A systematic review of the anxiety-attention relationship in far-aiming skills.

KL Payne[1], MR Wilson[2], SJ Vine[3]

Sport and Health Sciences, University of Exeter, Exeter, UK

Sport and Health Sciences, University of Exeter, St Luke's Campus, Exeter, Devon, UK, EX1 2LU Tel. +441392722891

[1]kp290@exeter.ac.uk

[2]M.R.Wilson@exeter.ac.uk

[3]S.J.Vine@exeter,ac.uk

Funding No sources of funding were used to assist with this review.

Conflicts of interest Katie L Payne, Samuel J Vine and Mark R Wilson have no potential conflicts of interest that are relevant to the content of this review

Word count 6334

Abstract

Background: Theoretical accounts of the anxiety and motor performance relationship cite disruptions to attention as a critical mediating factor. The aims of this paper were to (1) systematically review published research examining attentional mechanisms underpinning the anxiety-performance relationship in targeting skills, and (2) subsequently discuss these findings in relation to contemporary theoretical perspectives.

Methods: Adhering to PRISMA guidelines, three electronic databases (PubMed, PsycInfo, and SPORTDiscus) were searched from inception until June 2017. Thirty-four articles satisfied the inclusion criteria.

Results: Overall the research is of high methodological quality, however, there is a tendency to focus on the historical dichotomy between self-focus and distraction accounts, whereas empirical support for more contemporary theoretical perspectives is lacking.

Conclusion: Whilst this review provides further support for the role of attentional disruptions in anxiety-induced performance degradation, the exact mechanisms still lack consensus. In addition, more innovative experimental designs and measures are required to progress our understanding of moderating variables.

Key words: attentional focus, pressure, distraction, self-focus, performance

1. Introduction

High-level sport requires individuals to perform at an optimal level when it matters most. However, athletes do not always meet these demands, and impaired performance is often attributed to the associated pressure and anxiety of competition. Within the competitive sporting environment, state anxiety is a common occurrence (Martens, Burton, Vealey, Bump, & Smith, 1990), and is defined as an aversive emotional and motivational state that can develop during potentially threatening, evaluative circumstances (Eysenck, Derakshan, Santos, & Calvo, 2007). It is characterised as having a mostly negative effect on motor performance (Wilson, 2012), although the processes underpinning the anxiety-performance relationship are still poorly understood (Cheng, Hardy, & Markland, 2009). Most prevailing theoretical accounts of anxiety and performance make reference to attentional processes, even if a consensus on the role of the specific attentional mechanisms involved is lacking. While numerous opinion pieces and reviews have been written on the topic, we intend to provide a timely systematic review of the literature, to (1) examine the proposed attentional mechanisms responsible for motor skill decrements whilst anxious that have been tested in the existing research, and (2) assess the efficacy of different theoretical perspectives of the anxiety and performance relationship that implicate attention.

1.1 The role of attention

Whilst it is challenging to define and explicitly measure the construct of attention, there is a general agreement that attention involves selectively processing information; prioritising some aspects of what we are presented with whilst ignoring others (Carrasco, 2011). The attentional system determines the information that gains access to working memory and reflects the combined contribution of four processes: working memory, competitive selection, top-down sensitivity control, and automatic bottom-up filtering for salient stimuli (Knudsen, 2007). The top-down system influences bias processing to goal-relevant stimuli and directs the voluntary allocation of attention. In contrast, the stimulus-driven (bottom-up) system triggers shifts in attention by stimuli that are unexpected and initially unattended (Corbetta & Shulman, 2001). It is

suggested that anxiety disrupts the efficiency of the attentional system, leading to impaired performance (Eysenck et al., 2007). Consequently, researchers have developed theoretical frameworks in an attempt to explain the anxiety-performance relationship and the underpinning role of attention.

1.2 Theoretical accounts of the anxiety-performance relationship

Early research on the relationship between anxiety and performance was dominated by descriptive models such as the inverted-U hypothesis (Yerkes & Dodson, 1908) and the catastrophe model (Hardy, 1990). These models lacked a mechanistic focus and subsequent explanations for the negative effect of anxiety on motor performance borrowed heavily from the cognitive psychology literature. For example, distraction theorists (e.g. Eysenck, 1991; Sarason, 1984; Sarason, 1988; Wine, 1971) propose that anxiety serves as a distractor, drawing attention away from task-relevant information needed for task performance. Processing efficiency theory (PET; Eysenck & Calvo, 1992) is an early distraction-based account that has received support in the sport psychology literature (see Wilson, 2008, for a review). Processing efficiency is based on the relationship between performance effectiveness (the quality of performance as measured against an outcome standard) and the resources used to achieve that performance (Eysenck & Calvo, 1992). Processing efficiency can be reduced by task-irrelevant thoughts such as worries or performance concerns and crucially, is impaired to a greater extent than performance effectiveness. While individuals can compensate for reduced processing efficiency with increased effort in the short-term, this impairment may be an early warning sign of a subsequent drop in performance (Wilson, 2008).

Attentional control theory (ACT; Eysenck et al., 2007) is an extension and development of PET that is more explicit about the detrimental effect of anxiety on processes related to attention. Specifically, a diversion of processing resources from task-relevant stimuli toward task-irrelevant (and particularly threatening) stimuli is predicted to occur due to the disrupted balance between goal-directed and stimulus-driven attentional systems (Corbetta & Shulman, 2002). ACT also relates this disruption to specific functions of the central executive of working memory that are impaired; namely, the inhibition and shifting functions

(based on Miyake et al., 2000). As with PET, the predictions of ACT have received support in the sporting literature (see Eysenck & Wilson, 2016; Wilson, 2012, for reviews).

Whereas distraction theories can apply to the performance of any task with cognitive demands, explanations have been developed specifically to reflect anxiety's effect on automated *movement* control. These explanations have been termed self-focus theories and propose that under pressure anxiety increases one's self-consciousness, directing attention towards one's self and one's movements (Baumeister, 1984; Beilock & Carr, 2001; Masters & Maxwell, 2008; Masters, 1992). The theory of reinvestment (also known as the conscious processing hypothesis) suggests that by attempting to consciously control the mechanics of automated skilled behaviour, the fluency associated with expert performance is disrupted (Masters & Maxwell, 2008; Masters, 1992). The explicit monitoring hypothesis (EMH; Beilock & Carr, 2001) proposes a subtly different mechanism and states that when anxious, performance is disrupted by consciously monitoring the step-by-step execution of skill, interrupting proceduralised motor programs. As with the distraction theories, there has been much support for the predictions of both these self-focus accounts in the sport psychology literature (see, Beilock & Gray, 2007; Masters & Maxwell, 2008).

The self-focus versus distraction theory dichotomy has been a feature of the competitive anxiety-sport performance literature (Roberts, Jackson, & Grundy, 2017). Beilock and Carr (2001) suggest that both groups of theories are relevant to different tasks and domains, with self-focus theories being more applicable to sport because of the focus on disruptions to previously automated movements. However, this may be a false dichotomy for a number of reasons. First, even well-practised skills may not be fully automatic and a characteristic of expertise is the ability to flexibly deploy attention to where it might be most useful at that moment (Burke & Yeadon, 2009; Nyberg, 2015). Second, self-focus and distraction perspectives may not be entirely mutually exclusive. For example, a 'double whammy' effect (Beilock & Gray, 2007) has been suggested, whereby anxiety initially reduces attention directed towards task-relevant information by overloading working memory, and then encourages performers to consciously attend to skill

execution step-by-step. Third, it has also been suggested that self-focus effects may simply reflect increased distractibility. Movement cues may become paradoxically salient when anxious due to interpretational biases, and as such self-focus effects could potentially be subsumed within distraction accounts like ACT (Eysenck & Wilson, 2016).

