Anxiety: Attention, the Brain, the Body, and Performance

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Abstract and Keywords

In sport psychology, the relationship between competitive anxiety and performance has been one of the most debated and researched topics of enquiry. However, the mechanisms underlying this relationship are still unclear, as are the reasons why performance can sometimes be optimal ("clutch" performance) and sometimes far below what should be achieved ("choking"). The current chapter integrates research findings and models from the neuroscience, cognitive psychology, human movement science, and sport performance literature to offer a potential explanatory framework, especially with respect to self-paced, visually guided skills. The mediating role of visual attention is implicated, as it has been proposed to be central to both the top-down control of motor planning and the effects of anxiety on cognitive performance. Contemporary research testing the effects of anxiety on visual attention (particularly the quiet eye) in performance environments, and the efficacy of attentional training programs, are discussed.

Keywords: Attention, gaze, quiet eye, pressure, choking, competition

> Some people think football is a matter of life and death. I don't like that attitude. I can assure them it is much more serious than that.
>
> —*Bill Shankly* (then manager of Liverpool FC), *In Sunday Times (UK)* October 4, 1981

Performing in professional competitive sport requires athletes to make split-second decisions, coordinate their limbs within multiple degrees of freedom, and maintain fine motor control under physical and mental fatigue—all while operating under the stress imposed by perceptions of the consequences of victory or defeat. Although other settings (e.g., military and emergency services) are true proving grounds for the pressures Shankly alludes to (see Janelle & Hatfield, 2008), there is no doubt that to succeed in sport, athletes must excel in evaluative conditions. However, sporting history is replete with examples of highly skilled athletes who failed to cope with this pressure and performed below their best just when optimal performance was most important (e.g., Syed, 2010).

It is therefore perhaps not surprising that the relationship between competitive anxiety and sports performance has been one of the most debated and investigated topics in the sport psychology literature (p. 174) (Beilock & Gray, 2007; Hanton, Neil, & Mellalieu, 2008; Wilson, 2008; Woodman & Hardy, 2001). Although advances have been made by sport psychologists over the last 30 years in terms of the measurement, interpretation, and categorization of constructs related to anxiety, less systematic examination has been made of the mechanisms underlying the influence of anxiety on sporting performance (Janelle, 2002). The aim of this chapter is to integrate knowledge from the neuroscience, cognitive psychology, human movement science, and sport performance literature, in order to offer a mechanistic account of this relationship. Specifically, the mediating role of visual attention is implicated, as it has been proposed to be central to both the top-down control of motor planning and the effects of anxiety on cognitive performance.

Although some of the research reviewed may be of a fundamental motor control or cognitive psychology nature, the relevance to sport psychology and sporting performance should be evident. It has been suggested that of all the psychological constructs deemed important to quality sporting performance, the most critical factor is attention to the right *things* at the right *time* (Janelle, 2002; Vickers, 2007; see also Chapter 6, this volume). This chapter reviews contemporary research that has examined *how* anxiety might disrupt the optimal allocation of attention (location and timing) for sport skills. From an applied perspective, training regimes that may help performers maintain effective visual attention under pressure are also discussed. First, though, a brief introduction and historical perspective to competitive sport anxiety research will be provided.

Competitive Sport Anxiety

As this topic is one of the largest and most diverse research areas in sport psychology, it is not possible to adequately review all the relevant research in this chapter (see Hanton, et al., 2008; Jones, 1995; Raglin & Hanin, 2000; Wilson, 2008; Woodman & Hardy, 2001). However, the following sections provide a brief summary of what anxiety may mean in a sport/performance context and outline some of the most relevant theories. Generally, anxiety is postulated to occur as a result of threat and is related to the subjective evaluation of a situation with regard to one's self-esteem (Eysenck, 1992). It is considered a negative emotional state characterized by nervousness, worry, and apprehension and is associated with increased physiological arousal. Anxiety can be classified as a changing mood state and situation dependent (state anxiety), or an aspect of personality that generally influences behavior (trait anxiety; Spielberger, 1983).

In sport settings, anxiety is usually related to the ego-threatening nature of the competitive environment and, “refers to an unpleasant psychological state in reaction to perceived threat concerning the performance of a task under pressure” (Cheng, Hardy, & Markland, 2009, p. 271). Baumeister (1984) defined pressure as “any factor or combination of factors that increases the importance of performing well" (p. 610). Alongside uncertainty regarding the outcome, pressure is considered to be the most common source of situational stress in sport (Weinberg & Gould, 2007). The relationship between anxiety and performance has most frequently been considered in terms of the consequences of poor performance under pressure—the dreaded choke!

Choking Under Pressure

Choking under pressure is a pejorative colloquial term used to describe suboptimal sporting performance under stressful conditions (Hill, Hanton, Matthews, & Fleming, 2010). Choking is defined as, "the occurrence of inferior performance despite striving and incentives for superior performance" (Baumeister & Showers, 1986, p. 361). The choking phenomenon, which can involve acute or chronic bouts of suboptimal performance, is a complex process involving the interplay of several cognitive, attentional, emotional, and situational factors (Gucciardi, Longbottom, Jackson, & Dimmock, 2010). Clark, Tofler, and Lardon (2005) suggest that while choking, the athlete is able to make rational decisions and select the correct "plan of action" under pressure, but cannot *execute* it because of intervening psychological factors. Several theories have emerged that have attempted to explain the mechanisms underlying choking; however, self-focus and distraction theories have received the most attention (e.g., Beilock & Carr, 2001; Gucciardi & Dimmock, 2008; Masters, 1992; Mullen & Hardy, 2000; Wilson, Chattington, Marple-Horvat, & Smith, 2007).

Self-Focus Theories

Self-focus theories predict that pressure situations raise anxiety and self-consciousness about performing successfully, which in turn increase the attention paid to skill processes and their step-by-step control. The proposed mechanism of disruption is therefore the effortful allocation of attention to previously automated processes (Lewis & Linder, **(p. 175)** 1997). The most acknowledged self-focus theories are the *explicit monitoring hypothesis* (EMH; Beilock & Carr, 2001) and the *theory of reinvestment* (or the conscious processing hypothesis; Masters, 1992; see Chapter 7, this volume). Although the theories possess a number of similarities (e.g., that self-focus is particularly disruptive to expert performers), there are important differences regarding the mechanisms underlying choking. Reinvestment theory implicates conscious *control* of skill execution, whereas the EMH states that performance is disrupted by the athlete *monitoring* the step-by-step execution of the skill. Both theories have received considerable support in the sport psychology literature (see Beilock & Gray, 2007; Masters & Maxwell, 2008, for reviews).

Distraction Theories

Distraction theories (e.g., cognitive interference theory; Sarason, 1988) propose that cognitive anxiety, in the form of worry, is resource intensive and causes a diversion of attention from task-relevant cues. This diversion of resources effectively changes single-task performance into a dual-task situation in which controlling the task at hand and attending to worrisome thoughts compete for attention (Beilock & Carr, 2001). These thoughts therefore interfere with the mental processes that support performance as adequate attention cannot be directed to task-relevant information (Wilson, 2008).

It is noteworthy that self-focus and distraction accounts of choking make essentially opposite predictions regarding how pressure exerts its impact, although both implicate attentional mechanisms. Distraction theories suggest that anxiety shifts necessary attention away from task execution, whereas self-focus theories suggest that anxiety shifts too much attention to skill execution processes. As both accounts have received empirical support, it is clear that there are (at least) two ways in which increased pressure can induce skill failure, what Beilock and Gray (2007) term “Pressure's double whammy.”

Clutch Performance

Notwithstanding the support for attentional explanations of choking, the predicted negative influence of anxiety on sporting performance is less than would be expected (Wilson, 2008). Indeed, it is notable that some athletes not only do not choke, but actually tend to perform better than usual under pressure (Otten, 2009). Otten defines such “clutch: performance as, “any performance increment or superior performance that occurs under pressure circumstances” (p. 584). Support for clutch performance is provided by at least five theoretical frameworks that have been tested in the sporting domain: the directional perspective (Jones, 1991), the transactional perspective of stress (Lazarus & Folkman, 1984), processing efficiency theory (PET; Eysenck & Calvo, 1992), the cusp catastrophe model (Hardy, 1996), and Cheng et al.'s (2009) three-dimensional model.

The Directional Perspective

Jones (1991) suggested that performers may not always interpret their anxiety symptoms as being debilitative toward performance but may in fact feel that they are necessary for mental preparation and performance (i.e., facilitative). Jones and colleagues therefore questioned the utility of solely measuring anxiety in terms of intensity (how anxious one feels) and suggested that it was more important to consider whether the intensity of symptoms experienced were interpreted as positive or negative toward upcoming performance (see Jones, 1995, for an early review). Jones (1995) further explained his notion of facilitative and debilitative interpretations of anxiety symptoms using a control model based on Carver and Scheier's (1988) work. Performers who appraise that they possess a degree of control over a potentially threatening situation and can cope with their anxiety symptoms—thus achieving their goals—are predicted to interpret symptoms as facilitative to performance. In contrast, performers who appraise that they are not in control, cannot cope with the situation, and possess negative expectancies regarding goal attainment are predicted to interpret such symptoms in a negative (debilitative) manner.

