THE ROLE OF DISPOSITIONAL REINVESTMENT IN CHOKING DURING DECISION-MAKING TASKS IN SPORT

A thesis submitted for the degree of Doctor of Philosophy

By

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Abstract

This thesis examines the moderating effect of dispositional reinvestment upon ‘choking’ in cognitive based tasks such as decision-making. Study 1 tested sixty-three participants’ performances on low- and high-complexity tests of motor skill, psychomotor skill and working memory under low- and high-pressure conditions. The association between reinvestment and choking was shown to extend beyond the motor skill domain to cognitive tasks, particularly those that tax working memory, with task complexity moderating this relationship. Next, a psychometric scale to identify individuals more susceptible to impaired decision-making under pressure was developed. A 13-item decision-specific version of the Reinvestment Scale (Masters, Polman, & Hammond, 1993) measuring an individual’s propensity to engage in conscious control and manifestations of ruminative thoughts emerged following factor analysis. Initial assessment of the scale’s predictive validity showed scores were highly correlated with coaches’ ratings of players’ tendency to choke. The final two studies examined choking using sport specific decision-making tasks. Initial findings were inconclusive, as choking was not observed. It was suggested the task lacked the sufficient cognitive demands to induce reinvestment. The last study, manipulating task complexity, found dispositional reinvestment to be associated with choking in the high complexity condition. The Decision-Specific Reinvestment Scale was also shown to be a better predictor of choking than the original scale. Overall, support was found for the hypothesis that Reinvestment is detrimental to performance under pressure in cognitive based tasks; however may not be the sole cause of disrupted performance. Masters and Maxwell’s (2004) concept of a working memory based explanation and Mullen and Hardy (2000) attentional threshold hypothesis offer a potential explanation to the findings.

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Chapter 1: Introduction

1.1 Study Context

Today's modern athlete is undoubtedly better rewarded than those of yesteryear. Greater, wages, bonuses, prize money and sponsorship deals have resulted in the earning potential of many elite athletes reaching heights that are unfathomable to those who passionately follow their exploits. However, with such rewards available and a concomitant increase in intense media scrutiny, participation is often accompanied by huge psychological pressure stemming from the need to succeed. Indeed, instances of unexpected failure at crucial points often provide the media with a bigger story than those of success. The phenomenon of "choking" in sport is one that has interested the media and researchers for decades. Broadly defined as the occurrence of poor performance in spite of high motivation and incentives for success (Baumeister, 1984), choking in a sporting context has predominantly been examined using proceduralised motor skills (Jackson, Ashford & Norsworthy, 2006; Masters, 1992; Masters, Polman & Hammond 1993). Media representations of choking also commonly report on the breakdown of motor skills. Some of the most commonly referenced examples of choking refer to the performances of Greg Norman and Jana Novotna. Norman will forever be remembered for giving up a six-stroke lead in the final round of the 1996 U.S. Masters golf tournament, eventually losing to Nick Faldo by five strokes following a round of 78. This was some fifteen shots more than his course record equalling score of 63 set just three days before. Jana Novotna's display in 1993 was arguably the greatest disintegration ever witnessed in a Wimbledon final. Serving at 40-30 with a 4-1 lead in the deciding set, Novotna's double-fault initiated a complete capitulation in performance to the extent that Steffi Graf was being crowned champion just over 10 minutes later.

It is not only motor skills that can suffer as a result of increased pressure, the failure to make the correct decision under pressure can be equally detrimental to success. At the 1999 Open Championship at Carnoustie, golfer Jean Van de Velde only needed a double-bogey six on the final hole to win the tournament. Despite a three-shot lead, he decided to use his driver off the tee, and proceeded to drive the ball to the right of the burn, luckily finding land. Even more crucially, he then decided to go for the green with his second shot rather than what appeared to be the safer option of 'laying up'. His second shot drifted right and hit the grandstands on the side of the green, bounced off a rock and landed fifty yards back in knee deep rough. Hacking through the rough, his third shot flew into the Barry Burn and after a lengthy debate, and quick paddle in the water, he took a drop only to find the greenside bunker with his fifth shot. After firing to six feet from the hole, Van de Velde putted for a triple-bogey seven, dropping him into a three-way playoff, which he eventually lost to Paul Lawrie.

In a more time-constrained environment, Formula One racing driver Lewis Hamilton's recent performances provide further illustrations of poor decision making. With six races remaining Lewis Hamilton led the Formula One championship by three points over Mark Webber whilst holding a 41 point advantage over Fernando Alonso. Two races later and Hamilton fell to third place, 20 points behind championship leader Webber and even trailing Alonso by nine points, courtesy of two key decisions that have severely damaged his title aspirations. At Monza, Hamilton's hopes of defending his championship lead ended at the second chicane on the first lap as he was trying to take advantage of a battle between the two Ferrari drivers. Hamilton decided to try and pass Massa on the inside but collided with Massa’s rear wheel which in turn broke the suspension of Hamilton's car. Reflecting on the incident Hamilton said "In a realistic world I perhaps should've stayed there a while. I put my car up the inside and tried to get third - it was obviously a little bit too much.” Two weeks later in Singapore Hamilton found himself directly behind his rival Webber with Alonso leading. Hamilton decided to try to overtake the Australian after a restart by passing him on the outside, the two collided and Hamilton's race was over, and with it his title aspirations. Akin to Hamilton’s maiden season (where he was championship favourite until errors in the final two rounds cost him the title to Kimi Raikkonen), he lost the championship to Sebastian Vettel, finally finishing in fourth place behind Fernando Alonso and Mark Webber; thus illustrating the consequences of poor decision-making in high pressure situations.

Research exploring the underlying processes that govern the choking phenomenon in motor skills has often been conducted through self-focus theories, which suggest that performance pressure increases self-awareness about performing correctly causing individuals to attempt to consciously control normally automatic processes and behaviors. The most prominent of these is reinvestment theory (Masters, 1992) which has also been examined from an individual differences perspective (Masters, Polman, & Hammond, 1993). While there have been no investigations specifically measuring cognitive skill failure in sport, explanations of skill failure under pressure in cognitive-based tasks such as mathematical solutions have tended to focus on distraction-based theories, which suggest that increases in performance pressure provoke a shift in focus of attention to task-irrelevant cues (DeCaro, Rotar, Kendra, & Beilock, 2010). The current thesis aims to examine the applicability of reinvestment theory when examining choking in the more cognitive elements of sports performance, particularly in relation to decision making. In addition, it aims to develop and validate a psychometric instrument that can identify individuals with a greater predisposition to making poor decisions under pressure.

1.2 Thesis Overview

The current introduction is followed by a review of the extant literature, which introduces the theoretical concepts and offers critical appraisal of the empirical research that underpins the current line of investigation. Drawing from research in social and cognitive psychology, it develops a thorough and detailed account of the research topic housed in a sport psychology context. Chapters 3 to 6 focus on the four studies that comprise the research programme. These chapters are presented independently as 'stand-alone papers' but are interrelated and examine specific hypotheses in order to contribute to the existing body of knowledge, developing areas that currently lack depth and clarity in understanding. First, Chapter 3 examines the moderating effect of dispositional reinvestment on choking in motor and cognitive tasks. Chapter 4 is focused on the development of a psychometric instrument, based on the Reinvestment Scale (Masters et al., 1993), which aims to highlight individual differences in the propensity for engaging in conscious control and ruminative behaviors with respect to decision making. In Chapter 5, a study is presented that examines susceptibility to choking in a badminton perceptual judgment task that requires rapid decisions to be made regarding the intentions of an opponent. Additionally, the predictive validity of the Decision-Specific Reinvestment Scale and original Reinvestment Scale are compared. After failing to find evidence of choking in the badminton judgment task, Chapter 6 focuses on the issue of task complexity by examining decision making in a team sport (basketball) using 3-on-3 and 5-on-5 offensive plays. Again, the predictive validity of the Decision-Specific and original Reinvestment Scales are scrutinized.

The four experimental chapters are written as standalone papers and due to the common themes that run through the thesis, there is inevitably some repetition of literature-based information. Also, when referring to Experiment 1 and 2 later in the thesis, the published versions of these experiments are cited (Kinrade, Jackson & Ashford, 2010; and Kinrade, Jackson, Ashford & Bishop, 2010, respectively). Finally, Chapter 7 contains a general discussion which summarizes the key findings from the experimental work presented, highlights the emergent themes and discusses the practical implications stemming from the research. The chapter concludes with consideration of possible limitations with the research presented herein, and highlights possible directions for future investigation.

Chapter 2: Literature Review

2.1 Introduction

The following review of literature provides the theoretical backdrop in which the current line of investigation was undertaken. It is structured to enable the reader to familiarize themselves with the body of knowledge pertaining to the research topic by examining operational definitions, conceptual models and theoretical explanations that have been derived from the plethora of empirical research over the last few decades. This aims to provide the reader with the necessary grounding with which to appraise the concepts examined in the following four chapters. Each of these research chapters contains its own brief introduction and rationale pertaining to its specific area of investigation.

The present chapter will begin by offering a clear definition to the central theme of the current research, choking, followed by an insight into the hypothesized causes. The main body of the review is concerned with the proposed processes that underpin this phenomenon; specifically, distraction and reinvestment accounts of choking. Following this, evidence for mediating factors associated with choking will be addressed. Finally, the concept of decision-making in sport will be discussed, and conclusions drawn that lead into the rationale for the present programme of research.

2.2 Defining Choking

The concept of choking was initially defined by Daniel (1981) as “the inability to perform up to previously exhibited standards” (p. 70). However, this vague description of the phenomenon mirrors its colloquial use in the media. The term choking is often used in the media to describe just about any sub-optimal sports performance. Terms such as “choker” or, more derisively, “choke artist” are commonly used to describe individuals or even teams who fail to win a game or tournament after being strongly favored to do so. The issue with such a broad definition is that it fails to take into account external variables such as the opposition, motivation and the random variation of such instances occurring. A desire to achieve is vital for optimal performance and random fluctuations of skill happen to all athletes at some point during their careers. Baumeister's (1984) definition of choking under pressure defined the phenomenon as "performance decrements under circumstances that increase the importance of good or improved performance" and highlighted that pressure described "any factor or combination of factors that increases the importance of performing well" (p. 610). Closer inspection of each definition highlights inclusion of the term pressure as superfluous considering the latter half of the definition for choking, however Baumeister's definition certainly improved on the early description by Daniel (1981). Similarly, Baumeister and Showers (1986) referred to the term "paradoxical performance effect" that they further defined as "the occurrence of inferior performance despite striving and incentives for superior performance" (p. 361).

These definitions both address shortcomings of the early definition by encapsulating two vital elements: poorer performance and situational incentives. However, issues are still inherent in that inferior performance in the above situation could still occur as a result of an injury or adverse weather conditions. Indeed, Leith (1988) conceptualised the phenomenon by describing three different types of performance the term choking should be used to describe, citing perfect performance in practice accompanied with poor performance in game situations, successful performance in all games except the most important game and acute skill failure at clutch moments despite optimal performance throughout the rest of the game. Beilock and Gray (2007) looked to focus the definition by describing choking as "poor performance in response to what an individual perceives as an important and stress filled situation" (p. 426). Despite greater specificity, Gucciardi and Dimmock (2008) still draw criticism due to the lack of quantification applied to the term sub-optimal performance, suggesting that the choke only applies to a significant deterioration in performance rather than any poorer performance under pressure. The most recent definition comes from Hill, Hanton, Fleming and Mathews (2009) who drew on other research supporting the need to make reference to the acute nature of the phenomena (e.g., Clark, Tofler, & Lardon, 2005; Wilson, Chattington, Marple-Horvat & Smith, 2007). Using a grounded theory approach, analysis of qualitative data taken from interviews with four "experts" of applied sport psychology resulted in choking being defined as "a stress response that concludes with a significant drop in performance" (p. 203).

Baumeister and Showers (1986) well supported definition of choking was chosen to describe the concept in experimental chapters 3-6. However, when defining the phenomenon in regards to the current line of investigation presented within the thesis as a whole, the commonly associated link between anxiety and pressure (see Section 2.3.1) was also considered. Therefore, choking may be defined as a pressure induced deterioration in performance, often but not exclusively accompanied by feelings of increased anxiety, exhibited during situations where the performer is motivated and expected to succeed.

2.3 Theoretical Explanations

Despite the continued debate and lack of clarity concerning a widely accepted definition of choking, several theories have been proposed which attempt to explicate the mechanisms underpinning the phenomenon. The hypothesized theoretical explanations which aim to give a clearer picture of the choking processes can broadly be divided into two categories: drive theories or attentional theories.

2.3.1 Arousal Theories. General Arousal theories propose that performance is affected by an individual's current level of arousal or drive (Spence & Spence, 1966). Arousal is the intensity dimension of behavior, the general state of activation ranging on a continuum from deep sleep to extreme excitement (Gill, 2000). It is said to be a multi-dimensional construct, encompassing both physiological and psychological elements (Gould, Greenleaf & Krane, 2002). However, specific details regarding the precise way arousal affects performance have been subject to much debate. Hull's (1943) drive theory proposed a linear relationship between arousal and performance (See Figure 2.1) that suggests as arousal increases so does quality of performance. This theory however, has come under much criticism (Fisher, 1976; Martens & Landers, 1970) being considered too simplistic to explain athletic performance and fails to account for any performance decrements under pressure.

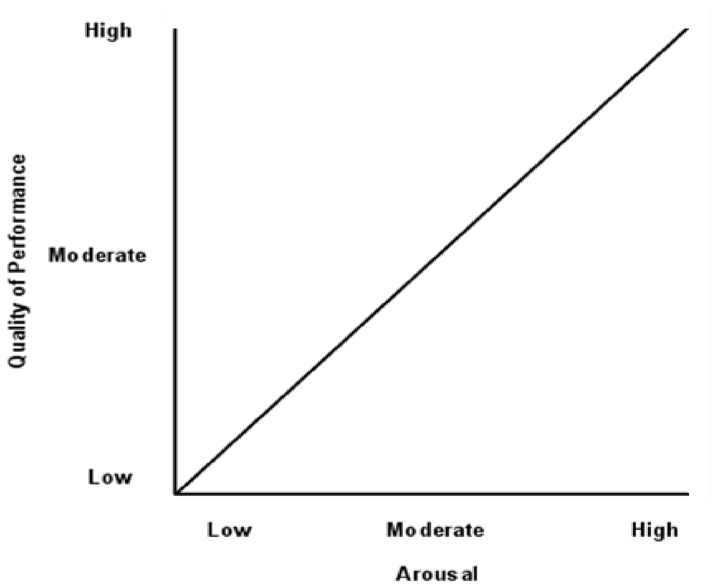

Figure 2.1. Hull's (1943) proposed drive theory.

Yerkes and Dodson's (1908) inverted-U hypothesis suggests a curvilinear relationship, suggesting that as arousal increases so does performance until reaching an optimal point whereby any further rise in arousal levels leads to a decrement in performance (see Figure 2.2). Essentially, arousal must be at an intermediate level, too much or too little arousal will result in sub-optimal performance. Despite empirical evidence supporting this theory (Klavora, 1977; Sonstroem & Bernado, 1982), it too, has come under criticism regarding the shape of the curve, lack of consideration of the multidimensional nature of arousal, and failure to distinguish between individual differences when performing the same skill (Neiss, 1988).

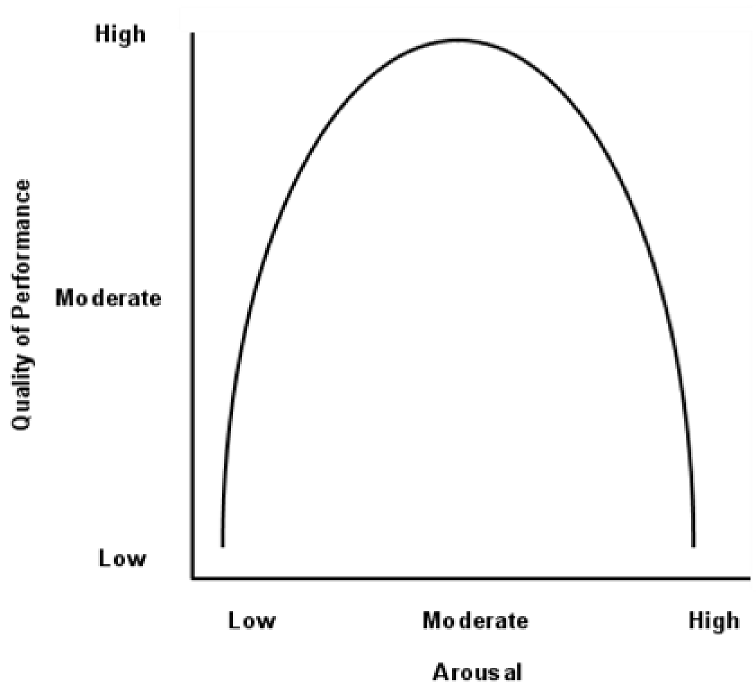

Figure 2.2. The Inverted-U hypothesis (Yerkes & Dodson, 1908).

Hanin (1989) moved away from the broader description of arousal focusing on the role of anxiety and performance under pressure. Anxiety has been defined as "a negative emotional state characterised by nervousness, worry, and apprehension and is associated with activation or arousal of the body" (Weinberg & Gould, 1999,

p. 72). Individual zones of optimal functioning theory suggests there is a bandwidth, rather than specific point, at which optimal performance can be attained and that this zone is specific to the individual. While this theory has received some support (Raglin & Turner, 1993; Randle & Weinberg, 1997) it considers anxiety as a unidimensional concept and fails to fully explain the interaction of individual differences variables (Gould & Tuffey, 1996).

Martens, Vealey and Burton, (1990) conceptualized anxiety as consisting of a cognitive component identified by negative self evaluations or expectations and worry, and a somatic component recognized by the perception of physiological manifestations of stress, and can occur chronically (trait) or acutely (state). They originally hypothesized that the two components would have differing relationships with performance, suggesting a negative linear relationship with cognitive anxiety, while somatic anxiety displayed an inverted-U relationship. Subsequent support for this theory has been rather ambiguous with several authors attributing observed differences to other factors including skill level (Martens, Vealey, Burton, Bump & Smith, 1990), and competitiveness (Swain & Jones, 1992). Additionally, the theory fails to consider the interaction between the multi-dimensional components, rather examining them as independent relationships (Woodman & Hardy, 2001).

To address the issues raised with the multidimensional theory of anxiety Hardy (1990) adapted the cusp catastrophe model to provide a three dimensional illustration of the anxiety-performance relationship. The model (Figure 2.3) demonstrates how, at high levels of cognitive anxiety, performance and physiological arousal share a positive curvilinear relationship up to a point. Beyond this point, even small increases in physiological arousal can result in a dramatic plunge in performance as opposed to the more steady decline predicted by the inverted-U hypothesis. Catastrophe theory also predicts that recovering from such sudden declines in performance can be difficult. A major strength of catastrophe theory is that it considers the interaction between cognitive anxiety and physiological arousal in determining performance. As with previous theoretical explanations this theory has received support (e.g. Hardy, Parfitt & Pates, 1994) and criticism (see Tenenbaum & Becker, 2005) with Hill, Hanton, Mathews and Fleming (2010) concluding that further research is required to establish this theory as an explanation for choking.

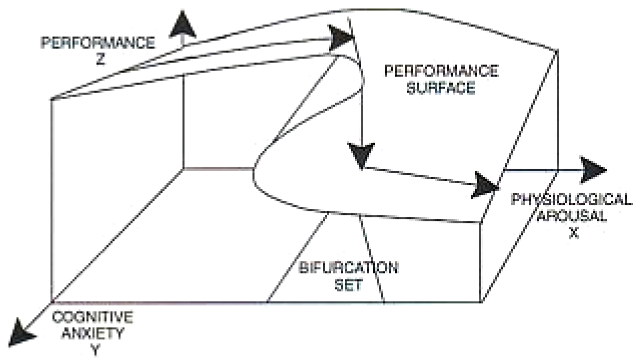

Figure 2.3. The Cusp Catastrophe Model (Hardy, 1990).

It should be noted that although arousal-based theories provide a useful explanation for some types of performance failure they suffer from three major limitations. First, they are descriptive, giving little insight into the mechanisms that cause the performance failure. Second, there is conflict within the theories as to how arousal should be conceptualised; and finally, they fail to account for a number of situations where performance failure is observed (Beilock & Gray, 2007). One such theory that looked to apply a mechanistic explanation to the inverted-U hypothesis is Easterbrook's (1959) cue utilization hypothesis, which suggest that increases in anxiety results in attentional narrowing. At low levels this narrowing aids performance by filtering out task irrelevant cues. However, high levels of arousal causes attention to narrow beyond optimum levels resulting in task relevant information being rejected and thus performance deteriorates.

2.3.2 Attentional Theories. Considering the aforementioned limitations of arousal-based theories, attentional theories offer an attempt to describe the processes underlying choking (Hill et al., 2010). Attentional theories aim to describe how the attentional mechanisms and memory structures are influenced by pressure and the subsequent impact these changes have upon performance (Beilock & Gray, 2007). They can be divided into two main theoretical frameworks; distraction and self-focus accounts, which draw evidence from differing backgrounds in order to explain choking.

2.3.2.1 Distraction Theory. Distraction-based accounts of choking view skill failure as a consequence of overloaded working memory. Working memory described as the "desktop of the brain" (Logie, 1999, p. 174) encompasses a compilation of distinct systems involved in cognitive functioning. Baddeley and Hitch's (1974) model of working memory describes three main components, the key contrivance being the central executive, which processes, stores and regulates the flow of information, retrieves information from alternative memory systems (e.g. long term memory) and co-ordinates its slave systems the visuo-spatial sketchpad and phonological loop (Baddeley, 1992). The former is concerned with the manipulation of material of a visual or spatial nature, while the latter provides temporary storage and manipulation of auditory verbal material (Logie, 1999). Baddeley (2000) has since added a fourth component, the episodic buffer. This third slave system of the central executive is responsible for linking information across domains to form integrated units of visual, spatial, temporal and verbal information.

Distraction theories propose that pressure creates a distracting environment by shifting attention towards task-irrelevant cues such as worries regarding the situation and importance of the outcome. These distracting cognitions consume working memory that is vital for holding, manipulating and processing task-relevant information necessary for successful performance. As a result, these competing demands create a dual-task environment that requires the individual to perform the task at hand while dealing with apprehension and manifested worry (Beilock & Gray, 2007). Support for this theory largely emanates from investigations utilising cognitive tasks that rely on working memory, such as complex math tasks (Ashcraft & Kirk, 2001). Beilock, Kulp, Holt, and Carr (2004), assessed individuals' performance on high- and low-complexity modular arithmetic tasks (Gauss, 1801) under conditions of low and high pressure. They found that only performance on the high-complexity modular arithmetic task deteriorated under pressure supporting the hypothesis that pressure reduced working memory capacity resulting in performance decrements on tasks that are more reliant upon working memory. Although not specifically examining performance under pressure, Beilock, Rydell, and McConnell (2007) examined this hypothesis using a different type of stress, negative performance stereotypes. Analyses revealed that women under stereotypical threat performed more poorly than controls (no negative stereotype) on problems heavily reliant working memory only. Beilock and Carr (2005) examined working memory from an individual differences perspective suggesting that the more working memory capacity an individual has, the better their performance on academic tasks (Engle, 2002). To explore how high-pressure situations influenced this assumption, individuals lower and higher in working memory were examined using the same experimental design highlighted in Beilock et al. (2004) and Beilock and Carr

(2005). It was found that only higher working memory individuals suffered performance decrements under pressure. In a follow-up study, Beilock and DeCaro (2007) examined the solution strategies used by each group. Again, using a similar experimental design they discovered that the high working memory group used more computationally demanding algorithms than the low working memory group in the low-pressure condition. Furthermore, under high pressure the high working memory group reverted to using the simpler solution strategies used by the low working memory group, and their performance duly suffered.

Similar to Beilock and colleagues' descriptions of distraction based accounts of choking; Eysenck and Calvo's (1992) processing efficiency theory examines the influence of cognitive anxiety, manifested as worry, on performance. The theory postulates that anxiety has two main effects. First, working memory's storage and processing resources are occupied by worry, producing performance decrements in cognitively demanding tasks. Second, anticipation of imminent skill failure results in additional processing resources (i.e., mental effort) being allocated in order to maintain performance (Wilson, 2008). Consequently, processing efficiency theory postulates that performance effectiveness is often less affected than processing efficiency due to increases in effort compensating for the depletion of attentional resources (Calvo, 1985). Furthermore, Eysenck and Calvo (1992) account for individual differences in the intensity of such responses to pressure, hypothesizing that individuals with high trait anxiety will be more likely to exhibit such responses compared to low-trait anxious individuals. Research evidence supports this prediction and indicates that there are fundamental differences between such individuals (Jerusalem, 1990). Moreover, an impressive body of research from within the mainstream cognitive psychology literature (e.g. Eysenck, 1996; Eysenck, Payne, & Derakshan, 2005) and a number of sport settings (e.g. Murray & Janelle, 2003; Williams, Vickers, & Rodrigues, 2002) has provided support for the predictions of processing efficiency theory (see Wilson, 2008, for a review). More recently, Eysenck, Derakshan, Santos and Calvo (2007) proposed an alternative attentional control theory to provide a more precise explanation regarding the specific functions responsible for skill failure under pressure. They suggest that anxiety disrupts the balance between two attentional systems (Corbetta & Shulman, 2002). More specifically, they propose the efficiency of the goal driven attentional system is impaired leading to a greater influence of the stimulus driven attentional system resulting in reduced attentional control and impaired functioning of ‘inhibition’ and ‘shifting’ functions of the central executive. These functions refer to the ability to suppress prepotent responses (inhibition) and the ability to switch back and forth between multiple tasks, operations or mental sets (Miyake et al., 2000). While addressing some of the limitations of processing efficiency theory in terms of its lack of precision or explanatory power theoretically, much more empirical research is required to test the predictions of Attentional Control Theory (Wilson, 2008).

2.3.2.2 Self-Focus Theory. The other class of attentional theory used to describe the processes underpinning choking is self-focus theory. The essence of this theory lies in the assumption that pressure increases anxiety which has been shown to lead to self-focus (e.g., Carver & Scheier, 1978), and that self-focus can lead to skill failure through attempts to apply conscious thought to automatic movements. Baumeister (1984) described the process thus;

> “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 co-ordination and precision of muscle movements) but consciousness does not

> contain the knowledge of these skills, so that ironically reduces the reliability and success of the performance when it attempts to control it." (p.610).

Central to this assumption is Fitts and Posner's (1967) progression–regression hypothesis which discusses the influence of processing changes as a result of the transition though the stages of skill acquisition. Here, novice performance is described as relying on the processing of explicit rule-based declarative knowledge for skill execution. Researchers have suggested that during the initial cognitive stage of learning, skill execution involves assistance from a collection of unintegrated control structures held in working memory that control performance in a step-by-step manner (Anderson, 1982; Fitts & Posner, 1967). As a result, spare processing capacity is considerably reduced and unavailable for interpreting and processing external stimuli yielding slow and errorful performance. Following prolonged practice, skills become more automated and function through the processing of implicit procedural knowledge. Such skills do not require online processing as they are executed outside of working memory, thus enabling sufficient attentional resources to process extraneous information (Fitts & Posner, 1967). However, it is claimed that under pressure individuals experience increased self-consciousness which causes individuals to regress back to inefficient processing of explicit information similar to that observed in novice performers. Support for this theory comes from a number of studies in the implicit learning literature, which have shown that providing participants with explicit information can actually degrade performance in comparison to those who learned implicitly (Berry & Broadbent, 1988; Green & Flowers, 1991; Reber, 1976; Reber, Kassin, Lewis & Cantor, 1980).

Support for a self-focus theory of choking has come from a number of studies examining the effect of attentional focus on performance, many of which do not directly examine pressure per se, but instead look to replicate the attentional demands that pressure might induce (Beilock & Gray, 2007). Beilock, Carr, MacMahon, and Starkes (2002) performed two studies in which they manipulated the attentional focus of experienced golfers by performing one of two types of dual task to either direct attention towards or away from movement execution. The skill focus manipulation required golfers to say ‘stop’ at the completion of their putting swing while the distracting secondary task required them to say ‘tone’ when they heard a target sound. They found putting performance was worse in the ‘skill-focused’ condition compared to both single-task and distracting dual-task conditions. A similar experimental design was then used to test the original hypothesis in experienced footballers. Here, the same secondary auditory monitoring task was used to distract attention away from execution and the skill-focused task required individuals to monitor the side of the foot that most recently contacted the ball. Again, performing in a distracting dual-task did not harm the dribbling skill of experienced soccer players in comparison to a single-task practice condition used as a baseline. However, the skill focused dual-task caused deterioration in dribbling skill compared to both the dual-task condition and a single-task baseline.

Gray (2004) directly investigated the effects of performance pressure on batting performance in highly skilled baseball players by comparing batting performance between pressure and control groups. Participants in the pressure group were required to perform a second set of trials under the proviso that they and a designated partner were to gain a monetary incentive based on them improving their performance. Control participants were given no further instruction during the second set of trials. Batters in the pressure group exhibited clear choking effects making significantly more temporal batting errors following the pressure manipulation than their baseline performance compared to a control group who showed no significant differences between mean temporal errors in the two blocks of trials. To investigate the role of attentional focus, a post test required participants to judge the direction their bat was moving at specified intervals. Gray found that only the participants in the pressure group showed a significant decrease in the percentage of judgment errors in this task in comparison to a pre-test used as a baseline. He concluded that the pressure caused an inward shift of attention to monitoring of swing execution therefore disrupting automated execution processes, resulting in poorer batting performance. Additional support for the role of attentional focus has also been observed using a manipulation that placed emphasis either on speed or accuracy of performance. Beilock, Bertenthal, McCoy and Carr (2004) limited the opportunity for skill-focused, explicit monitoring by instructing experienced golfers to perform a putting task rapidly. They found the golfers' performance improved in comparison with golfers who were instructed to take as much time as they needed to be accurate. Phenomenological reports indicated that golfers felt the speed instructions aided their performance by keeping them from thinking too much about execution.

Wulf and colleagues have conducted extensive research over the past decade (see Wulf, 2007 for a review) that provides evidence that an external focus of attention (i.e., focus on the movement effect) is more effective than an internal focus (i.e., focus on the movements themselves). They proposed the constrained action hypothesis (Wulf, Shea, & Park, 2001) in which they suggest that an external focus allows unconscious, fast, and reflexive processes to control the movement. By contrast, an internal attentional focus is hypothesized to constrain the motor system by intervening in the processes that regulate the coordination of an individual's movements. Consequently, the automatic control processes that have the capacity to control movements effectively and efficiently are disrupted. Advantages of adopting an external focus, induced by instructions or feedback, have been observed in a variety of sports including skiing (Wulf, Hob & Prinz, 1998), golf (Wulf, Lauterbach, & Toole, 1999), basketball (Zachry, Wulf, Mercer, & Bezodis, 2005), American football (Zachry, 2005) and soccer (Wulf, McConnel, Gartner, & Schwarz, 2002), across different skill levels (Wulf & Prinz, 2001), and in different populations including Parkinson's disease (Wulf, Landers, & Tollner, 2006, c.f. Wulf, 2007) and stroke patients (Fasoli, Trombly, Tickle-Degnen, & Verfaellie, 2002). Despite the considerable support for self-focus theories Mullen (2007) highlighted important fundamental flaws that affect the interpretation of attentional focus research to date. The first concerns the lack of manipulation checks to examine adherence to the treatment conditions. This potential issue here is neatly illustrated by Maxwell and Masters (2002) who found from post-experiment interviews that several participants had discovered the advantages of adopting an external focus of attention during practice and switched away from their assigned strategy. Second, Mullen suggested that examining attentional focus in experts is problematic due to pre-existing automated performance routines; thus, if the routines commonly adopted by experts contrast with the treatment condition requirements it is doubtful they will be adhered to.

