Dr Kelly Ashford or Dr Robin Jackson.
8. I acknowledge I have received a copy of this form and that I understand the above instructions regarding my participation in this study.

*I give my informed consent to participate in this study that assesses golf performance. I consent to publication of study results as long as the information is anonymous and disguised so that I cannot be identified. I further understand that although a record will be kept of my having participated in the study, all experimental data collected from my participation will be identified by number only.*

Name of participant (print): ______________________________________________

Email address: ________________________ Handicap: _________ Age: _____

Signature: ________________________________ Date: ________________

Researcher signature: ________________________________ Date: ________________

Note: Specific wording of the study information and declaration for each study vary slightly in accordance with the nature of the research.

# Appendix B

## Fluency/Universal (long) Scrambled Sentence Task

**Please use four out of the five words presented to form an understandable phrase. Write the phrase in the space provided.**

1. body about my relaxed is

2. automatic my to are movements

3. which am I motivated highly

4. I at am on ease

5. focused if am I mentally

6. I off challenge the met

7. performance has that my improved

8. performed are be movements automatically

9. perform I successfully that shall

10. I concentration have of total

11. feeling if am I positive

12. movements are on effortless the

13. think always what positively I

14. am some immersed I totally

15. extremely to went everything well

---

16. happen movements spontaneously when my

---

17. it I concentration complete have

---

18. my much is performance great

---

19. well I prepared one am

---

20. my waivers on never concentration

---

21. goal if my clear is

---

22. movements if flow seem to

---

23. feeling am I just confident

---

24. focused mind to is my

---

25. together everything off just came

---

26. feel in I calm very

---

27. attention is much my focused

---

28. task enjoyable about the is

---

29. my for channelled is energy

---

30. task enjoyable about the is

---

# Appendix C

## Skill-focus Scrambled Sentence Task

**Please use four out of the five words presented to form an understandable phrase. Write the phrase in the space provided.**

1. concerned the technique my about

___

2. important worrying presentation is self

___

3. performance about self-conscious my appearance

___

4. making is decisions hard difficult

___

5. make skill nervous me spectators

___

6. arm awareness movements you of

___

7. was self-conscious feeling play I

___

8. of concentration frequently wavers my

___

9. look wondering appear I how

___

10. my were jerky was movements

___

11. technique on I the focused

___

12. the keep under close ball

___

13. important position is hip correct

___

14. surfaces all about foot use

___

15. flexed me legs both are

16. your inside down keep haunches

17. slightly internal leaned I forward

18. speed I on sat focused

19. accurately dribbling must important is

20. be bent should up knees

21. feet between dribble my space

22. technique my focus important on

23. moving are quickly around feet

24. guide feet ball the cones

25. help balance to arms me

26. foot watch inside my dominant

27. balance me about I thought

28. in-step out-step foot and using

29. ball carefully dribble the cones

30. the watched I ball he

## Appendix D

## Neutral Scrambled Sentence Task

**Please use four out of the five words presented to form an understandable phrase. Write the phrase in the space provided.**

1. now legs have four tables
2. and hard the ground is
3. houses where live people in
4. university their am I at
5. the flat square box is
6. square round the is world
7. are there four the seasons
8. down the fell tower and
9. the miserable is weather a
10. green is purple grass the
11. the went university big is
12. where bicycles wheels have four
13. school children have go to
14. now the blue sky is

15. erase can rubbers it work

16. five cars wheels have four

17. when cows dairy milk produce

18. hayfever produces pollen can cause

19. sea at boats sail is

20. for storage when cupboards are

21. important journal information a contain

22. the it temperature thermometers measure

23. every two hands I have

24. lay can chicken some eggs

25. our liver hearts beat always

26. pens are we write with

27. some mouse mickey is a

28. I found watching sport like

29. yellow sun shines always the

30. paper hold rubber staples together

## Appendix E

## Universal (short) Scrambled Sentence Task

**Please use four out of the five words presented to form an understandable phrase. Write the phrase in the space provided.**

1. performance my this improved has

___

2. is the as smooth movement

___

3. mind my is focused and

___

4. enjoyable the do is task

___

5. at met I challenge the

___

6. energy my channelled is in

___

7. on came just together everything

___

8. performance my it great is

___

9. am I feeling in positive

___

10. complete up have I concentration

___

11. is movement the effortless but

___

12. my relaxed of body is

___

13. am I as motivated highly

___

14. focused my do is attention

___

15 feel control in I with

___

**Appendix F**

**Sport-specific (long) Scrambled Sentence Task**

**Please use four out of the five words presented to form an understandable phrase. Write the phrase in the space provided.**