There has been a great deal of support for the directional perspective, and a range of personal and situational variables have been investigated to further our understanding of the directional response (see Hanton et al., 2008, for a recent review). Furthermore, Hanton and colleagues have started to examine how performers might be trained in the psychological skills required to effectively use their anxiety symptoms in a productive way and to develop a rational appraisal process in relation to their experiences during competition (see Hanton, Thomas, & Mellalieu, 2009). There are, therefore, clear links between this directional perspective to competitive anxiety and the more general, transactional perspective of stress espoused by Lazarus (Lazarus, 2000, Lazarus & Folkman, 1984).

(p. 176) The Transactional Perspective of Stress

Stress can be conceived as an ongoing transactional process between the environmental demands and the individual's resources, with anxiety resulting from an imbalance between these demands and coping resources (Lazarus & Folkman, 1984). The primary emphasis of this transactional or process approach is, therefore, on how individuals *cope* with stress. Coping is defined as, "constantly changing cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of a person" (Lazarus & Folkman, 1984, pp.141). Lazarus further distinguished between *primary* and *secondary* appraisals in the coping process (Lazarus, 2000). Primary appraisal is related to an evaluation of how important the situation is to an individual and whether or not it might endanger his or her well-being (in terms of harm/loss, threat, challenge, benefit). Secondary appraisal is the cognitive-evaluative process of the coping options available to the individual. Through the effective development of coping resources and productive appraisals, performers can therefore cope with the pressures inherent in competitive environments (e.g., Woodman & Hardy, 2001).

Processing Efficiency Theory

Processing efficiency theory (PET) postulates that cognitive anxiety in the form of worry influences performance in two ways. First, as outlined for distraction theories, worry is assumed to preempt storage and processing resources from working memory, producing performance decrements in tasks that impose high levels of mental demand (Eysenck, 1992). Second, worry is also proposed to serve a motivational function. Concern over suboptimal performance leads to the allocation of additional processing resources (i.e., effort) to tasks or to the initiation of alternative processing strategies designed to maintain performance (Eysenck & Calvo, 1992). Although self-focus theories provide a potential explanation of how increased effort may be directed inappropriately to task control, PET explains how increased effort might aid performance (e.g., Edwards, Kingston, Hardy, & Gould, 2002). A particular strength of PET is, therefore, its ability to account for occasions when performance is not significantly impaired despite heightened anxiety (see Wilson, 2008, for a review of tests of PET in the sporting domain).

Catastrophe Model

Hardy (1996) proposed the cusp catastrophe model of anxiety and performance as a means of explaining the mixed findings that had previously been reported regarding the effects of anxiety upon performance. The model is based on the view that performance anxiety is a multidimensional construct combining a cognitive component (worry) and a physiological arousal component. According to the catastrophe model, performance depends on a complex interaction between these components. This interaction is used to explain how best and worst performance levels will occur when cognitive anxiety is high, depending on the level of physiological arousal experienced (Hardy, 1996). Although the model is difficult to test empirically and has received criticism (see Tenenbaum & Becker, 2005), it does provide an elegant framework to explain how clutch performance and choking can occur under high pressure. Furthermore, one of the strengths of the model is that different control parameters can be selected to examine other potential interactions in performance disruption (e.g., Beattie & Davies, 2010; Hardy, Beattie, & Woodman, 2007).

Three-Dimensional Conceptualization of Performance Anxiety

Cheng et al.'s (2009) framework is a recent attempt at reconceptualizing performance anxiety, due in part to a concern that the adaptive nature of anxiety had been under-represented in the sport psychology literature. This conceptual framework contains three main dimension of anxiety, characterized by five subcomponents: a cognitive dimension composed of worry and self-focused attention, a physiological dimension composed of autonomous hyperactivity and somatic tension, and a regulatory dimension indicated by perceived control.

Perceived control reflects the adaptive possibilities of anxiety within the framework and is defined as, “the perception of one's capacities to be able to cope and attain goals under stress” (Cheng et al., 2009, p. 273). Perceived control was also highlighted as a key mediator of clutch performance by Otten (2009) and is an important element of both PET (Eysenck & Calvo, 1992) and Carver and Scheier's (1988) control-process model of anxiety. Carver and Scheier proposed that expectancies regarding success in a task were critical in determining responses to and effects of anxiety. Cheng et al.'s new three-dimensional model of performance anxiety represents a promising step toward providing a detailed (p. 177) explanation for the sometimes conflicting results found in the sport anxiety literature. However, more research is required to develop its factorial structure and measures by which to test it.

Anxiety, Attention, and Cognitive Performance

As the brief summary of the competitive anxiety and choking under pressure literature has highlighted, attentional mechanisms are critical in understanding the relationship between increased anxiety and sporting performance. The remainder of the chapter will now examine these attentional mechanisms in more detail using a cognitive neuropsychology perspective (Moran, 2009). As the title of the chapter suggests, this review will focus on a cognitive approach to threat-related attentional bias (“anxiety”), the neural substrates underlying attention and anxiety (“the brain”), the planning and control of visually guided movements (“the body”), and the effect of all of these on sport (“performance”).

Anxiety: A Cognitive Psychology Perspective

The preceding section outlined some of the cognitive models of anxiety that have been most frequently examined in sport. However, the influence of anxiety on performance has had a long history of research interest in applied environments, originally in relation to test anxiety (see Stöber & Pekrun, 2004). For school students, individual differences in test anxiety play a major role not only for their academic achievement, but also for more wide-ranging outcomes, such as their career advancement and their personality development and health (Stöber & Pekrun, 2004). Research has tended to support an attentional resource explanation, with increased worry being related to lower examination performance (Keogh & French, 2001; Wine, 1971). The following section discusses some of the main concepts underpinning the influence of anxiety on attention.

Anxiety and Attentional Bias

From an evolutionary perspective, anxiety (like other emotions) evolved to quickly organize our cognitive functions when necessary and should therefore not just be considered as "negative" (Cheng et al., 2009). Anxiety has/had a functional role, acting as a defence mechanism that sends out warning signals that protect and prepare an individual to respond more effectively to perceived threat (Ohman, 2000). Additionally, another evolutionary advantage of anxiety could be that worrying about danger forces people to take fewer risks, seek safety, and focus on doing things well (to avoid the consequences of poor performance). However, these same threat bias processes have also been linked to less functional behaviors in our "modern" world, as evidenced in a diverse range of anxiety disorders (e.g., generalized anxiety, social phobias, physical phobias, etc.).

Anxiety disorders and generalized heightened anxiety can be hugely disruptive to everyday life. Consequently, there is a great deal of interest in "mainstream" cognitive psychology in advancing our understanding of the mechanisms underlying anxiety. Most theoretical models of anxiety disorders implicate attention to threat-relevant information in their etiology and maintenance (Weierich, Treat, & Hollingworth, 2008). For example, an enhanced tendency to select threatening items for processing is likely to lead to an artificially increased perception of the extent of threat in the environment, thereby influencing subsequent cognitive and emotional processes related to anxiety (Yiend, 2008).

A strong body of evidence now shows that anxiety is indeed associated with an attentional bias toward and an inability to "disengage" from the processing of threat-related distracters, and/or an enhanced distractibility in the presence of task-irrelevant threatening stimuli (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Weierich et al., 2008, for reviews and discussion). These cognitive models of anxiety extend biased competition models of selective attention, which implicate the interplay between "bottom-up" sensory mechanisms and "top-down" control processes (see Duncan, 2006, for a review). Selective attention to threat is therefore argued to be determined by the relative signal strength from a preattentive threat evaluation mechanism versus that from top-down control mechanisms (Pachego-Unguettit, Acosta, Callejas, & Lapianez, 2010). Anxiety alters the strength of output from the preattentive threat evaluation system, increasing the likelihood that threat-related stimuli will capture attention (Mogg & Bradley, 1999).

Regulatory Attentional Control

Derryberry and Reed (2002) provide an interesting adjunct to the typical finding that attentional biases are central to both processing and structural aspects of the experience of anxiety. These authors (p. 178) suggest that although individuals may differ in the way in which attention (relatively automatically) amplifies threat and exacerbates anxiety, they may also differ in the extent to which they use *voluntary* attention to control orienting. In effect, it is voluntary attention that is recruited in the coping strategies that people use to regulate their anxiety. Anxious individuals who have poorer attentional control find it more difficult to disengage from threatening stimuli than anxious individuals with better attentional control.

