

A moving goalkeeper distracts penalty takers and impairs shooting accuracy

GREG WOOD & MARK R. WILSON

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

(Accepted 1 May 2010)

Abstract

When facing penalty kicks in football (soccer), goalkeepers frequently incorporate strategies that are designed to distract the kicker. However, no direct empirical evidence exists to ascertain what effect such visual distractions have on the attentional control, and performance, of footballers. Eighteen experienced footballers took five penalty kicks under counterbalanced conditions of threat (low vs. high) and goalkeeper movement (stationary vs. waving arms) while wearing eye-tracking equipment. 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 on trials when the goalkeeper was moving and shots were also generally hit closer to the goalkeeper (centrally) on these trials. The results provide partial support for the predictions of attentional control theory and implications for kickers and goalkeepers are discussed.

Keywords: *Anxiety, football, soccer, attentional control, penalty kicks, quiet eye*

Introduction

The biggest memory I have is the 1984 European Cup final against Roma and my ‘spaghetti legs’ routine during the penalty shoot-out that won us the trophy. People said I was being disrespectful to their players, but I was just testing their concentration under pressure. I guess they failed that test.

Bruce Grobbelaar, Former Liverpool F.C.
Goalkeeper (in Jackson, 2005)

The outcome of important football matches is often decided by penalty kicks and the frequency of these tie-break scenarios has increased since their first introduction in 1974 (Armatas, Yiannakos, Papadopoulou, & Galazoulas, 2007; Miller, 1996). Due to this increase, and the financial incentives for success in today’s professional game, players strive to gain any advantage when taking part in such events. In particular, goalkeepers frequently incorporate strategies that are designed to disrupt, delay or distract the kicker during the preparation and execution of the kick. In one recent study, Jordet, Hartman, and Sigmundstad (2009) found that players that were delayed from taking their penalty kick, often by the goalkeeper, were more likely to miss. However, to

date, no empirical evidence exists to ascertain what effect distractions have on the visual attention and performance of footballers taking penalty kicks under pressure.

Research from general psychology would suggest that distracters have a detrimental impact upon cognitive performance, particularly in highly pressurised environments (Eysenck, Derakshan, Santos, & Calvo, 2007). Additionally, there is a strong body of evidence which shows that anxiety is associated with: (a) an attentional bias towards, and an inability to “disengage” from, the processing of threat-related distracters; and (b) an enhanced distractibility in the presence of task-irrelevant threatening stimuli (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007, for a review). Attentional Control Theory (ACT: Eysenck et al., 2007) attempts to encompass these attentional disruptions into a unified framework. ACT’s primary assumption is that attentional control is characterised by two attentional systems: top-down, goal-driven attentional control, influenced by current goals, expectations and knowledge; and bottom-up, stimulus driven attentional control, influenced by salient or conspicuous stimuli (Corbetta & Shulman, 2002). 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 driven system; especially in the presence of threat-related distracting stimuli (Eysenck et al., 2007; Eysenck & Derakshan, in press).

In a recent study, Wilson, Wood, and Vine (2009) explored whether the predictions of ACT could explain why anxiety may have a negative impact on the performance of footballers taking modified (five-a-side) penalty kicks, which incorporate smaller goals and a single-step run-up. By utilising eye-tracking technology, the gaze behaviour of kickers was analysed under counterbalanced conditions of threat. Results suggested that when anxious, participants made earlier and longer fixations to the goalkeeper. These findings are consistent with the predictions of ACT as anxious individuals showed an attentional bias towards 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).

Wilson, Wood et al., (2009) also found that this anxiety-induced disruption to attentional control brought about significant decreases in shooting accuracy. Specifically, the participants' centralised gaze also produced shots that were hit significantly closer to the goalkeeper (see also Bakker, Oudejans, Binsch, & van der Kamp, 2006; Binsch, Oudejans, Bakker, & Savelsbergh, 2010). These findings have led researchers to suggest that, in order to hit an accurate penalty kick, players should align gaze with aiming intention (Bakker et al., 2006; van der Kamp, 2006; Wilson, Wood et al., 2009; Wood & Wilson, in press). Indeed, neuroscience researchers have suggested that the neural mechanisms regulating goal-directed movements profit from the accurate and timely spatial information of the foveated target (Land, 2009; Neggers & Bekkering, 2000).

If, as suggested by ACT, an anxious performer is more easily distracted by threat-related task-irrelevant stimuli, then task-relevant information necessary for accurate shooting will be unavailable for the planning of responsive motor actions, and performance may breakdown (see Wilson, Vine, & Wood, 2009). Therefore, from a goalkeeper's perspective, distracting a kicker's attention may have real benefits in increasing the likelihood of an inaccurate shot. Furthermore, according to ACT, the effectiveness of such distractions is likely to be more pronounced under pressurised situations such as penalty kicks. However, in previous studies examining the gaze behaviour of football penalty takers researchers have adopted a modified task, incorporating only a one-step run-up (Bakker et al., 2006; Binsch et al., 2010; Nagano, Kato, & Fukuda, 2006; Wilson, Wood et al., 2009), and consequently, it is difficult to

determine if the distracting effect is most pronounced during the aiming phase or during the execution phase (i.e. run-up). The aim of this study was therefore to explore the effectiveness of goalkeeper movements in distracting penalty takers under pressure.