Furthermore, researchers have sought to develop new frameworks that seek to go beyond this dichotomy that has grounded the anxiety-sport performance research over the last 30 years. For example, there have been recent attempts to extend Eysenck and colleagues' ACT to reflect the specific demands of sport. First, Nieuwenhuys and Oudejans (2012) propose an integrated model of anxiety and perceptual-motor performance and suggest that disruption to attentional processes by anxiety not only affects attentional control, but also interpretational processes and emotion-specific behavioural responses. Second, Eysenck and Wilson (2016) consider the individual differences that might determine whether someone experiences anxiety in a pressurised environment. Whilst maintaining the attention disruption element of ACT, attentional control theory: sport (ACTS) suggests that whether increased pressure leads to increased anxiety depends on how cognitive biases alter both an individual's perceived probability of poor performance and the cost of poor performance (Eysenck & Wilson, 2016). Finally, Englert and Bertrams (2015) attempt to integrate ACT with the strength model of self-control (Baumeister, Bratslavsky, Muraven, & Tice, 1998) to reflect the potential influence of self-control on attentional control. Low self-control strength is suggested to determine the degree to which an individual pays attention to threatening stimuli (e.g., anxiety-related worries; Englert & Bertrams, 2012). Englert and colleagues have demonstrated that depleting mental resources (i.e., self-control) with a preceding cognitive activity can affect an individuals' ability to resist distraction when performing a sporting task (Bertrams, Englert, Dickhauser, & Baumeister, 2013; Englert & Bertrams, 2012; Englert, Zwemmer, Bertrams, & Oudejans, 2015).

Alternatively, other models have sought to build upon the two-dimensional approach to anxiety (Martens et al., 1990) that included cognitive and physiological (somatic) components. The three-

dimensional model of performance anxiety (Cheng et al., 2009) maintains a cognitive dimension that consists of distraction and self-focus effects, as well as a physiological dimension that includes autonomous hyperactivity and somatic tension. The authors propose that a third, regulatory dimension reflecting perceived control is critical in understanding an individual's perception of their capacity to cope under pressure. Carson and Collins (2016) suggest that a fourth dimension - skill establishment - should also be considered. Skill establishment refers to the level and consistency of movement automaticity, and the specific confidence a performer has in automaticity during stressful situations. It is important to note that while all these contemporary frameworks consider additional mediating and moderating variables (e.g., perceived control, cognitive biases, skill establishment, and self-control) they still acknowledge the importance of attention in understanding the anxiety-performance relationship.

1.3 Measures of attention

There is no single gold-standard measure to assess the attentional processes in these theoretical approaches and several different methods have been used to examine whether attention is disrupted in response to pressure. Firstly, advances in eye-tracking technology allow for the objective measurement of visual attention. It is suggested, by tracking eye movements on tasks where it is possible to specify where visual attention should be directed and how it might shift over time, attentional control can be assessed (Corbetta et al., 1998; Eysenck & Derakshan, 2011). Second, focus of attention is sometimes manipulated to mimic attentional disruptions under pressure (Beilock & Carr, 2001; Beilock, Carr, MacMahon, & Starkes, 2002; Wilson, Chattington, Marple-Horvat, & Smith, 2007). A self-focus is often influenced using explicit instructions relating to skill execution, whilst distraction is often manipulated through a dual-task paradigm (e.g., performing a cognitively demanding task concurrently with the motor task). In addition to these manipulations, probe reaction times (Lam, Maxwell, & Masters, 2010; Lam, Maxwell, & Masters, 2009) and/or retrospective self-reported measures (Englert & Oudejans, 2014; Oudejans, Kuijpers, Kooijman, & Bakker, 2011) can reflect the orientation of attention during task performance.

Attention has also been measured through the manipulation of self-control strength (i.e., the ability to override the automatic tendency to pay attention to threatening stimuli) using transcription tasks, to reflect disrupted attentional control under anxiety (Bertrams et al., 2013; Englert & Bertrams, 2012; Englert, Zwemmer, et al., 2015). In this research, participants are instructed to transcribe a story and leave out certain letters, in an attempt to override writing habits and deplete self-control strength. Finally, a fourth approach centres on the collection of performance process measures to examine the inferred effect of anxiety on attention. Objective measures of movement control, such as kinematic measures (Mullen & Hardy, 2000) and muscular activity (tension; Cooke, Kavussanu, McIntyre, Boardley, & Ring, 2011; Cooke, Kavussanu, McIntyre, & Ring, 2010) may reflect changes in the focus of attention; with less efficient movement patterns reflecting less automated movement control (Masters & Maxwell, 2008). Changes in heart rate variability (variations in the inter-beat interval; Wilson, Smith, & Holmes, 2007) reflect changes in mental effort and attentional processing (Mulder, 1992), and have also been used to indirectly assess attentional changes when anxious (Mullen, Hardy, & Tattersall, 2005; Wilson, Smith, & Holmes, 2007).

Moreover, these measures of attentional mechanisms have been employed to investigate the effects of anxiety across a range of sporting tasks; including, free throws in basketball (Wilson, Vine, & Wood, 2009), golf putting (Beilock & Carr, 2001; Cooke et al., 2010), dart throwing (Englert, Zwemmer, et al., 2015; Nibbeling, Daanen, Gerritsma, Hofland, & Oudejans, 2012; Nibbeling, Oudejans, & Daanen, 2012), shooting (Causer, Holmes, Smith, & Williams, 2011; Nieuwenhuys & Oudejans, 2010; Vickers & Williams, 2007), penalty taking (Wilson, Wood, & Vine, 2009), baseball (Gray, 2004; Gray & Allsop, 2013), table tennis (Williams, Vickers, & Rodrigues, 2002) and archery (Behan & Wilson, 2008). A pattern amongst these experimental studies is the use of self-paced, non-interactive and attentionally demanding sporting tasks that rely heavily on the goal-directed attentional system (Eysenck & Wilson, 2016). In general, performance in aiming tasks is easily measured, and from a cognitive perspective, the tasks provide sufficient thinking time for worry and disruptions to goal-directed attentional control to impair performance under pressure.

Consequently, the current systematic review focuses on the influence of anxiety on these self-paced targeting and aiming perceptual-motor tasks.

1.4 Objectives

The common factor among even the more contemporary frameworks is that attentional disruptions are a critical component of the anxiety-sport performance relationship and both self-focus and distraction elements may play their part. Furthermore, the field lacks an updated encompassing and systematic review that draws together the body of empirical evidence in support of anxiety's influence on attention. As such, the aim of this paper is to systematically review the available evidence that investigates the key attentional mechanisms involved in the anxiety-performance relationship. This will provide a better understanding of the current evidence, and the relative efficacy of the different theoretical perspectives described in section 1.2. We aim to review the methodological approach to examining anxiety and attention (how anxiety and attention are measured or manipulated) as well as the broader methodological rigour of the studies (e.g., generalisability, control groups, statistical approach). We will then synthesise this new information into a discussion of how the results relate to the anxiety-performance theories tested. In doing so, we hope to encourage further research that will advance understanding of the relationship between anxiety, attentional mechanisms and performance.