2.4 Reinvestment Theory

The disruption to skilled performance that occurs when attention is directed towards controlling one's movements has been described in a variety of ways. Beilock and Carr (2001) looked to conceptualise this theory as the explicit monitoring hypothesis; however, use of this terminology has since received criticism as it refers only to the monitoring of processes explicitly and not attempts to consciously control ones actions. Jackson, Ashford and Norsworthy (2006) speculated that 'explicit monitoring' of performance processes could take place without implicating 'conscious control' of them, in which case choking might not necessarily result from explicit monitoring (see also Masters & Maxwell, 2008). Furthermore, using explicit monitoring as an umbrella term for variants of self-focus theories is potentially misleading as a person could explicitly monitor the environment, a focus that is more aligned with distraction-based theories (Masters, Personal Communication, 2010).

Fitts, Bahrick, Noble and Briggs (1961) presented the progression-regression hypothesis, wherein they suggested that learning involves a progression from simple to complex control strategies, and that, under pressure, people may regress to simpler levels of control. Masters (1992) referred to this process as reinvestment, borrowing terminology from Deikman's (1969) concept of deautomatization in which he originally described the process of "reinvesting actions and percepts with attention" (p. 31). In discussing individual differences, Masters and Maxwell (2004) defined reinvestment as "the propensity for manipulation of conscious, explicit, rule based knowledge, by working memory, to control the mechanics of one's movements during motor output" (p. 208). Masters (1992) tested his reinvestment theory by hypothesizing that individuals who learned a skill explicitly would be more likely to choke than those who learned the skill implicitly, because the latter would not possess the explicit knowledge with which to reinvest. In his study, participants were allocated to one of two groups: one group learned a golf-putting task explicitly, via an instruction manual, and the other practiced the skill whilst performing a secondary-task to discourage hypothesis-testing which would result in explicit knowledge generation. The results revealed performance of the explicit learning group declined when participants were put under pressure, whilst performance of individuals using implicit techniques actually improved under stress. Masters concluded that implicit learners had no explicit-based rules to consciously draw from and so did not choke under pressure whereas the explicit learners tried to evoke control over their actions under pressure by applying their explicit knowledge and, so, choked.

Unfortunately there are difficulties in the interpretation of Masters' original findings owing to a methodological flaw. Hardy et al. (1996) and Bright and Freedman (1998) suggested that Masters' significant findings may have been due to a release from the secondary task, used during the learning phase to prevent the acquisition of explicit rules, in the high-pressure trials. To test this hypothesis Hardy et al. replicated Masters' (1992) protocol and added an implicit learning group that had to perform the dual-task during the stress trials. They hypothesised that only implicit learners without the secondary task would show performance improvements under pressure. However, both implicit learning groups showed performance increments during the stressed trials, thus supporting Masters' reinvestment theory. However, Bright and Freedman (1998) performed a similar replication of Masters (1992) study and found contrasting results. They found that only the implicit group released from the secondary task in the stressed trials showed an improvement in performance. To support this they performed a follow up study manipulating the complexity level of the secondary task and showed the improvement was greater in those individuals who were released from a more complex dual-task. However, there were several critical differences in their replication of the Masters (1992) and Hardy et al. (1996) studies that cast doubt on their interpretations. In this type of investigation there is a need for novice participants to eliminate the possibility of any residual explicit knowledge from previous experience. The criteria used by Bright and Freedman (1998) to screen participants for inclusion was inadequate as participants in the implicit groups may have been practicing with explicit knowledge previously acquired prior to the 12 month abstinence cut off that was implemented (Maxwell, Masters, & Eves, 2000). Other issues, surrounding the complexity of the task used, number of trials in the learning phase and differences in the pressure manipulation used have also been highlighted as weaknesses in the experimental design that cloud the researchers' conclusions (Mullen, Hardy & Oldham, 2007).

Mullen et al. (2007) looked to address the conflict in findings between Bright and Freedman (1998) and Masters (1992) and Hardy et al. (1996) by revisiting the study designs adopted. Here they replicated the study using absolute novices and more trials than that of Bright and Freedman. Thirty-two participants were allocated to one of three separate implicit training groups or an explicit training group, and practiced putting golf balls. Participants were exposed to an anxiety intervention at two points during practice. The Explicit practice group received a list of explicit instructions throughout the learning phase. Participants in the first two implicit learning groups were given no instructions on how to putt and were required to perform a random letter generation task while putting. The two groups differed in that one group was only exposed to the anxiety intervention at Test 2, while the second group was put under pressure at both Test 1 and Test 2. The final implicit group was required to learn the task while performing the random letter generation task. However, as in the previous studies, during the high-anxiety test conditions participants in the last implicit group were not required to generate random letters. Results revealed that practice improved performance in all of the putting conditions, a result that contradicted Bright and Freedman's (1998) finding of a difference between the implicit practice groups who performed the random letter generation task at test and those who did not. During the final pressure trial the three implicit practice groups continued to improve, regardless of whether participants were asked to putt with or without random letter generation task, while the explicit practice group failed to further improve their performance. Mullen et al. concluded that their findings supported Masters' (1992) and Hardy et al's (1996) earlier findings that motor skills are robust under pressure when acquired in implicit practice conditions.

Further support comes from Mullen and Hardy (2000) who compared the putting performance of 18 experienced golfers when performing two types of dual-task against normal putting conditions; verbalising explicit instructions and random letter generation, under conditions of low and high state anxiety. The explicit instruction group's performance deteriorated under pressure, whereas the performance of those in the random letter generation group remained stable. Mullen, Hardy, and Tattersall (2005) replicated this study, modifying the design by replacing the random letter generation with a tone counting task. In contrast to Mullen and Hardy (2000), participants' putting performance was impaired by both explicit knowledge cues and the task-irrelevant (tone counting) dual-task under pressure. The authors therefore suggested the findings offer only partial support to the conscious processing hypothesis and highlight that the performance decrements observed may not be the result of a single mechanism (Mullen et al., 2005).

Maxwell et al. (2000) performed a longitudinal replication of the Masters' (1992) study in order to examine the observed difference between explicit and implicit learning groups during the practice phase. In both Masters and Hardy et al., (1996) performance of the implicit group was inferior to that observed by the explicit learners. Although, the same pattern was shown regarding differences in learning even after 3000 trials, further support was found for reinvestment theory in that the explicit group accumulated more explicit rules during learning, which had a negative effect on subsequent performance during learning, particularly under stress. The association between explicit knowledge, self-focused attention and performance failure under pressure was also supported by Liao and Masters (2002) who found self-focused training of basketball free-throw shooting led to a greater amount of explicit knowledge (e.g., rules) and worse performance under pressure relative to a control group. Liao and Masters (2001) looked to the use of analogies as an alternative to implicit learning in providing instruction. The function of the analogy was to integrate the complex rule structure of a skill into a simple metaphor that could be reproduced by the learner without conscious awareness of the explicit rules that govern the skill's execution. Liao and Masters conducted two experiments to see if learning by analogy could invoke similar characteristics as implicit learning. The first experiment showed that the analogy and implicit learning groups accumulated fewer explicit rules during the learning phase than the explicit group on a table tennis forehand top-spin shot task. The second experiment tested subsequent performance under stress and thought suppression interventions and found that only the explicit group suffered impaired performance. These findings are supported by Lam, Maxwell, and Masters (2009) who found performance on a modified (seated) basketball shooting task by analogy and explicit learning groups was equal during learning and delayed retention tests. However, performance on a pressurized transfer test showed deterioration in the explicit groups performance whilst the analogy group's performance remained unaffected.

Several other studies have provided evidence to support Masters' (1992) initial hypothesis regarding a regression back to explicitly governed action as a result of pressure induced self-focus. Jackson et al. (2006) examined the attentional processes governing skilled motor behavior using a dribbling task. In the first experiment, field hockey players performed a dribbling task under single-task, dual-task, and skill-focused conditions under both low and high pressure situations. In Experiment 2, skilled soccer players performed a dribbling task under single-task, skill-focused, and process-goal conditions, again under low and high pressure situations. Results replicated those of work highlighted earlier supporting conscious processing hypothesis; specifically, the detrimental effect of skill-focused attention and the facilitative effect of dual-task conditions on skilled performance. Furthermore, it was noted that focusing on movement-related process goals adversely affected performance.

Pijpers, Oudejans, Holsheimer, and Bakker, (2003) explored behavioural changes to climbing performance as a result of pressure. Seventeen novice climbers traversed two routes on a climbing wall. Anxiety was manipulated by using routes defined at different heights (low and high). The results showed that state anxiety affected participants' movement behaviour, demonstrated by an increased geometric index of entropy and by longer climbing times. They concluded that the effects of anxiety had caused a temporary regress to a movement execution that is associated with earlier stages of motor learning.

Reinvestment theory has also been examined in music. Wan and Huon (2005) investigated the cognitive mechanisms responsible for performance degradation under pressure in music. Following lessons on basic note and rhythm reading skills, 72 novice musicians trained on a keyboard task under one of three conditions (single-task, dual-task, video-monitoring) before being exposed to either a high-pressure or low-pressure post-test. Analysis revealed that pressure led to skill failure in the single-task and dual-task groups, but resulted in improved performance in the video-monitoring group. They concluded that training under the video-monitoring condition familiarized participants with performing under conditions that encourage conscious monitoring of task processes; thus, resulting in resilience to performance failure under pressure.

2.5 Predicting Choking

Researchers have looked to examine the impact of self-focused attention from an individual differences perspective to try and identify those individuals who are more prone to engage in behaviours detrimental to performing under pressure. Two related scales have been used to examine individual differences in the propensity for reinvestment and in particular, the relationship between trait self-focus and performance under pressure. In his early examination of choking, Baumeister (1984), indicated that more self-conscious individuals, defined using the Self-Consciousness Scale (Fenigstein, Scheier & Buss, 1975), were less susceptible to choking (Baumeister, 1984, Experiments 4 and 5). Baumeister concluded that highly self-conscious individuals are more accustomed to performing in a self-aware state, and are therefore better able to cope with the self-scrutiny induced by pressure compared to individuals whom exhibited low levels of self-consciousness. Support for this hypothesis was reported by Lewis and Linder (1997) who found that acclimatizing participants to a high self-conscious environment, using the presence a video camera during practice, reduced the extent to which performance broke down under stressful conditions. More recently researchers have suggested that high dispositional self-focus increases susceptibility to choking. Wang, Marchant, Morris and Gibbs (2004) examined the role of dispositional self-consciousness and trait anxiety in Basketball free throw shooting under pressure. Sixty-six basketball players completed the Self-Consciousness Scale and the Sport Anxiety Scale prior performing free throws in low-pressure and high-pressure conditions. Multiple regression analyses revealed the best predictors of choking were private self-consciousness and somatic trait anxiety that together accounted for 35% of the explained variance; thus, supporting the hypothesis that self-conscious athletes were more susceptible to choking under pressure. Similarly, Dandy, Brewer, and Tottman (2001) found that high self-conscious basketball players showed greater deterioration in free-throw percentages during competitive games than low self-conscious players. Bawden, Maynard, and Westbury (2001) also found that golfers who scored high on the Self-Consciousness Scale (Fenigstein et al., 1975) were more likely to break down under self-focused attention than low self-conscious golfers. Support has also been derived from an examination of driving performance under evaluative pressure. Maxwell, Masters, and Poolton (2008) discovered that high self-conscious drivers exhibited riskier driving behaviours whilst being observed by a perceived evaluator and suggested thathigher self-consciousness was associated with poorer performance in general.

Masters, Polman, and Hammond (1993) looked to explore this phenomenon by developing the Reinvestment Scale which was constructed by pooling together items from several existing scales relevant to the processes underlying reinvestment. Following factor analysis, the final scale was comprised of twelve items from the private self-consciousness and public self-consciousness subscales of the Self-Consciousness Scale, seven items from the rehearsal factor of the Emotional Control Questionnaire (Roger & Nesshoever, 1987), and one item from the Cognitive

Failures Questionnaire (Broadbent, Cooper, Fitzgerald & Parkes, 1982). Private self-consciousness refers to the attention an individual gives to his or her thought processes, whereas public self-consciousness is concerned with the awareness of the self as a social object (Fenigstein et al., 1975). Rehearsal relates to one's tendency to mentally rehearse emotional events. The final item, taken from the Cognitive Failures Questionnaire item ("Do you have trouble making up your mind?"), describes the tendency to have action slips, occasions in which one's actions are not performed as intended (Broadbent et al., 1982) and was related to performance under pressure in the golf putting task used in Masters' (1992) original investigation. Initial assessments of the Reinvestment Scale's psychometric properties showed high internal reliability (coefficient alpha = .80) and test-retest reliability (r = .74). To examine the predictive validity of the Reinvestment Scale, Masters et al. (1993) examined performance on a rod tracing task under conditions of low and high pressure. The results failed to show performance decrements under pressure in either high or low reinvestment groups. The authors concluded that this was due to the level of complexity for the motor skill they employed, suggesting that the pegboard task was too simple to lend itself to explicit rule use. In a follow up experiment Masters et al used a more complex golf putting task. This time they found high Reinvestment Scale scores were associated with greater performance decrements under pressure. In their final validation experiment, Reinvestment Scale scores of university squash and tennis players were correlated with their tendency to choke under pressure, as rated by their coaches and team captains. Higher scores indicated those individuals rated as more prone to choke under pressure.

Support for the Reinvestment Scale's ability to highlight individuals more prone to choking has come from a variety of different sports tasks. Chell, Graydon, Crowley and Child (2003) examined whether the Reinvestment Scale predicted skill breakdown under pressure in fourteen university soccer players using a wall-volley task. They found that high reinvesters scored significantly worse in a high-stress than a low-stress condition, whereas low reinvesters' performance remained stable across conditions. Maxwell et al. (2006) also found a significant correlation between reinvestment score and change in golf putting performance under evaluative conditions, with high reinvesters suffering greater decrements in performance under pressure. Additional support comes from Jackson et al., (2006, Experiment 1) who found that Reinvestment Scale scores were a significant predictor of choking in a group of skilled field-hockey players, such that high reinvesters slowed more under pressure than did low reinvesters on a dribbling task. Similarly, in Maxwell et al.'s (2000) longitudinal study, participants in the explicit group only showed positive correlations between Reinvestment Scale score and the number of rules accrued which were negatively correlated with overall putting performance during the learning phase. The association between use of explicit knowledge, reinvestment and performance failure under pressure was also examined by Poolton, Maxwell and Masters (2004) who, using structural equation modelling, found that Reinvestment Scale scores predicted the number of rules accumulated by novice golf putters, which in turn predicted subsequent performance failure under anxiety-inducing conditions.

Despite the substantial evidence generated from this body of research to support the use of the Reinvestment scale, as a psychometric instrument it suffers from a number of limitations. The most important of which is a lack of face validity. The scale was developed by pooling items from various existing scales and does not directly specify movement. Jackson et al. (2006) highlighted that the scale 'does not attempt to measure the process of reinvestment directly but instead aims to bring together conceptually linked items that predict this process' (p. 65). Masters, Eves and Maxwell (2005; cf. Masters & Maxwell, 2008) developed a movement-specific version of the Reinvestment Scale to address these and other methodological issues present in the original scale's construction (e.g. sample size for factor analysis). The new scale comprised two factors (movement self-consciousness; conscious motor processing) and had sound test-retest and internal reliability properties. Evidence supporting the conscious motor processing factor present in the new scale has largely come from the health setting, specifically situations in which the propensity to focus attention on performance processes might be disruptive to movement execution. Comparison of stroke patients (Orrell, Masters & Eves, 2009), Parkinson's disease patients (Masters, Pall, MacMahon, & Eves, 2007) and age matched controls revealed higher Movement Specific Reinvestment Scale scores for the two groups of patients more than their age-matched controls. In stroke patients, conscious motor processing and time spent in rehabilitation were found to be associated with amount of movement difficulty; whilst higher conscious motor processing scores were associated with longer durations of Parkinson's disease, implying that patients use conscious control of their movements increasingly as the disease progresses. Additional studies found that people who had fallen scored higher on both factors on the scale that those who had not (Wong, Masters, Maxwell & Abernethy, 2008).

2.6 Distraction vs. Self-Focus Theory

Given the seemingly contrasting predictions of distraction-based and self-focus-based accounts of choking and the substantial support each has received, several studies have adopted experimental designs to examine which theoretical explanation truly represents the processes underpinning skill failure under pressure. As a result several other hypotheses have subsequently been generated. Beilock, Kulp, et al. (2004) suggested there may be a "double whammy" effect of pressure and that it is the characteristics of the skill demands that govern the nature of skill failure. More specifically, they suggest that pressure induces worries about the situation and its consequences, thereby reducing working memory capacity available for performance and concurrently encourages individuals to exert conscious control over skill execution. Therefore, for skills that rely heavily on working memory, skill failure will be as a consequence of reduced resources necessary for performance, whilst skills that run efficiently without working memory (e.g. proceduralised skills) will fail as a consequence of conscious control. Hardy, Mullen, and Martin (2001) investigated the role of conscious processing in performance breakdown using 12 national-level, female trampolinists who were required to performed their competition routines with and without concurrent explicit instruction from their coach in both high and low anxiety conditions. The results showed support for the conscious processing hypothesis in that performance deteriorated in the high anxiety condition when shadowing was present. In explaining the results of this and a previous study examining conscious processing and processing efficiency theories (Mullen & Hardy, 2000); Hardy et al. proposed the attentional threshold hypothesis. They suggested that anxiety-related cognitions (e.g., worry) and the coaching instructions, came at a cost to the attentional capacity of the individual that in isolation does not diminish performance; however, when an individual experiences both components collectively the depletion of attentional resources is too great to maintain efficient performance. To examine this theoretical explanation Gucciardi and Dimmock (2008) designed an experiment to compare the attentional threshold hypothesis with the conscious processing hypothesis. Twenty experienced golfers putted using three explicit knowledge cues, three task-irrelevant knowledge cues, and a single swing thought cue under low and high anxiety. Overall, the swing thought condition promoted the most successful putting performance. However more importantly, under increased cognitive anxiety putting performance deteriorated in the explicit knowledge condition, whilst remaining stable in the task-irrelevant and swing thought conditions, providing support for the conscious processing hypothesis. These theories complement Masters and Maxwell's (2004) concept of a working memory based explanation which looked for common ground in the two contrasting attentional theories of choking. They highlight that the explicit process used when reinvesting under pressure consumes working memory in the same way that distraction based accounts suggest anxiety induced worry and task irrelevant cues do. The reduced function of working memory then debilitates processing efficiency causing skill breakdown, a conclusion quite comparable to Eysenck and Calvo's (1992) processing efficiency theory.

2.7 Other Moderators of Choking

The moderating effects of explicit or procedural knowledge, self-consciousness, dispositional reinvestment, reduced working and memory on performance under pressure have been discussed in detail previously. There are several other moderating factors that have emerged from investigations into the effects of pressure on performance.

2.7.1 Trait Anxiety. A number of studies have demonstrated that high levels of trait anxiety are associated with poorer performance under pressure. Indeed qualitative investigations examining instances and experiences of choking have revealed anxiety to be described as the major contributor to suboptimal performance in penalty kicks (Jordet, 2009; Jordet, Elferink-Gemser, Lemmink, & Visscher, 2006; Jordet, Hartman, Visscher, & Lemmink, 2007). Murray and Janelle (2003) found that individuals who reported higher levels of trait anxiety were more susceptible to the paradoxical performance effects of pressure than their low-anxious counterparts during a simulated motor racing task. Wang, et al. (2004) also showed highly trait anxious players exhibited poorer free throw shooting under pressure than low anxious players. Several theories have been suggested to explain this observed association. Janelle (2002) suggests that anxiety in general may alter visual search and gaze behaviour, resulting in inefficient and ineffective search strategies. Giacobbi and Weinberg (2000) suggested it may be a result of the way pressure is perceived and the subsequent coping behaviours adopted between low and high trait-anxious individuals. Hill et al. (2010) highlight the association between trait anxiety and existing attentional theories of choking, suggesting that high trait anxiety appears to encourage choking through distraction and self-focus mechanisms. From a distraction perspective the frequent and intense state anxiety responses experienced by highly trait anxious individuals under pressure overwhelms their working memory causing processing inefficiency and thus encouraging choking (Wilson, 2008). Similarly, high trait anxious individuals also tend to have high dispositional reinvestment (Masters et al., 1993) and are therefore vulnerable to choking via conscious control processes. Indeed, Wang et al. (2004) reported that performance decrements were magnified for highly trait-anxious athletes who were also high in self-consciousness.

2.7.2 Skill Level. The majority of research supporting self-focus theory presented in this review has examined the phenomenon using skilled participants. However, differences in the attentional mechanisms that govern skill execution in novices and experts highlight issues in applying reinvestment theory to explain choking in novices. Novice performance relies on declarative or explicit knowledge manipulated by working memory and processed in a step-by-step fashion, and therefore should remain unaffected from pressure-induced attention to execution. To examine this, Beilock and Carr (2001) had novice participants practice a golf-putting task and tested putting performance under pressure both early and late in practice. Their results indicated that pressure actually facilitated execution in the early test trials. However, following prolonged practice performance decrements under pressure were observed. It was concluded that the proceduralised performances of experts are disrupted by pressure, whereas novice skill execution, which requires online processing, remained unaffected. Beilock and Carr (2001) suggested that choking in novices can be more readily explained through distraction. More specifically, novices' processing of task-relevant information exceeds their limited capacity to cope with additional demands of pressure. Despite limited evidence to suggest novice performers may also choke via self-focus (Pijpers, Oudejans, Holsheimer, & Bakker, 2003), further evidence has shown that the performances of novices are maintained or even enhanced when they explicitly monitor their skill under dual-task conditions (Beilock, Wierenga, & Carr, 2002). Additionally, Mullen and Hardy (2000) found that highly-skilled golfers' performance deteriorated under pressure; however, less skilled golfers' putting performance remained unaffected by the high pressure trial.

2.7.3 Coping Styles. Recently, researchers have suggested that the coping strategy adopted by an individual to deal with situations of increased pressure influences their susceptibility to choking. Initial observation data from penalty kicks taken at the World Cup, European Championships, and Copa America between 1976 and 2004 by Jordet et al. (2007) highlighted the importance of coping strategies in dealing with the immense pressure of a penalty shootout. The results showed that the importance of the kicks (indicative of stress) was negatively related to the outcomes of the kicks, whereas skill and fatigue were less, or not at all, related to outcome. It was concluded that psychological components are most influential for the outcome of penalty kicks. Wang et al. (2004) examined the role of coping style on basketball shooting performance of 88 basketball players under conditions of low and high pressure. Correlation and hierarchical regression analyses revealed that an approach coping style was significantly related to choking. However, Jordet and Hartman (2008) recently suggested that an escapist coping style is likely to increase susceptibility to choking. In this study, Jordet and Hartman analyzed the preparation time for 359 soccer penalty kicks from 291 players and found that players who missed goals in the high-pressure penalty kicks had significantly faster preparation times than those that scored a goal. The authors suggested that the quicker preparation times reflected an immediate, behavioural withdrawal from the situation.

2.7.4 Task Characteristics and Complexity. As discussed earlier, the two contrasting theories of distraction and reinvestment have received support from differing skill domains. The bulk of evidence supporting a self-focus model of choking has come from motor skills; whilst support for a distraction-based account of choking is derived from tasks dependent on working memory, including digit span tasks (Jones & Cale, 1989), analogical reasoning (Tohill & Holyoak, 2000) and mathematical problem solving (Ashcraft & Kirk, 2001; Beilock & Carr, 2005; Beilock & DeCaro, 2007; Beilock, Kulp, et al., 2004). However one facet central to both theoretical explanations is the role of task complexity. Within the motor skill literature, choking has only been observed in relatively complex motor tasks, such as golf putting, baseball batting and soccer and hockey dribbling tasks (Beilock, Carr et al, 2002; Jackson et al., 2006; Masters et al., 1993), training for which is typically associated with substantial technical instruction. However, research examining performance using simple motor tasks has tended to prove more robust under stress. For example, Magill and Clark (1997) and Masters et al. (1993) found no evidence of performance breakdown on a simple tracking task and rod-tracing task, respectively, while Baumeister, Hutton and Cairns (1990) found that performance on a simple card-sorting task actually improved under pressure. Similarly Beilock et al. (2004) found that pressure impaired performance on modular arithmetic problems that place high demands on working memory but not on problems that were less demanding.

2.8 Decision Making in Sport

Choking under pressure in a sporting context has predominantly examined skill failure in motor skills and has therefore supported reinvestment theory on skill failure (Masters, 1992; Masters et al., 1993), while research using cognitive tasks that place significant demands on working memory has generally supported distraction theory (Beilock and Carr, 2001; Beilock, Kulp, et al., 2004). However, sport-specific cognitive skills such as decision-making have received relatively little attention, especially regarding examinations into performance under pressure. Decision-making has been defined as the ability to select an advantageous response from among an array of available options (Damasio, 1994). The importance of decision-making in sport has been well documented for over half a century (Crossman, 1953), with the realisation that it is important for the athlete to know what specific movement to perform (cognitive skill) as well as knowing how to perform that specific movement (motor skill). Many skills in sport have a significant decision-making component such that cognitive and perceptual components reliably discriminate experts from their less-skilled counterparts (Abernethy, Zawi, Jackson, 2008; Williams, 2000). However, little research has been undertaken into decision-making in sport (McMorris & Graydon, 1997). Indeed, Bar-Eli and Raab (2006) exclaim the distinct lack of research into judgement and decision-making in sport despite the potential provided by this context. According to McMorris and Graydon, this lack of research is due to difficulties in examining decision making with regards to validity, reliability and objectivity. Research into decision-making in sport has generally used tachistoscopic presentations, which despite showing construct validity (Starkes, 1987; McMorris and MacGillivary, 1988) have been criticized for lacking ecological validity by presenting static stimuli, in contrast to the dynamic displays encountered in real life sporting situations (Helsen & Pauwels, 1988).

Whilst not directly investigating decision-making under pressure, several studies have examined the effects of moderators associated with choking and reinvestment, namely arousal, explicit instruction and conscious control, and found contrasting effects on performance. McMorris and Graydon's (1996a; 1996b; 1997) research into decision-making during exercise found that increases in arousal were beneficial to performance. Their findings from a series of experiments suggest that changes in physiological arousal, as a consequence of exercise, resulted in increases in speed of response whilst having no impact on decision accuracy.

Researchers have demonstrated the benefits of specific decision-making training. Raab, Masters, and Maxwell (2005) showed that a combination of behavioral and decision training significantly improved the performance of elite players compared to behavioral training alone; additionally Vickers (2003) found that decision training resulted in better performance during retention and transfer trials than behavioral training. Bunker and Thorpe (1982) examined the teaching of sports in British schools and discovered that the majority of teachers gave little consideration to the development of decision-making skills within their lesson plans. Dissatisfaction with this led to the development of the teaching games for understanding (TGFU) approach (Bunker & Thorpe, 1982) with its emphasis on decision-making. The TGFU is predominantly based upon providing individuals with explicit instructions of what they should look for in order to make faster and more accurate decisions. This explicit method of teaching is congruent with traditional beliefs in early motor learning literature. However as highlighted earlier, explicit learning is characterized by the use of deliberate problem solving strategies or specific instructions, which lead to a large verbalisable pool of explicit knowledge shown to be detrimental to performance under pressure (Masters, 1992; Liao & Masters, 2001; Farrow & Abernethy, 2002). Whilst implicit instruction has shown to provide resilience to choking symptoms in motor skill performance, Jackson and Farrow (2005) highlight several methodological and practical issues in implementing an implicit learning method to teach complex anticipation skills.

However, Raab (2002) evidenced that tactical decisions could be learnt implicitly; showing performance on a dynamic video-simulated decision-making task was superior in implicit and explicit groups compared to a control group and far superior than chance. However, improvements in decision quality that were retained after four weeks by the explicit group were not observed in the implicit group. Another study by Raab (2003) investigated implicit and explicit learning of decision-making in sports and the effects of task complexity. Four experiments were performed in low-complexity and high-complexity situations in handball, basketball and volleyball. The results showed that in low-complexity situations implicit learners were superior to explicit learners, whereas in high-complexity situations explicit learners were superior. Whether this finding transfers to performances under conditions of increased pressure has yet to be fully examined.

Although removed from a sporting context, Dijksterhuis (2004) highlighted the limitations of conscious thought when making complex judgments that require the weighting of several different attributes. For example, in one study participants were asked to judge the attractiveness of four apartments using a list of 12 attributes. Dijksterhuis found that participants who engaged in a distracter task for three minutes after listing the attributes were better able to differentiate between the most attractive and least attractive apartments than were participants who were encouraged to think carefully. Perhaps more relevant to the current line of investigation is the work of Smeeton, Williams, Hodges and Ward (2005) who conducted one of the few examinations into decision-making under pressure in sports. Here they compared the robustness under stress of explicit, discovery and guided discovery learning protocols in junior intermediate-level tennis players. The explicitly trained group was significantly slower than both of the other groups when under anxiety-inducing conditions; they were also inaccurate. Consistent with the reinvestment and conscious processing hypotheses, decision time under pressure was positively correlated with the number of rules accumulated during the learning period. Overall they discovered that explicit instruction, guided discovery, and discovery learning all lead to improvements in anticipation skill. However, guided discovery showed faster improvements in performance compared to discovery learning, which in turn was shown to be more robust under stressful conditions.

2.9 Rationale for present study

The theories and literature referred to throughout this chapter highlight the implications of self-focus of attention and consumed working memory for the phenomenon of choking. It has been shown that support for self-focus theories that include reinvestment theory and the conscious processing hypothesis are largely derived from examinations of skill failure in motor tasks (Masters, 1992; Masters et al., 1993). By contrast, distraction theory has generally been supported by examinations into skill failure on cognitive tasks that place significant demands on working memory (Beilock and Carr, 2001; Beilock, Kulp, Holt, & Carr, 2004). However, decision-making skill, despite being acknowledged as a vital component of expertise in many sports, has received relatively little attention regarding the influence of pressure on performance. Research examining concepts related to conscious processing have shown mixed results regarding their impact on decision-making performance. The aim of this research programme was to investigate, from an individual differences perspective, the underlying processes that may govern performance under pressure. More specifically, based on the work by Masters and colleagues (see Masters & Maxwell, 2008, for a review) the purpose of the current series of studies was to examine skill failure in the more cognitive elements of sports performance, and at the same time investigate the moderating effect of dispositional reinvestment. With respect to the latter, a second purpose was to develop a decision-specific version of the Reinvestment Scale with the aim of identifying individuals who might be more prone to poor decision-making when placed under pressure to perform well.