During the aiming phase, and in line with the predictions of ACT and Wilson, Wood et al. (2009), it was hypothesised that anxious participants would fixate on a moving goalkeeper more often (increased distractibility) and for a longer duration (disengage more slowly) than to a stationary goalkeeper. This disruption in attentional control should produce shots that are hit closer to the goalkeeper (as Bakker et al., 2006; Wilson, Wood et al., 2009).

Predictions regarding the attentional control of shooters during the run-up are somewhat exploratory, but it is expected that participants will fixate on the ball in order to ensure an accurate contact. Such visual behaviours are indicative of superior performance in tasks with two abstract targets (e.g. ice hockey shooting; Vickers, 2007; and golf putting; Vickers, 1992; Wilson & Pearcey, 2009). As well as the location of the last fixation, its duration (Quiet-eye; QE) has been shown to be important in a variety of aiming-based tasks, and can be negatively impacted (i.e. reduced) by anxiety (Vickers, 2007; Wilson, 2008). It was therefore hypothesised that during the execution phase (i.e. the run-up), participants would fixate predominantly on the ball, but the total time spent looking at the ball and the duration of the last fixation on the ball was expected to shorten under conditions of threat and goalkeeper movement.

Methods

Participants

Eighteen university footballers (mean age = 20.2 yrs, $s = 0.8$) volunteered to take part. All had experience of playing competitive football (mean years = 9.9, $s = 3.2$) and rated their penalty kicking ability to range from 5 to 8 (mean rating = 6.2, $s = 0.9$) on a scale of 0 to 10. A local ethics committee approved the study before any testing was carried out and written consent was obtained from all participants prior to the commencement of any procedures.

Apparatus

A standard, full-sized (7.32 m wide \times 2.44 m wide), football goal was marked on a wall and participants shot penalty kicks from the standard distance of 11 meters from its centre. The goal was split into 12 \times 4, 61 cm squares to aid the rating of performance error. Gym mats (32 mm) covered the goal area to prevent

injury to the goalkeeper when repeatedly diving (Figure 1). A standard size 5 Nike Duravel football of standard inflation was used throughout all trials. Participants were fitted with an Applied Science Laboratories (ASL; Bedford, MA, USA) Mobile Eye tracker, which measures eye-line of gaze at 25 Hz, with respect to eye and scene cameras, mounted on a pair of glasses.

The system incorporates a recording device (a modified DVCR) worn in a pouch around the waist and a laptop (Dell inspiron6400) with "Eyevision" recording software installed. A circular cursor, representing 1° of visual angle with a 4.5-mm lens, indicating the location of gaze in a video image of the scene (spatial accuracy of $\pm 0.5^\circ$ visual angle; 0.1° precision) is recorded for offline analysis. This system was calibrated for each participant using a firewire cable connected to the laptop. When calibrated, the firewire cable was removed allowing the eye tracker, and participant, to be fully mobile. Data were saved to DV tape on the DVCR and downloaded to the laptop for offline analysis.

Measures

State anxiety. The anxiety thermometer was used to assess the self-reported levels of state anxiety experienced by the participants in the low- and high-threat conditions (Houtman & Bakker, 1989). This 10 cm scale ranges from 0 (not at all anxious) to 10 (extremely anxious) and was chosen because it offers a rapid assessment of state anxiety, unlike more popular self-reported anxiety measures (e.g. CSAI-2; Martens, Burton, Vealey, Bump, & Smith, 1990). Furthermore, this inventory does appear to correlate with cognitive and somatic anxiety reported

on the CSAI-2, with coefficients of 0.59 and 0.62, respectively, and has been used in other studies that have explored anxiety's effect on attentional control (Nieuwenhuys, Pijpers, Oudejans, & Bakker, 2008).

Performance. In order to minimise the influence of goalkeeper performance on results, a measure of target accuracy was adopted in conjunction with totalling the number of saved and missed shots. Target accuracy was measured depending on where on the goal the ball hit, with this location being given a horizontal (\times) coordinate (as Wilson, Wood et al., 2009). Each half of the goal consisted of 6 zones of 61 cm, starting from an "origin" in the centre (0 cm) and moving out to 366 cm at each post. Higher scores therefore reflected shots that were placed further from the goalkeeper's reach where they would have more chance of scoring. The coordinate was determined via frame-by-frame analysis of the eye-tracker video file using GazeTracker analysis software (Eye Response Technologies, VA, USA) with a precision of 5 cm (approximately, one quarter the diameter of the ball). Shots that missed the target were not given an accuracy score. Shots that were saved were given an estimated accuracy score reflecting where they were predicted to hit on the goal area. Estimates of shooting accuracy from a sample of 40 shots (8 saves and 32 goals) had an inter-rater reliability of 98.3%.