2. Methods

2.1 Search strategy and inclusion criteria

An electronic search of the PsycInfo, PubMed, and SPORTDiscus databases was conducted for relevant research related to anxiety and attention, up to and including June 2017. The search was initially conducted in the PsycInfo database (see Table 1) and adapted accordingly to the other databases. The researchers independently assessed the eligibility of each retrieved record on the basis of title and abstract. If any information was unclear, the full-text article was screened. The researchers followed the Preferred Reporting of Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.

Insert Table 1 near here

Studies included in the review were required to meet the following selection criteria: the research needed to (1) use adult populations in studies which either measured anxiety (i.e. high vs. low state or trait anxiety) or manipulated anxiety (i.e. creating high vs. low pressure conditions); (2) engage participants in a form of target and aiming motor performance task; (3) directly or indirectly measure (as defined in 1.3) attentional mechanisms and 4) report original research. Studies were excluded from the review on the basis of the following criteria: (1) the study design did not involve a target or aiming motor performance task; (2) there was no measure or manipulation of anxiety or attention; (3) they were focused on training interventions; (4) they were written in a language other than English; (5) they included a clinically anxious population or they tested child populations; (6) they were unpublished material (dissertations, theses, conference proceedings); (7) they were a review paper or commentary. Any discrepancies in the reviewers' decisions to include or exclude a paper were discussed until a consensus was reached.

2.2 Data extraction and quality assessment

After all relevant articles were obtained, their quality was assessed and data extracted. The data extraction form retrieved the following information from the included studies: article; sample; sport; anxiety manipulation (yes/no); measure of attention; type of theory (self-focus or distraction); other measures and findings. To ensure accuracy and consistency, discussion and crosschecking of included studies was carried out amongst the authors.

The quality of a study was determined by examining the internal and external validity. No quality assessment instrument has been standardised for laboratory-based observational studies (Uiga, Cheng, Wilson, Masters, & Capio, 2015). However, the current systematic review adapted the Quality Index (Downs & Black, 1998), the checklist for the evaluation of research articles (Durant, 1994) and the appraisal instrument from Genaidy et al. (2007) to assess the quality of the included studies. The maximum score available for the quality assessment was 25, as summarised in Table 2, and presented as both a percentage

and absolute score, in Table 3. The first author performed the quality assessment, and discussed queries in the assessment with the remaining authors.

Insert Table 2 near here

3. Results

3.1 Search result

In the first stage of database searching, the search strategy resulted in the retrieval of 736,186 citations. After removing duplicates and screening titles, 575 abstracts were identified. These abstracts were examined against the inclusion and exclusion criteria, resulting in 215 papers identified for full-text review. Full-text articles were examined with respect to the objectives of the systematic review. Reference lists were inspected for further citations and suggestions were accepted should they match the criteria (n=3). A final list of 34 articles was identified as appropriate for the review (see Figure 1).

Figure 1 inserted near here

3.2 Quality Assessment

Quality assessment results ranged from 76-100%, with a mean score of 92.7% (see Table 3). Two of the included papers scored in the high (61%-80%) methodological quality range and 32 papers scored in the very high (81-100%) methodological quality range. Overall, studies scored highly in items relating to reporting of study design, the task used, reporting main findings, and substantiating conclusions. The lowest scoring item was direct measurement of outcome variables (item 22), which was only achieved in 10 studies (29.4%). Additionally, the generalisability of findings (item 25) was addressed by only 23 of 34 studies (67.6%). Finally, only 24 of 34 studies (70.6%) reported actual probability values (item 11).

Insert Table 3 near here

3.3 Characteristics of included studies

The main findings of the systematic review are presented in Table 4 and 5. Out of the 34 studies included in the review, nine studies manipulated attention, whilst 25 did not. Additionally, a total of twelve studies considered their findings in regards to the distraction approaches (i.e. PET and ACT). A total of eight studies considered their findings in regards to the self-focus approaches (i.e. CPH, EMH and Theory of Reinvestment) and fourteen studies either purposefully compared the difference between self-focus and distraction theories or retrospectively discussed the relevance of their findings to this debate. In thirteen studies participants were male and/or female students or novices, while in eighteen studies participants specialised in the respective tasks (e.g., golfers, baseball players, skeet shooters). Furthermore, in three studies there were two groups of participants; a novice or student group and a trained group who were experienced in performing the respective tasks.

Insert Table 4 near here

Insert Table 5 near here

4. Discussion

4.1 Quality Assessment

The scores from the quality assessment have highlighted a number of particular concerns regarding the included studies. Eleven out of 34 studies recommended caution when generalising findings to other relevant populations (item 25), identifying an issue with the extent to which results obtained can be used to make predictions about other situations and populations. As a result, future research may need to consider varied groups of populations and possibly larger sample sizes if findings are to be more generalisable. Furthermore, it is important to recognise that the lab-based nature of the experimental research reviewed

means that generalisability of findings to real-world environments (i.e. ecological validity) is also somewhat problematic. For example, while an experimental manipulation designed to cause a self-focus may impair performance, it does not mean that this mechanism actually occurs when sporting performers are anxious (Oudejans et al., 2011).

Moreover, item 22 (direct measures of attention) identified a methodological issue with objectively measuring attention during performance; in particular when examining focus of attention on 'the self' in relation to self-focus theories. Twenty-four studies failed to objectively measure focus of attention. Generally, objective measures consisted of eye tracking variables and were evident in research testing distraction-based assumptions. While gaze disruption might reflect distractibility, it is less relevant when trying to determine covert changes in attention (e.g., an individual focusing inappropriately on the mechanics of their movement). Research testing self-focus approaches is therefore more inclined to use indirect measures, such as kinematic and muscle activity measures that may reflect this form of disruption, as well as self-reported retrospective measures (Masters & Maxwell, 2008). This discussion of the findings from item 22 highlights differences between the designs and methods of the included studies, and consequently the difficulties in comparing tests of the self-focus and distraction accounts.

A number of papers did not present actual *p* values when reporting statistical analyses (item 11). The American Psychological Association (APA; Publication Manual, sixth edition) suggests "when reporting *p* values, report exact *p* values (e.g. $p = .031$) to two or three decimal places. However, report *p* values less than .001 as $p < .001$" (p.114). Reporting actual *p* values (rather than in comparative form; e.g., $p < .05$) as well as reporting effect sizes, should provide greater transparency and enable readers to form their own opinion of the findings based on the evidence provided (Sullivan & Feinn, 2012).

On a more positive note, anxiety was successfully manipulated in 30 studies, with measures of state anxiety in the high-pressure condition significantly higher than those found in a baseline, or low-pressure condition. Multiple methods tended to be employed, including the use of incentives, ego-threatening

instructions, and non-contingent negative feedback. Although unlikely to be representative of the high levels experienced during competition, the significant differences in reported anxiety between conditions are sufficient to allow examination of the role of attention when anxious. However, trait anxiety measures were seldom taken (see Englert & Bertrams, 2012; Englert, Bertrams, Furley, & Oudejans, 2015; Englert & Oudejans, 2014; Englert, Zwemmer, et al., 2015; Wilson, Smith, et al., 2007, for some notable exceptions) and therefore less is known about how individual differences influence the experience of pressure and levels of state anxiety. High trait anxious individuals are more likely to experience higher levels of state anxiety and to worry more in pressured and threatening situations than low trait anxious individuals (Spielberger, 1966). An examination of trait anxiety and other individual differences in how threat is attended to and interpreted is therefore important if we are to better understand variations in performance under pressure (Eysenck & Wilson, 2016; Vine, Moore, & Wilson, 2016).