Chapter 3: Dispositional Reinvestment and Skill Failure in Cognitive and Motor Tasks

3.1 Introduction

Skill failure under stress or 'choking' refers to the occurrence of poor performance in spite of high motivation and incentives for success (Baumeister, 1984; Jackson & Beilock, 2007). The processes underlying skill failure have been the focus of considerable interest in the social psychology, motor learning and sport psychology literature over the past two decades, with research conducted on the reinvestment of explicit knowledge or controlled processing (Masters, 1992; Maxwell, Masters & Eves, 2000), self-attention and skill-focused attention (Baumeister, 1984; Baumeister & Showers, 1986; Beilock, Carr, MacMahon & Starkes, 2002), internal and external attentional foci (Wulf, Hob & Prinz, 1998; Shea, Wulf, Whitacre & Park, 2001), dispositional factors (Baumeister, 1984; Masters, Polman & Hammond, 1993) and their interaction (Jackson, Ashford, & Norsworthy, 2006). This has generated a considerable body of evidence in support of what, collectively, Beilock and Carr (2001) call 'explicit monitoring' theories of choking.

Researchers have suggested that the processes underlying choking may differ for motor and cognitive tasks. In motor tasks, there is considerable evidence that performance is impaired when individuals attempt to exert conscious control over processes that normally run off automatically (Baumeister, 1984; Mullen & Hardy, 2000). For example, Beilock, Carr et al. (2002) found that experienced soccer players performed worse on a slalom course when attending to the point-of-contact of the ball on their foot than when performing a concurrent word-monitoring task. Similarly, Jackson et al. (2006) found that skilled soccer players who set movement-related process goals performed more slowly compared to a control condition. The role of conscious control in performance under pressure was examined by Gray (2004) in the perceptual-motor domain. He found that skilled baseball batters were more accurate at reporting the position of the bat during the hitting action when they were performing poorly than when performance level was high, lending support to the theory that pressure encourages on-line explicit monitoring of the motor action. Masters (1992) referred to this process as 'reinvestment' of explicit knowledge and conscious control and considered the applied implications of this process for motor learning. In particular, he hypothesized that skills learned in a manner that minimised the accrual of explicit rules would be more robust under stress or under dual-task conditions that placed significant demands on working memory; the underlying premise being that if performers did not have explicit rules in the first place they would not rely on this information to consciously control their actions under pressure. Support for this hypothesis was initially found in golf putting (cf. Hardy, Mullen & Jones, 1996) and has recently been extended to the domain of music (Wan & Huon, 2005) and to include robustness under physiological fatigue (Masters, Poolton, & Maxwell, 2008; Poolton, Masters, & Maxwell, 2007).

Thus far, the majority of evidence for choking has come from relatively complex motor tasks, training for which is typically associated with substantial technical instruction. These include golf putting, baseball batting and soccer and hockey dribbling tasks (Beilock, Carr et al., 2002; Jackson et al., 2006; Masters et al., 1993). Shea et al. (2001) proposed that complex motor skills might be more vulnerable to reinvestment because of the higher associated attentional demands and found that increasing explicit knowledge resulted in poorer performance of a complex stabilometer balance task. By contrast, simple motor tasks have tended to prove more robust under stress. For example, Magill and Clark (1997) and Masters et al. (1993) found no evidence of performance breakdown on a simple tracking task and rod-tracing task, respectively, while Baumeister, Hutton and Cairns (1990) found that performance on a simple card-sorting task improved under pressure.

In contrast to the work on motor skills, research using cognitive tasks that place significant demands on working memory tends to support a distraction-based account of choking. For example, researchers have found that cognitive anxiety impairs performance on tasks that place demands on the central executive component of working memory, including digit span tasks (Jones & Cale, 1989), analogical reasoning (Tohill & Holyoak, 2000) and mathematical problem solving (Ashcraft & Kirk, 2001; Beilock & Carr, 2005; Beilock & DeCaro, 2007; Beilock, Kulp, Holt, & Carr, 2004). The findings of this body of literature suggest that increases in pressure create worries about the situation and its consequences that compete for working memory resources. As a result, more anxious individuals or those who rely most heavily on working memory for successful execution are most likely to suffer performance decrements in high pressure situations. Recently, Beilock, Kulp et al. (2004) found that pressure impaired performance on modular arithmetic problems that place high demands on working memory but not on problems that were less demanding. In two subsequent studies, they found that practicing the more demanding problems until they could be directly retrieved from memory eliminated performance decrements under pressure. Interestingly, Beilock and Carr (2005) found that individuals with high working memory capacity were more prone to choking on demanding modular arithmetic problems. Beilock and Carr reasoned that these individuals routinely used more elaborate (and superior) solution strategies; however, increased pressure led to the use of simpler, less effective strategies, which resulted in impaired performance. Consistent with this account, the high working memory group attained a higher level of performance than the low working memory group under low pressure but the two groups performed at the same level under high pressure. In a follow-up study, Beilock and DeCaro (2007) examined the solution strategies used by each group and found that the high working memory group did indeed use more computationally demanding algorithms than the low working memory group in the low-pressure condition. Furthermore, under high pressure the high working memory group reverted to using the simpler solution strategies used by the low working memory group, and their performance duly suffered.

3.1.1 Dispositional Reinvestment and Skill Failure. To investigate individual differences in choking, Masters et al. (1993) developed a scale containing items that were hypothesised to predict conscious processing and motor skill failure under stress. The Reinvestment Scale contains twenty items drawn from the Self-Consciousness Scale (Fenigstein, Scheier & Buss, 1975), the Emotional Control Questionnaire (Roger & Nesshoever, 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. Subsequently, Chell, Graydon, Crowley & Child (2003) found that high reinvesters performed more poorly under pressure on a soccer "wall-volley" task, while Masters and Maxwell (2004) demonstrated that high reinvesters used more explicit knowledge than low reinvesters to control their movements during a stressed performance test. Using structural equation modelling to investigate choking in golf putting, Poolton, Maxwell and Masters (2004) shed light on the nature of the association between explicit rule usage and performance. Specifically, they found that the accumulation of rules was associated with higher RS-scores that in turn led to poorer performance under stress. Work using the Self-Consciousness Scale has similarly revealed a significant correlation between dispositional self-consciousness and performance decrements under pressure (Brockner, 1979; Dollinger, Greening, & Lloyd, 1997; cf. Baumeister, 1984). For example, Wang, Marchant, Morris and Gibbs, (2004) found that more self-conscious basketball players scored fewer free-throws under pressure than their low self-conscious counterparts.

While there is increasing evidence that the Reinvestment Scale predicts skill failure under pressure in motor tasks, the nature of any relationship with skill failure in more cognitive-oriented, working-memory dependent tasks has yet to be determined. The Reinvestment Scale was designed to measure individual propensity for engaging in conscious-control processes under pressure (Masters et al., 1993) and items from the private self-consciousness sub-scale such as “I am aware of the way my mind works when I work through a problem” align closely with the concept of reinvesting conscious control. However, the scale also contains several items that arguably align more closely with distraction-based accounts of choking. Specifically, the RS includes seven items assessing rumination about past emotional events (e.g., “I get ‘worked up’ just thinking about things that have upset me in the past”) and six items focusing on awareness of the self as a social object (e.g., “I am concerned about what other people think of me”). Accordingly, in the present study we aimed to investigate the predictive validity of the Reinvestment Scale and its constituent components in both motor and cognitive tasks of varying complexity.

We predicted that propensity for reinvestment would be associated with poorer performance under pressure in both motor and cognitive-oriented tasks. We further predicted that the rehearsal and public self-consciousness sub-scales would be more strongly related to choking in the cognitive-oriented tasks whereas the private self-consciousness sub-scale would be more strongly related to choking in the motor tasks. Finally, in line with evidence from motor and modular arithmetic tasks, we predicted that choking and associated relationships with dispositional reinvestment would be strongest in the high-complexity versions of these tasks (Beilock et al., 2004).

3.2 Methodology

3.2.1 Participants. Sixty-three university students participated in the study. The sample was comprised of 40 males and 23 females, with a mean age of 22.87 years (*SD* = 3.99). Institutional ethical approval was granted and all participants gave written consent (Appendix A) prior to participating in the study. All participants were novices with respect to golf putting, having never received instructional tuition or had competitive playing experience.

3.2.2 Design and Measures. The design was a 2 (Pressure: low pressure, high pressure) x 2 (Task complexity: low-complexity, high-complexity) repeated measures design, in which participants completed motor, psychomotor, and working memory tasks. Pressure was counterbalanced across participants such that half the participants performed the low-pressure trials first and half the participants performed the high-pressure trials first. To control for possible fatigue effects, high-pressure and low-pressure conditions were completed on different days separated by a minimum of one week. The order in which tasks were completed on each occasion was counterbalanced across participants and was the same for the low-pressure and high-pressure testing sessions.

3.2.2.1 The Reinvestment Scale. The Reinvestment Scale (Masters et al., 1993; Appendix B) is comprised of twenty items that were considered likely to predict individual propensity for reinvesting controlled processing under pressure or psychological stress. Twelve items were taken from the Self-Consciousness Scale (e.g., “I’m aware of the way my mind works when I work through a problem”; Fenigstein et al., 1975). These items can be further broken down into items assessing private self-consciousness, the attention one gives to one’s inner thoughts and feelings, and public self-consciousness, awareness of oneself as a social object. A further seven items were taken from the Rehearsal factor of the Emotional Control Questionnaire (Roger & Nesshoever, 1987). Rehearsal refers to an individual’s tendency to mentally rehearse or ruminate about emotional events; for example, “I often find myself thinking over and over about things that have made me angry”. The final item in the Reinvestment Scale (“Do you have trouble making up your mind?”) was taken from the Cognitive Failures Questionnaire, designed to measure the tendency to have ‘slips of action’, that is, occasions on which one’s actions “do not proceed in accordance with intention” (Broadbent et al., 1982, p1). Masters et al. reported that the Reinvestment Scale had good internal reliability (Cronbach alpha = 0.86) and test-retest reliability over a four-month period (r = .74).

In the present study participants rated each item on a 5-point scale from 0 (extremely uncharacteristic) to 4 (extremely characteristic). This scale was favoured because it enables respondents to indicate the extent to which they identify with each item (Oppenheim, 1992) and was used in the original Self-Consciousness Scale, from which more than half of the Reinvestment Scale items are drawn. In line with

Jackson et al. (2006), the item “Do you have trouble making up your mind?” was written in statement form: “I have trouble making up my mind” to facilitate rating using the 5-point scale.

3.2.3 Tasks. Each participant completed two motor tasks, two card-sorting tasks and two modular arithmetic tasks. In each case, one task was of low-complexity and one was high-complexity.

3.2.3.1 Motor Task: Low-complexity. The low-complexity motor task was a peg-board task that measures gross hand, finger and arm dexterity. The grasping and placing a peg in a hole is regarded as a simple motor task (Schulze, Lüders & Jäncke, 2002). The peg-board was divided into two sections of 28 holes displayed in a 4 x 7 grid. Across the top were 56 pegs (28 red and 28 blue) arranged in random order. The task involved placing red pegs along the right side of the board and blue pegs along the left side. Participants were allowed to pick up only one peg at a time with each hand but were allowed to use both hands simultaneously. Participants aimed to place the pegs in the holes as quickly as possible and completed two trials under each pressure condition. Mean task completion time served as the dependent variable.

3.2.3.2 Motor Task: High-complexity. The high-complexity motor task was a golf putting task in which participants attempted to putt a golf ball on a carpeted surface so that it came to rest in the centre of a circular target (diameter 0.5 m) located at a distance of 3 m. A score of 5 points was awarded for a ball that came to rest in the centre circle (diameter = 0.1 m) of the target, while 4, 3, 2, and 1 points were awarded to balls that came to rest within the surrounding concentric circles of diameters 0.2 m, 0.3 m, 0.4 m, and 0.5 m, respectively. Balls stopping more than 0.5 m from the target were awarded zero points. A standard golf putter and golf balls were provided and participants performed 20 putts in each pressure condition. Golf putting is a complex rule-bound skill that is associated with a plethora of technical instructions relating to how best to grip the club, the correct stance to adopt and the technical execution of the swing (Masters et al., 1993). It has been extensively used in choking research and appears susceptible to breakdown under stress in both skilled and relatively novice performers (Beilock & Carr, 2001; Masters, 1992).

3.2.3.3 Card Sorting Task: Low-complexity. In the low-complexity version of the card-sorting task, participants were required to sort a standard pack of playing cards by the four suits (clubs, hearts, spades and diamonds). Participants performed two trials under each pressure condition and were instructed that they could hold the cards however they wished, but could not turn over the cards until the experimenter instructed them to begin. Participants were asked to work as quickly and accurately as possible. This task has been used previously to assess psychomotor and cognitive performance (Woo, Proulx & Greenblatt, 1991).

3.2.3.4 Card Sorting Task: High-complexity. In the high-complexity version of the card-sorting task participants again sorted the pack into the four suits but additionally were required to place the “picture” cards (Jack, Queen and King) above their respective piles for the two red suits (hearts and diamonds) and below their respective piles for the two black suits (spades and clubs). It was further stipulated that the order of the piles should be spades, diamonds, clubs and hearts. Participants performed two trials under each pressure condition and were asked to work as quickly and accurately as possible. In both card sorting tasks, the mean number of errors made and the mean task completion time served as the dependent variables.

3.2.3.5 Working Memory Task: Low-complexity. For the working memory tasks, we used Gauss's (1801) modular arithmetic task (Bogomolny, 1996, cf. Beilock & DeCaro, 2007). The aim of modular arithmetic tasks is to assess the truth-value of problem statements such as "$5 \equiv 3 \pmod 2$." To solve each problem, the middle number is subtracted from the first number (i.e., 5 - 3) and the difference is divided by the last number (i.e., 2). If the dividend is a whole number (in this case, 1), the statement is true, if not then the statement is false. Following Beilock et al., the low-complexity version of the task required participants to perform a single-digit, no-borrow subtraction operation. Participants attempted to solve ten problems under each pressure condition and were asked to work as quickly and accurately as possible.

3.2.3.6 Working Memory Task: High-complexity. In the high-complexity working memory task participants were required to perform a double-digit borrow subtraction operation such as $44 \equiv 28 \pmod 7$. A heavier demand is placed upon working memory as larger numbers require longer sequences of steps and maintenance of more intermediate products than when managing smaller numbers (Ashcraft and Kirk, 2001). Participants attempted to solve ten problems under each pressure condition and were asked to work as quickly and as accurately as possible. In both working memory tasks, the mean number of errors made (accuracy) and the mean task completion time (speed) served as the dependent variables.

3.3 Procedure

After filling out the participant information (Appendix D) and consent form, each participant completed the Reinvestment Scale (RS; Masters et al., 1993). Participants were informed that the purpose of the study was to examine psychological aspects of sport participation and that the experiment required them to complete three tasks on two separate occasions. They were then shown each of the tasks and told about the associated requirements. In the high-pressure condition participants were required to perform the tasks in the presence of an associate of the experimenter who also filmed the trials. This technique has previously been found to induce self-focus and skill failure (Carver & Scheier, 1978; DeCaro, Carlson, Thomas & Beilock, 2008).

3.3.1 Manipulation checks.

3.3.1.1 State Anxiety. To assess the effectiveness of the pressure manipulation, the cognitive and somatic anxiety subscales of the Revised Competitive State Anxiety Inventory-2 (CSAI-2R; Cox, Martens & Russell, 2003; Appendix E) were administered prior to the low-pressure and high-pressure trials. Participants were asked to indicate the intensity with which they were experiencing each of the 12-items on a 4-point Likert-type scale anchored by 1 (not at all) and 4 (very much so).

3.3.1.2 Perceived Pressure. At the end of each testing session, participants responded to the question “How much pressure did you feel that you were under during the trials you have just completed?” on a 7-point Likert-type scale anchored by 1 (“no pressure”) and 7 (“extreme pressure”).

3.3.2 Data Analysis. To analyse the effects of pressure in the simple (peg-board) and complex (golf putting) motor tasks, separate one-way ANOVAs were conducted for the task completion time and point score performance data, respectively, with pressure entered as a repeated measure. For the card-sorting and modular arithmetic tasks, the task completion time and error data were analysed by separate 2 x 2 (Pressure x Complexity) repeated measures ANOVAs. To investigate the relationship between RS-score and performance change under pressure, Pearson's product-moment correlation coefficients were calculated between total RS score, the respective sub-scale items (private self-consciousness, public self-consciousness, rehearsal) and the difference between scores on each of the performance measures under low pressure and high pressure. Alpha was set to .05 with effect size being indicated by partial eta squared (η_p^2) for main statistical tests, and for the test of simple effects, a Bonferroni adjustment was applied to give an alpha level of .0125 with effect size indicated by Cohen's d.

3.4 Results

Preliminary screening of all data, using univariate z scores (> ±3.29) and Mahalanobis distance values, revealed three outliers who were removed prior to the main analyses. Descriptive statistics revealed that participants' reinvestment scores ranged from 19 to 70 (M = 43.30, SD = 10.60).

3.4.1 Motor Tasks.

3.4.1.1 Peg-board Task. The one-way ANOVA revealed a significant main effect for pressure (F(1,59) = 7.40, p = .01, η_p^2 = .11), with mean task completion time significantly longer under high pressure (M = 44.10 s, SD = 5.91) than under low pressure (M = 42.61 s, SD = 4.24). Higher RS-scores were associated with greater increases in task completion time from low pressure to high pressure (r = .23, p = .04).

3.4.1.2 Golf Putting Task. The mean number of points scored in the golf-putting task did not differ significantly between low-pressure (M = 35.30, SD = 12.93) and high-pressure conditions (M = 33.07, SD = 13.98; F(1,59) = 2.70, p = .11, η_p^2 = .04). RS-score was negatively correlated with the change in number of points scored from low pressure to high pressure (r = -.26, p = .02), indicating that high reinvesters scored fewer points under pressure. The only sub-scale to reveal a significant relationship with performance change under pressure was public self-consciousness (r = -.30, p = .01).

3.4.2 Card Sorting Task.

3.4.2.1 Completion Time. Analysis of the task completion time data revealed significant main effects of pressure ($F(1,59) = 5.40$, $p = .02$, $\eta_p^2 = .08$) and task complexity ($F(1,59) = 235.09$, $p < .001$, $\eta_p^2 = .80$) and a significant Pressure x Task complexity interaction ($F(1,59) = 4.61$, $p = .04$, $\eta_p^2 = .07$). Analysis of simple effects revealed a significant difference between low and high pressure conditions in the high complexity task ($t(59) = 2.59$, $p < .0125$, $d = .47$) but not in the low-complexity task. As can be seen in Figure 3.1A, mean task completion time remained stable across pressure conditions in the low-complexity card sorting task. However, in the high-complexity task participants were significantly faster under high pressure (M = 53.53, SD = 9.72) than under low pressure (M = 55.43, SD = 10.27). RS-score was significantly correlated with the difference in task completion time under low- and high-pressure conditions in both the low-complexity (r = -.22, p = .04) and high-complexity (r = -.23, p = .04) card sorting tasks. This reflected greater speeding of performance under pressure for high reinvesters. Rehearsal was the only sub-scale to yield a significant relationship with change in completion time under pressure in the simple (r = .26, p = .02) version of the task. This relationship approached significance in the high-complexity version of the task; r = .21, p = .05).

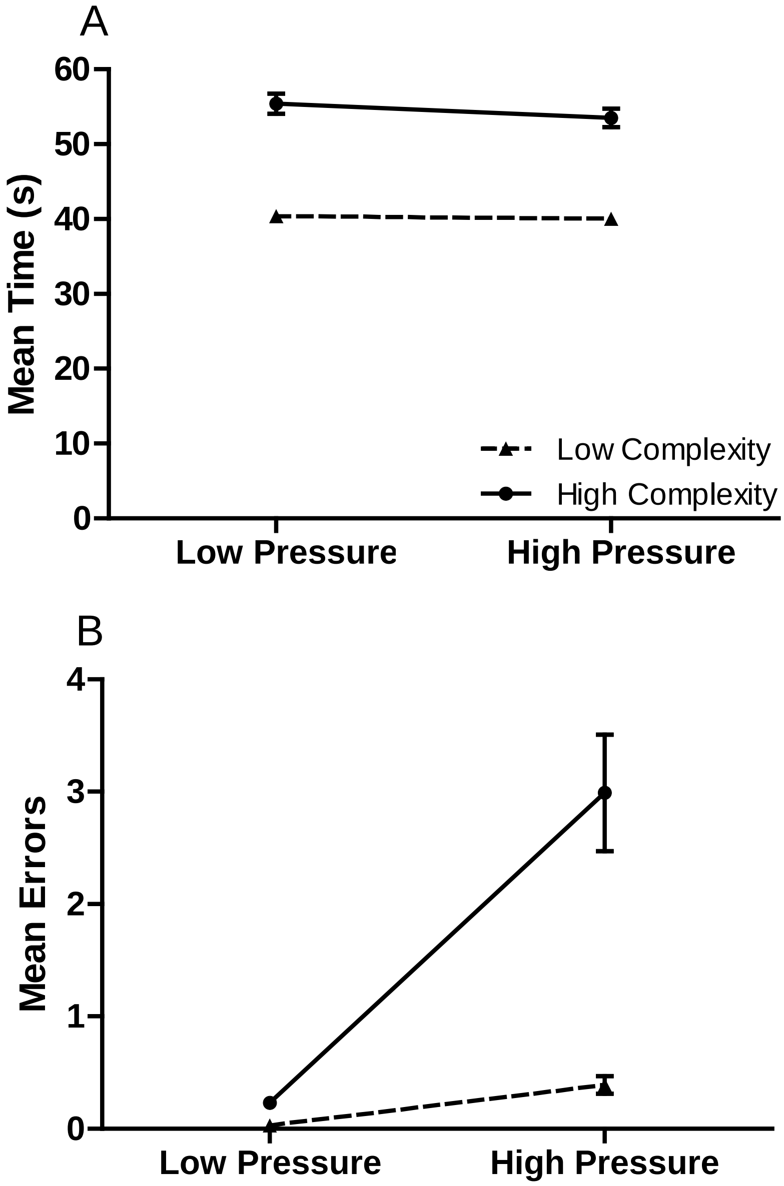

Figure 3.1. Mean task completion time (A) and mean errors made (B) for the card sorting tasks under low and high pressure conditions

3.4.2.2 Errors. Analysis of the mean number of errors revealed significant main effects for pressure ($F(1,59) = 32.41$, $p < .001$, $\eta p^2 = .36$) and task complexity ($F(1,59) = 32.83$, $p < .001$, $\eta p^2 = .36$) and a significant Pressure x Task complexity interaction ($F(1,59) = 25.71$, $p < .001$, $\eta p^2 = .30$). Analysis of simple effects revealed a significant difference between low and high pressure conditions in the low-complexity task ($t(59) = -4.89$, $p < .0125$, $d = -1.44$) and in the high complexity task ($t(59) = -5.45$, $p < .0125$, $d = -1.55$). As can be seen in Figure 3.1B, the mean number of errors was low but still increased under the high pressure conditions for the low-complexity card sorting task (low pressure, $M = 0.03$, $SD = 0.11$; to high pressure, $M = .39$, $SD = .63$); in the high-complexity card sorting task the change in mean number of errors from low pressure ($M = 0.23$, $SD = 0.35$) to high pressure ($M = 2.99$, $SD = 4.02$) was more visible. The relationship between RS-score and the difference between errors made under low-pressure and high-pressure conditions was non-significant in both the low-complexity and high-complexity card-sorting tasks ($r = .18$, $r = .16$, respectively). Sub-scale scores were also not significantly related to the change in errors made under pressure.

3.4.3 Modular Arithmetic Task.

3.4.3.1 Completion Time. Analysis of the task completion time data revealed a significant main effect of task complexity ($F(1,59) = 154.18$, $p < .001$, $\eta_p^2 = .72$). The main effect of pressure ($F(1,59) = 1.03$, $p = .32$, $\eta_p^2 = .02$) and the Pressure x Task complexity interaction ($F(1,59) = 0.31$, $p = .58$, $\eta_p^2 = .01$) were non-significant. As expected, the main effect for task complexity reflected the faster task completion times in the low-complexity task (Figure 3.2A). RS-score was not significantly related to changes in task completion time from low pressure to high pressure in either the simple or complex task ($r = -.12$, $r = -.11$, respectively). Only the rehearsal sub-scale score was also significantly related to the change in completion time under pressure in the low complexity task ($r = -.25$).

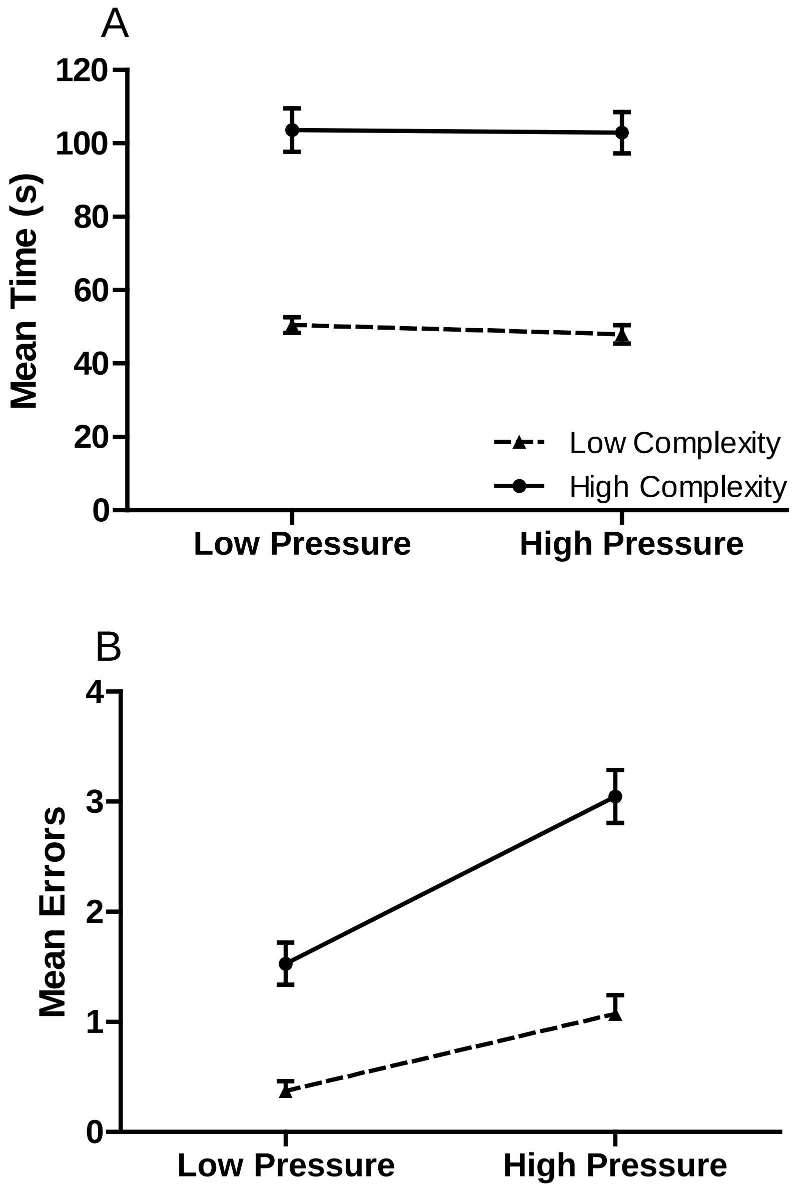

Figure 3.2. Mean task completion time (A) and mean errors made (B) for the modular arithmetic tasks under low and high pressure conditions.

3.4.3.2 Errors. Analysis of the mean number of errors revealed a significant main effect of pressure ($F(1,59) = 51.13$, $p < .001$, $\eta_p^2 = .46$) and task complexity ($F(1,59) = 64.61$, $p < .001$, $\eta_p^2 = .52$) and a significant Pressure x Task complexity interaction ($F(1,59) = 10.98$, $p = .002$, $\eta_p^2 = .16$). Analysis of simple effects revealed a significant difference between low and high pressure conditions in the low-complexity task ($t(59) = -4.48$, $p < .0125$, $d = -.91$) and the high complexity task ($t(59) = -6.53$, $p < .0125$, $d = -1.22$). As can be seen in Figure 3.2B, more errors were made in the high-pressure condition and on the high-complexity version of the task. The significant interaction reflected the fact that the increase in the mean number of errors made under pressure was greater in the high-complexity task (mean increase = 1.52 errors) than in the low-complexity task (mean increase = 0.70 errors). A significant positive correlation was evident between RS-score and the difference in errors made under low and high pressure in both the simple ($r = .26$, $p = .02$) and complex ($r = .32$, $p = .00$) modular arithmetic tasks. The public self-consciousness sub-scale was most strongly related to the change in errors made under pressure on the complex version of the task ($r = .30$, $p = .01$), followed by the rehearsal sub-scale ($r = .27$, $p = .02$). The rehearsal sub-scale was also significantly correlated with change in errors in the simple version of the task ($r = .25$, $p = .03$). For ease of reference, a collated summary of all correlations performed can be found in Table 3.1.

Table 3.1. Correlation between performance change from low to high pressure and Reinvestment Scale and its constituent components.

Task	Total Reinvestment	Private Self-Consciousness	Public Self-consciousness	Rehearsal
Low-complexity motor task- completion time	.23*	.09	.30**	.12
High-complexity motor task- point score	-.26*	-.15	-.30**	-.16
Low-complexity card sorting task- completion time	-.22*	-.11	-.12	-.26*
Low-complexity card sorting task- errors	.18	.04	.14	.18
High-complexity card sorting task- completion time	-.23*	-.06	-.15	-.21
High-complexity card sorting task- errors	.16	.01	.10	.14
Low-complexity modular arithmetic task- completion time	-.12	-.06	.12	-.25*
Low-complexity modular arithmetic task- errors	.26*	.16	.14	.25*
High-complexity modular arithmetic task- completion time	-.11	-.14	-.04	-.12
High-complexity modular arithmetic task- errors	.32*	.08	.30*	.27*

$^*p < .05$, $^{**}p < .01$

3.4.4 Pressure Manipulation Check. To test whether the pressure manipulation was successful a repeated measures multivariate analysis of variance (MANOVA) was performed with the cognitive and somatic sub-scale scores of the CSAI2-R and perceived pressure rating scores entered as dependent variables. The multivariate analysis indicated a significant overall effect of pressure ($F(3,56) = 26.65$, $p < .05$, Wilks Lambda = .41, $\eta_p^2 = .59$). The univariate analyses revealed significant effects of pressure for cognitive anxiety ($F(1,58) = 43.97$, $p < .001$, $\eta_p^2 = .43$), somatic anxiety ($F(1,58) = 26.50$, $p < .001$, $\eta_p^2 = .31$) and the perceived pressure rating score ($F(1,58) = 67.73$, $p < .001$, $\eta_p^2 = .54$). An inspection of the mean scores revealed increases from low pressure to high pressure for cognitive anxiety (M = 14.00 to 18.27), somatic anxiety (M = 11.14 to 14.77) and perceived pressure ratings (M = 2.53 to 3.95).