Pre-shot duration. The time taken to prepare and execute the shot (trial duration) was calculated in seconds, via frame-by-frame analysis. Trial onset began the instant the kicker took his hands away from the ball, after placing it on the penalty spot, and ended on foot to ball contact. The "aiming phase" of the penalty kick began when the participant made his first target-focused fixation (goalkeeper or goal) and ended when the "execution phase" began on the initiation of the run-up.

Total number of fixations. This measure was designed to reflect the distractibility of the participants between the relevant target locations (goalkeeper, goal, and ball). More fixations to any one area may highlight heightened distractibility to that area of the visual workspace (Wilson et al., 2009). The total number of fixations was calculated separately for both the aiming (prior to run-up) and execution (run-up) phases of each kick.

Total viewing time. This is a measure of the total (cumulative) amount of time (milliseconds) spent fixating at each target location, in each trial. This measure was designed to reflect attentional disengagement; the extent to which attention was grabbed and maintained by each location. Total viewing time



Figure 1. A screen grab from the Gazetracker software environment showing the experimental setup and each 'LookZone' for the goalkeeper (A; in the distraction process), goal (B) and ball (C).

to each location was calculated separately for both the aiming (prior to run-up) and execution (run-up) phases of each kick.

Last fixation duration on the ball. This measure was designed to reflect the quiet eye period for the penalty kick and was defined as the duration (in milliseconds) of the last fixation on the ball prior to foot-to-ball contact. The ball was chosen because such visual behaviour is apparent in aiming tasks that incorporate shooting to abstract targets (see Vickers, 2007).

Experimental conditions

Participants took 10 practice kicks to the goal with no goalkeeper present to prevent any prior learning from both parties. They then took five kicks under low- and high-threat counterbalanced conditions, in a repeated measures research design. In the low-threat condition, non-evaluative instructions were provided to participants, asking them to do their best but stressing that the research was testing the reliability of the eye tracker. In the high-threat condition, participants were made aware of a £50 prize for the kicker with the highest accumulated score and were told that a league table with each participants name and score would be circulated between all participants.

The instructions to the goalkeeper were that he was not to move along his goal line or make an attempt to anticipate ball direction until each shot was struck. On kicks 1, 3, and 4 in each threat condition the goalkeeper was asked to stand directly in the centre of the goal, with knees bent and arms by his side (i.e. stationary). These variables were standardised as previous research has shown that they may affect shooting performance in this task (Masters, van der Kamp, & Jackson, 2007; van der Kamp & Masters, 2008). For the “moving” goalkeeper manipulation, he was asked to wave his arms up and down during the pre-shot duration on shots 2 and 5 in each threat condition (see Figure 1).

Procedure

Participants attended individually and, after giving their written consent, were told that the aim of the study was to compare kicking performance under different conditions. After taking their practice kicks, the participants were fitted with the eye tracker and this was calibrated using each corner of the goal, the centre of the goal, and three other points that were marked above each post and centre of the goal.

Participants were then provided with instructions related to the condition in which they were going to

perform, and subsequently completed the anxiety thermometer before taking three of the five penalty kicks for that condition. In the threat condition, after these initial three kicks participants were told that the kicks they had just taken were worth one point. They were then told that their remaining two kicks would be worth three points each and if they were to win the prize money, it was important to score at least one of these kicks. This information was incorporated to re-affirm the anxiety manipulation which was expected to diminish over repeated trials. The relevant instructions were then re-iterated and the anxiety thermometer completed again before the final two kicks were taken in both low- and high-threat conditions. Before each kick participants stood on the penalty spot, with ball in hand, and a calibration check was performed.

Data analysis

Point of gaze data (consisting of avi. and csv. files) from the Mobile Eye were analysed using GazeTracker Software (Eye Response Technologies, VA, USA). A “LookZone” was created around the goalkeeper, the goal, and the ball and these were manipulated in a frame-by-frame fashion (Figure 1). The software then automatically measured the total number of fixations and total amount of time spent fixating within these pre-established LookZones. A fixation was classified as three or more consecutive frames (≥ 120 ms) in which the cursor stayed in the same location (Vickers, 1996).

Self-reported mean anxiety scores were analysed using a paired samples *t*-test across low- and high-threat conditions. Two repeated measures $2 \times 2 \times 2$ ANOVA's (threat \times goalkeeper movement \times location) were carried out to explore differences between the total number of fixations and total viewing time made to the goalkeeper and goal during the aiming phase of the kick. ANOVAs were also performed on the fixation data for the execution phase; however this involved the analysis of three locations (goalkeeper, goal, and ball). Shooting accuracy, the number of shots missed, the number of shots saved, trial duration, and the duration of last ball fixation data were subjected to 2×2 (threat \times goalkeeper movement) AVOVAs. Due to the differing number of kicks taken with a stationary and moving goalkeeper, the total number of kicks missed and saved was divided by the total number of kicks taken in each condition. These were expressed as percentages and were subjected to log transformations to normalise the data before analysis. Where sphericity was violated, Greenhouse-Geisser corrections were applied. All relevant interactions and main effects were followed up using Bonferroni corrected, paired samples *t*-tests and effect sizes were calculated using

Partial Eta squared (η_p^2) for omnibus comparisons and Cohen's d for pairwise comparisons.