4.2 Narrative of findings from included papers.

4.2.1 Studies performing a manipulation of attention

Out of the 34 reviewed studies, nine studies placed participants in groups and manipulated attentional focus in an attempt to replicate the attentional disruptions proposed by the relevant theoretical frameworks being tested (see Table 4). In six of the studies, a self-focus was manipulated by providing instructions relating to skill execution, whilst distraction was implemented through concurrent task loading (e.g., a counting task while putting). Individuals performing under self-focus instructions were susceptible to performance decrements (Gray, 2004; Liao & Masters, 2002), and in distraction conditions, effort increased in order to complete the task (Mullen & Hardy, 2000) and there was evidence of less accurate performance (Mullen, Hardy, & Tattersall, 2005).

Additionally, three of the nine studies manipulated attention through the use of a transcription task with the aim of depleting self-control. Under anxiety there was evidence of poor attentional control and disrupted performance in ego-depleted individuals (low self-control; Englert & Bertrams, 2012; Englert,

Bertrams, et al., 2015; Englert, Zwemmer, et al., 2015). These three studies examined predictions from the distraction approach, implicating reduced self-control strength as a reason for disrupted attentional control during performance. However, as highlighted through the quality assessment (see 4.1), whilst results may demonstrate impaired performance, experimentally manipulating attention cannot be used to comparatively assess the distraction and self-focus predictions or how anxiety spontaneously affects attention during task performance under pressure.

4.2.2 Studies that did not perform a manipulation of attention

Out of the 34 studies reviewed, 25 of these studies did not manipulate attentional focus (see Table 5). Nine of the 25 studies included gaze behaviour measures to assess attentional mechanisms under anxiety. Gaze behaviour provides an objective measure of attentional control during performance and was used in studies where attentional focus was not explicitly manipulated (i.e., in studies investigating predictions from distraction theories only; Vine, Lee, Moore, & Wilson, 2013). The disrupted attentional processes presented as less stable attentional focus, including shorter quiet eye durations (the final fixation towards a relevant target prior to the execution of movement; Behan & Wilson, 2008; Vine et al., 2013); an increased number of fixations (Wilson, Vine, et al., 2009; Wilson, Wood, et al., 2009); and longer gaze allocations towards less relevant areas (Causer, Holmes, Smith, et al., 2011; Nibbeling, Daanen, et al., 2012; Nibbeling, Oudejans, et al., 2012; Nieuwenhuys & Oudejans, 2010; Williams et al., 2002).

Furthermore, five of the 25 studies included retrospective, self-report measures of attentional focus whilst six employed reinvestment (or self-consciousness) scales to examine the inferred effect of anxiety on attention. Retrospective reports mentioned distracting thoughts significantly more often (Englert & Bertrams, 2012; Nibbeling, Daanen, et al., 2012; Tanaka & Sekiya, 2011) however; there were reports of increased attention to movements as well as distractors (Tanaka & Sekiya, 2010a, 2010b). Reinvestment scales were presented as the movement specific reinvestment scale, the decision specific reinvestment scale and the self-consciousness scale. Under high pressure, there was evidence of more conscious processing

(Cooke et al., 2011), including a greater amount of reinvesting (Kinrade, Jackson, & Ashford, 2010; Otten, 2009), a greater amount of self-consciousness leading to greater performance variance (Wang, Marchant, Morris, & Gibbs, 2004)(Wang et al., 2004), and disrupted fluency leading to less automatic, step-by-step processing (Whitehead et al., 2016).

Finally, one study of the 25 specifically included mental effort (through heart rate variability and self-report measures) to determine changes in attentional control during performance when anxious. Under high pressure, significantly higher effort was reported alongside commensurate changes in heart rate variability (Wilson et al., 2007). Increases in effort are argued to increase attentional resources to the task according to distraction approaches, but may lead to reinvestment from a self-focus perspective (Wilson, 2008). The remainder of the studies used performance accuracy measures (i.e., successful putts, directional variability) to assess changes in attentional control under pressure.

4.2.3 Studies using performance process measures

All 34 studies included performance measures to assess the potential outcome of anxiety-induced attentional disruptions. Findings from studies examining a self-focus approach sought to test the assertion that movement should be less automatic when attention focuses on the step-by-step processes of performance (Whitehead, Taylor, & Polman, 2015). Increased attention towards one's self and the mechanics of performance resulted in disrupted performance, as well as increases in mental effort and disrupted kinematics (Gray, 2004; Gray & Allsop, 2013; Gray, Allsop, & Williams, 2013; Kinrade et al., 2010; Wang et al., 2004). Furthermore, there was support for distraction-based theories as evidenced by decreased accuracy and response times, as well as increases in mental effort (Causer, Holmes, Smith, et al., 2011; Lawrence, Khan, & Hardy, 2013; Williams et al., 2002), and decreases in information processing efficiency (via gaze measures; Vine et al., 2013; Wilson, Vine, et al., 2009; Wilson, Wood, et al., 2009). However, while results tended to support the theories being tested, one study (Otten, 2009) - out of the 34

included in the review - found that participants performed better under pressure as a result of increased perceptions of control (Cheng et al., 2009).

4.2.4 Manipulation of anxiety

One of the inclusion criteria for the review was that participants must perform under low- and high-pressure conditions. Nine of these studies also manipulated attentional focus (see 4.1.1) to examine the influence of anxiety and attention on performance. The remainder of the studies (25) only used manipulations of evaluative threat and/or incentives to increase state anxiety and examine naturally occurring attentional changes when performing. Thirty studies in the review successfully manipulated anxiety (see Table 3), whereas in the remaining four studies, the lack of manipulation check between the low- and high-pressure conditions meant that changes in anxiety could not be assessed. The most frequently used (twelve times) measure of anxiety was the Competitive State Anxiety Inventory-2 (CSAI-2; Martens et al., 1990). The Mental Readiness Form-3 (MRF-3; Krane, 1994), the State Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970) and the anxiety thermometer (Houtman & Bakker, 1989) were used in six, seven and six studies, respectively. Furthermore, heart rate was used as an objective measure of state anxiety in ten of the 30 studies. Taken together, the review demonstrates the effectiveness of an experimental approach to examining the anxiety-performance relationship and potential attentional disruptions, even if the reported levels of anxiety are unlikely to be as high as in real, sporting competition.

4.2.5 Theoretical stance of the included papers

Despite newer theories being proposed in the literature (Carson & Collins, 2016; Cheng et al., 2009; Eysenck & Wilson, 2016; Nieuwenhuys & Oudejans, 2012; Nieuwenhuys & Oudejans, 2017), the majority of studies reviewed only considered attentional mechanisms in regards to the existing self-focus and distraction dichotomy. Although some studies made reference to the newer frameworks (see Englert & Bertrams, 2012; Englert, Bertrams, et al., 2015; Englert, Zwemmer, et al., 2015; Otten, 2009), results were still discussed in terms of the dominant self-focus or distraction approaches.