Derryberry and Reed adopted Posner and Raichle's (1994) cognitive neuroscience model of attention, which considers both involuntary and voluntary processes. The *posterior* attentional system is a relatively reactive system that orients the attentional “spotlight” from one location to another. Once information is engaged, it is transmitted to the *anterior* attentional system, which acts as an executive system that carries out more voluntary attentional functions. The anterior system can regulate the posterior system, thereby providing voluntary control (guided by expectations or motives) over the allocation of attention in space (see also Rothbart, Sheese, & Posner, 2007). Derryberry and Reed (2002) argue that the anterior system might help reduce anxiety (and improve performance) by enabling an individual to disengage from threat and engage effective attentional control on productive cues.

We will return to these ideas later in the chapter, as the concept of directing attention to productive (or task-relevant) cues is a critical component of *quiet eye* training interventions.

The Brain: Neural Mechanisms

The advent of neuroimaging has provided a route for examining the neural substrate of associative and attentional processes in humans. Although this chapter focuses mainly on the cognitive and attentional mechanisms underpinning the influence of anxiety on performance, other neural pathways have been implicated in the stress response associated with anxiety. For example, it is known that stress causes various physiological alterations, including homeostatic imbalances and activation of the hypothalamic-pituitary-adrenal (HPA) axis. During a stress response, corticotropin-releasing factor (CRF) activates the HPA axis, to stimulate the release of adrenocorticotropic hormone (ACTH). Corticotropin-releasing factor has also been proposed to have an involvement in the development of anxiety-related and mood disorders (Bale & Vale, 2004). As a detailed discussion of all arousal-related mechanisms is beyond the scope of this chapter, the remainder of this section will return to our focus on attentional processes underlying anxiety.

Attention and the Dorsal Lateral Prefrontal Cortex

Recent work by Bishop and colleagues has revealed that anxiety is associated with both enhanced amygdala activation and reduced recruitment of prefrontal cortical areas, primarily the dorsal lateral prefrontal cortex (DLPFC; see Bishop, 2007, 2008, 2009). The amygdala is part of the limbic system, a set of brain structures supporting a variety of functions including emotion, behavior, long-term memory, and olfaction (Swanson & Petrovich, 1998). The amygdala performs a primary role in the processing and memory of emotional reactions and is a key structure in the processing of threat-related stimuli (Bishop, Duncan, & Lawrence, 2004; Phelps, 2006).

The DLPFC is located on the middle frontal gyrus and superior frontal gyrus (Petrides, 2005) and is thought to support cognitive control processes that enable voluntarily control of actions (MacDonald, Cohen, Stenger, & Carter, 2000; Weissman, Perkins, & Woldorff, 2004). The DLPFC has been implicated in sustained and flexible control of attention, particularly for visuospatial working memory tasks (Knudsen, 2007). Importantly, in relation to the current chapter, this structure is thought to support the establishment and maintenance of representations for current goals and rules to facilitate task-related performance (Bishop, 2009; Corbetta & Schulman, 2002).

Bishop's research suggests that anxiety disrupts the amygdala–prefrontal circuitry, with deficient recruitment of prefrontal control mechanisms and amygdaloid hyperresponsivity to threat leading to a threat-related processing bias in anxious individuals (Bishop, 2007). In broad terms, these neuroscience findings provide support for the theories from the cognitive psychology literature referred to earlier (e.g., Bar-Haim et al., 2007; Weierich et al., 2008). Of particular interest to the current chapter is the impact that anxiety has been shown to exert on conscious, attentional control. A recent functional magnetic resonance imaging (fMRI) study by Bishop (2009) utilizing a response-conflict task revealed that anxious participants were slower to identify targets in the presence of incongruent distracters. Anxiety was also associated with deficient recruitment of DLPFC mechanisms used to augment attentional control in response to processing conflict.

(p. 179) A Theoretical Framework: Attentional Control Theory

A recent theoretical development from cognitive psychology, *attentional control theory* (ACT; Eysenck, Derakshan, Santos, & Calvo, 2007), aims to provide a framework by which to understand the influence of anxiety on attentional control and cognitive performance. Attentional control theory is an extension and development of processing efficiency theory (PET; Eysenck & Calvo, 1992), which has previously received empirical support in the cognitive psychology (see Eysenck et al., 2007, for a review) and sport psychology (see Wilson, 2008, for a review) literature. The primary hypothesis of PET is that anxiety impairs the efficiency of the central executive, an attention-like, limited capacity component of working memory (see Baddeley, 1986, 2001). When anxious, the efficiency with which individuals process and act upon information decreases, potentially resulting in performance degradation. Whereas PET makes predictions about the effect of anxiety on the general efficiency by which information is processed, ACT is more explicit about the specific attentional processes involved, as discussed below.

Top-Down Versus Stimulus-Driven Attentional Control

Attentional control theory shares similarities with other theoretical models of anxiety disorders that propose that anxious individuals both orient more rapidly to anxiety-inducing stimuli and disengage from them more slowly (see Weierich et al., 2008, for a review). Eysenck et al. (2007) suggest that anxiety is likely to cause a diversion of processing resources from task-relevant stimuli toward task-irrelevant (and particularly threatening) stimuli. This impairment in attentional control is proposed to occur irrespective of whether these stimuli are external (e.g., environmental distractors) or internal (e.g., worrying thoughts). The authors explicitly relate this impairment of attentional control to a disruption in the balance of two attentional systems first outlined by Corbetta and colleagues: the goal-directed and the stimulus-driven systems (Corbetta & Schulman, 2002; Corbetta, Patel, & Shulman, 2008).[1] According to ACT, anxiety disrupts the balance between these two attentional systems by increasing the influence of the stimulus-driven attentional system at the expense of the more efficient goal-directed system (Eysenck et al., 2007).

The top-down (goal-directed) control system is centered on the dorsal posterior parietal and frontal cortex and is involved in preparing and applying goal-directed selection of stimuli and action responses. The stimulus-driven control system includes the temporoparietal cortex and inferior frontal cortex and is largely lateralized to the right hemisphere (Corbetta & Schulman, 2002). Corbetta and Schulman suggest that this ventral frontoparietal network works as a “circuit breaker” (2000, p. 201) for the dorsal system. This circuit breaking effect can be an adaptive process, directing attention to potentially important or salient events. However, as anxiety alters the strength of output from the preattentive threat evaluation system, the likelihood that threat-related stimuli will capture attention is increased. If top-down attentional control is required to effectively complete a task, such stimulus-driven (ventral) processing will likely impair effective attentional control and potentially task performance (see Pachego-Unguettit et al., 2010, for a discussion of how trait and state anxiety may modulate attention through different effects on top-down and stimulus-driven attentional control).

Central Executive Functions: Inhibition and Shifting

Attentional control theory also makes predictions regarding those specific functions of the central executive that are most adversely affected by anxiety; namely, the “inhibition” and “shifting” functions (based on Miyake et al., 2000). The inhibition function involves using attentional control to resist disruption or interference from task-irrelevant stimuli (negative control). The shifting function involves using attentional control to shift the allocation of attention in a flexible and optimal way to remain focused on the task stimulus or stimuli that are currently most relevant (positive control). It is the impaired functioning of these elements of attentional control (i.e., inhibition and shifting) that is proposed to disrupt the balance between the goal-directed and stimulus-driven attentional systems (Eysenck & Derakshan, 2011; Eysenck et al., 2007).

As different sports make varying demands on inhibition and switching functions, anxiety is likely to impair attentional control (and potentially performance) via different mechanisms. For example, attentional control is likely to be impaired in target sports (e.g., shooting and archery) via less efficient inhibition of internal and external distracting stimuli. On the other hand, in invasion sports (e.g., football, basketball, etc.), it is the inability to effectively scan (p. 180) for appropriate cues that may impair performance (e.g., "ball watching").

There is considerable evidence that anxiety is associated with increased susceptibility to distraction and thus impaired efficiency of the inhibition function (Eysenck & Derakshan, 2011). This research has typically involved paradigms in which conditions vary in terms of the presence and/or nature of distracting stimuli (see Derakshan & Eysenck, 2009, for a review). Research testing the prediction that anxiety impairs the efficiency of the shifting function typically adopts the task-switching paradigm (Derakshan & Eysenck, 2009). These sorts of "process pure" tasks that isolate inhibition or switching functions are difficult to replicate in sport settings. However, Eysenck and Derakshan (2011) suggest that by tracking eye movements on tasks in which it is possible to specify *where* visual attention should be and *how* it might switch over time, optimal top-down attentional control (whether it is negative or positive) can be assessed.

The following section examines how this form of inquiry has been successfully adopted by researchers aiming to understand how vision provides the information needed to support goal-directed action (e.g., Land, 2009; Vickers, 2007).

The Body: Visual Attention and Visuomotor Control

Most of the research implicating attention in anxiety-induced performance disruptions has used cognitive tasks, which raises the question of whether the same principles can be applied to visuomotor (sport) tasks. By emphasizing mental processes only, cognitive psychology research has tended to ignore the planning and control of motor outputs. However, in order to behave adaptively in a complex environment, an individual must select the information that is most relevant at any point in time, so that effective plans for action can be developed (Knudsen, 2007). Indeed, the principal function of vision for our Neolithic ancestors was to provide the information required to support the actions of everyday life—hunting, foraging, lighting fires, etc. (Land, 2009). Attention and preparation for action are therefore closely linked, as is eloquently illustrated by William James' quote; "My thinking is first and last and always for the sake of my doing" (1890, p. 333).