Results

State anxiety

Paired samples t -test revealed that the participants were significantly more anxious, $t(17) = -8.04$, $P < 0.001$, $d = 1.6$, in the high threat (mean = 5.22, $s = 1.44$) compared to the low-threat condition (mean = 2.86, $s = 1.21$).

Performance

Shooting accuracy. No significant main effect was found for threat, $F(1,17) = 0.56$, $P = 0.47$, $\eta_p^2 = 0.32$. A significant main effect was evident for goalkeeper movement, $F(1,17) = 7.54$, $P < 0.05$, $\eta_p^2 = 0.31$, with shots centralising (by 32 cm) when the goalkeeper was moving (mean = 218.82 cm, $s = 64.10$) compared to when he remained stationary (mean = 251.20 cm, $s = 54.63$) compared to moving goalkeeper trials (mean = 218.82 cm, $s = 64.10$). The interaction between threat and goalkeeper movement was not significant, $F(1,17) = 0.21$, $P = 0.65$, $\eta_p^2 = 0.01$, (Figure 2).

Missed shots. Participants did not miss the target more often (shoot wide or over the goal) due to the influence of threat, $F(1,17) = 1.83$, $P = 0.19$, $\eta_p^2 = 0.09$, or goalkeeper movement, $F(1,17) = 0.44$, $P = 0.52$, $\eta_p^2 = 0.03$, and there was a non-significant interaction effect, $F(1,17) = 0.11$, $P = 0.74$, $\eta_p^2 = 0.01$, (Figure 2).

Saved shots. Exploration of shots that the goalkeeper saved revealed no significant main effect for threat, $F(1,17) = 0.68$, $P = 0.42$, $\eta_p^2 = 0.04$, but the number of saves the goalkeeper made significantly increased when he moved, $F(1,17) = 4.60$, $P < 0.05$, $\eta_p^2 = 0.21$. No significant interaction was evident, $F(1,17) = 0.71$, $P = 0.41$, $\eta_p^2 = 0.04$, (Figure 2).

Pre-shot duration

No significant main effects were evident for threat, $F(1,17) = 2.91$, $P = 0.11$, $\eta_p^2 = 0.15$, or goalkeeper movement, $F(1,17) = 0.03$, $P = 0.87$, $\eta_p^2 = 0.00$, and the interaction was also found to be non-significant, $F(1,17) = 1.04$, $P = 0.32$, $\eta_p^2 = 0.06$. This suggests that any attentional and performance differences found are not simply due to participants taking longer in any one condition. Mean pre-shot durations were, approximately 6 seconds (mean = 6.27, $s = 1.81$ seconds).

Attentional control: aiming phase

Due to technical issues with the eye-tracker, the gaze data for one participant was invalid and was therefore removed from further analyses.

Total number of fixations. A significant main effect was found for threat, $F(1,16) = 14.15$, $P < 0.01$, $\eta_p^2 = 0.47$, indicating that there were significantly more fixations in the high threat compared to the low-threat condition. No significant main effects were found for goalkeeper movement, $F(1,16) = 0.98$, $P = 0.34$, $\eta_p^2 = 0.06$, or location, $F(1,16) = 0.67$, $P = 0.04$, $\eta_p^2 = 0.01$. The interaction between