In particular, the review has highlighted a tendency for the self-focus and distraction approaches to employ measures of attention and performance that are biased towards their respective theoretical assumptions. For example, papers examining a distraction approach tailor the objective measures of attentional control (e.g. gaze behaviour) towards these predictions (Vine et al., 2013; Wilson, Vine, et al., 2009; Wilson, Wood, et al., 2009). Similarly, in research examining self-focus predictions, measures of muscle activity and kinematics (Cooke et al., 2011; Cooke et al., 2010; Gray, 2004; Gray et al., 2013) provide indirect support of detrimental self-focused attention when anxious. However, Williams et al. (2002) is a notable exception, using both gaze behaviour and kinematics, alongside probe reaction time data in a test of the distraction-based PET (Eysenck & Calvo, 1992). This study aside, notable differences between the designs and methods of the included studies hinder comparisons of the self-focus and distraction accounts.

Moreover, whilst the effects of anxiety on performance were suggested to be wholly mediated by distraction in some cases (Englert & Oudejans, 2014; Wilson, Vine, et al., 2009; Wilson, Wood, et al., 2009), eight of the reviewed papers supported predictions that underpin both the distraction *and* self-focus approaches (Cooke et al., 2011; Mullen & Hardy, 2000; Mullen, Hardy, & Tattersall, 2005; Tanaka & Sekiya, 2010a, 2010b, 2011; Vickers & Williams, 2007; Wilson, Smith, et al., 2007). Five other studies rejected support for one theory's assumptions (Beilock & Carr, 2001; Cooke et al., 2010; Gucciardi & Dimmock, 2008; Lawrence et al., 2013; Malhotra, Poolton, Wilson, Uiga, & Masters, 2015) and supported the other (for example, supporting ACT over the reinvestment theory). An over-riding weakness of the literature reviewed was that few studies examined potential inter-individual variables that might mediate the anxiety-attention-performance relationships.

4.3 Synthesis and implications

As demonstrated in the narrative above (4.2) it is difficult to draw conclusions as to the specific attentional mechanisms influenced by anxiety in sport settings. Tests of the competing self-focus and distraction-based accounts of this relationship have produced equivocal findings. In particular, it is difficult to compare and

contrast findings between studies adopting very different measurement approaches and experimental designs; something that holds back our ability to better understand the relative strengths and weaknesses of each approach in explaining the attentional mechanisms underpinning the anxiety-performance relationship.

Attempts at a more fine-grained approach to examining the anxiety-performance relationship may help clarify the current state of knowledge. Specifically, some of the newer models (outlined in the Introduction; Carson & Collins, 2016; Cheng et al., 2009; Eysenck & Wilson, 2016) have started to explore relevant mediating and moderating variables (e.g., perceived control or cognitive biases) which determine how likely it is that an individual will become anxious, and suffer attention and performance disruptions. However, there have been limited attempts at actually trying to test the main tenets of these contemporary frameworks. This may be due to a number of practical factors, including; the complexity of the new models, which make them more suited to opinion pieces as opposed to testable hypotheses and the need for innovative methods to test the proposed moderating variables.

The current review also emphasised the difficulty in objectively measuring focus of attention during performance, and in particular, examining focus of attention on 'the self' in relation to self-focus theories. Consequently, research may need to move beyond manipulated focus conditions and self-report variables taken alongside movement kinematic measures when making inferences about attention disruptions when anxious. For example, more central measures of attention derived from electroencephalography (EEG) recordings (e.g., high-alpha left temporal-frontal connectivity) have been used to assess performance differences during movement tasks under pressure (Cooke et al., 2015; Cooke et al., 2014) and have been shown to reflect increased reinvestment in investigations of implicit motor learning (Zhu, Poolton, Wilson, Maxwell, & Masters, 2011), and under high pressure conditions (Gallicchio, Cooke, & Ring, 2016). There is therefore an opportunity for future research to combine objective measures of reinvestment with gaze behaviour measures to test both self-focus and distraction predictions in a way that overcomes some of the difficulties with interpretation between the studies included in this review.

Out of the studies reviewed, only Otten (2009) revealed a performance-improving influence of competitive pressure. While this potential positive outcome is explicitly considered in the contemporary frameworks, the experimental designs of the studies reviewed perhaps did not provide the opportunity to test these newer predictions or the individual variations in response to pressure. Indeed, a limitation of the anxiety-performance research to date has been the use of blocked conditions and grouped data (see, Eysenck & Wilson, 2016). In real competitive environments, not only may there be differences in the ways in which individuals perceive pressure, but this is likely to vary during an event. ACTS (Eysenck & Wilson, 2016) suggests that a key factor of the anxiety-performance relationship is its bi-directional nature and the fact that performance errors will likely influence momentary state anxiety. As such, it is important that future studies take a more fine-grained approach to assessing performance and anxiety under pressure; as trying to relate measures of anxiety taken prior to performing a block of trials with the aggregated performance in those trials does not take into account this bi-directional relationship. Whilst research has begun to consider the differences between successful and unsuccessful performance attempts when under pressure (Cooke et al., 2015; Cooke et al., 2014; Gallicchio et al., 2016) changes in anxiety are not assessed with the same precision.

Despite the concerns identified above, the findings from the review do suggest that increased anxiety in response to competitive pressure *is* related to impaired attentional control and degraded performance. Interventions designed to improve performers' attentional control therefore have merit, as they are likely to limit both unwanted attention to the self, and/or irrelevant (and especially threatening) stimuli. For example, there is an existing evidence base to support the use of quiet eye training to protect performance of targeting skills under pressure for novices (Moore, Vine, Cooke, Ring, & Wilson, 2012; Vine & Wilson, 2010; Vine & Wilson, 2011) and for experienced performers (Causer, Holmes, & Williams, 2011; Vine, Moore, & Wilson, 2011; Wood & Wilson, 2011). While quiet eye training requires task-specific knowledge about relevant targets of attention, it might also be possible to train generic functions of working memory to protect performance. Ducrocq and colleagues recently revealed that practicing a computer task

designed to train the inhibition function of working memory can improve sport-specific visual attentional control, and subsequent performance, in a high-pressure tennis task (Ducrocq, Wilson, Smith, & Derakshan, 2018; Ducrocq, Wilson, Vine, & Derakshan, 2016).

There are other interventions designed to improve attention in sport, which may also help to mitigate the negative impact of anxiety on performance in targeting tasks (see Moran, 2012). For example, pre-performance routines can help to regulate attentional focus through a sequence of consistent behaviours and thoughts (Cotterill, 2010; Wilson & Richards, 2011). Mental imagery may also improve focus, and has been shown to lessen the impact of competitive pressure on shooting performance (Colin, Nieuwenhuys, Visser, & Oudejans, 2014). Finally, simulation (or habituation) training that replicates key aspects of an impending challenge may also help improve attentional control when anxious. Oudejans and colleagues have demonstrated that training with anxiety can help to improve subsequent performance under pressure in both expert and novice athletes (Oudejans & Pijpers, 2009; Oudejans & Pijpers, 2010) and in police officers (Oudejans, 2008). Importantly, there is early indication that these positive training effects are durable over time (Nieuwenhuys & Oudejans, 2011). While the specific impact on attentional control is less explicit in these interventions, compared to quiet eye training or working memory training, future research is warranted.