So, how important is visual attention in the control of motor tasks? Does anxiety affect attentional control in motor tasks in the same way that it does in cognitive tasks? The following sections address these questions.

Neuroscience and Visually Guided Movement

A great deal of cognitive neuroscience research supports the use of gaze measures as correlates of visual attention (e.g., Corbetta, 1998; Henderson, 2003; Shipp, 2004). It is generally accepted that a change in gaze requires the activation of covert and then overt attention, and it is difficult to shift the point of gaze without shifting covert attention (Shinoda, Hayhoe, & Shrivastava, 2001). The close linkage between gaze and visual attention is especially apparent in visually guided manual tasks. Individuals learn to program spatially congruent eye and hand motor commands, so that fixations on objects precede manual reaching and pass visually acquired goal position information to the arm and hand control systems (Land, 2009; Neggers & Bekkering, 2000; Sailer, Flanagan, & Johansson, 2005). Task-specific (goal-directed) eye movements that support the planning and control of manual action are therefore under top-down attentional control and are present throughout action sequences for more complex tasks (Land, 2009).

The development of lightweight head-mounted eyetrackers has meant that the planning and control of visually guided actions can now be undertaken in more natural environments (see Land, 2006, 2009). This research has shown that fixations extract very specific information needed by an ongoing task (Ballard & Hayhoe, 2009). Indeed, there is now general agreement that top-down instructions dominate gaze behavior during the performance of visually guided actions; very little visual information is taken up that is not of immediate use to the task (see Land, 2009, for examples).

For example, driving is a classic example of visually guided behavior in which the eyes move in relation to and just before another action. When driving along a winding road, eye movements and steering are tightly linked; when approaching a bend, the driver looks across to the inside curb (the tangent point) some time before turning the steering wheel (Land & Lee, 1994; Wilson, Stephenson, Chattington, & Marple-Horvat, 2007). Indeed, the degree of coordination and relative timing of the eye movements has been shown to be strongly linked to driving performance in simulated racing (Marple-Horvat et al., 2005; Wilson, Stephenson et al., 2007; Wilson, Chattington, & Marple-Horvat, 2008).

(p. 181) Recent research in laparoscopic surgery environments has also revealed differences in the gaze strategies of experienced and novice operators (Wilson, McGrath, Vine, Brewer, Defriend, & Masters, 2010, 2011). While novices switch their gaze between the tools they are controlling and the target they are aiming for, experienced performers adopt a “target locking” strategy in which they locate tool position using peripheral vision. This is a more skilled visuomotor strategy as it involves the ability to predict the consequences of one's actions and implement mapping rules relating motor and sensory signals (see Sailer et al., 2005).

In sport tasks, it has also been demonstrated that experts tend to use more efficient gaze strategies than nonexperts, focusing on only the information that is most useful to complete the task at hand (see Mann, Williams, Ward, & Janelle, 2007, for a recent meta-analysis on perceptual-cognitive expertise in sport). For example, recent research examining the cues used by cricket batsmen has revealed that, in addition to a capability to pick up advance information from the same cues used by intermediate and low-skilled players, highly skilled players demonstrated the additional, unique capability of picking up advance information from some specific early cues (especially bowling hand and arm cues) to which the less skilled players were not attuned. (e.g., Müller, Abernethy, & Farrow, 2006).

The preceding discussion has identified that gaze strategies are not random and appear to develop in accord with task demands to simplify the planning and control of movement. In outlining how the visual control of action unfolds, Land (2009) has described the role of several distinct but interacting brain systems. First, the gaze system is responsible for locating and fixating (targeting) task-relevant objects. Second, the motor system that controls the limbs carries out the task at hand. Third, the visual system supplies information to the other two systems, providing feedback as to what is being fixated and directional guidance to the motor system. These three systems are subject to joint programming by the *schema system*, a supervisory system mainly located in the DLPFC, which specifies the goals of the current task and then determines the sequence of actions that will achieve these (via attentional pathways). Land (2009) describes the schema as a basic unit of top-down control of action, “a set of instructions that determines where gaze will be directed, what information the visual system will be called upon to provide, and what action will be taken” (p. 53–54).

Land (2009) suggests that the temporal and spatial relationships between gaze fixations and the action they facilitate are of particular interest because they indicate the sequence in which the top-down schema instructions are obeyed and the precision required for their execution. Generally, fixation is close to the site of the action and precedes action by a short interval—approximately 1 second for many tasks (Land, 2009). In the sport-based literature, a particular measure of efficient visual attentional control, the quiet eye (QE; Vickers, 1996) relates explicitly to the spatial and temporal coordination of gaze and motor control. Indeed, the QE offers great potential in answering Land's concluding call to action for future research: “The challenge is now to find out how descending attentional mechanisms control gaze during purposeful action” (p. 61).

The Quiet Eye

The QE has been defined as the final fixation toward a relevant target prior to the execution of the critical phase of movement and has been adopted as a measure of optimal visual attentional control in visuomotor tasks (Vickers, 2007). Seminal work by Vickers (1996) highlighted the importance of the QE fixation in the basketball free throw. Vickers highlighted that expert performers displayed an optimal timing and duration of their final fixation toward the target, prior to the execution of the critical movement. The QE has since been shown to underlie higher levels of skill and performance in a wide range of aiming and interceptive skills, with experts having longer QE durations than nonexperts and successful attempts having longer QE durations than unsuccessful attempts (see Mann et al., 2007; Vickers, 2009, for reviews). The neural mechanisms by which the QE works are yet to be fully understood; however, the QE has been proposed to reflect a critical period of cognitive processing during which the parameters of the movement, such as force, direction, and velocity, are fine-tuned and programmed (Vickers, 1996).

Vickers (1996) used Posner and Raichle's (1994) conceptualization of posterior orienting, anterior executive networks to provide support for her postulations of how the QE may provide optimal attentional control. However, the explanation perhaps resonates more closely with Corbetta and Shulman's (2002) top-down, goal-directed attentional system (or “dorsal attention”; Corbetta et al., 2008). As previously highlighted, this system is important for response or action selection and is involved in linking relevant stimuli to motor planning (Corbetta et al., 2008; Jeannerod, 1997; MacDonald et al., 2000). Theoretically, longer QE periods therefore allow performers an extended duration of response programming, while minimizing distraction from other environmental cues (Vickers, 1996). In the language of Corbetta and colleagues, the QE may help maintain effective goal-driven attentional control, while reducing the impact of the stimulus-driven attentional system. If the predictions of ACT are to be upheld for visuomotor skills, anxiety should disrupt the QE, as the relative emphasis between goal-directed and stimulus-driven attentional control is shifted. The following section discusses contemporary research that has examined the influence of anxiety on the QE.

Performance: The Effect of Competitive Anxiety on the Quiet Eye

Recent research has demonstrated that goal-directed attentional control, as indexed by QE, may be impaired (shorter QE durations) under heightened levels of state anxiety (Behan & Wilson, 2008; Causer, Holmes, Smith, & Williams, 2011a; Vickers & Williams, 2007; Wilson & Vine, 2009; Wilson, Vine, & Wood, 2009; Wilson, Wood, & Vine, 2009; Wood & Wilson, 2010). Both Behan and Wilson (2008) in an archery task, and Wilson, Vine, et al. (2009) in basketball shooting, found that anxiety impaired the ability of participants to maintain goal-directed attention on the relevant target location for long enough to process the critical direction and force information required for successful performance. Quiet eye durations were reduced in the threatening condition as participants made more, shorter duration fixations to locations around the target area. A subsequent drop in performance effectiveness in pressure conditions was evident in both studies. These findings can be explained in terms of the circuit-breaking effect outlined by Corbetta and colleagues and subsequently applied to the influence of anxiety on attentional control by Eysenck et al. (2007). The increased emphasis of the ventral system appears to have disrupted the efficient and quiet focus created by the QE (dorsal attention), making the performers more distractible (see also Causer et al., 2011a).

Although it might be difficult to unpick how internal distractions (worry and negative rumination) influence visual attentional control in these studies, a more explicit test of the predictions of ACT is possible in tasks in which visual distractions are present. For example, Coombes, Higgins, Gamble, Cauraugh, and Janelle (2009) have recently demonstrated that the presence of distracting negative emotional images impairs the attentional control of individuals carrying out a motor task involving goal-directed force contractions. Wilson and Vine (2009), in an extension of their earlier basketball study (Wilson, Vine, et al., 2009) found that anxious participants were more likely to fixate on the ball in their hands during the lift stage of the throw, thus shortening their optimal QE durations.