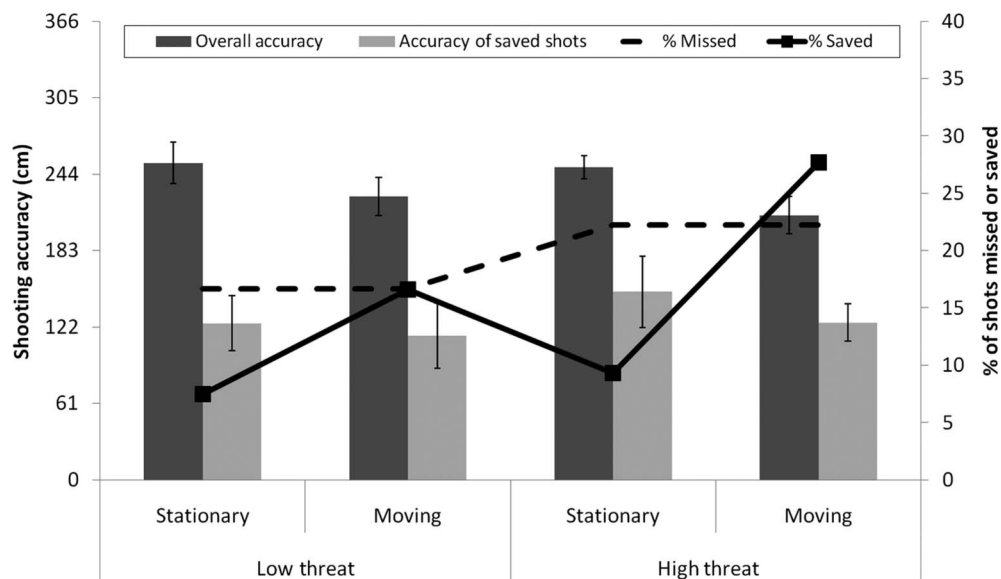


Figure 2. Performance data showing the overall shooting accuracy (distance from the centre of the goal), the accuracy of shots that were saved and the total percentage of shots that were saved across threat and goalkeeper movement conditions.

goalkeeper movement and location was the only significant interaction present, $F(1,16) = 29.11$, $P < 0.01$, $\eta_p^2 = 0.66$. Bonferroni corrected paired samples t -tests revealed that when the goalkeeper was moving, participants made significantly more fixations, ($P < 0.00$) towards him (mean = 2.10, $s = 1.20$) compared to when he was stationary (mean = 1.17, $s = 1.01$). Furthermore, participants fixated significantly more often, ($P < 0.025$), on the goal target area when the goalkeeper was stationary (mean = 2.26, $s = 1.96$) compared to when he was moving (mean = 1.63, $s = 1.37$, Figure 3).

Total viewing time. A significant main effect for threat was found, $F(1,16) = 11.50$, $P < 0.01$, $\eta_p^2 = 0.42$, indicating that there were significantly longer periods of time spent fixating targets in the high threat (mean = 462, $s = 386$ ms) than low-threat condition (mean = 347, $s = 380$ ms). Non-significant main effects were found for goalkeeper movement, $F(1,16) = 2.57$, $P = 0.13$, $\eta_p^2 = 0.14$, and location, $F(1,16) = 0.76$, $P = 0.40$, $\eta_p^2 = 0.45$. A three-way interaction between threat, goalkeeper movement, and location was evident, $F(1,16) = 6.80$, $P < 0.05$, $\eta_p^2 = 0.30$. As predicted, there were significantly longer periods of time spent fixated on the goalkeeper in the high threat, moving goalkeeper condition than to other locations, or to the goalkeeper in other conditions (all P s < 0.01 ; see Figure 3).

Attentional control: execution phase

Total number of fixations (Figure 4). ANOVA revealed no significant main effects for threat, $F(1,16) = 1.09$, $P = 0.32$, $\eta_p^2 = 0.06$, or goalkeeper movement, $F(1,16) = 0.00$, $P = 0.97$, $\eta_p^2 = 0.00$. A significant main effect was found for location, $F(1.02,1632) = 54.81$, $P < 0.001$, $\eta_p^2 = 0.77$. Paired samples t -tests showed that during the run-up there were significantly more fixations to the ball (mean = 1.81, $s = 0.14$) compared to the goalkeeper (mean = 0.00, $s = 0.01$) and goal (mean = 0.05, $s = 0.03$; P s < 0.001). All other interactions were non-significant (P s > 0.05 ; Figure 4).

Total viewing time. ANOVA revealed no significant main effects for threat, $F(1,16) = 0.09$, $P = 0.77$, $\eta_p^2 = 0.01$, or goalkeeper movement, $F(1,16) = 1.66$, $p = 0.22$, $\eta_p^2 = 0.09$. A significant main effect was found for location, $F(1.01,8.06) = 30.43$, $P < 0.00$, $\eta_p^2 = 0.66$. Paired sample t -tests showed that during the run-up, participants spent longer (P s < 0.00), looking at the ball (mean = 430, $s = 60$ ms) compared to the goalkeeper (mean = 0, $s = 0$ ms), and the goal (mean = 0, $s = 0$ ms). All other interactions were non-significant ($p > 0.05$; see Figure 4).

Last fixation duration on the ball. No significant main effects were found for threat, $F(1,15) = 1.09$, $P = 0.31$, $\eta_p^2 = 0.07$, or goalkeeper movement,