4.4 Limitations

While this systematic review adopted PRISMA guidelines, the quality assessments commonly used are developed for randomised controlled trials and therefore many items were not applicable to current sport psychology literature. The quality assessment included in this review was adapted from relevant quality assessments (Downs & Black, 1998; Durant, 1994; Genaidy et al., 2007), but there is no overall consensus as to criteria and therefore other researchers may have made different decisions. For example, our decision to exclude studies where target or aiming tasks were not adopted meant that those studies adopting continuous tasks (e.g., flying, Allsop & Gray, 2014; climbing, Nieuwenhuys, Pijpers, Oudejans, & Bakker,

2008; driving, Wilson, Chattington, et al., 2007), which might otherwise have scored highly on the quality assessment criteria, were left out of the current review. However, as the majority of experimental research has used self-paced, non-interactive tasks, it is recommended that the implications discussed (section 4.3) and conclusions drawn from the systematic review are considered within this context.

4.5 Conclusion

The aim of this review was to systematically examine the available evidence with the intent of investigating the key attentional mechanisms (and supporting theory) explaining the anxiety-performance relationship. Overall, the review has established that the most pertinent theoretical accounts of anxiety and sporting performance make reference to attention, even if there is still no shared consensus as to the precise mechanisms, or associated moderating variables. Limitations in the objective measurement of attention and the use of different research designs depending on whether predictions of self-focus or distraction theories were being examined, make comparisons between studies difficult. Future research needs to address these methodological issues, especially if the more complex, contemporary frameworks are to be empirically tested. This research is important if evidence-based interventions and training programmes are to be promoted for athletes seeking to thrive under the pressure of sporting competition.

References

Allsop, J., & Gray, R. (2014). Flying under pressure: effects of anxiety on attention and gaze behavior in aviation. *Journal of Applied Research in Memory and Cognition, 3*, 63-71.

American Psychological Association. (2010). *Publication manual of the American Psychological Association* (6th ed.). Washington, D.C.: American Psychological Association.

Baumeister, R. F. (1984). Choking under pressure: self-consciousness and paradoxical effects of incentives on skillful performance. *Journal of Personality and Social Psychology, 46*(3), 610.

Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: is the active self a limited resource? *Journal of Personality and Social Psychology, 74*, 1252.

Behan, M., & Wilson, M. (2008). State anxiety and visual attention: the role of the quiet eye period in aiming to a far target. *Journal of Sport Sciences, 26*(2), 207-215.

Beilock, S. L., & Carr, T., H. (2001). On the fragility of skilled peformance: what governs choking under pressure? *Journal of Experimental Psychology: General, 130*(4), 701-725.

Beilock, S. L., Carr, T. H., MacMahon, C., & Starkes, J. L. (2002). When paying attention becomes counterproductive: impact of divided versus skill-focused attention on novice and experienced performance of sensorimotor skills. *Journal of Experimental Psychology: Applied, 8*(1), 6.

Beilock, S. L., & Gray, R. (2007). Why do athletes choke under pressure? In Tenenbaum & Ecklund (Eds.), *Handbook of Sport Psychology* (3 ed., pp. 425-444). Hoboken: John Wiley & Sons.

Bertrams, A., Englert, C., Dickhauser, O., & Baumeister, R. F. (2013). Role of self-control strength in the relation between anxiety and cognitive performance. *Emotion, 13*(4), 668-680.

Burke, D., & Yeadon, F. (2009). *A comparison of compensation for release timing and maximum hand speed in recreational and competitive darts players.* Paper presented at the ISBS-Conference Proceedings Archive.

Carrasco, M. (2011). Visual attention: the past 25 years. *Vision research, 51*(13), 1484-1525.

Carson, H. J., & Collins, D. (2016). The fourth dimension: a motoric perspective on the anxiety–performance relationship. *International Review of Sport and Exercise Psychology, 9*(1), 1-21.

Causer, J., Holmes, P. S., Smith, N. C., & Williams, A. M. (2011). Anxiety, movement kinematics, and visual attention in elite-level performers. *Emotion, 11*(3), 595.

Causer, J., Holmes, P. S., & Williams, A. M. (2011). Quiet eye training in a visuomotor control task. *Medicine and Science in Sports and Exercise, 43*, 1042-1049.

Cheng, W.-N. K., Hardy, L., & Markland, D. (2009). Toward a three-dimensional conceptualization of performance anxiety: rationale and initial measurement development. *Psychology of Sport and Exercise, 10*(2), 271-278.

Colin, L., Nieuwenhuys, A., Visser, A., & Oudejans, R. R. D. (2014). Positive Effects of Imagery on Police Officers' Shooting Performance under Threat. *Applied Cognitive Psychology, 28*(1), 115-121. doi: 10.1002/acp.2972

Cooke, A., Gallicchio, G., Kavussanu, M., Willoughby, A., McIntyre, D., & Ring, C. (2015). Premovement high-alpha power is modulated by previous movement errors: Indirect evidence to endorse high-alpha power as a marker of resource allocation during motor programming. *Psychophysiology, 52*(7), 977-981.

Cooke, A., Kavussanu, M., Gallicchio, G., Willoughby, A., McIntyre, D., & Ring, C. (2014). Preparation for action: Psychophysiological activity preceding a motor skill as a function of expertise, performance outcome, and psychological pressure. *Psychophysiology, 51*(4), 374-384.

Cooke, A., Kavussanu, M., McIntyre, D., Boardley, I. D., & Ring, C. (2011). Effects of competitive pressure on expert performance: underlying psychological, physiological, and kinematic mechanisms. *Psychophysiology, 48*(8), 1146-1156.

Cooke, A., Kavussanu, M., McIntyre, D., & Ring, C. (2010). Psychological, muscular and kinematic factors mediate performance under pressure. *Psychophysiology, 47*(6), 1109-1118.

Corbetta, M., Akbudak, E., Conturo, T. E., Snyder, A. Z., Ollinger, J. M., Drury, H. A., . . . Van Essen, D. C. (1998). A common network of functional areas for attention and eye movements. *Neuron, 21*(4), 761-773.

Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience, 3*(3), 201-215.

Cotterill, S. (2010). Pre-performance routines in sport: current understanding and future directions. *International Review of Sport and Exercise Psychology, 3*(2), 132-153.

Downs, S. H., & Black, N. (1998). The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *Journal of Epidemiology and Community Health, 52*(6), 377-384.

Ducrocq, E., Wilson, M., Smith, T. J., & Derakshan, N. (2018). Adaptive Working Memory Training Reduces the Negative Impact of Anxiety on Competitive Motor Performance. *Journal of Sport and Exercise Psychology, 20*, 1-11.

Ducrocq, E., Wilson, M., Vine, S., & Derakshan, N. (2016). Training attentional control improves cognitive and motor task performance. *Journal of Sport and Exercise Psychology, 38*, 521-533.

Durant, R. H. (1994). Checklist for the evaluation of research articles. *Journal of Adolescent Health, 15*(1), 4-8.

Englert, C., & Bertrams, A. (2012). Anxiety, ego depletion, and sports performance. *Journal of Sport and Exercise Psychology, 34*(5), 580-599.

Englert, C., & Bertrams, A. (2015). Integrating attentional control theory and the strength model of self-control. *Frontiers in Psychology, 6*.

Englert, C., Bertrams, A., Furley, P., & Oudejans, R. R. (2015). Is ego depletion associated with increased distractibility? Results from a basketball free throw task. *Psychology of Sport and Exercise, 18*, 26-31.

Englert, C., & Oudejans, R. R. D. (2014). Is choking under pressure a consequence of skill-focus or increased distractibility? Results from a tennis serve task. *Psychology, 5*, 1035-1043.