3.5 Discussion

The purpose of the present study was to investigate the effect of pressure on performance in motor and cognitive tasks of varying complexity, and to examine the extent to which any evidence of choking was moderated by dispositional reinvestment and its sub-scale components of private self-consciousness, public self-consciousness and rehearsal. It was predicted that choking would be more evident in the more complex tasks and that RS-score would moderate the choking effect in both motor and cognitive tasks. With regard to the sub-scale components it was predicted that the rehearsal and public self-consciousness sub-scales would be more strongly related to choking in the cognitive-oriented tasks whereas the private self-consciousness sub-scale would be more strongly related to choking in the motor tasks. In the study, participants performed three high-complexity and three low-complexity tasks under low-pressure and high-pressure conditions. Analysis of the cognitive and somatic anxiety sub-scales of the CSAI2R and the ratings of perceived pressure revealed that the manipulation was successful. Whilst the changes observed between low and high pressure trials were similar to those reported by previous researchers (Jackson et al., 2006), it should be noted that a common criticism of studies in which experimenters attempt to manipulate pressure in contrived laboratory settings is that the resultant changes in anxiety are unlikely to reflect what we might expect to see "in the field". It should also be noted that the manipulation used to induce self focus to increase pressure, is just one of several contributory factors that influence pressure such as monetary rewards and audience presence. Overall, partial support was found for the prediction that dispositional reinvestment would be associated with susceptibility to skill failure under pressure and the nature of this evidence is discussed in relation to each of the tasks in the following section. However, closer inspection of the association between skill failure and the subscale items of public self-consciousness and rehearsal highlights potential limitations associated with viewing the Reinvestment Scale simply as a measure of individual propensity for engaging in conscious control processes under pressure.

In the motor tasks, higher RS scores were associated with greater performance decrements between low and high pressure conditions in both the peg-board and golf-putting tasks. In particular, higher RS scores were associated with a more negative difference in the number of points scored under high pressure compared to low pressure in the golf-putting task and in relatively slower task completion times under high pressure in the peg-board task. These results are consistent with the existing literature that has utilised the Reinvestment Scale (Masters et al., 1993; Maxwell et al., 2000); however, it should be noted that performance was only significantly worse under pressure for the peg-board task and not the golf putting task. It is also noted that caution needs to be expressed when comparing the results from the two tasks due to the difference in task demands. The presence of a significant relationship between RS-score and choking in this simple motor task suggests that reinvestment of explicit rules may not be a necessary precursor of explicit monitoring or conscious control of motor actions. The peg-board task does not lend itself to explicit technical instruction as it is not a complex, rule bound skill, therefore the significant correlation suggests either that explicit monitoring or control of movements may occur independently from the application of explicit rules or that a different process of skill breakdown may be implicated. However, it should be noted that the present study failed to adopt an explicit knowledge check to investigate the type and amount of information participants were relying upon when completing the tasks. Therefore, inferring whether or not the completion of any of the tasks used was governed by explicit knowledge is limited to conjecture. A further insight into the underpinning processes of skill failure comes from analysing the relationships between skill failure and the RS sub-scales. A non-significant relationship was found between skill failure under pressure and the sub-scale containing items that most clearly align with explicit monitoring accounts of choking (private self-consciousness). Only the public self-consciousness sub-scale was significantly related to decreases in performance under pressure in the motor tasks (both simple and complex). The RS was developed by using questions from previously validated scales, which the authors viewed as being associated with an inward focus of attention to the mechanics of one's movements (Masters & Maxwell, 2008). Jackson et al. (2006) noted that the RS "does not attempt to measure the process of reinvestment directly but instead aims to bring together conceptually linked items that predict this process" (p. 65). Items from the public self-consciousness sub-scale are concerned with the awareness of the self as a social object and it is argued would indicate a thought that draws attention away from the primary task (e.g., "I am concerned about what other people think of me") rather than relating to conscious processing of task relevant information to control performance.

With regard to the peg-board task, the nature of task may also offer a potential explanation due to its dependence upon two elements: the transfer of the peg to the vicinity of the hole and the fine motor adjustment required to insert the peg into the hole. Anecdotally, participants appeared faster under pressure on the transfer element but then made more errors or adjustments when attempting to place the pegs in the holes. Consequently, without a measure of errors made, care needs to be taken when interpreting the completion time data, which suggested a slowing in completion time under pressure, as this may have resulted from a change in the speed/accuracy trade off adopted by participants (Masters, Personal Communication, 2010). This observation needs to be confirmed empirically; however, it is consistent with previous research showing that the components of a task that rely upon effort tend to be unaffected by (or even improve under) pressure while the skill-based components tend to be impaired (Baumeister et al., 1990).

With respect to the golf putting task, it should be noted that performance was not significantly different in the low-pressure and high-pressure conditions; however, the change in performance from low pressure to high pressure was negatively related to RS-score and the public self-consciousness sub-scale. The participants in this study were novices with respect to golf putting so the lack of evidence for choking in the putting task might be explained by their reliance on explicit processes to support performance. For example, Beilock, Carr et al. (2002) found that novice soccer players performed faster under skill-focus conditions compared to dual-task conditions, a pattern that was also present when experienced soccer players dribbled the ball using their non-dominant foot. A similar pattern of results was reported by Beilock, Wierenga and Carr (2002) when experienced golfers putted using a novel ‘funny’ putter.

Evidence of choking was also mixed in the card sorting and modular arithmetic tasks. In the card-sorting task, participants generated more errors under pressure; however, in the more complex task they also exhibited faster task completion times, indicating that speed-accuracy trade-off may have been an issue. It is possible that participants compromised the accuracy of their actions in order to achieve a faster completion time. Of these, RS-score and rehearsal subscale score were associated with the change in task completion time from low pressure to high pressure but not with changes in the number of errors made. Specifically, higher scores were associated with significantly faster times under pressure. By contrast, in both modular arithmetic tasks, completion time remained stable across the two levels of pressure, with differences only relating to the rehearsal sub-scale in the low complexity task. However, the increase in errors from low pressure to high pressure was greater in the more complex modular arithmetic task and in both cases the difference in errors was significantly related to RS-score and more specifically, the more distraction aligned sub-scales of the instrument (Public Self-consciousness and Rehearsal). A possible explanation for this pattern of results is offered by Beilock & DeCaro (2007) who suggest there is a qualitative shift in the type of solution strategies employed by participants under pressure. A shift from using more elaborate strategies to using simpler ones under pressure would have masked any increase in response time one might have expected had participants engaged in distracting thoughts when attempting to apply the more elaborate solution strategies. Assuming the simpler strategies were less accurate, the number of mistakes would be expected to increase and would be more evident in the more complex version of the task, which is what was found. Consequently, this suggests that these performers may have suffered impaired 'inhibition' functioning of the central executive which prevented them from being able to suppress the less effective simple strategies they automatically reverted to.

In further considering the pattern of results for RS-score correlations, the difference in the direction of the relationships in the peg-board and card-sorting tasks is noteworthy. These tasks are similar in that they both involve placing objects in different positions; however, the peg-board task requires participants to exhibit fine motor control in order to place each peg in a hole. The demands of the card sorting task are largely limited to the process of classifying each card appropriately: there are no contingencies relating to the accuracy or precision with which each card is placed on the appropriate pile. Baumeister et al. (1990) used a card-sorting task in which participants had to sort the cards by suit and number. They classified the task as 'effort-based' and found that praise improved performance relative to baseline whereas praised participants did worse on a 'skill-based' video game task compared to their unpraised counterparts. Baumeister et al. hypothesized that effort-based tasks are facilitated by conscious control as this helps focus attention and increase motivation. Consistent with this, we found no adverse effect of pressure on either the speed or accuracy of performance in the simple card sorting task. However, in the more complex version of the task pressure led to faster, more error-prone performance. Taken together, the findings with respect to RS score on these tasks are more consistent with a motivational explanation because RS score was significantly correlated with the difference in task completion time in both versions of the task. Additional support for differences observed between effort-based and skill-based tasks comes from Eysenck and Calvo's (1992) processing efficiency theory and later Eysenck, Derakshan, Santos and Calvo's (2007) attentional control theory. The main assumption of these theories is that anxiety (induced by pressure) impairs processing efficiency rather than performance effectiveness. They suggest that anxiety disrupts the balance between two attentional systems (Corbetta & Shulman, 2002); more specifically, the efficiency of the goal driven attentional system is impaired leading to a greater influence of the stimulus driven attentional system therefore resulting in reduced attentional control and also the impairment of the inhibition and shifting functions of the central executive. In order to compensate for this impairment, strategies such as increased effort and greater use of processing resources are utilised. Consequently, tasks that require low resources (such as effort based tasks) performance will be unaffected and possibly even enhanced.

In conclusion, the results of the present study lend support to the hypothesis that high reinvesters are more susceptible to the detrimental effects of pressure (Masters et al., 1993) and that findings from studies of motor tasks extend to cognitive tasks and particularly to those that place significant demands on working memory. However, it is suggested that the observed relationship between skill failure and Reinvestment score is not necessarily indicative of an individual's propensity to exert conscious control because the scale contains several items that are more closely associated with distraction. At the same time, the present study gives some indication about the process by which performance is disrupted. In tasks in which speed is the most salient feature (e.g., card sorting), high reinvesters appear more prone to emphasising this feature of performance under pressure, a process that results in more errors when the task becomes more complex. In tasks in which the cognitive component is the dominant feature (e.g., modular arithmetic), performance accuracy appears more affected than speed and high reinvesters were duly more affected than low reinvesters in the number of errors made. These results have implications for more cognitive elements of skilled performance, for example those in which both fast and accurate decisions are necessary for effective performance. Although speculative at this stage, the present data suggest that high reinvesters may be prone to making more errors under pressure, thereby exhibiting a form of choking that parallels that observed in the motor domain.

Chapter 4: Development and Validation of the Decision-Specific Reinvestment Scale

4.1 Introduction

"At the elite level, factors such as the presence of an audience (Baumeister & Showers, 1986), evaluative others (Martens & Landers, 1972), a competitive environment (Seta, Paulus & Risner, 1977), and financial incentives (Baumeister, 1984) can result in *choking*, defined as the occurrence of inferior performance in spite of high motivation and incentives for success (Jackson & Beilock, 2007)." Self-focus or *reinvestment* theories of choking propose that, under pressure, performers consciously attempt to focus their attention on the process of how to perform the task, thus disrupting the normal automatic processing of the task (Masters, 1992; Beilock & Carr, 2001). In this chapter, we consider the role of attention-based psychological constructs in the propensity for engaging in conscious control processes and describe the development of the Decision-Specific Reinvestment Scale, in which items from the Reinvestment Scale (Masters, Polman & Hammond, 1993) are adapted to apply to the decision-making component of skilled performance.

The disruption to skilled performance that occurs when attention is dedicated to controlling one's movements has been described in a variety of ways. Fitts, Bahrick, Noble and Briggs (1961) presented the *progression-regression hypothesis*, wherein they suggested that learning involves a progression from simple to complex control strategies, and that, under pressure, people may regress to simpler levels of control. Masters (1992) referred to this process as reinvestment, borrowing terminology from Deikman's (1969) concept of deautomatization in which he described the process of "reinvesting actions and percepts with attention" (p. 31).

Masters and Maxwell (2004) defined reinvestment as an inward focus of attention to consciously control the mechanics of one's movements by processing explicit knowledge of how the movement is performed.

4.1.1 Dispositional Self-Focus. Two related scales have been used to examine individual differences in the propensity for reinvestment and in particular, the relationship between *trait self-focus* and performance under pressure. In his early examination of choking, Baumeister (1984) used the Self-Consciousness Scale (Fenigstein, Scheier & Buss, 1975), while Masters et al. (1993) explored this phenomenon through the development of the Reinvestment Scale. This scale comprises 12 items from the private self-consciousness and public self-consciousness subscales of the Self-Consciousness Scale, seven items from the rehearsal factor of the Emotional Control Questionnaire (Roger and Nesshoever, 1987), and one item from the Cognitive Failures Questionnaire (Broadbent, Cooper, Fitzgerald & Parkes, 1982). Private self-consciousness refers to the attention an individual gives to his or her thought processes, whereas public self-consciousness is concerned with the awareness of the self as a social object. Rehearsal relates to one's tendency to mentally rehearse emotional events. The final, Cognitive Failures Questionnaire item ("Do you have trouble making up your mind?"), describes the tendency to have action slips, occasions in which one's actions are not performed as intended (Broadbent et al., 1982). High internal reliability (coefficient alpha = .80) and test-retest reliability ($r = .74$) were evident in the initial assessment of the Reinvestment Scale's psychometric properties.

Early work using the Self-Consciousness Scale indicated that more self-conscious individuals were less susceptible to choking (Baumeister, 1984). These results were consistent with Baumeister's hypothesis that highly self-conscious individuals would be used to performing in a self-aware state, enabling them to cope better with the self-scrutiny induced by pressure than their low self-conscious counterparts. However, more recently researchers have suggested that high dispositional self-focus increases susceptibility to choking. For example, in golf putting Masters et al. (1993) found a significant correlation (r = .59) between Reinvestment Scale score and performance change between stressed and non-stressed conditions; high scores were associated with greater performance decrements under pressure. Similarly, Masters et al. found a significant correlation (r = .64) between the Reinvestment Scale scores of university squash and tennis players and their tendency to choke under pressure, as rated by their coaches and team captains.

Chell, Graydon, Crowley and Child (2003) examined whether the Reinvestment Scale predicted skill breakdown under pressure in 14 university soccer players using a wall-volley task. They found that high reinvesters scored significantly worse in a high-stress than a low-stress condition, whereas low reinvesters performance remained stable across conditions. Jackson, Ashford and Norsworthy (2006, Experiment 1) also found that Reinvestment Scale scores were significant predictors of choking in a group of skilled field hockey players, such that high reinvesters slowed more under pressure than did low reinvesters on a hockey dribbling task. Similarly, Maxwell, Masters and Poolton (2006) found a significant correlation between reinvestment score and change in golf putting performance under evaluative conditions, with high reinvesters suffering greater decrements in performance under pressure. Using structural equation modelling, Poolton, Maxwell and Masters (2004) also found that Reinvestment Scale scores predicted the number of rules accumulated by novice golf putters, which in turn predicted subsequent performance failure under anxiety-inducing conditions.

To date, research into the relationship between dispositional self-focus and choking has centred on the motor component of skilled activity. Masters, Eves and Maxwell (2005; cf. Masters & Maxwell, 2008) recently developed a movement-specific version of the Reinvestment Scale to further enhance the face validity of the original scale, which comprised two factors (movement self-consciousness; conscious motor processing) and had sound test-retest and internal reliability properties. Masters and colleagues have also extended this research to non-sport populations, for example, by examining the relationship between reinvestment and medical conditions such as Parkinson's disease (Masters, Pall, MacMahon & Eves, 2007), stroke (Orrell, Masters & Eves, 2009) and the association between movement specific Reinvestment Scale and "faller or non-faller" status in the elderly (Wong, Masters, Maxwell & Abernethy, 2008). Many skills have a significant decision-making component such that cognitive and perceptual components reliably discriminate experts from their less-skilled counterparts (Abernethy, Zawi, Jackson, 2008; Williams, 2000). The relationship between propensity for reinvesting conscious control and decision-making performance under stress has received little attention; however, the need for both fast and accurate judgments in many competitive sports, often made under complex and changing visual environments, suggests that more deliberative decision making may impair performance.

Outside of sport, Dijksterhuis (2004) highlighted the limitations of conscious thought when making complex judgments that require the weighting of several different attributes. For example, in one study participants were asked to judge the attractiveness of four apartments using a list of 12 attributes. Dijksterhuis found that participants who engaged in a distracter task for three minutes after listing the attributes were better able to differentiate between the most attractive and least attractive apartments than were participants who were encouraged to think carefully. This finding has been mirrored in sport. Smeeton, Williams, Hodges and Ward (2005) found that explicit processing inhibited not only the accuracy, but also the speed, of perceptual judgments. Smeeton et al. compared the robustness under stress of explicit, discovery and guided discovery learning protocols in junior intermediate-level tennis players. The explicitly trained group was significantly slower than both of the other groups when under anxiety-inducing conditions; they were also inaccurate. Consistent with the reinvestment and conscious processing hypotheses, decision time under pressure was positively correlated with the number of rules accumulated during the learning period (r = .76).

In this study we develop a decision-specific version of the Reinvestment Scale that measured the individual's propensity for engaging in conscious decision-making. In so doing, we aimed to construct a tool that predicts susceptibility to impaired decision-making under pressure. The validity of the scale was examined in several stages, each examining a different aspect of validity (Anastasi & Urbina, 1997). In the first study, we examine the adequacy of the item pool in terms of relevance to theory and understanding by modifying items from the original Reinvestment Scale and assessing face validity through a review by expert coaches. We then employ exploratory factor analysis to explore the underlying structure of the data by performing principal components analysis. Finally, we test the factorial validity of the proposed factors using confirmatory factor analysis. Here the competing models, representing different theoretical positions, are examined before testing the generality of the best fitting factor structure across the samples. In the second study, we assess the predictive validity of the final version of the Decision-Specific Reinvestment Scale by correlating scores on the scale with peer assessment ratings of participants' likelihood to choke, made by their respective coaches.

4.2 Development of the Decision-Specific Reinvestment Scale

4.2.1 Stage 1: Scale Construction. Items from the Reinvestment Scale (Masters et al., 1993) were modified so as to reflect cognitions when making decisions. For example, the item "I'm aware of the way my mind works when I work through a problem" was modified to "I'm aware of my thought processes when I make a decision". One additional item was created: "I always try and weigh up all the different factors when making decisions" in order to draw parity with reinvestment theory in regard to the use of explicit rules in controlling behavior (Appendix F).

4.2.1.1 Face Validity. To assess face validity, the modified items were administered to two basketball coaches and one volleyball coach (M = 7.20 years' experience); both sports require performers to make decisions in time-constrained environments. It was explained to coaches that the purpose of the items was to assess individual differences in the way sports performers make decisions. The coaches were asked to assess how well each item applied to the decision-making processes in their sport, to highlight any items they deemed unsuitable and to add any items they thought would improve the instrument. The scale was also administered to 16 postgraduate students to address any wording issues within the questionnaire which included hypothetical, leading or double-barrelled questions, ambiguous or technical terminology and hidden assumptions as well as more general aspects, such as the layout, typeface and size (Nunnally, 1978; Oppenheim, 1992).

As a result of the assessment of face validity, only minor amendments to the layout were made.

4.2.2 Stage 2: Exploratory Factor Analysis. Institutional ethics approval was granted and all participants gave written consent (Appendix A) prior to taking part in the study. The modified instrument was administered to 165 undergraduate university students (88 males, 77 females; mean age = 20.88 years, *SD* = 3.80) who were competing at the time in a variety of team sports, primarily football (*n* = 52), rugby (*n* = 25), field hockey (*n* = 18), netball (*n* = 13), athletics (*n* = 9) and basketball (*n* = 7), thus satisfying the minimum sample size required for factor analysis (see Gorsuch, 1983) of five participants per item. Participants were currently competing for local clubs or in inter-university competitions (*n* = 82); for recreational teams (*n* = 41); in county or regional level teams (*n* = 28), or at national or international level (*n* = 14) with a mean of 9.88 years (*SD* = 5.36) competitive playing experience.

The first author administered the scale to five groups of approximately thirty participants prior to classes taken as part of their undergraduate degree. Participants were instructed to rate how each statement characterised their own decision-making processes in sport by considering situations in their sport that required them to make a decision. To aid in directing participants towards decision demanding situations, the experimenter provided some sport specific examples, such as the decision to retain possession, pass to a team-mate or shoot in team sports such as football, basketball and field hockey. Participants were informed that there were no right or wrong answers, were asked to answer as honestly as possible and were instructed not to spend too long on each item. These instructions were reinforced at the top of the questionnaire. Finally, the experimenter stated that all answers would remain anonymous, and answered participants' outstanding questions. All 21 items were rated on a five-point Likert scale, anchored by 0 (extremely uncharacteristic) and 4 (extremely characteristic).

4.2.2.1 Statistical Analysis. Following the procedure recommended by Gerbing and Hamilton (1996), principle components analysis using varimax rotation and Kaiser normalisation to enhance orthogonal separation was used to group items into uncorrelated factors. Two main decision rules were used for factor extraction: First, variables should yield an eigenvalue greater than 1.00, indicating that a factor explained more variance than a single item; second, items loading at > .50 on one factor and < .40 on all others were considered for inclusion (Pallant, 2007).

4.2.3 Stage 3: Confirmatory Factor Analysis. Institutional ethical approval was granted and all participants gave written consent prior to taking part in the study. The updated instrument was administered to 111 participants (80 male, 31 female; mean age = 24.45, *SD* = 6.22 years) from a range of team sports, primarily football (*n* = 25), rugby (*n* = 11), basketball (*n* = 23), netball (*n* = 7) and athletics (*n* = 5). Participants were currently competing for local clubs or in inter-varsity competitions (*n* = 48); in recreational teams (*n* = 33); in county or regional level competitions (*n* = 17), or at national or international level (*n* = 13). Participants had a mean of 12.50 years (*SD* = 6.62) competitive playing experience. The procedure for administering the scale was the same as that used for the exploratory factor analysis.

4.2.3.1 Statistical Analysis. Absolute fit indices such as the chi-square statistic and the goodness-of-fit index (GFI) as well as incremental fit statistics such as the comparative fit index (CFI), the based standardised root mean squared residual (SRMR) and the root mean square error of approximation (RMSEA) were calculated. For both GFI and CFI, values > .95 constitute a good fit and values > .90 an acceptable fit of the resultant model (Medsker, Williams, & Holahan, 1994). For the SRMR a cut-off value close to .08 has been suggested (Hu & Bentler, 1999). For the RMSEA, it has been suggested that values of less than .05 constitute good fit; values in the .05 to .08 range constitute acceptable fit; values in the .08 to .10 range marginal fit, and values > .10 poor fit (Browne & Cudeck, 1992). Akaike Information Criterion (AIC), representing both absolute and incremental fit indexes was also used. AIC adjusts the model chi-square to penalize for model complexity; the lowest AIC value indicates the optimal solution.

4.2.4 Results.

4.2.4.1 Exploratory Factor Analysis. Prior to performing principle components analysis we assessed the suitability of the data for factor analysis. Inspection of the correlation matrix revealed the presence of many coefficients of .30 and above. The Kaiser-Meyer-Oklin value was .85, exceeding the recommended value of .60 (Kaiser, 1974) and Bartlett's test of sphericity (Bartlett, 1954) reached statistical significance, supporting the factorability of the correlation matrix. The results of the principle components analysis indicated four possible factor structures for the Decision-Specific Reinvestment Scale; an eight-item one factor solution (accounting for 33.70% of the variance), a 13-item two-factor solution (45.48%; shown in Table 4.1), a 17 item three-factor solution (52.51%; Appendix G), and an 18-item four-factor solution (58.53%; Appendix H). From a theoretical perspective the two-factor solution offered a clear distinction between one factor comprising six items, of which five were adapted from the private self-consciousness component of the original Reinvestment Scale (one from public self-consciousness), and a second factor comprising seven items, six of which were adapted from rehearsal items (one from public self-consciousness). Thus, items contained in the first factor focused on the role of consciousness in the decision making processes, while items in the second factor were concerned with ruminating about past decisions. The three-factor solution differed from the two-factor solution in that it separated items assessing awareness of the decision-making processes and items assessing public self-consciousness about the decision-making process. The four-factor solution introduced a factor containing two items relating to the individual's cognitive load when making a decision. The one-factor solution comprised a mixture of items from the rehearsal, private and public self-consciousness constructs of the original Reinvestment Scale.

Table 4.1. Items and loadings for the two-factor solution of the Decision-Specific Reinvestment Scale following varimax rotation.

Item	Factor Loadings	
	Factor 1	Factor 2
I'm always trying to figure out how I make decisions.	.80	
I'm concerned about my style of decision-making.	.67	
I remember poor decisions I make for a long time afterwards.		.72
I'm constantly examining the reasons for my decisions.	.75	.31
I get "worked up" just thinking about poor decisions I have made in the past.		.79
I sometimes have the feeling that I'm observing my decision-making process.	.68	
I often find myself thinking over and over about poor decisions that I have made in the past.		.81
I think about better decisions I could have made long after the event has happened.		.77
I am alert to changes in how much thought I give to my decisions.	.74	
I'm aware of the way my mind works when I make a decision.	.68	
I rarely forget the times when I have made a bad decision, even about the minor things.		.75
When I am reminded about poor decisions I have made in the past, I feel as if they are happening all over again.		.68
I'm concerned about what other people think of the decisions I make.		.55

*Factor loadings below 0.50 or cross loading above .40 are excluded

4.2.4.2 Confirmatory Factor Anlaysis. The results of the exploratory factor analysis revealed that the one-, two-, three- and four-factor solutions contained eigenvalues greater than 1.00. Given the subjective nature of the scree plot analysis, all of the solutions were tested using confirmatory factor analysis.

4.2.4.2.1 Distribution of the data. Mardia's (1970) coefficient of multivariate kurtosis was used to assess multivariate normality. Statistical analysis revealed that the data violated the multivariate normality assumption in the one factor (multivariate kurtosis estimate = 11.54), two factor (11.39), three factor (9.19), and four factor (9.48) solutions, therefore, robust maximum likelihood estimation was employed in confirmatory factor analysis. Univariate kurtosis values ranged from -.24 to -1.18 (mean kurtosis value = -.76, *SD* = .28).

4.2.4.2.2 Confirmatory Analysis of the Factor Structures of the Decision-Specific Reinvestment Scale. In order to test the comparative fit of the competing factor structures of the Decision-Specific Reinvestment Scale arising from the exploratory factor analysis, robust maximum likelihood confirmatory factor analyses were performed using EQS (Bentler & Wu, 1995). The results (Table 4.2) revealed that although all of the models met the criterion value of the comparative fit index (< .90) the two factor model was the only one to achieve an acceptable level for RMSEA (.08 to .10) and good fit for the CFI (> .95). The two factor solution showed the best fit across all of the fit criteria (χ^2 =129.83 (64), CFI = .95, GFI = .87, SRMR = .06, RMSEA = .09, AIC = 1.83), maintaining acceptable values for all fit indices except for the GFI (< .90).

Table 4.2. Goodness of fit indexes for the competing models of the Decision-Specific Reinvestment Scale.

Model	χ^2	CFI	GFI	SRMR	RMSEA	AIC
One Factor	74.06 (20)*	.90	.87	.06	.16	34.06
Two Factor	129.83 (64)*	.95	.87	.04	.09	1.83
Three Factor	276.64 (116)*	.91	.80	.06	.11	44.64
Four Factor	302.84 (129)*	.91	.79	.06	.11	44.84

Note. χ^2 degrees of freedom are shown in parentheses after the test statistic.

*P < .001

4.2.4.3 Internal Consistency. Internal consistency estimates for the Decision-Specific Reinvestment Scale subscales using Cronbach's alpha coefficient across both Sample A and B were .89 (Factor 1) and .91 (Factor 2). Both factors show high internal consistency well above the criterion value (.70; see Tabachnick & Fidell, 2007).

4.2.5 Discussion

We developed and validated a new instrument to assess individuals' predisposition for exerting conscious control over their decision-making processes. Exploratory factor analysis revealed that the original list of items from the adapted Reinvestment Scale could be reduced to a one-, two-, three-or four-factor model. The two-and three-factor solutions had clearer conceptual coherence in comparison to the one- and four-factor solutions. According to assessments of model fit, confirmatory factor analysis revealed the thirteen-item two-factor scale showed the best fit.

Factor 1, labelled decision reinvestment, measures the respondent's tendency to consciously monitor the processes leading up to the decision. A high score on this factor reflects a strong propensity for consciously monitoring the decision-making process, and parallels the conscious monitoring and control of movements in the motor domain (Masters et al., 1993; Hardy, Mullen & Jones, 1996). The seven items in the second factor, labelled decision rumination, assess the tendency to reflect upon previous poor decisions. Rumination is a thought process related to failure to achieve and typically involves repetitive thoughts about past events or current mood states (Martin & Tesser, 1996). For example, Scott and McIntosh, (1999) found that people who tend to ruminate also experience more negative affect, greater worry, and perform poorer on cognitively demanding tasks.

4.3 Assessing Predictive Validity of the Decision-Specific Reinvestment Scale

We assessed the predictive validity of the Decision-Specific Reinvestment Scale by correlating scale scores with coaches' peer assessments of participants' ability to perform under pressure (See Study 4 in Masters et al., 1993). It is suggested that if the process of reinvestment extends to decision-making tasks then, in time-constrained environments, the propensity to engage in conscious decision-making should result in poorer decision-making under pressure. Accordingly, we hypothesize that Decision-Specific Reinvestment Scale scores will be positively associated with coach ratings of the players' tendency to make incorrect decisions under pressure.

4.3.1 Participants. Following granting of ethical approval, written informed consent (Appendix A) was obtained from participants. The sample comprised 59 participants (31 males, 28 females), drawn from two university men's basketball teams (n = 24), one university women's basketball team (n = 12), one university women's netball team (n = 10), and one National League mixed korfball team (n = 13). Participants had a mean age of 21.15 years (SD = 3.49) and a mean of 7.98 years' competitive experience (SD = 4.09). The mean age of the coaches was 32.40 (SD = 8.05), with a mean of 7.40 years' experience (SD = 1.67). All of the coaches had been with their respective teams for at least one year.

4.3.2 Procedure. After completing the informed consent and demographic questionnaire (Appendix D), the Decision-Specific Reinvestment Scale (Appendix I) was administered to each team member immediately prior to a weekly training session. Participants were instructed to rate how each statement characterized their own decision-making in sport. They were asked to think about instances from their own sport in which they are required to make decisions, such as when to pass and to whom. They were further informed that there were no right or wrong answers, were asked to answer as honestly as possible, and were instructed not to spend too long on each item. These instructions were reiterated at the top of the questionnaire. Finally, participants were reassured that all answers would remain anonymous. All 13 items were rated on a 5-point Likert scale, anchored by 0 (extremely uncharacteristic) and 4 (extremely characteristic). The coach of each team was required to rate each player's tendency to choke using a ten-point Likert scale. The scale was anchored by 1 = never chokes under pressure (makes correct decisions). 10 = always chokes under pressure (makes incorrect decisions). Coaches were instructed to think of each player's ability to perform under pressure during instances in which he or she is required to make a decision, when completing their ratings. They were also instructed to ensure that their players remained unaware of their ratings.

4.3.3 Results and Discussion. The relationship between Decision-Specific Reinvestment Scale scores and ratings of decision-making under pressure was assessed through calculation of Pearson product-moment correlation coefficients. The analysis revealed a strong positive correlation between the global Decision-Specific Reinvestment Scale scores and the decision-making ratings by the coaches ($r = .74$, $p < .01$). The subscale factors, decision reinvestment and decision rumination, were also significantly correlated with coaches' ratings of players' susceptibility to choking ($r = .62$, $p < .01$ and $r = .60$, $p < .01$, respectively). Correlations for each team were also calculated and ranged from .59 to .91 for global Decision-Specific Reinvestment Scale scores (Table 4.3); figures that are similar to those reported using the Reinvestment Scale by Masters et al. (1993) for squash and tennis players ($r = .64$, $p < .01$). The correlations for each factor differed from team to team with decision rumination revealing moderate but non-significant relationships for women's Basketball, Netball and Korfball teams and decision reinvestment replicating this relationship in the men's Basketball 2nd team.