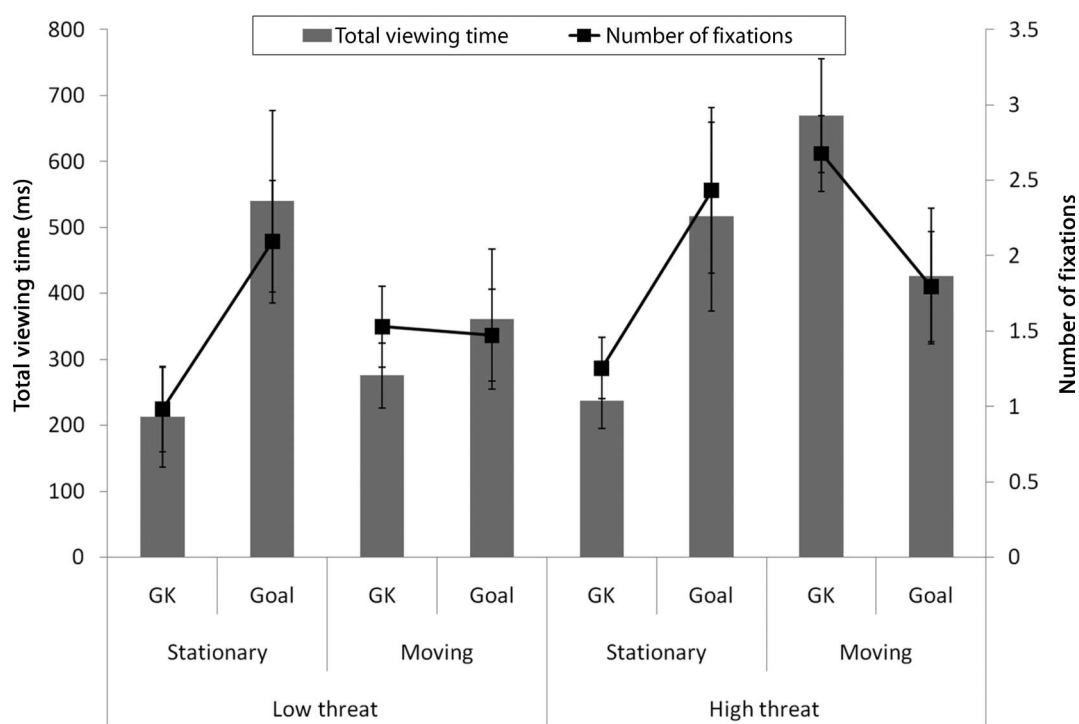


Figure 3. Gaze behaviour data during the aiming phase of the kick, showing the mean total viewing time (ms) and mean number of fixations to each location (GK and Goal) under threat and goalkeeper movement conditions (with s.e.m.s).

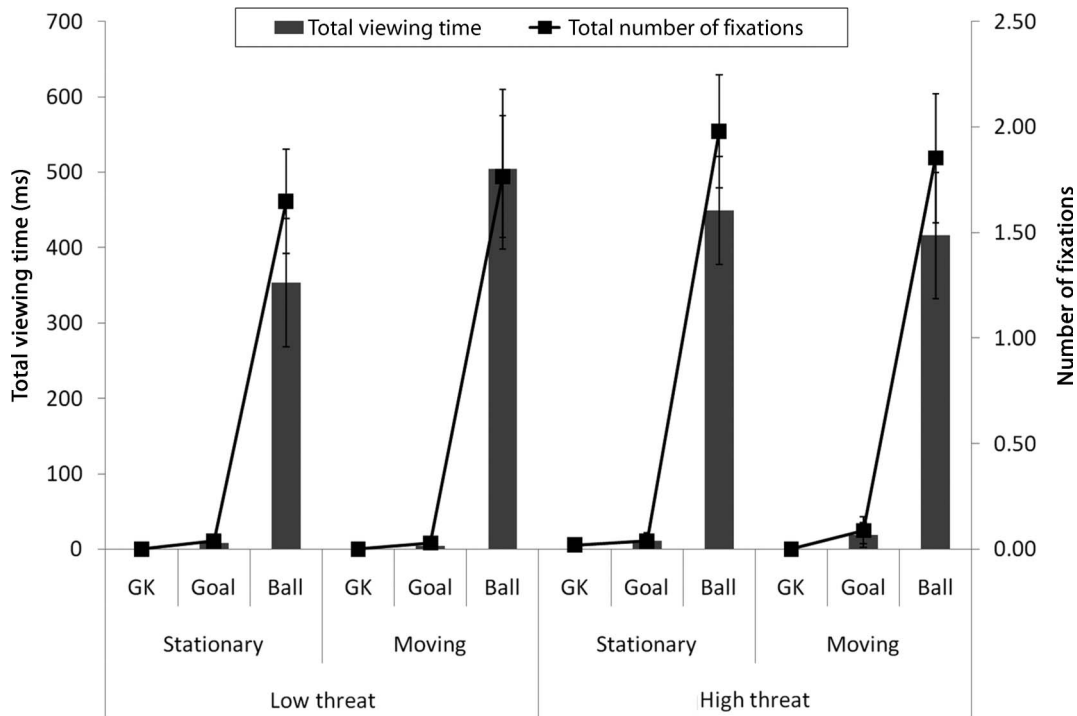


Figure 4. Gaze behaviour data during the execution phase of the kick, showing the mean total viewing time (ms) and mean number of fixations to each location (GK, Goal and Ball) under threat and goalkeeper movement conditions (with s.e.m.s).

$F(1,15) = 1.29$, $P = 0.27$, $\eta_p^2 = 0.08$, and the interaction was also found to be non-significant, $F(1,15) = 1.31$, $P = 0.27$, $\eta_p^2 = 0.08$. Mean durations were in the order of 200 ms (mean = 230, $s = 103$ ms).