Englert, C., Zwemmer, K., Bertrams, A., & Oudejans, R. R. (2015). Ego depletion and attention regulation under pressure: is a temporary loss of self-control strength indeed related to impaired attention regulation? *Journal of Sport and Exercise Psychology, 37*(2), 127-137.

Eysenck, M. (1991). Cognitive factors in clinical anxiety: potential relevance to therapy *In: New concepts in anxiety* (pp. 418-433): Macmillan Education UK.

Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: the processing efficiency theory. *Cognition and Emotion, 6*(6), 409-434.

Eysenck, M. W., & Derakshan, N. (2011). New perspectives in attentional control theory. *Personality and Individual Differences, 50*(7), 955-960.

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion, 7*(2), 336-353.

Eysenck, M. W., & Wilson, M. (2016). Introducing attentional control theory: sport. In Groome & Eysenck (Eds.), *An Introduction to Applied Cognitive Psychology*: Psychology Press.

Gallicchio, G., Cooke, A., & Ring, C. (2016). Lower left temporal-frontal connectivity characterizes expert and accurate performance: high-alpha T7-Fz connectivity as a marker of conscious processing during movement. *Sport, Exercise, and Performance Psychology, 5*(1), 14.

Genaidy, A., Lemasters, G., Lockey, J., Succop, P., Deddens, J., Sobeih, T., & Dunning, K. (2007). An epidemiological appraisal instrument–a tool for evaluation of epidemiological studies. *Ergonomics, 50*(6), 920-960.

Gray, R. (2004). Attending to the execution of a complex sensorimotor skill: expertise differences, choking and slumps. *Journal of Experimental Psychology: Applied, 63*, 42-54.

Gray, R., & Allsop, J. (2013). Interactions between performance pressure, performance streaks, and attentional focus. *Journal of Sport and Exercise Psychology, 35*(4), 368-386.

Gray, R., Allsop, J., & Williams, S. (2013). Changes in putting kinematics associated with choking and excelling under pressure. *International Journal of Sport Psychology, 44*, 387-407.

Gucciardi, D. F., & Dimmock, J. A. (2008). Choking under pressure in sensorimotor skills: conscious processing or depleted attentional resources? *Psychology of Sport and Exercise, 9*(1), 45-59. doi: 10.1016/j.psychsport.2006.10.007

Hardy, L. (1990). A catastrophe model of performance in sport. In Jones & Hardy (Eds.), *Stress and Performance in Sport* (pp. 81-106). Oxford, England: John Wiley & Sons.

Houtman, I., & Bakker, F. (1989). The anxiety thermometer: a validation study. *Journal of personality assessment, 53*(3), 575-582.

Kinrade, N. P., Jackson, R. C., & Ashford, K. J. (2010). Dispositional reinvestment and skill failure in cognitive and motor tasks. *Psychology of Sport and Exercise, 11*(4), 312-319.

Knudsen, E. I. (2007). Fundamental components of attention. *Annual Review of Neuroscience, 30*, 57-78.

Krane, V. (1994). The mental readiness form as a measure of competitive state anxiety. *Sport Psychologist, 8*, 189-189.

Lam, W., Maxwell, J., & Masters, R. (2010). Probing the allocation of attention in implicit (motor) learning. *Journal of Sports Sciences, 28*, 1543-1554.

Lam, W. K., Maxwell, J. P., & Masters, R. (2009). Analogy learning and the performance of motor skills under pressure. *Journal of Sport and Exercise Psychology, 31*, 337-357.

Lawrence, G. P., Khan, M. A., & Hardy, L. (2013). The effect of state anxiety on the online and offline control of fast target-directed movements. *Psychological Research, 77*(4), 422-433.

Liao, C., & Masters, R. (2002). Self-focused attention and performance failure under psychological stress. *Journal of Sport and Exercise Psychology, 24*(3), 289-305.

Malhotra, N., Poolton, J. M., Wilson, M. R., Uiga, L., & Masters, R. (2015). Examining movement-specific reinvestment and performance in demanding contexts. *Journal of Sport and Exercise Psychology, 37*(3), 327-338.

Martens, R., Burton, D., Vealey, R. S., Bump, L. A., & Smith, D. E. (1990). Development and validation of the competitive state anxiety inventory-2. In Martens, Vealey & Burton (Eds.), *Competitive anxiety in sport.* (pp. 117-190). Champaign, IL: Human Kinetics.

Masters, R., & Maxwell, J. (2008). The theory of reinvestment. *International Review of Sport and Exercise Psychology, 1*(2), 160-183.

Masters, R. S. (1992). Knowledge knerves and know-how: the role of explicit versus implicit knowledge in the breakdown of a complex motor skill under pressure. *British Journal of Psychology, 83*(3), 343-358.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: a latent variable analysis. *Cognitive psychology, 41*(1), 49-100.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D., G, & group, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Medicine, 6*(7).

Moore, L. J., Vine, S. J., Cooke, A., Ring, C., & Wilson, M. R. (2012). Quiet eye training expedites motor learning and aids performance under heightened anxiety: the roles of response programming and external attention. *Psychophysiology, 49*(7), 1005-1015. doi: 10.1111/j.1469-8986.2012.01379.x

Moran, A. (2012). Concentration: attention and performance. In Murphy (Ed.), *The Oxford Handbook of Sport and Performance Psychology* (pp. 117-130): Oxford University Press.

Mulder, L. (1992). Measurement and analysis methods of heart rate and respiration for use in applied environments. *Biological Psychology, 34*(2), 205-236.

Mullen, R., & Hardy, L. (2000). State anxiety and motor performance: testing the conscious processing hypothesis. *Journal of Sport Sciences, 18*(10), 785-799.

Mullen, R., Hardy, L., & Tattersall, A. (2005). The effects of anxiety on motor performance: a test of the conscious processing hypothesis. *Journal of Sport and Exercise Psychology, 27*(2), 212-225.

Nibbeling, N., Daanen, H. A., Gerritsma, R. M., Hofland, R. M., & Oudejans, R. R. (2012). Effects of anxiety on running with and without an aiming task. *Journal of Sport Sciences, 30*(1), 11-19.

Nibbeling, N., Oudejans, R. R. D., & Daanen, H. A. M. (2012). Effects of anxiety, a cognitive secondary task, and expertise on gaze behavior and performance in a far aiming task. *Psychology of Sport and Exercise, 13*(4), 427-435.

Nieuwenhuys, A., & Oudejans, R. (2010). Effects of anxiety on handgun shooting behavior of police officers: a pilot study. *Anxiety Stress and Coping, 23*(2), 225-233. doi: 10.1080/10615800902977494

Nieuwenhuys, A., & Oudejans, R. R. (2011). Training with anxiety: short- and long-term effects on police officers' shooting behavior under pressure. *Cognitive Processing, 12*(3), 277-288. doi: 10.1007/s10339-011-0396-x

Nieuwenhuys, A., & Oudejans, R. R. (2012). Anxiety and perceptual-motor performance: toward an integrated model of concepts, mechanisms, and processes. *Psychological Research, 76*(6), 747-759.

Nieuwenhuys, A., & Oudejans, R. R. (2017). Anxiety and performance: perceptual-motor behavior in high-pressure contexts. *Current Opinion in Psychology*.