An aiming task that has been the subject of recent investigation and involves a task-relevant visual distracter is the football (soccer) penalty. This is an interesting task to study from an ACT perspective for a number of reasons. First, anxiety has been shown to be *the* major contributing factor that influences performance failure in soccer penalty shootouts (Jordet, 2009; Jordet, Hartman, Visscher, & Lemmink, 2007). Second, the goalkeeper's actions are the principal source of uncertainty bearing on the shooter's success in achieving his or her goal, in what would otherwise be a straightforward aiming task. Given that the goalkeeper is therefore a threatening external stimulus in this evaluative situation, it is interesting to determine what effect the goalkeeper might have on the penalty taker's attentional control and performance.

Wilson, Wood et al. (2009) attempted to determine how anxiety affected the gaze and aiming behaviors of penalty takers. The results indicated that when anxious, participants were significantly quicker to fixate on the (centrally located) goalkeeper and fixated upon him for longer periods. This anxiety-induced change in gaze behavior led to disruption in aiming behavior, resulting in more centrally hit kicks and more saved shots. These findings are consistent with the predictions of ACT, as anxious individuals showed an attentional bias toward the salient and threatening stimulus (the goalkeeper) at the expense of goal-driven, task-relevant stimuli (the optimal scoring zones just inside the post of the goal).

Wood and Wilson (2010) then further manipulated the saliency of the goalkeeper by asking him to attempt to distract the penalty taker (by waving his arms) under counterbalanced conditions of threat. Results suggested that participants were more distracted by a moving goalkeeper than a stationary one and struggled to disengage from a moving goalkeeper under situations of high threat. Significantly more penalties were saved when the goalkeeper was distracting, and shots were also hit closer to the **(p. 183)** goalkeeper on these trials. The authors concluded that this shift in attentional control toward the “threatening” and distracting goalkeeper was again supportive of the predictions of ACT.

The results from the highlighted research in sport settings suggest that the QE is sensitive to increases in anxiety and may be a useful index of the efficiency of visual attentional control in aiming tasks. Interestingly, Vickers and Williams (2007) found that elite biathletes who increased their QE duration during high-pressure competition, compared to low-pressure practice, were less susceptible to sudden performance disruption or "choking." Vickers and Williams suggested that the act of allocating attention externally to critical task information (via the QE) appeared to insulate athletes from the normally debilitating effects of anxiety. Wilson and colleagues have therefore suggested that QE training programs may be a useful intervention to enhance attentional control in stressful environments (Wilson, 2010). By actively maintaining effective gaze behavior, the negative effects of anxiety on visual attentional control and subsequent performance may be alleviated (Behan & Wilson, 2008).

Implications for Sport Psychologists

A key goal of a consultant sport psychologist is to help performers deal with the emotional and cognitive factors inherent in performing in ego-threatening situations (e.g., Hardy, Jones, & Gould, 1996; Zinsser, Bunker, & Williams, 2006). Eysenck et al. (2007) suggest that the adverse effects of stimulus-driven attentional control can be reduced or eliminated by adopting compensatory strategies. The authors suggest the use of increased task-based effort and processing resources, but don't provide guidance as to how this may work in practice. Applied sport psychology research has outlined the benefit of focusing effort on "controlling the controllables" and maintaining present/process-focused attention in order to cope with the distracting nature of cognitive intrusions (e.g., Mullen & Hardy, 2010; Wilson & Smith, 2007).

Pre-performance routines, consisting of behavioral and cognitive elements, have been proposed as a useful strategy for maintaining concentration and perceptions of control in pressurized environments (Moran, 1996). Singer's five-step strategy, a particular example of a pre-performance routine, has been shown to facilitate learning and performance in a number of laboratory and field studies (see Singer, 2000, 2002). It focuses on creating the conditions for a "just do it" performance state and emphasizes that optimally focused attention is best achieved by selecting one, appropriate external cue. The QE may be seen as part of such a pre-performance routine, helping the performer focus on what he or she can control (an external, process-related cue) rather than on nonproductive (internal) thoughts and emotions (see Wilson & Richards, 2010, for a discussion of how this pre-performance routine might be developed).

Quiet Eye Training

The aim of QE training is to better prepare individuals for dealing with pressure by guiding them to focus on their optimal visual cues for accurate performance. It is therefore important to know what these cues are, and when and how long they should be fixated during the planning and execution of a sport skill. To date, the research examining QE training as a means of dealing with the evaluative threat inherent in sporting competition has focused on aiming tasks, in which there has already been much QE research (e.g., golf, basketball free-throw shooting, and shotgun shooting). This is important as the characteristics of optimal visual attention are well known in these tasks and can be incorporated easily into a pre-shot routine (see Wilson & Richards, 2010).

For example, in golf putting, training would first focus on providing golfers with video feedback of the gaze strategy they currently adopt (using a mobile gaze registration system). Second, they are asked to compare their own strategy to that of an expert video model, adopting effective QE attentional control. Third, the importance of this gaze strategy is reinforced by discussing some of the key elements of effective visuomotor control with the golfer. Finally, the golfer continues to practice the gaze strategy with video feedback and works the process into his or her “normal” pre-putt routine. The important elements to include are that, after they have lined up the putt and imagined a successful outcome, they should direct a final fixation to the back of the ball and maintain this for about a second (for example by saying, “clean contact”) before initiating the backswing of the putter head. The golfer is reminded to maintain this fixation during the putting stroke and to keep it on the green (where the ball was) for half a second after contact (to ensure attention is totally focused on the process of contact and not on the outcome of where the ball goes).

(p. 184) What Mechanisms Underpin Quiet Eye Training?

There are at least four mechanisms through which QE training helps maintain performance under pressure, consisting of both visuomotor control and psychological control elements (see also Vine, Moore, & Wilson, 2011). First, as discussed already, the motor system tends to be more accurate when provided with timely information about targets from the gaze system. Quiet eye training provides “technical” guidance to performers to ensure that their attentional control, gaze control, and motor control are effectively coordinated (see section on Action-Focused Coping). So, for example, in golf putting, by holding a ball-focused QE throughout a putting stroke and through impact, golfers are able to replicate a more accurate contact with the sweet spot of the putter, thus ensuring more consistent ball strike.

Second, the QE may provide the “external focus of attention” described by Wulf and colleagues (see Wulf, 2007) or the “external cue” described in Singer's (2000, 2002) five-step pre-performance routine. Singer advocates focusing on an external cue to prevent athletes from focusing on internal or external distracters, negative thoughts, or the mechanics of skill execution (Singer, 2002). As the stimulus-driven attentional system is more active when performers are anxious (Eysenck et al., 2007), such internal and external distracters are more likely to influence performance under pressure. A further advantage of QE training is that not only is the external *target* of the focus of attention considered, but also its optimal *duration* and *timing* relative to the key movement components of the task (Vine & Wilson, 2010). Linked to this second explanation is the idea that QE training might also act as a form of implicit motor learning (Masters, 1992) when applied to novices. By preventing the generation of explicit rules related to movement control and freeing up attentional resources, QE trained performers are unable to choke via mechanisms related to reinvestment (Wilson, McGrath, & Coleman, 2010). In this way, QE training appears to be supportive of William James’ famous quote relating to attentional control: “Keep your eye at the place aimed at, and your hand will fetch [the target]; think of your hand, and you will likely miss your aim” (James, 1890, p. 520).Third, the QE may also help provide a focus on what is controllable (e.g., maintaining a steady fixation and good contact) rather than what is not (a successful outcome) when performers are under pressure. As competitive anxiety is associated with the outcome uncertainty of a task, it is easy for attention to be involuntarily “attracted” toward such future-related thoughts. However, as highlighted by Derryberry and Reed (2002), individuals can utilize voluntary (anterior system) control of their attention to facilitate the posterior system's capacity to disengage from threatening stimuli. Quiet eye training provides a task-relevant location for attention to engage and can include cue word phrases to reinforce the “in control” nature of the process.

Fourth, QE training may simply help the performer achieve general quiescence of the psychomotor system (i.e., create a more relaxed pre-performance state). Previous research has demonstrated that superior visuomotor performance is reflected in increased psychomotor and neural efficiency (e.g., Janelle & Hatfield 2008; Yarrow, Brown, & Krakauer, 2009). The quiet focus provided by the QE fixation might help pressure performance by providing a moment of calm just prior to and during the performance of motor skills. For example, Singer (2002) also suggested that an external (target) fixation period serves as a means of self-regulation to enter and sustain an optimal attentional state for performing.

Although some areas of overlap exist between the mechanisms highlighted above, subsequent research should attempt to untangle *how* the QE exerts its influence on pressurized performance through these various pathways. Although this has not been achieved to date, there has been growing support for the efficacy of QE training for both novices and experienced performers in evaluative conditions.