Discussion

The predictions of ACT (Eysenck et al., 2007) have been tested in a range of visuomotor tasks such as basketball free-throw shooting (Wilson, Vine et al., 2009), climbing (Nieuwenhuys et al., 2008), police firearms response (Nieuwenhuys & Oudejans, 2009), and modified football penalty shooting (Wilson, Wood et al., 2009). However, this is the first study that has attempted to manipulate the degree of salience of any external, distracting stimuli; in this instance the goalkeeper. The aim was to discover if a moving goalkeeper would distract anxious penalty takers, and if so, whether this disruption in attentional control would impair shooting performance.

The anxiety manipulation was deemed successful, although the intensity of the threat experienced was expected to be less than that experienced in “real” penalty shootouts (Jordet, Elferink-Gemser, Lemmink, & Visscher, 2006; Jordet, Hartman, Visscher, & Lemmink, 2007). However, the intensity of the anxiety experienced was sufficient to have had a detrimental impact on the attentional control of the participants, although not performance *per se*, and is similar to levels

reported in other laboratory-based studies that have used this inventory (e.g. Nieuwenhuys et al., 2008; Pijpers, Oudejans, Holsheimer, & Bakker, 2003).

Performance

While it was predicted that we would find significant interactions for shooting accuracy and the number of saved shots between threat and goalkeeper movement conditions, no such interactions were evident. A moving goalkeeper had a significant effect on the frequency of saved shots and the shooting accuracy of penalty takers regardless of threat (Figure 2). A possible explanation for this finding may be that the effect of increasing the salience of the goalkeeper, by increasing his movements, diluted any additional effect of the anxiety manipulation. Indeed, previous research has suggested that the mere presence of a goalkeeper can influence the aiming intention and accuracy of penalty takers, even when anxiety is not manipulated (Wood & Wilson, in press).

Attentional control: aiming phase

It was hypothesised that when anxious, participants would fixate on a moving goalkeeper more often (increased distractibility) and for a longer duration (disengage more slowly) than when shooting to a stationary goalkeeper. Findings from the gaze measures adopted provide some support for these

hypotheses. In short, the results indicated that the 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 (see Figure 3). Therefore, it seems that a moving goalkeeper has a similar level of distractibility across low- and high-threat conditions but when anxious, participants found it difficult to disengage from this threat-related distraction. These findings are entirely consistent with ACT, with anxious individuals displaying a shift in attentional control from a target-focused, top-down attentional strategy (goal focused), to stimulus-driven (goalkeeper-focused) bottom-up attentional control (Eysenck & Derakshan, in press).

Attentional control: execution phase

While the results for the aiming phase supported the predictions of ACT (Eysenck et al., 2007) the effect of anxiety on attentional control during the run-up had not been previously examined. It was hypothesised that the primary objective of the run-up was to successfully guide the performer towards the ball and had little to do with extracting information from the environment in relation to choosing an aiming location (see Vickers, 1992; Wilson & Pearcey, 2009). During the run-up phase of a penalty kick, it is clear that the primary focus of the kicker's attention is directed towards the ball, which is consistent across threat and goalkeeper movement conditions (see Figure 4). This contradicts previous research utilising a one-step run-up, which has consistently shown that prior to shooting, penalty takers tend to focus on target-specific information (goalkeeper or goal) and pay little or no attention to the ball (Bakker et al., 2006; Nagano et al., 2006; Wilson, Wood et al., 2009).

The dependence on the ball as a source of visual information during the execution phase of a penalty kick can be explained with reference to vision's role in the guidance of action. In order to ensure an accurate ball contact, the eyes steer the performer towards the ball, thus providing the motor system with appropriate directional guidance (Land, 2009). Such visual behaviour is typical of abstract aiming tasks where an object must be accurately struck towards another target (e.g. golf putting and ice hockey shooting). The ball/puck has been found to be the location of the quiet-eye fixation in these abstract aiming tasks (Vickers, 2007).

No significant differences were evident between the duration of last fixation to the ball across threat and goalkeeper movement conditions. With no external video footage available to define a critical movement, this is admittedly a crude attempt at exploring a "quiet-eye" measure. Further research is warranted in

this area in order to define the critical movement phase of a penalty kick and explore how the quiet-eye period may change under pressure (Vickers, 2007). These results do suggest, however, that during the run-up, a kicker's attention is primarily fixated on the ball and these data appear to add no additional explanation for potential anxiety-induced changes in attention and performance in penalty shooting.

As a moving goalkeeper impaired attentional control during the *aiming* phase, and shooting accuracy in a similar direction (i.e. centrally), it would appear, that this is the critical period for constructing the aiming intention-shooting accuracy relationship. This aiming information must be stored during the execution phase (when gaze is located on the ball) if it is to guide subsequent shooting direction. While many goal-directed movements are guided online with visual control (Land, 2009; Neggers & Bekkering, 2000), there is support for the role of a visual memory buffer in the planning of a variety of motor tasks (see Hayhoe, Shrivastava, Mruczek, & Pelz, 2003; Land & Furneaux, 1997). Gaze, intention, and motor control can therefore be temporally dissociated and information from prior "look-ahead" fixations (Pelz & Canosa, 2001) used to guide subsequent actions.