Table 4.3. Pearson product-moment correlation coefficients between Decision-Specific Reinvestment Scale (DSRS) global and subscale scores, and coach ratings of players' tendency to choke.

Sports Team	Global DSRS	Decision Reinvestment	Decision Rumination
University Men's Basketball 1st Team	.80**	.85*	.70*
University Men's Basketball 2nd Team	.91***	.50	.86***
University Women's Basketball 1st Team	.59*	.73**	.35
University Netball 1st Team	.80**	.79**	.59
National League mixed Korfball Team	.63*	.67*	.34

*$p < .05$, **$p < .01$, ***$p < .001$,

4.4 General Discussion

The purpose of this experiment was to develop a decision-specific version of the Reinvestment Scale (Masters et al., 1993) that focused on individual propensity for engaging in conscious decision-making. Potentially this could help to identify individuals who are vulnerable to making poor decisions in complex or time-constrained environments. The analysis revealed a 13-item, two-factor scale that assessed conscious monitoring of the decision-making process (decision reinvestment) and rumination over previous poor decisions (decision rumination) The results of Study 2 indicated that the Decision-Specific Reinvestment Scale scores of team sport participants were moderately related to their propensity to choke, as judged by their respective coaches.

Data analysis revealed two separate factors that were equally related to performance breakdown under pressure: decision reinvestment ($r = .62$, $p < .01$) and decision rumination ($r = .60$, $p < .01$). The emergence of these two factors appears to reflect the distraction and reinvestment theories that constitute the two distinct classes of attention-based accounts of choking (Beilock, Kulp, et al., 2004, Masters et al., 1993). The Movement Specific Reinvestment Scale (Masters et al., 2005) revealed a comparable two factor structure (conscious motor processing, movement self-consciousness) following a similar redevelopment of the original Reinvestment Scale. Both scales highlight the importance of conscious control of processes to this concept, whilst reference to ruminative thoughts is made in defining the second factor of the Movement Specific Reinvestment Scale as the "contemplation of the process of movement, as reflected in *past*, present and future motor activity" (p. 2). In addition, the rumination component corresponds well to the rehearsal items in the

Reinvestment Scale. Distraction and reinvestment theories have originally been viewed as contrasting explanations of the choking phenomenon. However, Beilock (2007) has suggested that pressure exerts two effects such that a performer's working memory is consumed by worries *and* they are enticed into paying more attention to the step-by-step processes that govern performance. The effect these processes have on performance depends upon the demands of the task being performed. Well-learned proceduralised skills that do not tax working memory suffer from conscious control processes that disrupt the effortless, automatic nature of performance whereas working memory dependent tasks (e.g., mathematical problem solving) suffer when other cognitive activity consumes working memory resources.

The role of consumed working memory in performance disruption was also examined by Poolton, Masters and Maxwell (2006) and later by Masters, Poolton, Maxwell and Raab (2008). This research examined the role of working memory on concurrent decision and motor performance by manipulating the extent of explicit knowledge of a motor skill using different learning conditions. They argued that explicit processes are dependent upon working memory due to the conscious retrieval of declarative knowledge to control motor skill execution and that implicit learning offers a method of 'freeing up' working memory in order to cope more efficiently with the increased processing demands of multiple concurrent tasks. They found the efficiency of performance for participants who learnt the motor skill explicitly deteriorated when required to make a complex decision in tandem with the motor action. The implication that both distraction and reinvestment based accounts of choking can induce a reduction in working memory resources highlights the importance of this function for performance under pressure. It can be argued that the present scale reflects this in that ruminative thoughts (Decision Rumination) and the processing of explicit information in order to control actions (Decision Reinvestment) consume working memory. Decision-making in time-constrained, complex environments conceivably involves elements that place significant demands on working memory (e.g., implementation and evaluation of a game plan or strategy) as well as more proceduralized elements that *run off* with minimal conscious involvement (e.g., processing of visual patterns). Further research is required to test the validity of the Decision-Specific Reinvestment Scale with consideration to the variety of demands and situations commonly found in today's sporting environments. More generally, the manipulation of the cognitive load through the use of different tasks (more motor tasks or more cognitive tasks) could also be used to test the different attentional theories of choking and the influence of dispositional reinvestment.

Validation of the instrument in the present study is limited to time-constrained, dynamic team sports that incorporate many different types of decisions, ranging from tactical game plans to immediate decisions (e.g., whether to shoot or pass). A logical extension of the present study is to assess the sensitivity of the scale with respect to different types of decision. Additionally, the present study used coach assessments of the performers' decision-making performance under pressure and there is a need to corroborate these observations using actual performance data. For example, while coaches were asked to rate performers' decision making performance, it might prove difficult to do so in skills where decisions also involve a motor component. While the coaches in the present study reported no difficulty in discriminating between the decisions made by their players and their subsequent attempt to execute the desired skill, it remains possible that a poor pass to an individual might be rated as a poor decision to pass to them in the first place. One way of addressing this issue would be to assess predictive validity using sports skills or lab-based tasks that more clearly delineate the cognitive and motor components (Kinrade, Jackson & Ashford, 2010).

The findings reported here should be viewed as preliminary, as for other psychometric tool development and initial validation studies. Cook and Campbell (1979) suggest that evidence of a tool's psychometric properties and construct validity must come from a variety of investigations and methods (cf. Carron, Widmeyer & Brawley, 1985). Of particular interest in ongoing validation of the Decision-Specific Reinvestment Scale is the need to determine whether it measures an individual difference factor that is sufficiently distinct from that measured by the Reinvestment Scale, and to what extent the Decision-Specific Reinvestment Scale improves on the predictive validity and other psychometric properties of the Reinvestment Scale. Research that uses the Reinvestment Scale, the Decision-Specific Reinvestment Scale, and indeed the Self-Consciousness Scale, is necessary to assess the discriminant validity of the Decision-Specific Reinvestment Scale. Finally, the nature of performance breakdown could be examined by using tasks that record both response time and accuracy (e.g. see Williams, Hodges, North & Barton, 2006). In addition to this, validation studies are required to replicate the proposed factor structure in both sport and other decision-making domains.

Chapter 5: Decision-Making in Badminton. Predicting Performance Under Pressure

5.1 Introduction

Research into the role of attention in inducing the paradoxical performance effect of pressure has received considerable attention over the last three decades (Baumeister, 1984; Jackson, Ashford & Norsworthy, 2006; Masters, Polman & Hammond 1993). Despite this, comparatively little is known about the dispositional factors that predict 'choking' (Wang, Marchant, Morris & Gibbs, 2004), defined as the occurrence of poor performance in spite of high motivation and incentives for success (Baumeister, 1984; Jackson & Beilock, 2007).

Investigations into the attentional processes underlying this phenomena have often been examined though two main theoretical frameworks; distraction and self-focus. Distraction theory suggests that increases in performance pressure induces a shift in focus of attention to task-irrelevant cues or cause the performer to attempt to process large amounts of information rather than selecting specific cues, thus not giving enough attention to relevant information resulting in a poorer performance (Baumeister & Showers, 1986). Support for this theory has been found in studies indicating that highly anxious people are preoccupied with task-irrelevant thoughts (Eysenck, 1979; Wine, 1971) and from cognitive tasks that rely on working memory (DeCaro, Rotar, Kendra, & Beilock, 2010). In contrast to distraction theory self-focus theories maintain that a process of heightened self-awareness about performing correctly leads to a more conscious focus on the individual motor components of a skill. This results in a shift from an automatic, habitual response to a more step-by-step process that governs performance (Beilock & Carr, 2001; Masters, 1992). Researchers have examined this theoretical model under a variety of different terms including deautomisation (Deikman, 1969), conscious processing (Hardy, Mullen & Jones, 1996), explicit monitoring (Beilock, 2007) and reinvestment (Masters, 1992).

Investigation into the role attention plays in performance under pressure has led researchers to explore individual differences that may predict those individuals with a greater tendency to suffer performance decrements under pressure. These factors include trait-anxiety, skill-level, self-consciousness and reinvestment propensity (Baumeister & Showers, 1986; Masters et al., 1993). Self-consciousness is a trait that describes a person's disposition to direct their attention either inward or outward (Fenigstein, Scheier & Buss, 1975). Baumeister (1984) found that individuals with low dispositional self-consciousness were more likely to choke on a sensorimotor game than their high self-conscious counterparts. It was concluded that those of a highly self-conscious disposition were more acclimatised to performing whilst self-focusing, compared to their low self-consciousness counterparts, and therefore did not suffer performance decrements as a result of the pressure-induced increase to self-consciousness. However, others have reasoned that those high in self-consciousness are more susceptible to choke as they are more inclined to think too much under pressure (Jackson & Beilock, 2007). For example, Wang, Marchant, Morris and Gibbs (2004) found that self-conscious players were more susceptible to choking under pressure than less self-conscious players in basketball free-throws.

Dispositional reinvestment can be defined as the "propensity for manipulation of conscious, explicit, rule-based knowledge, by working memory, to control the mechanics of one's movements during motor output" (Masters & Maxwell, 2004, p.208). Masters et al. (1993) developed the Reinvestment Scale from the proposition that individual differences in the propensity to reinvest conscious control processes exist. The scale is comprised of items drawn from previously validated scales, including the Cognitive Failure Questionnaire (Broadbent, Cooper, Fitzgerald & Parkes, 1982), the Self Consciousness Scale (Fengstein et al., 1975) and the Emotion Control Questionnaire (Roger & Nesshoever, 1987). Individuals classified as high reinvesters were found to be more likely to suffer skill failure under pressure than low reinvesters (Kinrade, Jackson & Ashford, 2010; Jackson et al., 2006; Maxwell, Masters & Eves, 2000; Maxwell, Masters & Poolton, 2008;). However, Masters & Maxwell, (2008) highlight that despite its support the Reinvestment Scale suffers from a number of limitations. The main issue lies in the lack of reference specifically to movement despite the majority of this research focusing on motor skills (Baumeister, 1984; Masters et al, 1993), which undermines its face validity. This led to the development of a movement specific reinvestment scale (Masters, Eves and Maxwell, 2005; cf. Masters & Maxwell, 2008), which comprised two distinct factors (movement self-consciousness; conscious motor processing) and had sound test-retest reliability (r = .67 and r = .76, respectively) and internal reliability properties (α = .78 and α = .71, respectively). Support for the use of the movement specific scale has largely come from health settings in which an inward focus of attention on performance processes might be disruptive. For example, Wong, Masters, Maxwell and Abernethy (2008) investigated the relationship between reinvesting in motor processes and falls when walking in elderly individuals. Individuals who experienced falls scored significantly higher on the scale than those who did not experience falls, suggesting tendency to fall was associated with the propensity to exert conscious control. Masters, Pall, MacMahon, & Eves, (2007) examined differences between Parkinson's disease sufferers' and age matched controls. Awareness of action mechanics and propensity to consciously monitor movements appeared to increase with the length of time individuals had been suffering from the disease. This was linked to rehabilitation strategies that encourage reinvestment to control actions as well as incessant anxiety about correctly executing motor processes that may increase reinvestment. Furthermore, Orrell, Masters, & Eves, (2009) used the MSRS to compare the differences in propensity to reinvest between stroke patients and non-disabled individuals, and to examine the relationship between reinvestment and functional impairment from stroke. Reinvestment was significantly linked with functional impairment in stroke patients and the authors concluded that over-reliance upon reinvestment strategies in stroke rehabilitation may be debilitative when trying to regain functional independence.

Decrements in performance under pressure are not confined to motor skills, and decrements in decision making and perceptual judgment tasks have also been observed (Dijksterhuis, Bos, Nordgren, & van Baaren, 2006; Payne, Bettman & Johnson, 1988; Smeeton, Williams, Hodges & Ward, 2005). Research on skill failure in cognitive tasks that place significant demands on working memory has generally supported distraction theory (Beilock & Carr, 2001; Beilock, Kulp, Holt, & Carr, 2004). Kinrade, Jackson and Ashford (2010) examined the moderating effect of dispositional reinvestment upon ‘choking’ in motor and cognitive tasks of varying complexity. They found that pressure had a deleterious effect on performance in a low complex motor task (peg-board), led to faster but more error-prone performance in a high-complexity psychomotor task (card sorting), and led to more errors in a high-complexity working memory task (modular arithmetic). High reinvestment scale scores were significantly correlated with performance decrements from low to high pressure conditions in both low and high complex (golf-putting) motor tasks, and in both working memory tasks. However, higher reinvestment scores were associated with a speeding of performance from the low to high pressure condition in the psychomotor tasks. Their findings suggest that the association between reinvestment and choking extends beyond the motor skill domain to cognitive tasks, particularly those that place significant demands on working memory, and that this relationship is moderated by task complexity. Similarly, Smeeton et al. (2004) discovered participants who learned an anticipation skill (return of a tennis stroke) explicitly suffered performance decrements under anxiety provoking conditions, compared to participants who learned through guided discovery and discovery leaning based methods. This evidence lends support to earlier work in the motor skill domain which suggests that explicit learning leads to reinvestment (Liao & Masters, 2001; Masters, 1992; Maxwell et al., 2000). In an attempt to examine the propensity for reinvesting explicit knowledge in decision making tasks, Kinrade, Jackson, Ashford & Bishop (2010) developed the Decision-Specific Reinvestment Scale. The scale was primarily developed from items based on the original reinvestment scale (Masters et al, 1993). From a pool of 21 items, factor analysis revealed a 13-item 2-factor model. The first factor focused on the conscious monitoring of the processes that produce a decision (decision reinvestment), while the second factor highlights an individual's propensity to focus upon past inaccurate decisions that they have made (decision rumination). Their initial investigation into the predictive validity of the scale used judgments of coaches, who were required to rate each player's tendency to choke using a ten-point Likert scale. The scale was anchored by 1 = never chokes under pressure (makes correct decisions). 10 = always chokes under pressure (makes incorrect decisions). Coaches were instructed to think of each player's ability to perform under pressure during instances in which he or she is required to make a decision, when completing their ratings. The analysis revealed a very strong correlation between Decision-Specific Reinvestment Scale score and peer ratings ($r = .74$, $n = 59$, $P < .01$).

Whilst encouraging, the initial validation of the DSRS did not assess actual decision making performance. The aims of the current study were, first, to investigate susceptibility to choking in a perceptual judgment task in which rapid decisions regarding the intentions of an opponent need to be made. Evidence from Smeeton et al. highlights the potential for a perceptual analogue of reinvestment yet choking in such tasks has yet to be systematically examined. The second aim of the study was to examine the predictive validity of the Decision-Specific Reinvestment Scale in a relevant sport-specific task. The return of an overhead strike in badminton was chosen as it has been used extensively in studies of anticipation skill and relies on the attunement to the quantifiable kinematic information that constrains the execution of the action (Abernethy, 1988; Abernethy & Russell, 1987; Abernethy, Zawi & Jackson, 2008). Abernethy et al. (2008) highlighted that the striking action of an overhead shot is segmented into several parts recruited sequentially, in a proximal-to distal manner. With each segment, and the transfer between segments, giving an insight into the outcome of the action the explicit knowledge base for the action may be substantial. Based on the initial correlations with peer review ratings of decision making performance under pressure (Kinrade, Jackson, Ashford, & Bishop, 2010), we predicted that propensity for reinvestment would be associated with poorer performance under high pressure trials. Additionally, there is a need to determine whether the Decision-Specific Reinvestment Scale measures an individual difference factor that is sufficiently distinct from that measured by the Reinvestment Scale, and specifically the extent to which the Decision-Specific Reinvestment Scale improves on the predictive validity and other psychometric properties of the Reinvestment Scale. Therefore, the current study will also compare the predictive properties of the Decision-Specific Reinvestment Scale and original Reinvestment Scale.

5.2 Method

5.2.1 Participants. Twenty-four skilled badminton players (*M* experience = 10.08 years, *SD* = 4.58) participated in the study. The sample was comprised of 18 males and 6 females, with a mean age of 23.46 years (*SD* = 4.90). Institutional ethical approval was granted and all participants gave written consent (Appendix A) prior to participating in the study.

5.2.2 Design and Measures. The study used a 3 (Pressure) x 2 (Reinvestment group) factorial design with the pressure factor incorporating an A-B-A design (low pressure, high pressure, low pressure). Response time and response accuracy served as dependent variables.

5.2.2.1 The Reinvestment Scale. The Reinvestment Scale (Masters et al., 1993; Appendix B) is comprised of twenty items that were considered likely to predict individual propensity for reinvesting controlled processing under pressure or psychological stress. Twelve items were taken from the Self-Consciousness Scale (Fenigstein et al.,1975), a further seven items were taken from the Rehearsal factor of the Emotional Control Questionnaire (Roger & Nesshoever, 1987), and one item was taken from the Cognitive Failures Questionnaire, (Broadbent et al., 1982). Masters et al. reported that the Reinvestment Scale had good internal reliability (Cronbach alpha = .86) and test-retest reliability over a four-month period (r = .74). In line with previous studies, (Jackson et al., 2006; Kinrade, Jackson, & Ashford, 2010) and consistent with the Self-Consciousness Scale, participants rated each item on a 5-point scale from 0 (extremely uncharacteristic) to 4 (extremely characteristic). As a result the item "Do you have trouble making up your mind?" was written in statement form: "I have trouble making up my mind" to facilitate rating using the 5-point scale.

5.2.2.2 Decision-Specific Reinvestment Scale. The Decision-Specific Reinvestment Scale (Kinrade, Jackson, Ashford, & Bishop, 2010; Appendix I) comprises 13 items that were considered likely to predict individual propensity for choking under pressure or psychological stress. Items from the original RS were re-worded to focus on decision making. The scale is comprised of 13 items split into two factors. The first factor, decision reinvestment, contains 6 items assessing the conscious monitoring of processes involved in making a decision; for example, "I'm always trying to figure out how I make decisions". The second factor, decision rumination, contains 7 items assessing the tendency to focus on past inaccurate decisions that they have made; for example, "I often find myself thinking over and over about poor decisions that I have made in the past". Internal consistency estimates for the Decision-Specific Reinvestment Scale subscales using cronbach's alpha coefficient were as follows; Factor 1 = .89, and Factor 2 = .91. Participants rated each item on the same 5-point scale used for the Reinvestment Scale.

5.2.2.3 Explicit Knowledge. To measure participants' awareness of information governing their decisions, participants were required to write down any information they considered important in making their judgments. Practice clips were shown to participants to aid recall and enhance the sensitivity of the test. Rules reported by the participants referred to a specific body part or aspect of shuttle flight, or contained relevant information relating these features to flight direction.

Participants were also required to rate the importance of this information and their awareness of using this information in each block of trials (Appendix J).

5.2.3 Manipulation Checks.

5.2.3.1 State Anxiety. To assess the effectiveness of the pressure manipulation, the cognitive and somatic anxiety subscales of the Revised Competitive State Anxiety Inventory-2 (CSAI-2R: Cox, Martens & Russell, 2003; Appendix E) were administered prior to the low- and high-pressure trials. Participants were asked to indicate the intensity with which they were experiencing each of the 12-items on a 4-point Likert-type scale anchored by 1 (not at all) and 4 (very much so). Cox et al. (2003) reported acceptable internal consistency estimates, using Cronbach's alpha coefficient, for both cognitive ($\alpha > .81$) and somatic anxiety subscales ($\alpha > .82$).

5.2.3.2 Perceived Pressure. After each block participants were asked to respond using a 7-point Likert-type scale anchored by 1 ("no pressure") and 7 ("extreme pressure"), how much pressure they felt they were under. Additionally, at the end of the testing session, participants responded to the question "In which trials did you feel you were under the most pressure?" and asked to select an option from "trials with the camera", "trials without the camera" or "no difference" (Appendix K).

5.2.4 Experimental Task and Construction of Test Stimuli. A four-choice task was developed in which participants were required to judge which of four court locations a badminton player was about to strike the shuttle towards (near left, near right, far left or far right, see Figure 5.1). The task represented returning an overhead strike (overhead clear or overhead drop) from the centre of the court. Two expert players were used to create the practice and test stimuli. Players were filmed with a digital video camera from a central position in the opposing court.

Video clips were digitised and edited using Pinnacle Studio (Version 11.0) to create the practice and test films. The practice block comprised 16 trials including two examples of each opposing player striking to each of the four targets, all of which were randomly presented. The three test blocks each contained 32 trials comprised of four examples of each opposing player striking to each of the four target locations. All trials began fifty frames prior to, and were occluded ten frames after, shuttle racquet impact. A grey screen followed the occlusion point of each clip and lasted for 1700ms. Participants were instructed that responses must be made before the end of the grey screen or the response would be recorded as incorrect. Inclusion of a time limit for responding and the instruction to respond as quickly and accurately as possible were designed to discourage participants from waiting for full ball flight information prior to making their decision.

The task was designed and run using E-Prime (v.2.0.1; Psychology Software Tools, Inc., Pittsburgh, Pennsylvania, US). Visual stimuli were presented on a computer screen, viewed from a distance of approximately 0.5m. Participants were instructed to indicate their judgment by pressing one of four response buttons on a handheld key pad, corresponding to the four target locations.

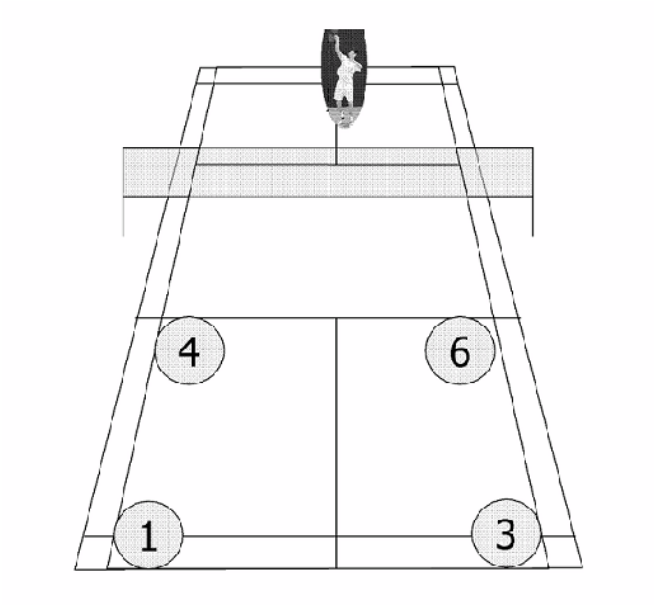

Figure 5.1. Diagram depicting the design of the video stimuli used for the four-choice reaction time task

5.2.5 Pressure Manipulation. The pressure manipulation involved two steps; the first was to induce evaluation apprehension by requiring participants to perform the tasks in the presence of an associate of the experimenter who filmed the trials. A cover story was given in which participants were told their performance on the next set of trials was to be filmed for the Badminton National Governing Body in order to assess their anticipation and decision making skills against other players of their level and ability. Participants were informed that the computer used both reaction time and response accuracy equally to compute a performance score. Finally, participants were told that if they could improve their performance score by 20% relative to the average for their age and ability, they would receive £10 and that the best performance from all participants would win £100.

5.2.6 Procedure. Having gained informed consent from participants, a convenient time for testing was arranged. Upon arrival at the testing area the initial questionnaire package (consisting of the Decision-Specific Reinvestment Scale, Reinvestment Scale and demographic questionnaire; Appendix I, B & D respectively) was administered. Participants were tested individually and informed not to discuss the task after the experiment.

After being informed about the nature of the task participants were shown the 16 practice trials. Prior to the practice trials, participants were instructed that they should respond as quickly and as accurately as possible as both decision time and accuracy were being recorded. This instruction was reinforced before each block of trials. The practice trials enabled participants to become familiar with the viewing perspective, the time constraints for responding, as well as the striking actions of the performers used in the test stimuli. Immediately prior to the first block of test trials, the cognitive and somatic subscales of the CSAI-2R were administered. The 32 trials constituting the low-pressure test phase were then presented. These were followed by a five-minute interval in which the scenario used to create the high-pressure environment was presented. Participants were introduced to the experimenter's associate, were given the cover story regarding the filming of trials for the Badminton National Governing Body, and were informed of the performance needed in order to win their prize money. The cognitive and somatic subscales of the CSAI-2R were then administered for a second time, after which the 32 trials constituting the high-pressure phase were presented. Following the conclusion of the high pressure block of trials, the associate then left the room. Participants were then informed the final block of trials was for calibration purposes, would not be filmed or used for the National Governing Body, nor would their performance affect any money they may or may not have won. They then completed the cognitive and somatic subscales of the CSAI-2R and were again reminded to perform as quickly and accurately as possible.

Following completion of the final block of test trials, the awareness test was administered and final perceived pressure check performed. Upon completion of the experiment participants were then thanked for their participation and debriefed about the purpose of the experiment and the true nature of the cover stories provided during the protocol. Following completion of the analysis, participants were later contacted to inform them regarding their performance.

5.2.7 Data Analysis. To analyze the overall effect of pressure on performance, the response time and response accuracy data were subjected to separate paired samples *t*-test's between high and low pressure blocks (mean low pressure block score – block 1 and block 3). To test for differences in the use of explicit knowledge between low and high reinvesters the awareness data were subjected to an independent samples *t*-test. The number of explicit rules reported was also correlated with change in performance between high and low pressure blocks (mean low pressure block score – high pressure block score). To assess the role of dispositional reinvestment in choking, and compare the predictive validity of the Reinvestment Scale and Decision-Specific Reinvestment Scale, a multiple regression analysis was performed using global scores of each scale as predictors of performance change between high and low pressure blocks. Alpha was set to .05 for all statistical tests and effect size is indicated by partial eta squared (η_p^2).

5.3 Results

Preliminary screening of all data, using univariate z scores (> ±3.29) and Mahalanobis distance values, revealed no outliers. Descriptive statistics revealed that participants' Reinvestment Scale scores ranged from 17 to 57 (M = 40.96, SD = 11.43). Decision-Specific Reinvestment Scale scores ranged from 13 to 41 (M = 27.46, SD = 7.97).

5.3.1 Decision-Specific Reinvestment.

5.3.1.1 Response Accuracy. A paired samples *t*-test was conducted to compare response accuracy between the high and low (mean low pressure block score – block 1 and block 3) pressure conditions. There was no significant difference between response accuracy in the low (*M* = .78, *SD* = .16) and high pressured conditions (*M* = .79, *SD* = .17; *t* (23) = .11, *p* = .91, 95% CI: -.03 to .04). As can be seen in Figure 5.2A, the response accuracy remained stable across pressure conditions for both low reinvestment (low pressure block one, *M* = 0.80, *SD* = 0.17; high pressure block, *M* = .80, *SD* = .18; low pressure block two, *M* = 0.79, *SD* = 0.15) and high reinvestment groups (low pressure block one, *M* = 0.76, *SD* = 0.18; high pressure block, *M* = .77, *SD* = .16; low pressure block two, *M* = 0.79, *SD* = 0.18).

5.3.1.2 Response Time. A paired samples *t*-test was conducted to compare response time (ms from shuttle impact) between the high and low (mean low pressure block score – block 1 and block 3) pressure conditions. There was no significant difference between response accuracy in the low (*M* = 419.07, *SD* = 148.78) and high pressured conditions (*M* = 420.27, *SD* = 142.74; *t* (23) = .13, *p* = .90, 95% CI: -17.83 to 20.23). As can be seen in Figure 5.2B, the response time remained stable across pressure conditions for both low reinvestment (low pressure block one, *M* = 383.82, *SD* = 162.71; high pressure block, *M* = 385.73, *SD* = 148.54; low pressure block two, *M* = 388.90, *SD* = 167.65) and high reinvestment groups (low pressure block one, *M* = 440.97, *SD* = 137.38; high pressure block, *M* = 454.82, *SD* = 133.92; low pressure block two, *M* = 462.60, *SD* = 132.46).

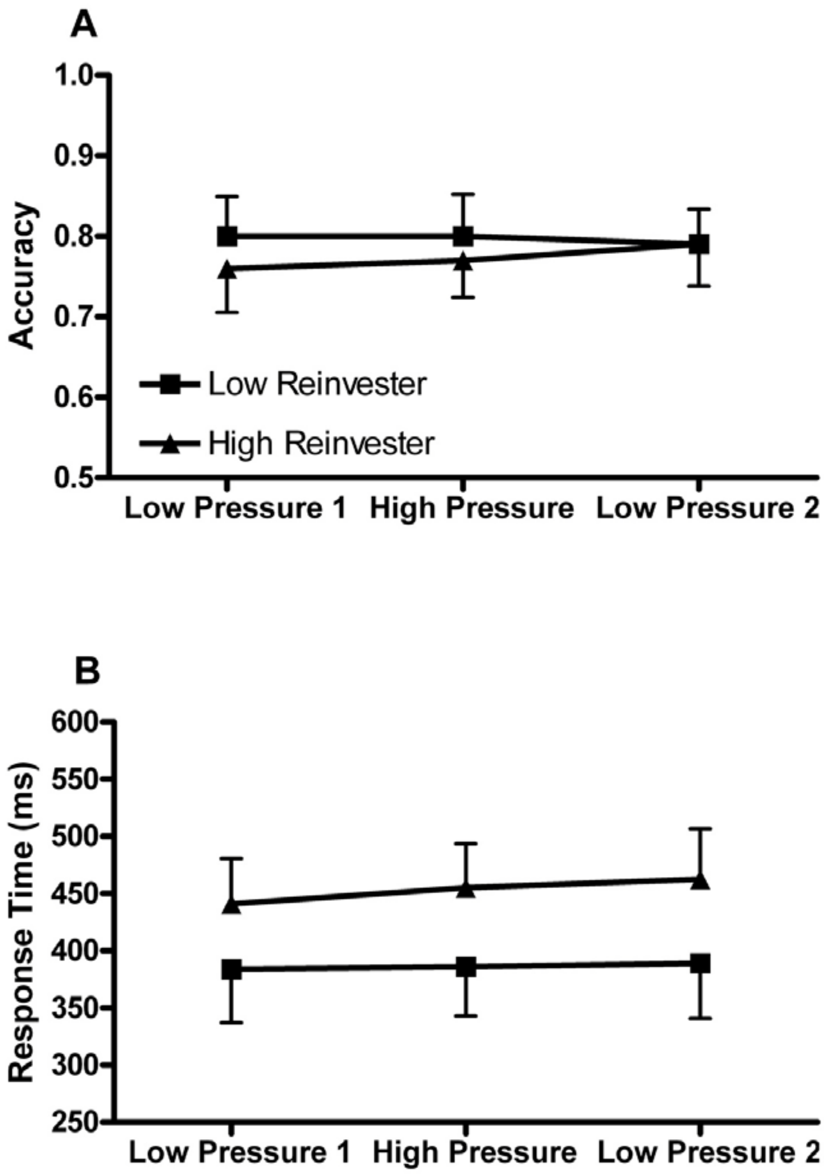

Figure 5.2. Mean response accuracy (A) and mean response time (B) for high and low reinvesters using the Decision Specific Reinvestment Scale under low and high pressure conditions.