Quiet Eye Training: Research Support

Recent research has demonstrated that novices taught basketball free-throw shooting (Vine & Wilson, 2011) and golf-putting (Vine & Wilson, 2010) via a QE training program learn more quickly and have more robust performance under stress than those trained using a traditional “movement-focused” training program. In both these studies, QE-trained novices maintained their QE periods at above optimal threshold levels in a condition designed to increase ego threat. Importantly, these performers also maintained performance at low pressure levels, whereas the movement-trained group performed significantly worse under pressure. The movement-trained group also displayed impaired QE fixations that were below optimal thresholds and significantly lower than their QE-trained counterparts.

(p. 185) Quiet eye training has also recently been shown to protect against stress-related performance effects in more experienced performers who have already developed their idiosyncratic gaze strategies (Causer, Holmes, & Williams, 2011b). For example, a recent study by Vine, Moore, and Wilson (2011) sought to demonstrate if a brief QE training intervention might help to protect low-handicap golfers from the impact of competition pressure. The golfers (average handicap 2.5) were split into two groups and recorded their putting performance over ten rounds before and after coming to the laboratory. One group received an individual 2-hour QE training intervention during this period, whereas the other group only received the gaze feedback of their own gaze behavior. The QE-trained group performed significantly better in a subsequent laboratory-based pressure competition; holing 17% more putts than their competitors. The performance improvements also transferred to the course, with the QE-trained group holing 6% more putts from 6–10 ft and reducing their average number of putts by two per round following training.

A 3-week QE training program has also recently been developed for soccer players to train the penalty kick and was tested by means of an experimental penalty shootout (Wood & Wilson, 2011). The aim of the study was to explore if, by aligning gaze with aiming intention, penalty takers could increase their shooting accuracy. Although other aspects of the penalty shootout scenario are outside the kicker's control, penalties that are struck to the corners of the goal are more likely to score, irrespective of the behaviors and ability of the goalkeeper (Bar-Eli & Azar, 2009). The training did help the QE-trained participants to shoot more accurately than their control group counterparts in a retention test and to maintain their performance under the pressure of a shootout. However, the results were somewhat equivocal as to the benefit of maintaining long, distal aiming fixations, as the control group also maintained performance under pressure, despite having poorer attentional control (Wood & Wilson, 2011).

Action-Focused Coping

The intention of QE training is, therefore, to (re)direct the performer to the critical cues required for successful performance, rather than to focus on dealing with either the emotions or cognitions surrounding the pressure environment (Wilson, 2010). In this way, the approach is mechanisms-driven and focuses on what the performers know they can control. Hanin and Hanina (2009) have also recently suggested that interventions for “performance problems” do not always have to be emotion-focused; that is, designed to help the athlete find (and/or maintain) an optimal performance state in stressful conditions. Instead, action-focused coping is related to technical execution and requires the performer to understand more about how he or she performs well and why things may go wrong under pressure. Specifically, performers self-generate a chain of interrelated task components that they can then rate to determine individual zones for optimal performance. The authors argue that whereas emotion-focused coping directly affects the performer's emotional state, action-focused coping aims to directly optimize the performance process (through technical excellence).

The strength of such an approach is that athletes are tuned into the language of performance data feedback and tend to find the objective nature of such feedback intuitive. Furthermore, some performers will find the technical focus to be less negatively charged and threatening than discussing emotional concerns underlying their choking experiences. A concern with the technique-focused nature of action-focused coping is that by building the athlete's knowledge base of the movements underlying performance, the propensity to reinvest in this knowledge under pressure is increased (Masters, 1992; Masters & Maxwell, 2008). A specific advantage of gaze-related action-focused coping is that it may actually prevent reinvestment and act as a form of implicit motor learning (Wilson, McGrath, & Coleman, 2010).

Training with Anxiety

Another interesting approach to dealing with the attentional disruptions caused by increased anxiety has been outlined by Raul Oudejans and colleagues (Nieuwenhuys & Oudejans, 2010; Oudejans, 2008; Oudejans & Nieuwenhuys, 2009; Oudejans & Pijpers, 2009, 2010). These authors have demonstrated that training *with* anxiety can lead to improved performance under future stressful circumstances (see also Baumeister, 1984; Beilock & Carr, 2001, for discussions of *acclimatization training*). For example, in Oudejans and Pijpers' (2009) study, performers practiced perceptual-motor tasks (basketball free-throw shooting and dart throwing) with or without induced anxiety. Only after training with anxiety did performance no longer deteriorate during a pressurized transfer test, despite these performers experiencing similar elevated levels (p. 186) of anxiety, heart rate, and perceived effort to their control group counterparts. The authors concluded that practising under anxiety can prevent choking in expert perceptual-motor performance, as one acclimatizes to the specific processes accompanying anxiety.

Oudejans and colleagues have also applied this training protocol outside of sport, to police officers using firearms (Oudejans, 2008; Nieuwenhuys & Oudejans, 2010). For example, Oudejans (2008) found that police officers' shooting accuracy decreased significantly when they performed in stressful conditions, in which opponents shot back using colored soap cartridges. However, police officers who practiced handgun shooting with high levels of anxiety (against the opponent) performed better at this task after training compared to a control group who practiced with low anxiety (on cardboard targets).

In explaining these effects, Oudejans and Nieuwenhuys (2009) suggested that performers who train with anxiety may invest their increased mental effort more efficiently and effectively (as hypothesized by Eysenck and colleagues' processing efficiency theory and attentional control theory). Individuals who have not trained with anxiety still invest increased effort when anxious, but this is done less effectively and may not be directed to the right (goal-directed) targets or processes. The benefit of training with anxiety is, therefore, explicitly related to attentional control and a more effective and efficient use of limited visual attentional resources.

Conclusion

Research from cognitive psychology and neuroscience has implicated attentional mechanisms as mediating the anxiety–performance relationship. Although much of this research has examined the impact of trait (dispositional) anxiety on visual attention and cognitive task performance (see Pachego-Unguettit et al., 2010, for a discussion), there are still clear implications for sport, where the impact of state anxiety appears to be more relevant. As Janelle (2002) highlights, "Given the heavy reliance on visual input for decision making and response planning in sport tasks, logical questions concern whether and how visual attention is modified under increased anxiety” (p. 237). However, little research has tried to answer these questions. The chapter discussed contemporary research examining sport skills that has examined how the QE (an objective measure of visual attention) might be impaired when performers are anxious. It finished with a discussion of training programs that may help performers maintain this optimal attentional control even when they are anxious.

The approach of intervening by focusing upon the athlete's ability to control certain aspects of his or her active motor preparation (e.g., QE) in order to limit the disruptive effects of anxiety is a new one in sport psychology. Traditional anxiety-reduction interventions have typically focused on arousal reduction (e.g., relaxation) and cognitive control (e.g., positive self-talk) strategies. This attentional approach to anxiety coping may represent a major breakthrough in the applied sport psychology area, and certainly this paradigm-changing approach is deserving of greater applied and outcome-based research.

Future Directions

- More research is required to understand the mechanisms of effective visuomotor control and how these may be impaired under pressure for a variety of sport tasks. How exactly does maintaining a longer QE help performance under pressure?
- Whereas aiming skills are the easiest to assess from a gaze control perspective, other sport skills requiring decision-making would potentially be a useful avenue for inquiry (e.g., Raab & Johnson, 2007).
- Other performance arenas where visuomotor control is required under pressure are also ripe for examination. Experts from movement science have already started to apply knowledge gained in sport settings to military (Janelle & Hatfield, 2008), police (Oudejans, 2008), and surgical (Wilson, McGrath, & Coleman, 2010) environments, as alluded to in previous sections. For example, Wilson and colleagues have recently demonstrated that novice surgeons following a gaze training intervention were better able to perform a laparoscopic task under stressful, multitasking conditions than were surgeons trained using a technical (explicit motor learning) or discovery learning approach (Wilson et al., 2011).
- Dispositional mediators of the anxiety–performance relationship have probably been under-represented in the sport/performance literature (whereas in most other domains these trait differences in attentional control have received most attention). Individual differences in executive processes may be important for an understanding of the development and maintenance of negative (p. 187) emotional states (Eysenck & Derakshan, 2011). In the sport-based literature Masters and colleagues have examined the influence of trait reinvestment on performance under pressure (see Masters, this book). However, do some individuals have genetic advantages in terms of executive attentional control (see Emes, Vickers, & Livingston, 1994; Rothbart et al., 2007)? Might these advantages be determined early through measures of visual attentional control (e.g., QE)?

- Both QE-based training and acclimatization training have been shown to be effective in protecting performance against choking by changing the effectiveness of attentional control. More research is required testing these interventions, and perhaps a combined approach might lead to even stronger effects.

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References

Baddeley, A. D. (1986). *Working memory*. Oxford, UK: Clarendon Press.

Baddeley, A. D. (2001). Is working memory still working? *American Psychologist, 56*, 851–864.

Bale, T. L., & Vale, W. W. (2004). CRF and CRF receptors: Role in stress responsivity and other behaviours. *Annual Review of Pharmacological Toxicology, 44*, 525–557.