1. well is about putting enjoyable

2. to on prepared putt I'm

3. putting I focus to on

4. in automatic stroke the is

5. if performance putting my improved

6. his putting totally concentrated on

7. must golfers positively to think

8. putting I on and concentrate

9. putt thing the spontaneously happens

10. putted I if ease with

11. the to effortless is putt

12. swing if my relaxed is

13. attend I in putting to

14. great on golf my is

15. putt in the well went

16. is performed who putting automatically

17. golf some calmly I play

18. ball top the in goes

19. smooth my stroke an is

20. I putt will if successfully

21. play I into well golf

22. putting not energy to channelled

23. but are motivated highly golfers

24. automatically of the flowed putt

25. to the great putt is

26. control putting when of in

27. focused is putting my that

28. positively about feeling golf which

29. the into ball hole on

30. together in my putt came

## Appendix G

## Sport-specific (short) Scrambled Sentence Task

**Please use four out of the five words presented to form an understandable phrase. Write the phrase in the space provided.**

1. flowed but the putt automatically
______________________________
2. relaxed and swing is my
______________________________
3. my focused is putting at
______________________________
4. putt will to successfully I
______________________________
5. in motivated are golfers highly
______________________________
6. is to stroke my smooth
______________________________
7. to channelled on energy putt
______________________________
8. is putting enjoyable well in
______________________________
9. the is effortless he putt
______________________________
10. I in well golf play
______________________________
11. on totally about putting concentrated
______________________________
12. I golf into play calmly
______________________________
13. great my on is putting
______________________________
14. but think must positively golfers
______________________________
15. focused putting and I'm on
______________________________

## Appendix H

## Neutral (short) Scrambled Sentence Task

**Please use four out of the five words presented to form an understandable phrase. Write the phrase in the space provided.**

1. now legs have four tables

2. and hard the ground is

3. houses where live people in

4. university their am I at

5. the flat square box is

6. square round the is world

7. are there four the seasons

8. down the fell tower and

9. the miserable is weather a

10. green is purple grass the

11. the went university big is

12. where bicycles wheels have four

13. school children have go to

14. now the blue sky is

15. erase can rubbers it work

## Competitive State Anxiety Inventory-2R

A number of statements that athletes have used to describe their feelings before participating in sport are given below. Read each statement and circle the appropriate number in Section 1 to indicate *how you feel right now* about this experiment. There are no right or wrong answers. Do *not* spend too much time on any one statement, but choose the answer which best describes your feelings *right now*. Additionally, in Section 2 please indicate whether you regard this thought/feeling as negative (debilitative) or positive (facilitative) in relation to your performance.

| Section 1: Please read each statement and then circle the appropriate number to the right of the statement to indicate *how you feel right now.* | | | | | | Section 2: Please indicate whether you regard this thought/feeling as negative (debilitative) or positive (facilitative) in relation to your performance | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Not at all | Somewhat | Moderately so | Very Much so | | Very debilitative | | | Neutral | | | Very Facilitative |
| 1) I am concerned about this experiment | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 2) I feel jittery | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 3) My body feels tense | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 4) I am concerned about losing | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 5) I feel tense in my stomach | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 6) I am concerned about choking under pressure | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 7) I'm concerned about performing poorly | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 8) My heart is racing | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 9) I feel my stomach sinking | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 10) I'm concerned that others will be disappointed with my performance | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 11) My hands are clammy | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |
| 12) My body feels tight | 1 | 2 | 3 | 4 | | -3 | -2 | -1 | 0 | +1 | +2 | +3 |

## Appendix J

## CSAI-2R Score Sheet (Cox, Martens, & Russell 2003)

Cognitive Anxiety (Cog)

Add items 1, 4, 6, 17, and 10

Somatic Anxiety (SomA)

Add items 2, 3, 5, 8, 9, 11, and 12

Subscale scores are obtained by summing the items, dividing by the number of items, and multiplying by 10. Scores range from 10-40 for each subscale. If an athlete fails to respond to an item, merely sum and divide by items answered.

## Appendix K

## List of Publications Emanating from the Present Programme of Research

Adams, D., Ashford, K. J., & Jackson, R. (2009). The efficacy of priming as a means of promoting fluent motor behaviour. Proceedings of the 14th annual congress of the European College of Sport Sciences conference, Oslo, Norway.

Adams, D., Ashford, K. J., & Jackson, R. (2009). A qualitative investigation into choking under pressure. Proceedings of the 12th World Congress of Sport Psychology, Marrakech, Morocco.

Adams, D., Ashford, K.J., Jackson, R. (2010). The efficacy of priming as a means of promoting fluent motor behaviour. Proceedings of the 25th annual congress of the Association for Applied Sport Psychology Annual Conference, Rhode Island, USA.