5.3.2 Predictive Validity of Reinvestment and Decision-Specific Reinvestment Scale. Multiple regression, using performance change between high and low pressure trials (mean low pressure block score – high pressure block score), to assess predictive power of the Decision-Specific and original

Reinvestment Scale was performed on response accuracy and response time separately (Table 5.1). Analyses revealed neither scale to be a significant predictor of performance change under pressure for response accuracy (Decision Specific Reinvestment Scale, β = -.31, p = .07; Reinvestment Scale, β = -.31, p = .07) or response time (Decision Specific Reinvestment Scale, β = -.31, p = .07; Reinvestment Scale, β = -.31, p = .07).

Table 5.1. Multiple Regression Analysis between Decision-Specific Reinvestment Scale scores and original Reinvestment Scale scores on performance change under pressure.

	B	*SE B*	β
Response Accuracy			
Constant	0.02	.07	
Decision-Specific Reinvestment Scale	-0.002	.003	-.17
Original Reinvestment Scale	0.001	.002	.09
Response Time			
Constant	28.59	38.53	
Decision-Specific Reinvestment Scale	-1.76	1.49	-.31
Original Reinvestment Scale	.45	1.04	.11

Note: Response Accuracy, R^2 = .02, ΔR^2 = -.07;
Response Time, R^2 = .07, ΔR^2 = .-.02;
*P < .05.

5.3.3 Pressure Manipulation Check. To test whether the pressure manipulation was successful a repeated measures multivariate analysis of variance (MANOVA) was performed with the cognitive and somatic sub-scale scores of the CSAI2-R and perceived pressure rating scores entered as dependent variables. The multivariate analysis indicated a significant overall effect of pressure (Wilks' Lambda = .24, F(6,18) = 9.76, p < .001, η_p^2 = .77). The univariate analyses revealed significant effects of pressure for cognitive anxiety (F(2,46) = 17.78, p < .001, η_p^2 =.44), somatic anxiety (F(1.41,32.43) = 13.35, p < .001, η_p^2 = .37) and the perceived pressure rating score (F(2,46) = 40.03, p < .001, η_p^2 = .64). Inspection of the means revealed greater scores in the high pressure block compared to the low pressure blocks for cognitive anxiety (low pressure block one, *M* = 18.00, *SD* = 6.24; high pressure block, *M* = 24.58, *SD* = 9.26; low pressure block two, *M* = 17.42, *SD* = 7.42), somatic anxiety (low pressure block one, *M* = 14.52, *SD* = 5.26; high pressure block, *M* = 19.05, *SD* = 7.03; low pressure block two, *M* = 14.17, *SD* = 5.77) and perceived pressure ratings (low pressure block one, *M* = 2.63, *SD* = 1.21; high pressure block, *M* = 4.58, *SD* = 1.67; low pressure trial block, *M* = 2.25, *SD* = 1.15).

5.3.4 Explicit Knowledge. The type of information, reported by participants as underpinning their choices, focused either on explicit knowledge of the performer (e.g. footwork, body / arm position and direction of gaze) or the racket (e.g. angle / speed at impact, backswing / follow-through and sound of impact). Pearson product moment correlations were performed on the number of explicit rules reported and the change in performance between high and low pressure blocks (mean low pressure block score – high pressure block score). Analyses revealed a weak and non significant relationship between increase in number of explicit rules reported and poorer performance accuracy under pressure (r = -.31, p = .07) however, increases in the number of explicit rules reported was significantly related to increases in response time under pressure (r = -.41, p = .02). Also, slower response times were related to more accurate performance under pressure (r = .41, p = .02).

An independent samples t-test was conducted to compare the number of explicit rules reported by participants in the high and low reinvestment groups.

There was no significant difference between the number of rules reported by the low (M = 2.58, SD = 1.00) and high reinvesters (M = 2.75, SD = 9.65; t (22) = -.42, p = .34, 95% CI: -1.00 to .66). All 24 participants stated they felt “no difference” in terms of their reliance upon this information between low pressure and high pressure trials.

5.4 Discussion

The purpose of the present study was to investigate the effect of pressure on performance in a time-constrained decision-making task, and to examine the predictive validity of the Decision Specific Reinvestment Scale (Kinrade, Jackson, Ashford, & Bishop, 2010). In the study, participants were required to respond to video stimuli of an opponent performing an overhead shot to one of four targets. Participants responded as quickly and accurately as possible by indicating which of four possible locations the shuttle would land. Analysis of the cognitive and somatic anxiety sub-scales of the CSAI2-R and the ratings of perceived pressure revealed that the manipulation was successful. Overall, there was no evidence for performance decrements under pressure, in spite of clear evidence that participants were both more anxious and felt under greater pressure to perform well. Consequently, the prediction that dispositional reinvestment would be associated with susceptibility to skill failure under pressure was not supported and the nature of this evidence is discussed in relation to both speed and accuracy of participants’ performance. As choking was not observed, neither the Decision-Specific nor original Reinvestment scales were found to be significant predictors of performance change under pressure for response accuracy or response time. Explicit knowledge was also found to be unrelated to performance change under pressure and no different between low and high reinvesters.

The analysis of performance data revealed no significant difference in either response time or decision accuracy between the high-pressure trials (Block 2) and the low-pressure trials (Block 1 and Block 3). This was despite participants reporting increases in cognitive and somatic anxiety, and feelings of perceived pressure during the high pressure block and contradicts a large corpus of research that has linked increases in state-anxiety and levels of reinvestment to choking (Masters et al, 1993; Smeeton et al, 2005; Wang et al, 2004). There are two possible explanations for these findings; (1) pressure did not increase sufficiently to affect performance; and (2) the task is not susceptible to skill failure. The first explanation extends from the presence of anxiety in several of the dominant theories of choking. For example, distraction theories suggest that choking occurs because increased anxiety levels cause individuals to become distracted, limiting available working memory resources (Ashcraft & Kirk, 2001). Explicit monitoring theories also link choking to anxiety, suggesting that anxiety leads to conscious attempts to control processes resulting in deautomisation of the skill (Vickers & Williams, 2007) or that anxiety leads to individuals reinvesting in explicit rules to control performances (Masters, 1992). Therefore, if the pressure manipulation used in the high pressure block failed to illicit increases in anxiety, performance would be unaffected. However, the manipulation used in the present study has been used in a number of studies (Beilock, Carr et al, 2002; Beilock, Kulp et al., 2004; DeCaro, Carlson, Thomas & Beilock, 2008) and uses a reward incentive to create a competitive environment and invokes evaluation apprehension through the presence of a camera. Whilst Hardy et al., (1996) suggest that using a financial incentive to induce pressure may actually increase extrinsic motivation without inducing an anxiety response, data from the manipulation check shows that participants did exhibit an anxiety response. These findings highlight increases in anxiety and pressure ratings greater than those observed in Kinrade, Jackson and Ashford (2010) investigation into choking in cognitive and motor tasks. Choking was still observed in some tasks despite smaller increases in anxiety responses suggesting that the non significant findings in the performance data are not the result of the pressure manipulation.

Therefore, the non-significant impact of pressure might alternatively be a result of the task is not susceptible to skill failure. Evidence for choking has largely come from motor tasks such as golf putting, wall volley and hockey dribbling tasks (Beilock & Carr, 2001; Chell et al., 2003; Jackson et al., 2006). Shea, Wulf, Whitacre and Park, (2001) suggested that more complex skills might be more vulnerable to skill breakdown because of their higher attentional demands. Masters et al.'s (1993) initial study using a simple two-dimensional rod tracing task, showed performance of the individuals was not affected under high pressure conditions. The investigators suggested an explanation that the rod tracing task was not complex enough to present demands that would lead to reinvestment. Wang et al (2004) also suggested that when complex tasks were used the result was generally negative on performance, however when simple tasks were employed the performance was positive or constant. Similarly, Kinrade, Jackson and Ashford (2010) found that increased anxiety led to faster but more error-prone performance in a high-complexity card sorting task, and led to more errors in a high-complexity modular arithmetic task; without changes to performance on low complex versions of the same tasks. The clips used in the present task were occluded 10 frames after shuttle impact, thus providing participants with a lot of information (including shuttle flight) upon which to base their decision. Additionally, the window in which participants were required to respond (1700ms) was much greater than the average response time needed (*M* = 419.47ms, *SD* = 147.11) suggesting that the task may have been too easy and participants may not have experienced any real temporal pressure. The findings from the current study show similar results to those that used low complex skills. It may be that this task is dependent on proceduralized elements that run off with minimal conscious involvement and place minimal demands on working memory or the task does not lend its self to explicit monitoring. However, the current findings do contrast those of Smeeton et al. (2005) whom utilised a very similar task to that of the present study. Here participants were required to respond to visual stimuli of a tennis stroke using pressure sensitive floor mats that recorded response time and accuracy. In contrast to our findings they found that participants from an explicit learning group (associated with propensity to reinvest) performed worse when placed under pressure than participants from discovery and guided discovery learning groups. However, the small group sample (Explicit group, N= 8) and relative young age of participants do limit comparisons.

The findings from the explicit knowledge test support those of Smeeton et al. who found increases in the number of explicit rules reported to be significantly related to increases in response time under pressure. However, the current study did not find explicit knowledge to be related to decrements in decision accuracy, as seen by Poolton et al. (2004) who found that Reinvestment Scale scores predicted the number of rules accumulated by novice golf putters, which in turn predicted subsequent performance failure under anxiety-inducing conditions. This suggests that participants were taking longer to process information, perhaps as a result of exerting conscious control but without concurrent effect of decrements in accuracy during high pressure trials. This again suggests that the complexity of the task may be significant. Indeed, the data indicated that participants reported using relatively few explicit rules in making their judgments. Whilst there may be four options for the task, participants' decisions were based on processing information from two or three visual cues.

Another possible explanation may lie in the environment in which decision-making skills are learnt. Anticipation skill has proved to be a reliable discriminator of novice and expert performers (Abernethy, 1990a; 1990b). It may be that skill acquisition for such skills takes place later on in learning, when athletes are frequently engaged in a competitive sport environment. Elite athletes practice daily and compete in heightened pressure situations on a regular basis. It has been suggested that skills learnt under conditions of heightened performance pressure are less likely to be affected by performance pressure (Beilock & Carr, 2001). This is supported by Oudejans and Pijpers (2009), who conducted experiments in which athletes practiced their skills under induced anxiety. Results showed during the anxiety post test that, although levels of cognitive and somatic anxiety were increased, performance was maintained by those who trained under conditions of high anxiety. Similarly, athletes' perceptions of anxiety may also influence the effect it has on performance. Jones, Hanton, and Swain (1994) investigation into elite and non elite swimmers revealed that elite performers interpreted cognitive and somatic anxiety states as being more facilitative to performance than non elite performers.

In conclusion, the results of the present study do not support the original hypothesis that high reinvesters are more susceptible to the detrimental effects of pressure on cognitive based tasks such as decision-making (Kinrade, Jackson & Ashford, 2010). Neither the Decision-Specific nor original Reinvestment scales were found to be significant predictors of choking, nor was the amount of explicit knowledge related to performance breakdown. The main explanation for these findings is a result of the study not yielding a “choking” effect on performance with regard to participants’ response accuracy and time. It is suggested that the reason for this observation may lie in the cognitive demands of the task, or task complexity. Therefore, future research may consider examining decision-making in sport using more complex decision-making based tasks.

Chapter 6: The Role of Reinvestment and Task Complexity on Decision-Making in Basketball

6.1 Introduction

In today's sporting climate the prevailing Lombardian focus exemplifies the need for athletes to succeed, huge psychological pressures are experienced. Consequently, it is common to see competitors perform significantly below expectations in spite of high motivation and incentives for success, generally referred to as 'choking' (Baumeister, 1984; Jackson & Beilock, 2007). A significant body of research has examined the processes underlying this phenomenon, with much research focusing on the attentional processes that govern skill execution (Baumeister, 1984; Jackson, Ashford & Norsworthy, 2006; Masters, Polman & Hammond 1993). The two main theoretical frameworks; distraction and self-focus that have been used to explain choking draw evidence from differing backgrounds. Distraction theory, which suggests that increases in performance pressure provoke a shift in focus of attention to task-irrelevant cues, draws support from cognitive tasks that rely on working memory (DeCaro, Rotar, Kendra, & Beilock, 2010). In contrast, self-focus theory suggests that performance pressure increases self-awareness about performing correctly causing individuals to attempt to consciously control normally automatic processes and behaviours (Baumeister, 1984; Masters, 1992). Researchers have examined self-focus theory from different psychological perspectives (social, cognitive, behavioural) and under a variety of different terms including deautomisation (Deikman, 1969), reinvestment (Masters, 1992), conscious processing (Hardy, Mullen & Jones, 1996), and explicit monitoring (Beilock, 2007).

Masters and colleagues' work on Reinvestment Theory includes consideration of individual differences in the tendency to reinvest, defined as the “propensity for manipulation of conscious, explicit, rule-based knowledge, by working memory, to control the mechanics of one’s movements during motor output” (Masters & Maxwell, 2004, p.208). More broadly, the concept of reinvestment has received substantial support from a variety of motor tasks including golf putting (Hardy et al, 1996), a football ‘wall volley’ task (Chell, Graydon, Crowley, & Child, 2003) and field-hockey dribbling (Jackson et al., 2006). Interest in individual differences prompted Masters et al. (1993) to develop the Reinvestment Scale (RS), a 20-item scale comprised of items drawn from previously validated scales, including the Cognitive Failure Questionnaire (Broadbent, Cooper, Fitzgerald & Parkes, 1982), the Self Consciousness Scale (Fengstein, Scheier & Buss, 1975) and the Emotion Control Questionnaire (Roger & Nesshoever, 1987). Individuals classified as high reinvesters were found to be more likely to suffer skill failure under pressure than were low reinvesters (Maxwell, Masters & Eves, 2000; Jackson et al., 2006; Maxwell, Masters & Poolton, 2008; Kinrade, Jackson & Ashford, 2010). Following conceptual advancements to the definition of reinvestment, and to address limitations in the design of the original scale, Masters, Eves and Maxwell, (2005; cf. Masters & Maxwell, 2008) developed the Movement-Specific Reinvestment Scale (MSRS). Factor analysis of the new scale revealed two distinct factors: movement self-consciousness, which focuses on the concern about ‘style’ of movement and public perceptions, and conscious motor processing, which focuses on the contemplation of the process of movement. To date, there is little research into the psychometric properties of the MSRS in sport; however, evidence from health settings indicates that an inward focus of attention on performance processes might be disruptive. For example, MSRS scores have been found to be associated with the incidence of falls in the elderly (Wong, Masters, Maxwell &

Abernethy, 2008), the length of time individuals have been suffering from Parkinson's disease (Masters, Pall, MacMahon, & Eves, 2007), and functional impairment in stroke patients (Orrell, Masters, & Eves 2009).

Research examining the role of reinvestment in skill failure under pressure has largely focused on motor tasks while researchers have tended to appeal to distraction theory to explain skill failure in cognitive tasks (Beilock & Carr, 2001; Beilock, Kulp, Holt, & Carr, 2004). Although not measuring individual differences, there is some evidence that reinvestment might also apply to skill failure in perceptual-motor tasks. Specifically, Smeeton et al., (2005) found that junior players who learned to judge the direction and depth of tennis strokes with the aid of explicit rules subsequently suffered performance decrements when performing the task under pressure. Indeed, explicit learners became both slower and less accurate under pressure and slowing of decision time was strongly correlated with the number of explicit rules reported. By contrast, this correlation was non-significant in the guided discovery and discovery leaning groups. Similarly, Poolton, Masters and Maxwell (2006) and Masters, Poolton, Maxwell and Raab (2008) investigated the benefits of implicit learning to cognitive efficiency in a table tennis task involving both a motor and decision-making component. Following a training period, in which participants learned to perform a table tennis shot either implicitly (through analogy learning) or explicitly, motor performance and movement kinematics were assessed as participants performed a concurrent low- and high-complexity decision-making task concerned with where to direct the shot. Findings from both studies revealed that only explicit learners exhibited performance decrements when performing a concurrent decision-making task and this was only apparent in the high-complexity version of the task. They concluded that explicit processes place an increased load upon working memory, due to the conscious retrieval of declarative knowledge to control motor skill execution, which impairs processing efficiency and the ability to meet the demands of multiple concurrent tasks.

Kinrade, Jackson and Ashford (2010) examined the moderating effect of dispositional reinvestment upon choking in motor and cognitive tasks of varying complexity. They found that pressure had a deleterious effect on performance in a low complex motor task (peg-board), led to faster but more error-prone performance in a high-complexity psychomotor task (card sorting), and led to more errors in a high-complexity working memory task (modular arithmetic). High RS scores were significantly correlated with performance decrements from low to high pressure conditions in both low and high complex (golf-putting) motor tasks, and in both working memory tasks. However, higher RS scores were associated with a speeding of performance from the low to high pressure condition in the psychomotor tasks.

Evidence that the association between reinvestment and choking extends beyond the motor domain led Kinrade, Jackson, Ashford and Bishop (2010) to develop the Decision-Specific Reinvestment Scale (DSRS); their intention being to measure propensity for reinvesting explicit knowledge in decision-making tasks. The scale was developed by adapting items from the original RS and adding one item ("I always try and weigh up all the different factors when making decisions"). From a pool of 21 items, factor analysis revealed a 13-item 2-factor model. The first factor was labeled decision reinvestment and focused on conscious monitoring of the processes that produce a decision (e.g., "I'm always trying to figure out how I make decisions."). The second factor was labeled decision rumination and focused on an individual's propensity for ruminating about inaccurate decisions they have made in the past. Their initial investigation into the predictive validity of the scale used judgments of coaches, who were required to rate each player's tendency to choke on a 10-point scale anchored by 1 ("never chokes under pressure (makes correct decisions)") and 10 ("always chokes under pressure (makes incorrect decisions)"). Coaches were instructed to think of each player's ability to perform under pressure during instances in which he or she is required to make a decision, when completing their ratings. The analysis revealed a strong correlation between DSRS scores and peer ratings of decision failure under stress ($r = .74$, $n = 59$, $p < .01$).

Whilst encouraging, the initial validation of the DSRS did not assess actual decision making performance. Consequently, Kinrade, Jackson and Ashford (in preparation; Chapter 5) investigated the predictive validity of the scale utilising a perceptual judgment task in badminton. Twenty-four skilled badminton players were required to judge which of four court locations an opposing player was about to strike the shuttle towards. The researchers adopted an A-B-A design in which the task was performed under low-pressure and high-pressure conditions. Although significant increases in cognitive anxiety, somatic anxiety and ratings of perceived pressure were observed during the high-pressure block, pressure did not significantly affect response time or judgment accuracy in either the low or high reinvestment groups. Consequently, it was not possible to draw conclusions about the moderating effect of dispositional reinvestment because choking was not observed. The authors suggested a possible explanation may lie in the complexity of the judgments being made, and the possibility they did not place sufficient cognitive demands on the processing capacity of individuals, thereby making it less susceptible to reinvestment of conscious processing under pressure. In support, Kinrade, Jackson & Ashford (2010) only observed choking in the complex versions of the cognitive based tasks (working memory and psychomotor). Set against this, the type of judgments were similar to the tennis judgment task employed by Smeeton et al. (2005). Complexity of decision-making tasks can be manipulated in a variety of different ways including using dual tasks (Siemann & Gebhardt, 1996, c.f. Raab, 2003), transferring tasks (Reber, 1967) or as is the case in the present study, by manipulating the number of choices and interacting elements (Raab, 2003).

Following the inconclusive results presented in Chapter 5, the aims of the current study were, first, to investigate susceptibility to choking in a complex perceptual judgment task. In so doing, the second aim of the study was to examine the predictive validity of the DSRS in a team sport task in which decision complexity was systematically manipulated. A choice reaction time basketball task was chosen that required participants to judge to whom to pass the ball, with complexity manipulated by depicting 3-on-3 and 5-on-5 versions of the task. Based on the correlations between DSRS scores and peer review ratings of decision making performance under pressure (Kinrade, Jackson, Ashford, & Bishop, 2010), we predicted that propensity for reinvestment would be associated with greater decision-making decrements under high pressure relative to low pressure. Last, there is a need to determine whether the DSRS measures an individual difference factor that is sufficiently distinct from that measured by the RS, and specifically the extent to which the DSRS improves on the predictive validity and other psychometric properties of the RS. Accordingly, in the current study we also compared the predictive validity of the DSRS and original RS.

6.2 Method

6.2.1 Participants. Thirty-eight skilled male basketball players with a mean age of 23.46 years (*SD* = 4.90) participated in the study. Participants were currently competing for local clubs or in inter-university competitions (*n* = 25), in county or regional level teams (n = 2), or at national level (n = 11) at the time of the study. They had a mean of 10.00 years (SD = 4.65) of competitive playing experience. Institutional ethical approval was granted and all participants gave written consent (Appendix A) prior to participating in the study.

6.2.2 Design and Measures. The design used a 3 (Pressure) x 2 (Reinvestment Group) x 2 (Task Complexity) factorial design, with the pressure factor incorporating an A-B-A design (low pressure, high pressure, low pressure). Response time and response accuracy served as dependent variables.

6.2.2.1 The Reinvestment Scale. The RS (Masters et al., 1993; Appendix B) is comprised of twenty items. Twelve items were taken from the Self-Consciousness Scale (Fenigstein et al., 1975), a further seven items were taken from the Rehearsal factor of the Emotional Control Questionnaire (Roger & Nesshoever, 1987), and one item was taken from the Cognitive Failures Questionnaire, (Broadbent et al., 1982). Masters et al. reported that the RS had good internal reliability (Cronbach alpha = .86) and test-retest reliability over a four-month period (r = .74). In line with previous studies, (Jackson et al., 2006; Kinrade, Jackson, & Ashford, 2010) and consistent with the Self-Consciousness Scale, participants rated each item on a 5-point scale from 0 (extremely uncharacteristic) to 4 (extremely characteristic). As a result the item “Do you have trouble making up your mind?” was written in statement form: “I have trouble making up my mind” to facilitate rating using the 5-point scale.

6.2.2.2 Decision-Specific Reinvestment Scale. The DSRS (Kinrade, Jackson, Ashford, & Bishop, 2010; Appendix I) comprises 13 items that were considered likely to predict individual propensity for choking under pressure or psychological stress. Items from the original RS were re-worded to focus on decision making. The scale is comprised of 13 items split into two factors. The first factor, decision reinvestment, contains 6 items assessing the conscious monitoring of processes involved in making a decision; for example, “I’m always trying to figure out how I make decisions”. The second factor, decision rumination, contains 7 items assessing the tendency to focus on past inaccurate decisions they have made; for example, “I often find myself thinking over and over about poor decisions that I have made in the past”. Internal consistency estimates for the DSRS subscales using Cronbach’s alpha coefficient were as follows; Factor 1 = .89, and Factor 2 = .91. Participants rated each item on the same 5-point scale used for the RS.

6.2.2.3 Explicit Knowledge. To measure participants’ awareness of information governing their decisions, participants were required to write down any information they considered important in making their judgments. Practice clips were shown to participants to aid recall and enhance the sensitivity of the test (Shanks & St John, 1994). Explicit rules were operationally defined as statements that referred to specific aspects of the offensive set, individual player characteristics or relevant information relating these features to a player’s openness to receive a pass. Participants were also required to rate the importance of this information along with their awareness of using this information in each block of trials (Appendix J).

6.2.3 Manipulation Checks.

6.2.3.1 State Anxiety. To assess the effectiveness of the pressure manipulation, the cognitive and somatic anxiety subscales of the Revised Competitive State Anxiety Inventory-2 (CSAI-2R: Cox, Martens & Russell, 2003; Appendix E) were administered prior to the low- and high-pressure trials. Participants were asked to indicate the intensity with which they were experiencing each of the 12-items on a 4-point Likert-type scale anchored by 1 (not at all) and 4 (very much so). Cox et al. (2003) reported acceptable internal consistency estimates, using cronbach's alpha coefficient, for both cognitive ($\alpha > .81$) and somatic anxiety subscales ($\alpha > .82$).

6.2.3.2 Perceived Pressure. After each block participants were asked to rate how much pressure they felt they were under on a 7-point Likert-type scale anchored by 1 ("no pressure") and 7 ("extreme pressure"), Additionally, at the end of the testing session, participants responded to the question "In which trials did you feel you were under the most pressure?" and asked to select an option from "trials with the camera", "trials without the camera" or "no difference" (Appendix K).

6.2.4 Experimental Task and Construction of Test Stimuli. Two-choice and four-choice reaction time tasks were developed in which the participants were required to judge to whom to pass the ball (see Figures 6.1 and 6.2). The task represented a common offensive set viewed from the centre of the court and from each wing. The situation used in this experiment was based on a simple "motion offence" in basketball. This involved players 'screening' away from the ball to provide two passing options (low complexity task: pass to the cutting forward; pass to the sealing guard) or four passing options (high complexity task: pass to the cutting forward; pass to the cutting guard; pass to the sealing forward; pass to the sealing guard). Expert coaches were consulted to define the correct option in each video sequence. Scenarios were filmed to provide a pool of between 8-10 trials for each option at each of the three viewing angles. Players from a premier division University basketball team were used as the actors for clip construction. Video trials were digitised and edited using Pinnacle Studio (Version 11.0) to create the stimuli for the practice and test blocks. A grey screen followed the occlusion point of each clip and lasted for 1700ms. Participants were instructed that responses must be made before the end of the grey screen or the response would be recorded as incorrect. The inclusion of the time constraint was designed to reflect the presence of a similar time constraint that participants would face in a game situation.

Video sequences of each scenario were selected based on the independent evaluations of two expert national league coaches who rated each clip for quality, based on how much the clip represented a good example of the offensive arrangement, and clarity of the available passing option. This left a pool of between four and seven trials available for each option at each viewpoint. The coaches then ranked the top four trials based on clarity and quality for each option at each viewpoint. Inter-rater reliability was assessed using intra-class correlations for high complexity (ICC = .74) and low complexity tasks (ICC = .79). Finally, the coaches calculated a ‘decision point’ for each video sequence, operationally defined as the point at which the best passing option became evident. This was used as a reference to determine participant decision time for each trial. Inter-rater reliability between the two coaches for decision point was found to be very high (high complexity task: ICC = .99; low complexity task ICC = .99).

Participants were presented with 36 practice trials, made up of two cycles of each passing option filmed at each of the three viewpoints for the high-complexity (2 x 4 x 3 = 24 trials) and low-complexity (2 x 2 x 3 = 12 trials) sequences. The test blocks consisted of one cycle of the above (18 trials). Trials were allocated to each block (practice, low pressure 1, high pressure, low pressure 2) based on the coaches’ quality ratings. Within each condition trials were blocked by viewpoint, the presented order of which was counterbalanced across participants, passing option and complexity were randomised throughout and each block consisted of novel clips.

The task was designed and run on E-Prime (v. 2.0.1; Psychology Software Tools, Inc., Pittsburgh, Pennsylvania, US). Video sequences were presented on a computer screen and were viewed from a distance of approximately 0.5 m. Participants were instructed to respond to each sequence by pressing one of four response buttons using a handheld number pad depicting the two (low complex task) or four (high complex task) passing options (see Figures 6.1 and 6.2).

Figure 6.1. Video still depicting the design of the video stimuli used for the low complexity, two-choice reaction time task

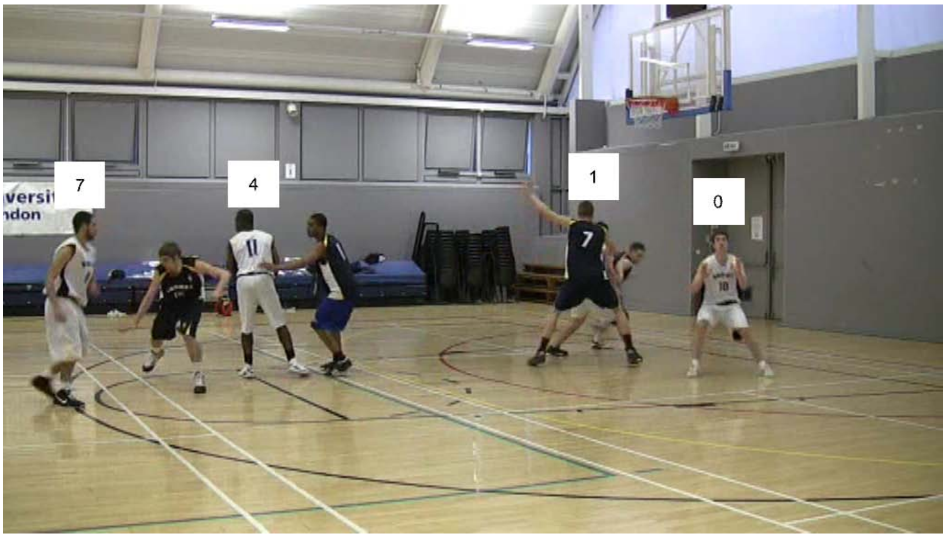

Figure 6.2. Video still depicting the design of the video stimuli used for the high complexity, four-choice reaction time task

6.2.5 Pressure Manipulation. The pressure manipulation involved two steps; the first was to induce evaluation apprehension by requiring participants to perform the tasks in the presence of an associate of the experimenter who filmed the trials. A cover story was given in which participants were told their performance on the next set of trials was to be filmed for the Basketball National Governing Body in order to assess their anticipation and decision making skills against other players of their level and ability. Participants were informed that the computer used both response time and response accuracy equally to compute a performance score. Finally, participants were told that if they could improve their performance score by 20% relative to the average for their age and ability, they would receive £10 and that the best performer in the study would win £100.

6.2.6 Procedure. Having gained informed consent from participants, a convenient time for testing was arranged. Upon arrival at the testing area the initial questionnaire package (consisting of the DSRS, RS and demographic questionnaire;

Appendix I, B & D respectively) was administered. Participants were tested individually and informed not to discuss the task after the experiment.

After being informed about the nature of the task participants were told they should respond as quickly and accurately as possible because both decision time and judgment accuracy were being recorded and used to determine overall performance. This instruction was reinforced prior to each subsequent block of trials. Participants were then shown the 36 practice trials in order to familiarise them with the viewing perspectives and the time constraints for responding, as well as the offensive arrangement used in the test stimuli. Immediately prior to each block of test trials, the cognitive and somatic subscales of the CSAI-2R were administered. The 18 trials constituting Low Pressure 1 test block were then presented and were described to participants as more practice. After this block, participants rated their perception of pressure. Following the Low Pressure 1 test block, participants were introduced to the experimenter's associate and were given the cover story regarding the filming of trials for the National Governing Body. They were then informed of the performance needed in order to win their prize money and were reminded to perform as quickly and accurately as possible. The cognitive and somatic subscales of the CSAI-2R were then administered for a second time and the 18 trials constituting the High Pressure test block were presented. Following the conclusion of the high pressure block of trials, the associate left the room. Participants were then informed that the final block of trials (Low Pressure 2) was to be used for calibration purposes, would not be filmed or used for the National Governing Body, and that their performance would not affect any money they may or may not have won. They then completed the cognitive and somatic subscales of the CSAI-2R and were reminded to perform as quickly and accurately as possible.