Ballard, D. H., & Hayhoe, M. M. (2009). Modelling the role of task in the control of gaze. *Visual Cognition, 17*, 1185–1204.

Bar-Eli, M., & Azar, O. H. (2009). Penalty kicks in soccer: An empirical analysis of shooting strategies and goalkeepers' preferences. *Soccer and Society, 10*, 183–191.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*, 1–24.

Baumeister, R. F. (1984). Choking under pressure: Self-consciousness and paradoxical effects of incentives on skillful performance. *Journal of Personality and Social Psychology, 46*, 610–620.

Baumeister, R. F., & Showers, C. J. (1986). A review of paradoxical performance effects: Choking under pressure in sports and mental tests. *European Journal of Social Psychology,16*, 361–383.

Beattie, S., & Davies, M. (2010). A test of engagement versus disengagement in catastrophe models. *British Journal of Psychology, 101*, 361–371.

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 Sports Sciences, 26*, 207–215.

Beilock, S. L., & Carr, T. H. (2001). On the fragility of skilled performance: What governs choking under pressure? *Journal of Experimental Psychology, 130*, 701–725.

Beilock, S. L., & Gray, R. (2007). Why do athletes choke under pressure? In G. Tenenbaum & R. C. Eklund. (Eds.), *Handbook of sports psychology* (3rd ed., pp. 425–444). Hoboken, NJ: Wiley & Sons.

Bishop S. J. (2007). Neurocognitive mechanisms of anxiety: An integrative account. *Trends in Cognitive Sciences, 11*, 307–316.

Bishop, S. J. (2008). Neural mechanisms underlying selective attention to threat. *Annals of New York Academy of Sciences, 1129*, 141–152.

Bishop, S. J. (2009). Trait anxiety and impoverished prefrontal control of attention. *Nature Neuroscience, 12*, 92–98.

Bishop, S. J., Duncan, J., & Lawrence, A. D. (2004). State anxiety modulation of the amygdala response to unattended threat-related stimuli. *Journal of Neuroscience, 24*, 10364–10368.

Carver, C. S., & Scheier, M. F. (1988). A control-process perspective on anxiety. *Anxiety Research, 1*, 17–22.

Causer, J., Holmes, P. S., Smith, N. C., & Williams, A. M. (2011a). Anxiety, movement kinematics, and visual attention in elite-level performers. *Emotion*, *11*, 595–602,

Causer, J., Holmes, P. S., & Williams, A. M. (2011b). 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: Rational and initial measurement development. *Psychology of Sport and Exercise, 10*, 271–278.

Clark, T. P., Tofler, I. R., & Lardon, M. T. (2005). The sport psychiatrist and golf. *Clinics in Sports Medicine, 24*, 959–971.

Coombes, S. A., Higgins, T., Gamble, K. M., Cauraugh, J. H., & Janelle, C. M. (2009). Attentional control theory: Anxiety, emotion, and motor planning. *Journal of Anxiety Disorders*, *23*, 1072–1079.

Corbetta, M. (1998). Frontoparietal cortical networks for directing attention and the eye to visual locations: Identical, independent, or overlapping. *Proceedings of the National Academy of Sciences, 95*, 831–838.

Corbetta, M., Patel, G., & Schulman, G. L. (2008). The reorienting system of the human brain: From environment to theory of mind. *Neuron, 58*, 306–324.

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

Derakshan, N., & Eysenck, M. W. (2009). Anxiety, processing efficiency, and cognitive performance: New developments from attentional control theory. *European Psychologist, 14*, 168–176.

Derryberry, D., & Reed, M. A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Psychology, 111*, 225–236.

(p. 188) Duncan, J. (2006). EPS mid-career award 2004: Brain mechanisms of attention. *Quarterly Journal of Experimental Psychology, 59*, 2–27.

Edwards, T., Kingston, K., Hardy, L., & Gould, D. (2002). A qualitative analysis of catastrophic performances and the associated thoughts, feelings and emotions. *The Sport Psychologist, 16*, 1–19.

Emes, C., Vickers, J. N., & Livingston, L. (1994). Gaze control of children with high versus low motor proficiency. *Adapted physical activity* (pp. 147–154). Tokyo: Springer-Verlag.

Eysenck, M. W. (1992). *Anxiety: The cognitive perspective*. Hove, UK: Lawrence Erlbaum.

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

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

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

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*, 45–59.

Gucciardi, D. F., Longbottom, J. L., Jackson, B., & Dimmock, J. A. (2010). Experienced golfers' perspectives on choking under pressure. *Journal of Sport and Exercise Psychology, 32*, 61–83.

Hanin, Y., & Hanina, M. (2009). Optimization of performance in top-level athletes: An action-focused coping approach. *International Journal of Sports Science and Coaching, 4*, 47–58.

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

Hanton, S., Thomas, O., & Mellalieu, S. D. (2009). Management of competitive stress in elite sport. In B.W. Brewer (Ed.) *The Olympic handbook of sports medicine and science: Sport psychology* (pp. 30–42). Oxford, UK: Wiley-Blackwell.

Hardy, L. (1996). A test of catastrophe models of anxiety and sport performance against multidimensional anxiety theory models using the method of dynamic differences. *Anxiety, Stress, and Coping, 9*, 69–86.

Hardy, L., Beattie, S., & Woodman, T. (2007). Anxiety-induced performance catastrophes: Investigating effort required as an asymmetry factor. *British Journal of Psychology, 98*, 15–31.

Hardy, L., Jones, G. & Gould, D. (1996). *Understanding psychological preparation for sport*. Chichester, UK: Wiley.

Henderson, J. M. (2003). Human gaze control during real-world scene perception. *Trends in Cognitive Science, 7*, 498–504.

Hill, D. M., Hanton, S., Matthews, N., & Fleming, S. (2010). Choking in sport: A review. *International Review of Sport and Exercise Psychology, 3*, 24–39.

James, W. (1890). *Principles of psychology*. New York: Holt.

Janelle, C. M. (2002). Anxiety, arousal and visual attention: A mechanistic account of performance variability. *Journal of Sports Sciences, 20*, 237–251.

Janelle, C. M., & Hatfield, B. (2008). Visual attention and brain processes that underlie expert performance: Implications for sport and military psychology. *Military Psychology, 20*, 117–134.

Jeannerod, M. (1997). *The cognitive neuroscience of action*. Cambridge, MA: Blackwell.

Jones, G. (1991). Recent issues in competitive state anxiety research. *The Psychologist, 4*, 152–155.

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

Jordet, G. (2009). Why do English players fail in soccer penalty shootouts? A study of team status, self-regulation, and choking under pressure. *Journal of Sports Sciences, 27*, 97–106.

Jordet, G., Hartman, E., Visscher, C., & Lemmink, K. A. P. M. (2007). Kicks from the penalty mark in soccer: The roles of stress, skill, and fatigue for kick outcomes. *Journal of Sports Sciences*, *25*, 121–129.

Keogh, E., & French, C. C. (2001). Test anxiety, evaluative stress, and susceptibility to distraction from threat. *European Journal of Personality, 15*, 123–141.

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

Land, M. F. (2006). Eye movements and the control of actions in everyday life. *Progress in Retinal and Eye Research, 25*, 296–324.

Land, M. F. (2009). Vision, eye movements, and natural behavior. *Visual Neuroscience, 26*, 51–62.

Land, M. F., & Lee, D. N. (1994). Where we look when we steer. *Nature, 369*, 742–744.

Lazarus, R. S. (2000). Cognitive-motivational-relational theory of emotion. In Y. Hanin (Ed.), *Emotions in sport* (pp. 39–63). Champaign, IL: Human Kinetics.

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

Lewis, B. P., & Linder, D. E. (1997). Thinking about choking? Attentional processes and paradoxical performance. *Personality and Social Psychology Bulletin*, *23*, 937–944.

MacDonald, A. W., III, Cohen, J. D., Stenger, V. A., & Carter, C. S. (2000). Dissociating the role of the dorsolateral prefrontal and anterior cingulate cortex in cognitive control. *Science, 288*, 1835–1838.

Mann, D. T. Y., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta analysis. *Journal of Sport and Exercise Psychology, 29*, 457–478.

Marple-Horvat, D. E., Chattington, M., Anglesea, M., Ashford, D. G., Wilson, M., & Keil, D. (2005). Prevention of coordinated eye movements and steering impairs driving performance. *Experimental Brain Research, 163*, 411–420.

Masters, R. S. W. (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*, 343–358.

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

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*, 49–100.

Mogg, K., & Bradley, B. P. (1999). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy, 36*, 809–848.

Moran, A. P. (1996). *The psychology of concentration in sports performers: A cognitive analysis*. Hove, UK: Psychology Press.

(p. 189) Moran, A. P. (2009). Cognitive psychology in sport: Progress and prospects. *Psychology of Sport and Exercise, 10*, 420–426.

Mullen, R., & Hardy, L. (2000). State anxiety and motor performance: Testing the conscious processing hypothesis. *Journal of Sports Sciences, 18*, 785–799.