Nieuwenhuys, A., Pijpers, J. R., Oudejans, R. R., & Bakker, F. C. (2008). The influence of anxiety on visual attention in climbing. *Journal of Sport and Exercise Psychology, 30*(2), 171-185.

Nyberg, G. (2015). Developing a 'somatic velocimeter': the practical knowledge of free skiers. *Qualitative Research in Sport, Exercise and Health, 7*(4), 488-503.

Otten, M. (2009). Choking vs. clutch performance: a study of sport performance under pressure. *Journal of Sport and Exercise Psychology, 31*(5), 583-601.

Oudejans, R. (2008). Reality-based practice under pressure improves handgun shooting performance of police officers. *Ergonomics, 51*, 261-273.

Oudejans, R. R., Kuijpers, W., Kooijman, C. C., & Bakker, F. C. (2011). Thoughts and attention of athletes under pressure: skill-focus or performance worries? *Anxiety Stress and Coping, 24*(1), 59-73.

Oudejans, R. R., & Pijpers, J. R. (2009). Training with anxiety has a positive effect on expert perceptual-motor performance under pressure. *The Quarterly Journal of Experimental Psychology, 62*, 1631-1647. doi: 10.1080/17470210802557702

Oudejans, R. R. D., & Pijpers, J. R. (2010). Training with mild anxiety may prevent choking under higher levels of anxiety. *Psychology of Sport and Exercise, 11*, 44-50. doi: 10.1016/j.psychsport.2009.05.002

Roberts, L. J., Jackson, M. S., & Grundy, I. H. (2017). Choking under pressure: illuminating the role of distraction and self-focus. *International Review of Sport and Exercise Psychology*, 1-21.

Sarason, I. G. (1984). Stress, anxiety, and cognitive interference: reactions to tests. *Journal of Personality and Social Psychology, 46*(4), 929-938.

Sarason, I. G. (1988). Anxiety, self-preoccupation and attention. *Anxiety Research, 1*, 3-7.

Spielberger, C. D. (1966). *Theory and research on anxiety*: Academic Press.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. (1970). State-trait anxiety inventory. Palo Alto: ca: consulting psychologists press.

Sullivan, G. M., & Feinn, R. (2012). Using effect size—or why the P value is not enough. *Journal of graduate medical education, 4*(3), 279-282.

Tanaka, Y., & Sekiya, H. (2010a). The influence of audience and monetary reward on the putting kinematics of expert and novice golfers. *Research Quarterly for Exercise and Sport, 81*(4), 416-424.

Tanaka, Y., & Sekiya, H. (2010b). The relationships between psychological/physiological changes and behavioral/performance changes of a golf putting task under pressure. *International Journal of Sport and Health Science, 8*, 83-94.

Tanaka, Y., & Sekiya, H. (2011). The influence of monetary reward and punishment on psychological, physiological, behavioral and performance aspects of a golf putting task. *Human Movement Science, 30*(6), 1115-1128.

Uiga, L., Cheng, K. C., Wilson, M. R., Masters, R. S., & Capio, C. M. (2015). Acquiring visual information for locomotion by older adults: a systematic review. *Ageing Research Reviews, 20*, 24-34.

Vickers, J. N., & Williams, A. M. (2007). Performing under pressure: the effects of physiological arousal, cognitive anxiety, and gaze control in biathlon. *Journal of Motor Behaviour, 39*(5), 381-394.

Vine, S. J., Lee, D., Moore, L. J., & Wilson, M. R. (2013). Quiet eye and choking: online control breaks down at the point of performance failure. *Medicine & Science in Sports & Exercise, 45*(10), 1988-1994.

Vine, S. J., Moore, L. J., & Wilson, M. R. (2011). Quiet eye training facilitates competitive putting performance in elite golfers. *Frontiers in Psychology, 2*, 8. doi: 10.3389/fpsyg.2011.00008

Vine, S. J., Moore, L. J., & Wilson, M. R. (2016). An integrative framework of stress, attention, and visuomotor performance. *Frontiers in Psychology, 7*.

Vine, S. J., & Wilson, M. R. (2010). Quiet Eye Training: effects on learning and performance under pressure. *Journal of Applied Sport Psychology, 22*(4), 361-376. doi: 10.1080/10413200.2010.495106

Vine, S. J., & Wilson, M. R. (2011). The influence of quiet eye training and pressure on attention and visuo-motor control. *Acta psychologica, 136*(3), 340-346. doi: 10.1016/j.actpsy.2010.12.008

Wang, J., Marchant, D., Morris, T., & Gibbs, P. (2004). Self-consciousness and trait anxiety as predictors of choking in sport. *Journal of Science and Medicine in Sport, 7*(2), 174-185.

Whitehead, A. E., Taylor, J. A., & Polman, R. C. (2015). Evidence for skill level differences in the thought processes of golfers during high and low pressure situations. *Frontiers in Psychology, 6*.

Williams, A. M., Vickers, J., & Rodrigues, S. (2002). The effects of anxiety on visual search, movement kinematics, and performance in table tennis: a test of Eysenck and Calvo's processing efficiency theory. *Journal of Sport & Exercise Psychology, 23*(4), 438-455.

Wilson, M. (2008). From processing efficiency to attentional control: a mechanistic account of the anxiety-performance relationship. *International Review of Sport & Exercise Psychology, 1*(2), 184-201.

Wilson, M. (2012). Anxiety: attention, the brain, the body and performance. In Murphy (Ed.), *The Oxford Handbook of Sport and Performance Psychology*: Oxford University Press.

Wilson, M., Chattington, M., Marple-Horvat, D. E., & Smith, N. C. (2007). A comparison of self-focus versus attentional explanations of choking. *Journal of Sport and Exercise Psychology, 29*(4), 439-456.

Wilson, M., & Richards, H. (2011). Putting it together: skills for pressure performance. In D. Collins, A. Button & H. Richards (Eds.), *Performance Psychology* (pp. 337-360). Edinburgh, UK: Elsevier.

Wilson, M., Smith, N. C., & Holmes, P. S. (2007). The role of effort in influencing the effect of anxiety on performance: testing the conflicting predictions of processing efficiency theory and the conscious processing hypothesis. *British Journal of Psychology, 98*(3), 411-428.

Wilson, M., Vine, S. J., & Wood, G. (2009). The influence of anxiety on visual attentional control in basketball free throw shooting. *Journal of Sport and Exercise Psychology, 31*(2), 152-168.

Wilson, M., Wood, G., & Vine, S. J. (2009). Anxiety, attentional control, and performance impairment in penalty kicks. *Journal of Sport and Exercise Psychology, 31*(6), 761-775.

Wine, J. (1971). Test anxiety and direction of attention. *Psychological Bulletin, 76*(2), 92.

Wood, G., & Wilson, M. R. (2011). Quiet-eye training for soccer penalty kicks. *Cognitive Processing, 12*, 257-266. doi: 10.1007/s10339-011-0393-0

Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-formation. *Journal of Comparative Neurology and Psychology, 18*(5), 459-482.

Zhu, F., Poolton, J., Wilson, M., Maxwell, J., & Masters, R. (2011). Neural co-activation as a yardstick of implicit motor learning and the propensity for conscious control of movement. *Biological Psychology, 87*(1), 66-73.

****Insert page 10****

Figure 1 Stages and results of the search process using the four-phase PRISMA flow diagram

Adapted from Moher, Liberati, Tetzlaff, Altman, and group (2009)