After completion of the test trials participants again rated the perceptions of pressure, after which the awareness test was administered.Upon completion of the experiment participants were thanked for taking part in the study and were debriefed about the true purpose of the experiment. Following completion of the study and associated analyses, participants were contacted to inform them of their performance.

6.2.7 Data Analysis. To analyze the effect of pressure on performance, the response time and response accuracy data were subjected to separate 2 x 3 x 2 x 3 (Group x Block x Complexity x Viewpoint) ANOVAs, with DSRS Group entered as a between subjects factor and all other variables entered as repeated measures. Where appropriate, follow-up analyses were conducted to further investigate the source of any interaction effects. Assignment of each participant to the high or low reinvester group was determined by conducting a median split on the DSRS data. Continuous data from the scale was dichotomized to facilitate analysis of interaction effects while maintaining inclusion, given the constraints of the sample size, which would otherwise be lost. Although it is acknowledged that this is at the cost of a slight loss to statistical power." To test for differences in use of explicit knowledge between low and high reinvesters the awareness data were subjected to an independent samples *t*-test. The number of explicit rules reported was also correlated with change in performance between high and low pressure blocks (mean low pressure block score minus high pressure block score). To compare the predictive validity of the RS and DSRS a multiple regression analysis was performed using global scores of each scale as predictors of performance change between high and low pressure blocks. Alpha was set to .05 for all statistical tests and Greenhouse-

Geisser corrections were applied where the test for sphericity was significant. Effect size is indicated by partial eta squared (η_p^2).

6.3 Results

Preliminary screening of all data, using univariate z scores (> ±3.29) and Mahalanobis distance values, revealed no outliers. Descriptive statistics revealed that participants' DSRS scores ranged from 11 to 48 (M = 30.00, SD = 9.11). RS scores ranged from 19 to 64 (M = 41.71, SD = 10.68). An independent samples *t*-test revealed a significant difference in DSRS global scores between low (M = 22.47, SD = 5.03) and high (M = 37.53, SD = 5.09) reinvestment groups, categorised using a median split technique (t (36) = -9.17, p < .001, 95% CI: -18.39 to -11.72).

6.3.1 Decision-Specific Reinvestment Scale Group.

6.3.1.1 Response Accuracy. A 2 x 3 x 2 (Group x Block x Complexity) ANOVA revealed significant main effects for block (F(2,72) = 6.09, p = . 004, η_p^2 = .15) and complexity (F(1,36) = 29.92, p < .001, η_p^2 = .45), and a non-significant main effect for DSRS Group (F(1,36) = .11, p = .74, η_p^2 = .03). Significant interactions were found between DSRS group and block (F(2,72) = 4.03, p = .02, η_p^2 = .10) as well as complexity and block (F(2,72) = 7.11, p = .002, η_p^2 = .17). To test the interaction effect of block and DSRS group, separate one way ANOVAs were performed on combined complexity scores for high and low reinvestment groups. Low reinvestment group analyses revealed a non-significant effect for block (F(2,36) = 3.17, p = .05, η_p^2 = .15). However in the high reinvestment group there was a significant effect of block (F(2,36) = 5.56, p = .008, η_p^2 = .24) with pairwise comparisons indicating differences between the high pressure trial (M = .75, SD = .03) and low pressure trial two (M = .86, SD = .03, p = .007). Figure 6.3 highlights observations that in the low complexity condition, decision accuracy showed slight but non-significant increases across blocks for low reinvesters (Low Pressure 1, M = .83, SE = .06; High Pressure, M = .90, SE = .05; Low Pressure 2, M = .91, SE = .04) and high reinvesters (Low Pressure 1, M = .84, SE = .06; High Pressure, M = .87, SE = .05; Low Pressure 2, M = .95, SE = .04). However, in the high complexity condition, decision accuracy remained stable across blocks for low reinvesters (Low Pressure 1, M = .75, SE = .03; High Pressure, M = .75, SE = .04; Low Pressure 2, M = .76, SE = .03) whilst high reinvesters displayed poorer performance under high pressure than low pressure (Low Pressure 1, M = .76, SE = .03; High Pressure, M = .62, SE = .04; Low Pressure 2, M = .78, SE = .03).

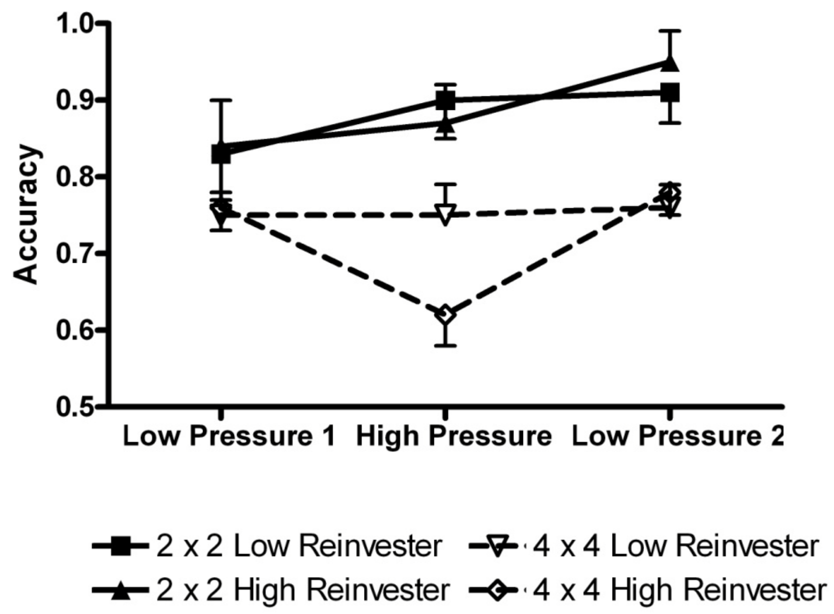

Figure 6.3. Mean response accuracy scores on a low- and high-complex decision-making task for high and low reinvesters using the Decision Specific Reinvestment Scale under low and high pressure conditions.

6.3.1.2 Response Time. A 2 x 3 x 2 (Group x Block x Complexity) ANOVA revealed significant main effects for block ($F(2,72) = 66.85$, $p < .001$, $\eta_p^2 = .65$) and complexity ($F(1,36) = 26.48$, $p < .001$, $\eta_p^2 = .42$), and a non-significant main effect for DSRS Group ($F(1,36) = 2.75$, $p = .11$, $\eta_p^2 = .07$). A significant interaction was found between complexity and block ($F(2,72) = 8.57$, $p < .001$, $\eta_p^2 = .19$), while other interactions were non-significant. To test the interaction effect of complexity and block, separate one way ANOVAs were performed on response time data for each level of complexity. Low complexity condition analyses revealed a significant effect for block ($F(1.73,64.07) = 52.17$, $p < .001$, $\eta_p^2 = .59$) with pairwise comparisons highlighting that the low pressure trial one ($M = 76.21$, $SD = 177.62$) was significantly slower than the high pressure trial ($M = -104.43$, $SD = 151.58$, $p < .001$) and low pressure trial two ($M = -105.22$, $SD = 143.53$, $p < .001$). Additionally, in the high complexity condition there was also a significant effect of block ($F(1.58,58.28) = 25.51$, $p < .001$, $\eta_p^2 = .41$) with pairwise comparisons highlighting that the low pressure trial two ($M = -58.56$, $SD = 186.80$) was significantly faster than the high pressure trial ($M = 71.37$, $SD = 194.99$, $p < .001$) and low pressure trial one ($M = 127.26$, $SD = 202.53$, $p < .001$).

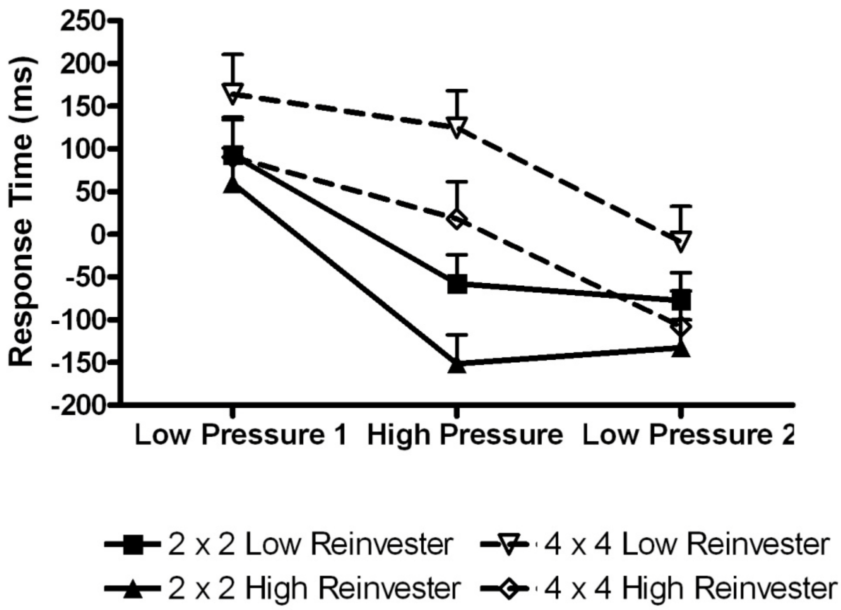

Figure 6.4. Mean response time scores on a low- and high-complex decision-making task for high and low reinvesters using the Decision Specific Reinvestment Scale under low and high pressure conditions.

6.3.2 Predictive Validity of Reinvestment and Decision-Specific Reinvestment Scale. To compare predictive validity of the Decision-Specific to the original RS, separate multiple regressions were conducted for the low-complex (3 v 3; Table 6.1) and high-complex (5 v 5; Table 6.2) conditions, using response accuracy and response time change across pressure conditions as the dependent variables. Analysis of the low complex condition revealed neither scale to be a significant predictor of response accuracy change under pressure (DSRS, β = .13, p = .47; RS, β = -.03, p = .86) or response time change under pressure (DSRS, β = .30, p = .09; RS, β = -.15, p = .39). However, in the high complex condition, DSRS score was shown to be a significant predictor of decrements in response accuracy under pressure (β = .47, p = .01) but not decision time (β = .19, p = .25), whilst global RS score was not a significant predictor of decision accuracy change (β = -.04, p = .82) or decision time change (β = -.28, p = .10).

Table 6.1. Multiple Regression Analysis between Decision-Specific Reinvestment Scale scores and original Reinvestment Scale scores on performance change under pressure in the low complexity (3 v 3) task.

	B	*SE B*	*β*
Response Accuracy			
Constant	-0.04	.09	
Decision-Specific Reinvestment Scale	0.002	.002	.13
Original Reinvestment Scale	< 0.001	.002	-.03
Response Time			
Constant	43.86	87.43	
Decision-Specific Reinvestment Scale	3.75	2.13	.30
Original Reinvestment Scale	-1.60	1.81	-.15

Note: Response Accuracy, $R^2 = .02$, $\Delta R^2 = -.04$; Response Time, $R^2 = .09$, $\Delta R^2 = .03$; $*p < .05$.

Table 6.2. Multiple Regression Analysis between Decision-Specific Reinvestment Scale scores and original Reinvestment Scale scores on performance change under pressure in the high complexity (5 v 5) task.

	B	*SE B*	*β*
Response Accuracy			
Constant	-.16	.12	
Decision-Specific Reinvestment Scale	.01	.003	.47*
Original Reinvestment Scale	-0.001	.003	-.04
Response Time			
Constant	16.39	86.08	
Decision-Specific Reinvestment Scale	2.44	2.09	.19
Original Reinvestment Scale	-3.03	1.79	-.28

Note: Response Accuracy, $R^2 = .21$, $\Delta R^2 = .17$; Response Time, $R^2 = .09$, $\Delta R^2 = .04$; $*p < .01$.

6.3.3 Pressure Manipulation Check. To test whether the pressure manipulation was successful a repeated measures multivariate analysis of variance (MANOVA) was performed with the cognitive and somatic sub-scale scores of the CSAI2-R and perceived pressure rating scores entered as dependent variables. The multivariate analysis indicated a significant overall effect of pressure (Wilks' Lambda = .22, $F(6,32) = 18.46$, $p < .001$, $\eta_p^2 = .78$). Mauchly's test of sphericity revealed violations in cognitive and somatic anxiety subscales as well as pressure ratings, so Greenhouse-Geisser corrections were applied. The univariate analyses revealed significant effects of pressure for cognitive anxiety ($F(1.69,62.47) = 22.85$, $p < .001$, $\eta_p^2 = .38$), somatic anxiety ($F(1.49,55.25) = 13.09$, $p < .001$, $\eta_p^2 = .26$) and the perceived pressure rating score ($F(1.53,56.57) = 64.07$, $p < .001$, $\eta_p^2 = .63$). Inspection of the means revealed higher cognitive anxiety, somatic anxiety, and perceived pressure in the high pressure block than in the low pressure blocks (cognitive anxiety: Low Pressure 1, $M = 16.47$, $SD = 4.61$; High Pressure, $M = 20.63$, $SD = 7.19$; Low Pressure 2, $M = 14.53$, $SD = 4.91$; somatic anxiety: Low Pressure 1, $M = 12.71$, $SD = 2.89$; High Pressure, $M = 15.60$, $SD = 5.38$; Low Pressure 2, $M = 12.70$, s = 3.40; perceived pressure: Low Pressure 1, $M = 2.45$, $SD = 1.18$; High Pressure, $M = 4.50$, $SD = 1.50$; Low Pressure 2, $M = 2.02$, $SD = 1.38$).

6.3.4 Explicit Knowledge. The type of information, reported by participants as underpinning their choices, focused either on offensive awareness (e.g. readiness of receiver, size mismatches, speed of cutter, strength / speed of screener) defensive awareness (e.g. Location of defender, defensive strategy for dealing with screens, help position of other defenders) and threats to outcome (e.g. ease of pass required, type of pass required, ease of shot from pass, distance of pass / to basket). Pearson product moment correlations were calculated on the number of explicit rules reported and the change in performance between high and low pressure blocks (mean low pressure block scores minus high pressure block score). Analyses revealed no significant relationships between the number of explicit rules reported and performance change between low- and high-pressure trials for decision accuracy or decision time in either the low complexity (Accuracy, r = -.04, P = .41; Time, r = -.23, p = .08) or high complexity (Accuracy, r = -.24, P = .07; Time, r = .17, p = .15) conditions. Faster response times were related to larger performance decrements in decision accuracy under pressure in both the low-complexity (r =.35, p = .02) and high-complexity (r = .36, p = .01) conditions.

An independent samples t-test was conducted to compare the number of explicit rules reported by participants in the high and low reinvestment groups. There was no significant difference between the number of rules reported by the low (M = 4.21, SD = 1.65) and high reinvesters (M = 4.00, SD = 1.86; t (36) = .37, p = .36, 95% CI: -.95 to 1.37). All 38 participants stated they felt “no difference” in terms of their reliance upon this information between low pressure and high pressure trials.

6.4 Discussion

The purpose of the present study was to investigate the effect of pressure on performance on a low- and high-complex version of a time-constrained decision-making task, and to examine the predictive validity of the DSRS (Kinrade et al., 2010). In the study, participants were required to respond to video stimuli of a common offensive set, based on a simple “motion offence”, in basketball, viewed from three viewpoints (the centre of the court and from each wing). The task required either a two-choice (low complexity 3 v 3 situation) or four-choice (high complexity 5 v 5 situation) response. Participants responded as quickly and accurately as possible by indicating which player was the best option to pass to. The cognitive and somatic anxiety sub-scales of the CSAI2-R and the ratings of perceived pressure were used to examine the success of the pressure manipulation. Overall, the analysis revealed performance decrements under pressure with regard to response accuracy, which were moderated by both task complexity and DSRS. More specifically, support was found for the prediction that dispositional reinvestment would be associated with susceptibility to skill failure under pressure in the high complexity condition of the decision-making task. Whilst the analysis of the reaction time data was less clear, a general speeding of performance over successive blocks was observed, either blocks to and/or three being faster depending on complexity. There was also clear evidence that participants were both more anxious and felt under greater pressure to perform well. Examination of the predictive validity of Decision-Specific and original Reinvestment scales revealed that only the former was a significant predictor of performance change under pressure with regard to response accuracy in the high complexity condition. Explicit knowledge was found to be unrelated to performance change under pressure and no different between low and high reinvesters. This discussion will elaborate on the theoretical explanations of these findings and highlight their congruence with the existing body of research.

The analysis of performance data revealed significant differences in the decision accuracy between the high-pressure trials (Block 2) and the low-pressure trials (Block 1 and Block 3) and that this difference was moderated by Decision-Specific Reinvestment. More specifically, the results show that low reinvesters performance remained largely stable across all blocks. However, high reinvesters' decision accuracy was significantly lower during the high-pressure block compared to the low-pressure block two. The findings from the regression analysis revealed DSRS global scores to be associated with performance breakdown in response accuracy for the high complex task. This is consistent with research in the motor skill literature that has examined the role of reinvestment in performance breakdown (Masters et al., 1993; Maxwell et al., 2000) and extends the findings from the initial validation of the DSRS, whereby global scale scores were highly correlated with peer ratings of choking tendency. This supports the hypothesis that a tendency to engage in conscious control and ruminative mental thoughts is detrimental to performance under conditions of increased pressure. The observation of this phenomenon in only the high complexity condition mirrored the findings of Kinrade, Jackson and Ashford (2010), who found performance decrements in high complexity versions of working memory and psychomotor tasks. The findings also lend support to Masters et al., (1993) who observed that simple tasks place relatively little burden on the processing capacity of individuals, meaning they are still able to meet the processing demands of the task efficiently despite increases in workload from the concurrent application of conscious control. Performance failure in the high-complexity condition for high reinvesters under pressure is particularly interesting considering reinvestment's association with explicit learning and Raab's (2003) contention that high complexity decisions are better served by explicit learning, whereas low complexity decisions are better learnt implicitly. He investigated the role of learning and complexity on tactical decision-making using a similar interactive simulation of a game situation to that adopted in the present study. When the decision was low in complexity (Experiments 1 and 2), participants who learned the task implicitly had superior decision-making performance. However, in high-complexity tasks (Experiments 3 and 4), explicit learners showed superior decision-making performance. Conversely, the present study found decision-making performance in both complexity conditions to be no different between low and high reinvesters (linked with reliance upon explicit knowledge). Furthermore, the finding that the propensity to reinvest can be detrimental to performance under conditions of increased anxiety in complex decisions is incongruent with Raab's (2003) recommendation for explicit learning in teaching complex decision-making.

There is evidence of an association between explicit knowledge and propensity for reinvestment in the motor learning literature (Poolton et al., 2004); however, there was no difference in the amount of explicit knowledge reported by high and low reinvesters in the present study, nor was it correlated with performance change under pressure. These findings leave open the possibility raised by Kinrade, Jackson and Ashford (2010) that explicit monitoring and control of movements may occur independently from the application of explicit rules or indeed that a different process of skill breakdown is implicated. A possible explanation may lie in the role of working memory. Distraction-based accounts view choking as a result of reduced working memory due to consumption from task irrelevant cues and thoughts of worry. Masters and Maxwell (2004) drew parity between reinvestment and distraction explanations highlighting that the explicit processes used when reinvesting ones actions rely on working memory to store and manipulate information and that a reduction in working memory capacity to perform the primary task can result in performance breakdown. Support for a working memory explanation was also found in the studies of Poolton et al., (2006) and Masters et al., (2008) on concurrent motor and decision making performance of implicit and explicit learners.

The DSRS was developed from the original RS; however, there are differences in the factor structures of each instrument. The original scale consisted of a single Reinvestment factor and did not attempt to measure the process of reinvestment directly, but rather linked conceptually-related items that aimed to predict this process. The DSRS arguably has greater face validity and comprises two factors concerned with processes hypothesized to consume working memory: ruminative thoughts (Decision Rumination) and processing of explicit information during the decision-making process (Decision Reinvestment). Results of the multiple regression analyses indicated that in the more complex decisions the DSRS was a better predictor of less accurate decision making under pressure than was the original RS. Perhaps the DSRS's factor structure is more sensitive in examining of processes that inhibit working memory than the original RS. Indeed, the factor structure is comparable to the two factor structure of Movement Specific Reinvestment Scale (Masters et al., 2005) (conscious motor processing, movement self-consciousness) developed due to the criticisms of the lack of face validity with the original RS.

The general trend from the response time data seemed to be a speeding of decision time between blocks one and two and/or between blocks two and three that was moderated by the complexity condition. Of important note was the consistent finding across complexity regarding the lack of difference between low and high reinvesters. This suggests that a speed-accuracy trade-off, often observed in sports domains (Schmidt & Lee, 2005), does not explain the performance decrements under pressure in decision accuracy exhibited by the high reinvesters. A potential explanation for the observed differences in decision accuracy under pressure without differences in decision time may come from decision field theory (Busemeyer &

Townsend, 1993). The theory holds that, under time pressure, decision makers may be subject to a decision threshold (the point at which a decision must be made), leading them to reduce the amount of information used in making a decision (Johnson, 2006). Participants were all required to complete the task as quickly and as accurately as possible in order to achieve a best performance score. Faster decision times result in less time available to sample the relevant information upon which to base a decision. As a result less salient information is often missed. As low and high reinvesters showed no difference in decision time under pressure it may be assumed that the slower processing efficiency of high reinvesters, as a result of conscious control strategies and ruminative thoughts, reduced the amount of information they were able to process before reaching the decision threshold, resulting in a poorer decision than that of low reinvesters who were able to draw from a more complete sample of processed information. However, caution must be taken when interpretation this data as preliminary analysis revealed an interaction effect of viewpoint. Results revealed that the observed speeding across trials was inconsistent between the different viewpoints but not interact with DSRS groups. From a theoretical perspective there is no apparent reason why decision time should differ across viewpoints. Differences were observed between all viewpoints despite two viewpoints essentially being mirror image perspectives. All viewpoints viewed attacking players move away from the camera to set the screen with other attacking players coming towards the camera. Task instructions, demands, viewing distance and clip quality were all equated and presentation order was counterbalanced thereby eliminating order and familiarity or learning effects.

In conclusion, the results of the present study support the original hypothesis that high reinvesters would be more susceptible to the detrimental effects of pressure in complex decision-making tasks (Kinrade, Jackson, Ashford, & Bishop, 2010). Individuals with high scores on the DSRS made less accurate decisions under pressure compared to their low reinvesting counterparts. The DSRS was found to be a significant predictor of choking, whilst the amount of explicit knowledge individuals reported was unrelated to choking. The findings of the present study support a working memory explanation of choking by which Reinvestment of explicit knowledge through conscious control and ruminative thought consume working memory thereby reducing the information available for task performance (Masters & Maxwell, 2004).

Chapter 7: General Discussion

7.1 Introduction

The aim of this thesis was to examine the choking phenomenon in tasks with a significant cognitive component. More specifically, it aimed to examine the roles of reinvestment and task complexity, and to identify individual differences that may highlight those individuals with a greater propensity to choke. In Chapter 3, the moderating effect of dispositional reinvestment upon 'choking' was examined by testing performance of a battery of tests that included low-complexity and high-complexity tests of motor skill, psychomotor and working memory, performed under low-pressure and high-pressure conditions. The aim of Chapter 4 was to construct a tool that predicts susceptibility to impaired decision-making under pressure. Here, a decision-specific version of the Reinvestment Scale was developed, which measured an individual's propensity for engaging in conscious control of decision-making processes and manifestations of ruminative thoughts. Chapter 5 described an investigation into the susceptibility to choking in a perceptual judgment task, which required rapid decisions regarding the intentions of an opposing badminton player's shuttle placement from an overhead shot. The second aim of the experiment was to examine the predictive validity of the Decision-Specific and original versions of the Reinvestment Scale in a relevant sport-specific task. Expanding further on this work, Chapter 6 examined the moderating effect of task complexity on choking in a perceptual judgment task and again scrutinized the predictive validity of the Decision-Specific and original Reinvestment Scales.

This discussion is in three parts. The first part summarizes the main findings of the experiments presented in the preceding chapters. The second part considers the emergent themes and implications of these findings and is split into three parts; theoretical explanations of choking, the role of task complexity and the practical implication of the findings. The final part of the discussion considers some limitations of the present research and highlights possible directions for future investigation.

7.2 Summary of findings from Experiments

Initial inspiration for investigating the present area of research stemmed from a desire to examine choking, through an individual differences perspective, in a different sporting context to that of the traditional well learnt motor skill. In particular, do theoretical explanations for the underlying mechanisms of performance failure under pressure still hold under different task constraints and can we highlight those individuals more prone to choking based on these accounts.

The first hypothesis came from Masters' (1992) Reinvestment theory that has examined the choking phenomenon in motor tasks, and theorizes that performance breakdown is a result of undoing the automatic nature of well learnt motor skills due to exertion of conscious control using explicit knowledge. More specifically, the hypothesis was to examine the role of Reinvestment in choking on cognitive based tasks such as working memory and psychomotor tasks. A plethora of evidence has corroborated the Reinvestment Scale's validity to predict skill failure under pressure in motor tasks (Masters et al., 1993; Poolton et al, 2004; Maxwell et al., 2000); however the nature of any relationship with skill failure in more cognitive-oriented, working-memory dependent tasks had yet to be determined. Additionally, the mediating effect of task complexity has shown that the relationship between Reinvestment scores and performance decrements under pressure are more apparent in complex tasks. It was hypothesized that reinvestment would be associated with poorer performance under pressure in both motor and cognitive-oriented tasks, highlighting that the scale also contains several items that arguably align more closely with distraction-based accounts of choking such as rumination about past emotional events.

Experiment one was designed to test this hypothesis using low complex and high complex tests of card sorting (psychomotor), modular arithmetic (working memory) as well as pegboard (low complexity) and golf putting (high complexity) tests of motor skill. The results revealed that pressure had a deleterious effect on performance in the peg-board motor task, led to faster but more error-prone performance in the high-complexity card sorting task, and led to more errors in the high-complexity modular arithmetic task; thus supporting research that has found similar performance breakdown in tasks under pressure (Beilock, Kulp, et al., 2004). These findings support the original hypothesis in showing that high reinvestment scale scores were significantly correlated with performance decrements from low to high pressure conditions in both the peg-board and golf-putting tasks, and in both modular arithmetic tasks in line with previous research (Masters et al., 1993; Maxwell et al., 2000). However, in the card-sorting tasks, higher reinvestment scores were associated with a speeding of performance from the low to high pressure conditions. The findings suggest that the association between reinvestment and choking extends beyond the motor skill domain to cognitive tasks, particularly those that place significant demands on working memory, and that this relationship is moderated by task complexity. However, closer inspection of the relationship between skill failure and the subscales of the Reinvestment scale suggest this may not necessarily be indicative of an individual's propensity to exert conscious control as the scale contains several items that are more closely associated with distraction (Public Self-Consciousness and Rehearsal).

These findings, coupled with conceptual advancements in defining reinvestment and the observation that the original scale did not directly specify movement (Jackson et al., 2006), prompted steps to develop a psychometric instrument that highlighted a performer's predisposition to reinvest explicit knowledge relating specifically to decision making. Experiment 2 followed a similar process to Masters, Eves, and Maxwell (2005) in their development of a movement specific version of the Reinvestments Scale. Here, items from the original Reinvestment Scale were modified to reflect cognitions when making decisions. From a pool of 21 items, factor analysis revealed a 13-item 2-factor model. The first factor focused on the conscious monitoring of the processes that produce a decision (decision reinvestment) that reflected the conscious control processes described in reinvestment theory (Masters & Maxwell, 2008). The second factor highlighted an individual's propensity to focus upon past inaccurate decisions that they have made (decision rumination), associated with increased worry (Scott & McIntosh, 1999) and prevalent in distraction based accounts of choking (Beilock, Kulp, et al, 2004). In an initial validation of the psychometric properties of the instrument, peer rating scores of players' tendency to choke, as judged by their coaches, were shown to be highly correlated with their responses to the scale and were similar to those reported using the original Reinvestment Scale by Masters et al. (1993) for squash and tennis players. However, while these data were encouraging, one obvious limitation was reliance on peer ratings of performance failure under pressure rather than a direct measure of decision making performance.

Considering this, the purpose of Experiment 3 was to examine the differences between high and low reinvesters' performance on a sport specific perceptual judgment task under conditions of low and high pressure. The experiment failed to fully examine the moderating effect of dispositional reinvestment as choking was not observed. Pressure had a non-significant effect on response time or judgment accuracy in low or high reinvestment groups, using both the original and decision specific reinvestment scales. Significant increases in the cognitive and somatic anxiety sub-scales of the CSAI-2R and ratings of perceived pressure during the high pressure block indicated that this was not the result of a weak pressure manipulation. Instead, based on evidence from motor skill failure under pressure (Beilock & Carr, 2001; Chell et al., 2003; Jackson et al., 2006) it was suggested that the task itself did not place sufficient cognitive demands on the processing capacity of individuals, thereby rendering performance more tolerant to reinvestment of conscious processing.

Experiment 4 looked to address the issues emanating from experiment three by manipulating the complexity of a perceptual judgment task. Using the same experimental design as experiment three, the results supported the hypothesis that dispositional reinvestment would be associated with susceptibility to skill failure under pressure in the complex version of the decision-making task only, specifically with regard to decision accuracy. Although constrained by interactions of viewpoint, the reaction time data showed a general speeding of performance as participants progressed through the blocks, whilst pressure ratings and CSAI-2R data showed participants were anxious and under pressure. Examination of the predictive validity of Decision-Specific Reinvestment scales and its discriminant validity from the original Reinvestment scale found only the former to significantly predict performance change under pressure with regard to response accuracy in the complex version of the task. Explicit knowledge was found to be unrelated to performance change under pressure and no different between low and high reinvesters. It is suggested that the increased face validity and the more specific consideration of a broader range of processes that inhibit working memory, those being conscious control and ruminative thoughts, enhanced its predictive power over that of the original scale.

7.3 Emergent Themes and Implications of Findings

Throughout the course of the present research programme a number of salient themes have emerged regarding the effects of pressure, dispositional reinvestment, allocation of attention and task complexity. Hence, the purpose of this section is to appraise the main findings and highlight the possible implications with regard to theoretical explanations for the processes that underlie choking and sports performance under pressure.

7.3.1 Theoretical explanations of choking. As highlighted in the literature review, the two main theoretical explanations of the processes that underpin choking, distraction and reinvestment were once considered to be conflicting accounts with the former citing attention away from the task as detrimental to performance whist the latter claimed attention towards the task to be disadvantageous. However, Masters and Maxwell's (2004) concept of a working memory based explanation looked for common ground in the two theories and the findings of this thesis seem to support such an account. They highlight that the explicit process used when reinvesting under pressure consumes working memory in the same way that distraction based accounts suggest anxiety induced worry and task irrelevant cues. The reduced function of working memory then debilitates processing efficiency causing skill breakdown, a conclusion quite comparable to Eysenck and Calvo's (1992) processing efficiency theory. Experiment one found choking to occur in a task that does not lend itself to conscious control using explicit information. Furthermore, correlations between the source subscales of the Reinvestment Scale and performance change under pressure revealed the subscale that aligns most with explicit monitoring accounts of choking (private self-consciousness) was unrelated to performance change. Whilst public self-consciousness and rehearsal subscales, more concerned with distracting thoughts of external factors or rumination over previous emotional events, were related to choking. The factor structure of the Decision-Specific Reinvestment Scale also reflects the importance of considering elements that consume working memory with the presence of ruminative thoughts (Decision Rumination) and the processing of explicit information in order to control actions (Decision Reinvestment) prominently featured.