Mullen, R., & Hardy, L. (2010). Conscious processing and the process goal paradox. *Journal of Sport and Exercise Psychology, 32*, 275–297.

Müller, S., Abernethy, B., & Farrow, D. (2006). How do world-class cricket batsmen anticipate a bowler's intention? *The Quarterly Journal of Experimental Psychology, 59*, 2162–2186.

Neggers, S. F., & Bekkering, H. (2000). Coordinated control of eye and hand movements in dynamic reaching. *Human Movement Science, 21*, 349–376.

Nieuwenhuys, A., & Oudejans, R. R. D. (2010). Effects of anxiety on handgun shooting behavior of police officers: A pilot study. *Anxiety, Stress and Coping, 23*, 225–233.

Ohman, A. (2000). Fear and anxiety: Evolutionary, cognitive and clinical perspectives. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed., pp. 573–593). New York: Guilford Press.

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

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

Oudejans, R. R. D., & Nieuwenhuys, A. (2009). Perceiving and moving in sports and other high pressure contexts. *Progress in Brain Research, 174*, 35–48.

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

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.

Pachego-Unguettit, A. P., Acosta, A., Callejas, A., &, Lapianez, J. (2010). Attention and anxiety: Different attentional functioning under state and trait anxiety. *Psychological Science, 21*, 298–304.

Petrides, M. (2005). Lateral prefrontal cortex: Architectonic and functional organization. *Philosophical Transactions of the Royal Society B, 360*, 781–795.

Phelps, E. (2006). Emotion and cognition: Insights from studies of human amygdala. *Annual Review of Psychology, 57*, 27–53.

Posner, M. I., & Raichle, M. E. (1994). *Images of mind*. New York: Scientific American Library.

Raab, M., & Johnson, J. (2007). Option-generation and resulting choices. *Journal of Experimental Psychology: Applied, 13*, 158–170.

Raglin, J. S., & Hanin, Y. L. (2000). Competitive anxiety. In Y. Hanin (Ed.), *Emotions in sport* (pp. 93–112). Champaign, IL: Human Kinetics.

Rothbart, M. K., Sheese, B. E., & Posner, M. I. (2007). Executive attention and effortful control: Linking temperament, brain networks and genes. *Child Development Perspectives, 1*, 2–7.

Sailer, U., Flanagan, J. R., & Johansson, R. S. (2005). Eye-hand coordination during learning of a novel visuomotor task. *Journal of Neuroscience, 25*, 8833–8842.

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

Shinoda, H., Hayhoe, M. M., & Shrivastava, A. (2001). What controls attention in natural environments? *Vision Research, 41*, 3535–3545.

Shipp, S. (2004). The brain circuitry of attention. *Trends in Cognitive Science, 8*, 223–230.

Singer, R. N. (2000). Performance and human factors: Considerations about cognition and attention for self-paced and externally-paced events. *Ergonomics, 43*, 1661–1680.

Singer, R. N. (2002). Preperformance state, Routines and automaticity: What does it take to realise expertise in self paced events? *Journal of Sport and Exercise Psychology, 24*, 359–375.

Spielberger, C. D. (1983). *Manual for the State Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Stöber, J., & Pekrun, R. (2004). Advances in test anxiety research (Editorial). *Anxiety, Stress, and Coping, 17*, 205–211.

Swanson, L. W., & Petrovich, G. D. (1998). What is the amygdala? *Trends in Neuroscience, 21*, 323–331.

Syed, M. (2010). *Bounce: How champions are made*. London: Fourth Estate.

Tenenbaum, G., & Becker, B. (2005). Is self-confidence a bias factor in higher-order catastrophe models? An exploratory analysis—A critique. *Journal of Sport and Exercise Psychology, 27*, 375–381.

Vickers, J. N. (1996). Visual control when aiming at a far target. *Journal of Experimental Psychology: Human Perception and Performance, 2*, 324–354.

Vickers, J. N. (2007). *Perception, cognition and decision training: The quiet eye in action*. Champaign IL: Human Kinetics.

Vickers, J. N. (2009). Advances in coupling perception and action: The quiet eye as a bidirectional link between gaze, attention, and action. *Progress in Brain Research*, *174*, 279–288.

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 Behavior, 39*, 381–394.

Vine, S. J., & Wilson, M. R. (2010). Quiet eye training: Effects on learning and performance under pressure. *Journal of Applied Sport Psychology, 22*, 361–376.

Vine, S. J., & Wilson, M. R. (2011). The influence of Quiet Eye training and pressure on attentional control in a visuo-motor task. *Acta Psychologica, 136*, 340–346.

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

Weierich, M. R., Treat, T. A., & Hollingworth, A. (2008). Theories and measurement of visual attentional processing in anxiety. *Cognition and Emotion, 22*, 985–1018.

Weinberg, R. S., & Gould, D. (2007). *Foundations of sport and exercise psychology* (4th ed.). Champaign, IL: Human Kinetics.

Weissman, D. H., Perkins, A. S., & Woldorff, M. G. (2008). Cognitive control in social situations: A role for the dorsolateral prefrontal cortex. *Neuroimage, 40*, 955–962.

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

Wilson, M. (2010). Gaze and cognitive control in motor performance: Implications for skill training. *The Sport and Exercise Scientist, 23*, 29–30.

Wilson, M., Chattington, M., & Marple-Horvat, D. E. (2008). Eye movements drive steering: The effect of reduced eye (p. 190) movement distribution on steering and driving performance. *Journal of Motor Behavior, 40*, 190–202.

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*, 439–456.

Wilson, M., McGrath, J., & Coleman, M. (2010). Developing basic eye-hand coordination skills for laparoscopic surgery using gaze training. *British Journal of Urology—International, 105*, 1356–1358.

Wilson, M., & Smith, N. C. (2007). A test of the predictions of processing efficiency theory during elite team competition using the Thought Occurrence Questionnaire for Sport. *International Journal of Sport Psychology, 38*, 245–262.

Wilson, M., Stephenson, S., Chattington, M., & Marple-Horvat, D. E. (2007). Eye movements coordinated with steering benefit performance even when vision is denied. *Experimental Brain Research*, 176, 397–412.

Wilson, M. R., McGrath, J., Vine, S. J., Brewer, J., Defriend, D., & Masters, R. S. W. (2010). Psychomotor control in a virtual laparoscopic surgery training environment: Gaze control parameters differentiate novices from experts. *Surgical Endoscopy*, *24*, 2458–2464.

Wilson, M. R., McGrath, J. S., Vine, S. J., Brewer, J., Defriend, D., & Masters, R. S. W. (2011). Perceptual impairment and visuomotor control in virtual laparoscopic surgery. *Surgical Endoscopy*, *25*, 2268–2274.

Wilson, M. R., & Richards, H. (2010). Putting it together: Skills for pressure performance. In D. Collins, A. Button, & H. Richards (Eds.), *Performance psychology* (pp. 333–356). Edinburgh, UK: Elsevier.

Wilson, M. R., & Vine, S. J. (2009). Performing under pressure: Attentional control and the suppression of vision in basketball free-throw shooting. In C. H. Chang (Ed.), *Handbook of sports psychology* (pp. 277–296). Hauppauge, NY: Nova Science.

Wilson, M. R., Vine, S. J., Bright, E., Defriend, D., Masters, R. S. W., & McGrath, J. S. (2011). Gaze training enhances laparoscopic technical skill acquisition and multi-tasking performance: A randomized controlled study. *Surgical Endoscopy*. *25*, 3731–3739.

Wilson, M. R., 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*, 152–168.

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

Wine, J. (1971). Test anxiety and direction of attention. *Psychological Bulletin*, *76*, 92–104.

Wood, G., & Wilson, M. R. (2010). Goalkeeper distractions increase the likelihood of missing a penalty kick. *Journal of Sports Sciences, 28*, 937–946.

Wood, G., & Wilson, M. R. (2011). Quiet Eye training for soccer penalty kicks. *Cognitive Processing*, *12*, 257–266.

Woodman, T., & Hardy, L. (2001). Stress and anxiety. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (pp. 127–170). New York: Wiley.

Wulf, G. (2007). *Attention and motor skill learning*. Champaign, IL: Human Kinematics.

Yarrow, K., Brown, P., & Krakauer, J. W. (2009). Inside the brain of an elite athlete: The neural processes that support high achievement in sports. *Nature Reviews Neuroscience, 10*, 585–596.

Yiend, J. (2008). The effects of emotion on attention: A review of attentional processing of emotional information. *Cognition and Emotion, 24*, 3–47.

Zinsser, N., Bunker, L. K., & Williams, J. M. (2006). Cognitive techniques for improving performance and building confidence. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (5th ed., pp. 349–381). Mountain View, CA: Mayfield.

Notes:

(1.) Note the similarity to the anterior/executive (voluntary) and posterior (involuntary) attentional systems described in Posner and Raichle's (1994) model, discussed earlier.

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