7.3.2 Task Complexity. With regard to the examination of skill failure under pressure, the experiments presented here have displayed performance decrements in a variety of tasks that required varying cognitive demands. Experiment one found performance decrements under artificially induced pressure in motor, psychomotor and working memory tasks, whilst experiment four showed the phenomenon in a perceptual judgment task. These findings support a plethora of research that observed phenomena in similar tasks (Masters et al., 1993; Chell Graydon et al., 2003; Jackson et al., 2006; Beilock, Kulp, et al., 2004; Beilock & DeCaro, 2007). However, not all tasks were found to be susceptible to the debilitating effects of pressure. Experiment three found performance on a perceptual judgment task to be unaffected by pressure. Similarly, the low complexity version of the task used in experiment four also showed no performance difference between high and low pressure conditions. Confirmation that the manipulations used in each study were successful by the CSAI2-R data led to suggestions that these findings were a result of the complexity of the task. Indeed, the interaction effects of complexity observed in the psychomotor and working memory tasks also highlight the mediating effect of task complexity in the observation of choking. It is suggested that simple tasks were not complex enough to present demands that would lead to reinvestment (Masters et al., 1993). Whilst not specifying the role of reinvestment, other research has pointed to the attentional cost of more complex skill yielding a greater tendency to suffer task failure (Shea, et al., 2001; Wang et al., 2004). The current evidence suggests support for the notion that skill failure under pressure is mediated by task complexity. Due to the lower attentional demands of simple tasks, following the additional demands created by conscious control of ruminative thought, sufficient working memory is still available in order to maintain undisrupted performance.

7.3.3 Practical Implications. The practical implications of the results discussed concern, first, the identification of those individuals more prone to choking from a decision-making perspective, second, insight into potential precautionary measures, and, third, a possible grounding for preventative interventions. The encouraging findings for the use of the Decision-Specific Reinvestment Scale as a tool to highlight those individuals more prone to disrupted decision-making under pressure provide coaches and practitioners with a useful instrument with which to complement their observations. The two-factor structure may also offer an explanation to the root cause of any observed performance breakdown to examine if failure under pressure was a result of ruminative thought or exertion of conscious control. This will then better inform coaches in their selection of suitable training or interventions in order to alleviate the symptoms of such phenomenon.

Training methods which promote cognitively efficient decision-making should be encouraged to ensure individuals are capable of meeting the increased attentional demands of pressure. Whilst implicit learning has shown resilience to performance breakdown under pressure (Masters, 1992) performance fails to progress at the rate of explicit learning and even after longer periods of learning implicit learners do not achieve the same performance levels as their explicit counterparts (Maxwell et al., 2000). However, perceptual training methods such as video-based procedures are often conducted using a highly explicit form of learning, implicit learning methods suffer from a slower learning rate and lack practicality, particularly in terms of transfer to the field. Jackson and Farrow (2005) highlight several methodological and practical issues in implementing an implicit learning method to teach complex anticipation skills. A possible alternative to implicit learning, which looks to avoid the issues regarding performance level, whilst still maintaining efficient motor control is that of analogy learning. Liao and Masters (2001) used analogies to integrate the complex rule structure of a skill into a simple metaphor to aid instruction. Crucially, whereas explicit rules would occupy and be manipulated by the phonological loop, analogies are most likely held on the visuo-spatial sketchpad thus sharing the cognitive load across each element of the central executive, the key contrivance in working memory (Baddeley, 1992). Evidence has suggested analogies provide a learning method that produces robustness under pressure, dual task demands and stable performance under tasks that require decisions and motor skills to be executed in close temporal proximity (Liao & Masters, 2001; Poolton et al., 2006; Masters et al., 2008). Instructing individuals to evaluate opponents' actions when executing a motor skill using analogies that describe the mechanics of those actions, may provide an effective method of teaching decision-making skills without the inherent issues surrounding explicit instruction.

7.4 Strengths of Present Research

One of the main strengths of this research programme is the contribution it makes to the existing body of knowledge. Although the phenomenon of choking has received a relatively large amount of attention over the past decade (See Beilock & Gray, 2007 and Hill et al., 2010 for reviews), the vast majority of this work has focused on the performance of motor skills under pressure, with little consideration of the cognitive skills that affect sports performance such as decision-making. Using attentional theories of choking, predominantly the construct of Reinvestment (Masters, 1992), performance decrements under pressure have been examined in a variety of sport specific decision-making tasks in Chapters 5 and 6, following confirmation that this phenomenon is observed in working memory and psychomotor tasks in Chapter 3. Additionally, this work has led to the development of the Decision Specific Reinvestment Scale, a psychometric tool for identifying individuals with a propensity to engage in behaviors under pressure that compromise decision-making performance. Initial findings suggest the scale has sound predictive validity and the scale has the potential to be useful in a variety of domains, extending beyond sport, that require decision-making in high pressured environments.

7.5 Limitations of Present Research

The goal of this line of research was to gain a more complete understanding of the concept of choking in decision making and the processes that underlie this phenomenon. A further goal was to develop a psychometric instrument to identify those individuals more susceptible to disrupted decision-making under pressure. Throughout the process of conducting this investigation, a number of limitations were identified and therefore must be addressed.

7.5.1 Generalization of research. The present study is limited to time-constrained, dynamic team sports. In experiments three and four perceptual judgments, based on visual stimuli, were isolated in order to produce a performance measure of decision making. However, the sporting domain as a contextual environment offers a multidimensional framework with which to examine decision-making. Johnson (2006) highlights the variety of decision *agents* (coaches, players, officials, etc.) *tasks* (tactics, ball allocation, team selection, etc.) and *contexts* (before a game, during play, during timeouts, etc.) that produce different task demands, rely on different processes and interact with each other to influence how decisions are made. Johnson also highlights several key characteristics of decision-making in sports, such as naturalistic, dynamic and processed online, most of which were maintained in the tasks used for the various experiments within this thesis. However the fact remains there is no “standard” type of decision in sports and the findings of this work relate largely to the context in which it was examined.

7.5.2 Tasks used. There is also a possible limitation regarding the characteristics of the tasks used that affect the interpretation of the findings. As highlighted earlier, the peg-board task, selected as a measure of psychomotor skill (Woo, Proulx & Greenblatt, 1991) has also been referred to as an effort based task (Baumeister, Hutton & Cairns, 1990). The implications of the classification of this task have been discussed in detail in Chapter 3. Caution should also be shown in the interpretation of findings from the golf putting task used in Experiment 1. The golf putting task used for the high complex version of a motor skill differs from putting on a real golf course. Here participants were not required to "hole" a putt, rather to putt the golf ball on a carpeted surface so that it came to rest in the centre of a circular target. The lack of a hole, in combination with the scoring criteria of the task, resulted in the task becoming more of an assessment of the ability to judge the weight or distance of the putt rather than the direction. Putts that have perfect line and would usually be holed in a normal putting situation may continue rolling beyond the high scoring zones of the target whilst puts off line, that would not normally end in the hole (width of a standard golf cup is 10.8cm), may come to rest in a high scoring zones. It could therefore be argued the task used was not a true reflection of putting ability. However, in comparison to the peg board the task is still a reflection of performance on a high complex motor skill, as it requires fine motor control and coordination of various muscle groups, plus is subject to a plethora of technical instructions that underlie the putting action used in golf.

7.5.3 Isolating Decision Making. In experiments three and four, perceptual judgment tasks, which required participants to respond using a keypad, were used to measure decision-making performance. In the sporting contexts from which they are taken, the act of responding is far more complex a motor skill than the act of pressing a button. In both tasks there are often additional decisions within the response itself. For example, in the badminton task, not only must the receiver process the information regarding the intended destination of the opposing players shot, they must also make a decision on where to return the shuttle to and then execute the motor skill correctly to achieve the desired outcome. The attentional cost of processing information in real life situations is therefore likely to be greater than in the tasks used in the present studies. Masters Poolton, Maxwell and Raab (2008) highlighted the effect of this additional load in examining the effects of explicit and implicit learning methods on performance of a table tennis shot that required a concurrent decision to be made. Their findings revealed that only participants who learnt explicitly suffered performance disruption when performing a concurrent high complex decision. It was suggested that implicit learning promotes cognitively efficient motor control allowing individuals to meet the demands required to execute movements and make decisions in close temporal proximity. Therefore a more ecologically valid measure would be to replicate the experimental design of experiment four using a similar task to that used by Masters et al. (2008).

7.5.4 Magnitude of Pressure Manipulation. The methods used to manipulate the degree of pressure individuals experienced during high pressure trials in experiments one, three and four were based on established methods used in previous studies (Beilock & Carr, 2001; Gray, 2004) and were all found to increase feelings of cognitive and somatic anxiety as well as perceived pressure. However, despite the advantages of manipulating pressure in a lab based setting, such as a controlled and measurable setting, the problem of ecological validity is still inherent by design. Whilst experiments three and four looked to address this issue by creating environments that contained multiple sources of pressure commonly seen in the real world, including monetary incentives, peer pressure and social evaluation components (Beilock & Gray, 2007; Hardy et al., 1996; Masters, 1992) it is still doubtful that the pressure induced by such manipulations approaches that experienced in real world settings. Of course, we are bound by ethical considerations so even if it were possible to mimic the feelings of pressure experienced by, for example, performers charged with taking a penalty kick in a football World Cup final, it is doubtful whether ethical clearance would be granted.

7.5.5 Self Report Measures. Whilst the administration of self-report questionnaires is advantageous to some extent, as they reflect information derived directly from the person experiencing the phenomena and collect a large amount of comparable data, they do have limitations. Self-report measures rely on the individual to report their own behaviors and feelings truthfully and may result in response distortions such as acquiescence, extreme and central tendency responding, and negative affectivity bias, and socially desirable responding (Lanyon & Goodstein, 1997). Using a similar scale, Orrell et al. (2008) suggested that the scores on the questionnaires they distributed may have been influenced by a social desirability bias with some individuals overestimating their functional capabilities and some repeating the same answer regardless of the question being asked. Despite these potential criticisms, self-report continues to offer both practical and conceptual advantages to researchers and is considered the most common tool in social and behavioural sciences research (Harrison, McLaughlin & Coalter, 1996).

In the experiments that examined differences in anxiety ratings between high and low pressure trials, perceived anxiety intensity was measured using the CSAI2-R to record perceived anxiety intensity. Although this provided consequential information, it must be recognized that an insight into the frequency of experiences of anxiety may have enhanced the findings. It has been suggested that both frequency and intensity of responses should be viewed as independent dimensions, each contributing to the development of affective states (Hanton, Mellalieu and Hall, 2004). Considering this notion, a possible extension would be to examine differences in the proportion of time an individual experiences anxiety related symptoms between high and low reinvesters.

7.6 Suggestion for Future Research

The findings of the current programme of research provide a basis for further investigation into the examination of choking in decision-making based tasks in sport. The development of the Decision-Specific Reinvestment Scale showed promise in its ability to identify those individuals who are susceptible to disrupted decision-making under pressure. However, the process of establishing the scale as a valid and reliable tool is still in its infancy and must be examined further in order to fully ascertain its psychometric properties.

Further investigation into the discriminant validity of the DSRS must be completed, considering both the original Reinvestment Scale and the Movement Specific Reinvestment Scale have been shown to discriminate stroke patients (Orrell et al., 2009) and Parkinson disease patients (Masters et al., 2007) from age matched controls. Such an examination may look to examine football players who have missed penalties under pressure, whereby we may hypothesize that those individuals who failed due to poor decision-making (e.g. selecting side of goal to shoot at) may score higher on the DSRS (especially the decision rumination factor). However, players who failed due to poor execution of the motor skill (e.g. blasting the ball over / 'scuffing' the kick) may score higher on the Movement-Specific Reinvestment Scale. This line of investigation could also be applied beyond the sporting environment perhaps examining the discriminant validity of individuals with a history of poor decision-making (e.g. failed stockbrokers or convicted felons).

As highlighted earlier, the complex, dynamic and multidimensional nature of sport provides an excellent domain within which to examine decision-making. Investigations into those situations in sport, in which performance relies solely on an individual's ability to make the right decision, would provide a particularly fertile research area to further examine the role of conscious control and ruminative thoughts on choking in decision-making. Umpiring or refereeing provide a unique context in which match officials are required to make subjective judgments, based on guidelines that are often open to interpretation and are habitually subjected to intense scrutiny. Indeed, future research should look to expand on Poolton, Chan and Masters (under review) recent investigation, which showed a tendency to ruminate upon poor decisions was associated with football referees making a disproportionate amount of decisions in favor of the home team. Another example of a context displaying interesting characteristics relates to tactical decisions made by coaches under temporal pressure. The time-out in basketball often places coaches into an environment where tactical decisions, based on a number of contributing factors must be made in a short period of time.

Experiments three and four provide a good basis for further research. The findings highlight the role of complexity as being critical in examining susceptibility to choking. However, as highlighted earlier, the current investigation does not consider the additional attentional load that accompanies the natural response to this task in the form of a complex motor skill. Findings from Poolton, et al., (2006) and Masters, et al., (2008) indicate the potential scope for examining performances which require athletes to meet the demands of decision-making tasks and the concurrent execution of complex motor responses. A more ecologically valid measure of the Decision-Specific Reinvestment Scale would be to utilise such tasks (concurrent decision making and complex motor response) and methods of analysis (accuracy and movement mechanics), and would also provide an insight into the effect rumination has on movement execution.

Another line of future research would be to address the limitations surrounding the environment within which these experiments are explored. A large majority of the choking research is undertaken in a laboratory based setting with very few examining this phenomenon in real-world settings (Jordet, 2009). One of the main reasons is the ease with which pressure can be ethically manipulated and measured in a controlled laboratory setting. The purpose of laboratory-based investigations is to provide insight in to the real world; however Beilock and Gray (2007) highlight conflict in comparisons between the two environments. They suggest that lab based settings may exaggerate the frequency with which the phenomenon is observed in the real world due to the novelty of the experience, whilst countering with the implication that the types of pressure observed in lab-based settings are magnified in real world settings causing a greater frequency of occurrence in the latter environment. Future research could follow the work of Wills and Kinrade (2010) who examined the role of movement-specific and decision-specific reinvestment in choking in netball using actual game performance measures. Here, fifteen female university netball players' performances were followed across a season with video-based performance statistics (passing accuracy and interceptions) analyzed for the three highest and three lowest pressure games. They found a strong relationship between passing accuracy performance change and Decision-Specific Reinvestment Scale scores and its subscales, but no relationships for Movement-Specific Reinvestment Scale scores. This suggests DSRS was better at predicting skill failure in passing which relies on two elements for successful performance: making the correct decision as to who and when to pass the ball, and then executing the motor skill effectively. Given the multi-faceted nature of skills required in many sports, research using both the movement-specific and decision-specific reinvestment scales has the potential to provide the most complete assessment of habitual tendencies that make individuals susceptible to skill failure under pressure.

Future research should look to utilise match analysis techniques that address common criticisms of laboratory based research that highlight a failure to link findings with practice. Specifically, these techniques enable researchers and coaches to assess performance in an environment where ‘real’ pressure is experienced rather than the simulated pressure often observed in laboratory based experiments. Further, ecological validity is enhanced by examining decision-making and motor actions concurrently rather than isolating either component.

7.7 Conclusion

The present research examined the choking phenomenon in cognitive based tasks. More specifically, it looked to identify the role reinvestment plays in skill failure under pressure on tasks other than proceduralised motor skills. Overall, support was found for the hypothesis that Reinvestment is detrimental to performance under pressure; however it is suggested that it is not the only process to disrupt performance. Initial findings from the first experiment suggested a tendency to reinvest was associated with skill failure under pressure in both cognitive and motor tasks, especially those that place significant demands on working memory; thus lending support to the conscious processing hypothesis (Masters et al., 1993). However, interpretation of these findings was clouded due to the lack of face validity with the original Reinvestment score, suggesting that several items are more closely associated with distraction. The development of a Decision-Specific Reinvestment Scale in Experiment 2 provided similar conclusions. The factor structure of the proposed scale reflected the importance of conscious control tendencies whilst also implicating the role of ruminative thoughts. Findings from subsequent investigations into choking in sport specific decision-making tasks based on perceptual judgment skills, lend support to the predictive validity of the scale, suggesting it proved to be a better predictor of skill failure under pressure on these tasks than the original Reinvestment Scale, however similar to Masters et al., (1993) choking was only observed in tasks of greater complexity. Whilst the study fails to provide definitive evidence to support one of the main attentional theories of choking, namely distraction and self-focus, Masters and Maxwell's (2004) concept of a working memory based explanation and Mullen & Hardy (2000) attentional threshold hypothesis do offer suitable explanations to the results presented here. Both highlight the detrimental effect to performance of engaging in behaviors that consume working memory, such as conscious control and ruminative thought. However as suggested, research into the precise mechanisms underpinning skill failure in decision-making tasks and examinations of the predictive validity of the DSRS are still in their infancy and much more research is required to establish its usefulness as a psychometric tool. It is hoped that the research presented herein provides the basis for further investigation into the disrupted decision-making observed in high pressure situations.

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Appendices

Appendix A

DECLARATION OF INFORMED CONSENT

I give my informed consent to participate in this study, which examines psychological aspects of sport participation. 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.

1) I have been informed that my participation in this study will involve me filling in a series of questionnaires that examine psychological aspects of sport. *

2) I have been informed that there are no known discomforts or risks involved in my participation in this study

3) I have been informed that there are no "disguised" procedures in this study. All procedures can be taken at face value.

4) I have been informed that the investigator will gladly answer any questions regarding the procedures or purpose of this study when the questionnaires have been completed and returned.

5) I have been informed that I am free to withdraw from the study at any time without any kind of penalty.

Experimenter:
Noel Kinrade

Participant's signature ____________________ Date: ____________________

For further information please contact on: noel.kinrade@brunel.ac.uk

*Note: Slight wording changes were made to better describe the demands of each experiment

Appendix B

Reinvestment Scale

Please answer the following questions about yourself by circling the appropriate number. For each of the statements, indicate how much each statement is like you by using the following scale:

Extremely Uncharacteristic	Un Characteristic	Neutral	Characteristic	Extremely Characteristic
0	1	2	3	4

Please be as honest as you can throughout, and try not to let your responses to one question influence your response to other questions. There are no right or wrong answers.

1	I'm always trying to figure myself out	0	1	2	3	4
2	I'm concerned about my style of doing things	0	1	2	3	4
3	I remember things that upset me or make me angry for a long time afterwards	0	1	2	3	4
4	I get 'worked up' just thinking about things that have upset me in the past	0	1	2	3	4
5	I reflect about myself a lot	0	1	2	3	4
6	I'm concerned about the way I present myself	0	1	2	3	4
7	I often find myself thinking over and over about things that have made me angry	0	1	2	3	4
8	I think about ways of getting back at people who have made me angry long after the event has happened	0	1	2	3	4
9	I'm self-conscious about the way I look	0	1	2	3	4
10	I never forget people making me angry or upset, even about small things	0	1	2	3	4
11	When I am reminded of my past failures, I feel as if they are happening all over again	0	1	2	3	4
12	I usually worry about making a good impression	0	1	2	3	4
13	I'm constantly examining my motives	0	1	2	3	4
14	I worry less about the future than most people I know	0	1	2	3	4
15	One of the last things I do before I leave my house is look in the mirror	0	1	2	3	4
16	I sometimes have the feeling that I'm off somewhere watching myself	0	1	2	3	4
17	I'm concerned about what other people think of me	0	1	2	3	4
18	I'm alert to changes in my mood	0	1	2	3	4

19	I'm aware of the way my mind works when I work through a problem	0	1	2	3	4
20	I have trouble making up my mind	0	1	2	3	4

Appendix C

Reinvestment Scale Score Sheet

Master, R. S. W., Polman, R. C. J., & Hammond, N. V. (1993). Reinvestment: A dimension of personality implicated in skill breakdown under pressure. *Personality and Individual Differences, 14,* 655-666.

Private Self-Consciousness (PrSC)

Add items 1, 5, 13, 16, 18, and 19

Public Self-consciousness (PuSC)

Add items 2, 6, 9, 12, 15, and 17

Rehearsal (RH)

Add items 3, 4, 7, 8, 10, 11, and 14

Item 14 is reverse scored (i.e. 0 = 4, 0 = 1)

Cognitive Failure (CF)

Add items 20

The score for each factor of the RS is calculated by adding the scores of the items in each factor together. To get a total reinvestment score add all items together

Appendix D

Demographic Questionnaire

Please complete the following set of questions as accurately as possible.

Full name	
Age	Years:

Ethnic origin (please circle)

White-UK/Irish	Black-Caribbean	Black-African
Indian	Pakistani	Bangladeshi
Chinese	Mixed race	White European
White-Other	Asian-Other	Other ethnic group
(If **Other**, please specify)	______________________________	

At what level do you currently play? (please circle)

Recreational	Club	County
Regional	National	International

At what age did you start playing?	Years:
How long have you been playing at your current level?	Years: Months:

All information provided will remain completely confidential.

Appendix E

Competitive State Anxiety Inventory- 2 Revised

A number of statements that athletes have used to describe their feelings before competition are given below. Read each statement and circle the appropriate number to indicate *how you feel right now*. 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*. For each of the statements, indicate how much each statement is like you by using the following scale:

Not at all	Somewhat	Moderately so	Very Much so
1	2	3	4

1) I am concerned about this experiment	1	2	3	4
2) I feel nervous	1	2	3	4
3) I have self-doubts	1	2	3	4
4) I feel jittery	1	2	3	4
5) I am concerned that I may not do as well in this experiment as I could	1	2	3	4
6) My body feels tense	1	2	3	4
7) I am concerned about losing	1	2	3	4
8) I feel tense in my stomach	1	2	3	4
9) I am concerned about choking under pressure	1	2	3	4
10) My body feels relaxed	1	2	3	4
11) I'm concerned about performing poorly	1	2	3	4
12) My heart is racing	1	2	3	4
13) I'm concerned about reaching my goal	1	2	3	4
14) I feel my stomach sinking	1	2	3	4
15) I'm concerned that others will be disappointed with my performance	1	2	3	4
16) My hands are clammy	1	2	3	4
17) I'm concerned I won't be able to concentrate	1	2	3	4
18) My body feels tight	1	2	3	4

Appendix F

Reinvestment Scale Modified Items for Scale Construction

Please answer the following questions about yourself by circling the appropriate number. For each of the statements, indicate how much each statement is like you by using the following scale:

Extremely Uncharacteristic	Uncharacteristic	Neutral	Characteristic	Extremely Characteristic
0	1	2	3	4

Try to think of situations in which you have to make decisions. Please be as honest as you can throughout, and try not to let your responses to one question influence your response to other questions. There are no right or wrong answers.

1	I'm always trying to figure out how I make decisions.	**0**	**1**	**2**	**3**	**4**
2	I'm concerned about my style of decision making.	**0**	**1**	**2**	**3**	**4**
3	I remember poor decisions I make for a long time afterwards.	**0**	**1**	**2**	**3**	**4**
4	I reflect about decisions I have made a lot.	**0**	**1**	**2**	**3**	**4**
5	I'm concerned about the way I make decisions.	**0**	**1**	**2**	**3**	**4**
6	I'm constantly examining the reasons for my decisions.	**0**	**1**	**2**	**3**	**4**
7	I get "worked up" just thinking about poor decisions I have made in the past.	**0**	**1**	**2**	**3**	**4**
8	I sometimes have the feeling that I'm observing my decision-making process.	**0**	**1**	**2**	**3**	**4**
9	I often find myself thinking over and over about poor decisions that I have made in the past.	**0**	**1**	**2**	**3**	**4**
10	I'm self-conscious about making decisions.	**0**	**1**	**2**	**3**	**4**
11	I think about better decisions I could have made long after the event has happened.	**0**	**1**	**2**	**3**	**4**
12	I am alert to changes in how much thought I give to my decisions.	**0**	**1**	**2**	**3**	**4**
13	I worry about whether my decision-making makes a good impression.	**0**	**1**	**2**	**3**	**4**
14	I'm aware of the way my mind works when I make a decision.	**0**	**1**	**2**	**3**	**4**

15	I rarely forget the times when I have made a bad decision, even about the minor things.	**0**	**1**	**2**	**3**	**4**
16	One of the last things I do before making a decision is re-check all of the facts.	**0**	**1**	**2**	**3**	**4**
17	When I am reminded about poor decisions I have made in the past, I feel as if they are happening all over again.	**0**	**1**	**2**	**3**	**4**
18	I'm concerned about what other people think of the decisions I make.	**0**	**1**	**2**	**3**	**4**
19	I have trouble making up my mind.	**0**	**1**	**2**	**3**	**4**
20	I always try and weigh up all the different factors when making decisions.	**0**	**1**	**2**	**3**	**4**
21	I worry less about future decisions I may have to make than most people I know.	**0**	**1**	**2**	**3**	**4**

Appendix G

Factor Loadings for the 3 Factor Solution

Variable	Factors		
	Factor 1	Factor 2	Factor 3
DMS Question 1		.78	
DMS Question 2		.64	
DMS Question 3	.72		
DMS Question 5	.35	.61	
DMS Question 6	.31	.74	
DMS Question 7	.80		
DMS Question 8		.71	
DMS Question 9	.81		
DMS Question 10		.37	.68
DMS Question 11	.75		
DMS Question 12		.69	
DMS Question 13			.68
DMS Question 14		.71	
DMS Question 15	.75		
DMS Question 17	.66		
DMS Question 18	.38		.65
DMS Question 19			.71

*Factor loadings below 0.50 or cross loading above .40 are excluded

Appendix H

Factor Loadings for the 4 Factor Solution

Variable	Factors			
	Factor 1	Factor 2	Factor 3	Factor 4
DMS Question 1		.77		
DMS Question 2		.65		
DMS Question 3	.72			
DMS Question 5	.36	.63		
DMS Question 6	.33	.74		
DMS Question 7	.81			
DMS Question 8		.72		
DMS Question 9	.82			
DMS Question 11	.75			
DMS Question 12		.70		
DMS Question 13		.32	.71	
DMS Question 14		.68		
DMS Question 15	.76			
DMS Question 16				.79
DMS Question 17	.66			
DMS Question 18	.37		.70	
DMS Question 19			.65	.32
DMS Question 20				.62

*Factor loadings below 0.50 or cross loading above .40 are excluded

Appendix I

The Decision-Specific Reinvestment Scale

Please answer the following questions about yourself by circling the appropriate number. For each of the statements, indicate how much each statement is like you by using the following scale:

Extremely Uncharacteristic	Uncharacteristic	Neutral	Characteristic	Extremely Characteristic
0	1	2	3	4

Try to think of situations in which you have to make decisions. Please be as honest as you can throughout, and try not to let your responses to one question influence your response to other questions. There are no right or wrong answers.

1	I'm always trying to figure out how I make decisions.	**0**	**1**	**2**	**3**	**4**
2	I'm concerned about my style of decision making.	**0**	**1**	**2**	**3**	**4**
3	I remember poor decisions I make for a long time afterwards.	**0**	**1**	**2**	**3**	**4**
4	I'm constantly examining the reasons for my decisions.	**0**	**1**	**2**	**3**	**4**
5	I get "worked up" just thinking about poor decisions I have made in the past.	**0**	**1**	**2**	**3**	**4**
6	I sometimes have the feeling that I'm observing my decision-making process.	**0**	**1**	**2**	**3**	**4**
7	I often find myself thinking over and over about poor decisions that I have made in the past.	**0**	**1**	**2**	**3**	**4**
8	I think about better decisions I could have made long after the event has happened.	**0**	**1**	**2**	**3**	**4**
9	I am alert to changes in how much thought I give to my decisions.	**0**	**1**	**2**	**3**	**4**
10	I'm aware of the way my mind works when I make a decision.	**0**	**1**	**2**	**3**	**4**
11	I rarely forget the times when I have made a bad decision, even about the minor things.	**0**	**1**	**2**	**3**	**4**
12	When I am reminded about poor decisions I have made in the past, I feel as if they are happening all over again.	**0**	**1**	**2**	**3**	**4**
13	I'm concerned about what other people think of the decisions I make.	**0**	**1**	**2**	**3**	**4**

Appendix J

Explicit Rule Use Questionnaire

Please write down any rules or information you used in order to judge where the shuttle will land. For each rule/information, indicate its importance for judging shuttle direction using the following scale*:

Unimportant	Of Little Importance	Moderately Important	Important	Very Important
0	1	2	3	4

Please also indicate which trials you used this information the most:

More on trials without camera	More on trials with camera	No Difference
1	2	3

Please be as honest as you can throughout. There are no right or wrong answers.

1		Importance	**0**	**1**	**2**	**3**	**4**
		Information Use	**1**		**2**		**3**
2		Importance	**0**	**1**	**2**	**3**	**4**
		Information Use	**1**		**2**		**3**
3		Importance	**0**	**1**	**2**	**3**	**4**
		Information Use	**1**		**2**		**3**
4		Importance	**0**	**1**	**2**	**3**	**4**
		Information Use	**1**		**2**		**3**
5		Importance	**0**	**1**	**2**	**3**	**4**
		Information Use	**1**		**2**		**3**
6		Importance	**0**	**1**	**2**	**3**	**4**
		Information Use	**1**		**2**		**3**
7		Importance	**0**	**1**	**2**	**3**	**4**
		Information Use	**1**		**2**		**3**

*Note: Slight wording changes were made to better describe the demands of each experiment

Appendix K

Pressure Manipulation Check

Block 1
How much pressure did you feel that you were under during the trials you have just completed?

1	2	3	4	5	6	7
No pressure						Extreme pressure

Block 2
How much pressure did you feel that you were under during the trials you have just completed?

1	2	3	4	5	6	7
No pressure						Extreme pressure

Block 3
How much pressure did you feel that you were under during the trials you have just completed?

1	2	3	4	5	6	7
No pressure						Extreme pressure

In which trials did you feel you were under the most pressure?

More on trials without camera	More on trials with camera	No Difference
1	2	3

Appendix L

List of Publications Emanating from the Present Programme of Research

Kinrade, N., Jackson, R. C., & Ashford, K. J. (2010). Dispositional reinvestment and skill failure cognitive and motor tasks. *Psychology of Sport & Exercise, 11*, 312-319.

Kinrade, N., Jackson, R. C., Ashford, K. J., & Bishop, D. T. (2010). Development and validation of the Decision-Specific Reinvestment Scale. *Journal of Sports Sciences, 28,* 1127-1135.

Kinrade, N. P., Jackson, R. C., & Ashford, K. J. (2008). Dispositional reinvestment and choking in cognitive and motor tasks of varying complexity. Paper presented at the annual meeting of the North American Society for the Psychology of Sport and Physical Activity, Niagara, ON. (Abstract: *Journal of Sport and Exercise Psychology, 30* (Suppl.), S177).

Jackson, R. C., Ashford, K. J., Kinrade, N. P., & Adams, D. (2009). To be or not to be? Self-consciousness, explicit monitoring and skill failure under pressure. Paper presented at the 14th annual meeting of the European College of Sport Science, Oslo, Norway.