Vickers' (1996) conceptualisation of the quiet-eye as being a period of time when the force and direction commands of the task are computed without outside distraction appears to support this explanation. The purpose of predominantly ball-focused attention during the run-up may be to preserve earlier aiming information (from the aiming phase) and prevent its disruption. This period would also provide time for the transformation of sensory (target) information into an appropriate motor command (Sailer, Flanagan, & Johansson, 2005); that is, where and how should the ball be struck to achieve the aiming intention.

Caution must be taken when attempting to transfer these findings to penalty kicks from professional football. First, as well as the limitation of a laboratory-based manipulation of threat, the skill level of the participants involved in this study is lower than professional players. It could be the case that professional players would show a greater resistance to the negative effects of distraction, although anecdotal evidence would suggest otherwise (e.g. Berbatov, 2009). Second, penalty takers usually only have one attempt, rather than the series of kicks taken in this study. Recent research suggests that penalty takers are likely to modify their aiming strategies when taking consecutive kicks in order to prevent the goalkeeper from learning anticipatory cues (Wood & Wilson, in press). Future studies should therefore attempt to adopt a single-kick research design in order to address this limitation. Third, the prevention of anticipatory

movements by the goalkeeper may have negatively influenced the number of saves that he made. However, this internal control was necessary to reduce the likelihood of confounding variables influencing penalty takers' aiming strategies.

From a penalty taker's perspective, it seems that unwarranted attention to a goalkeeper is suboptimal for accurate shooting and more importantly, increases the likelihood of performance failure. Coaches and psychologists may wish to explore the utility of directing a kicker's attention to target-focused information during the aiming phase. Performance routines incorporating gaze-based elements may help to maintain effective attentional control while resisting threat-related distracters. Conversely, from a goalkeeper's perspective, attempting to distract penalty takers (especially during the aiming phase) may increase the likelihood of saving a subsequent shot by influencing aiming. Whether it is a "spaghetti legs" routine or simply the waving of arms, it seems that Bruce Grobbelaar was right: a distracting goalkeeper does test the concentration of penalty takers. The participants in the current study also failed that test.

References

- Armatas, V., Yiannakos, A., Papadopoulou, S., & Galazoulas, C. (2007). Analysis of the set-plays in the 18th football World Cup in Germany [online]. *Physical training*. Retrieved September 26, 2009, from http://ejmas.com/pt/2007pt/ptart_galazoulas_0710.html
- Bakker, F.C., Oudejans, R.D., Binsch, O., & van der Kamp, J. (2006). Penalty shooting and gaze behavior: Unwanted effects of the wish not to miss. *International Journal of Sport Psychology*, 37, 265–280.
- 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.
- Berbatov, D. (2009). I let the team down. Retrieved March 16, 2010, from Sky Sports website: http://www.skysports.com/story/0,19528,11667_5211477,00.html
- Binsch, O., Oudejans, R.R.D., Bakker, F.C., & Savelsbergh, G.J.P. (2010). Ironic effects and final target fixation in a penalty shooting task. *Human Movement Science*, 29, 277–288.
- Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience*, 3, 201–215.
- Eysenck, M.W., & Derakshan, N. (in press). New perspectives on attentional control theory. *Personality and Individual Differences*.
- Eysenck, M.W., Derakshan, N., Santos, R., & Calvo, M.G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion*, 7, 336–353.
- Hayhoe, M.M., Shrivastava, A., Mruczek, R., & Pelz, J.B. (2003). Visual memory and motor planning in a natural task. *Journal of Vision*, 3, 49–63.
- Houtman, I.L.D., & Bakker, F.C. (1989). The anxiety thermometer: A validation study. *Journal of Personality Assessment*, 53, 575–582.
- Jackson, J. (2005, June 5). Triumph and despair: Bruce Grobbelaar. *Observer Sport Monthly*. Retrieved October 20, 2009, from <http://observer.guardian.co.uk/osm/story/0,,1496653,00.html>
- Jordet, G., Elferink-Gemser, M.T., Lemmink, K.A.P.M., & Visscher, C. (2006). The "Russian roulette" of soccer?: Perceived control and anxiety in a major tournament penalty shootout. *International Journal of Sport Psychology*, 37, 281–298.
- Jordet, G., Hartman, E., & Sigmundstad, E. (2009). Temporal links to performing under pressure in international soccer penalty shootouts. *Psychology of Sport and Exercise*, 10, 621–627.
- 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.
- Land, M.F. (2009). Vision, eye movements, and natural behavior. *Visual Neuroscience*, 26, 51–62.
- Land, M.F., & Furneaux, S. (1997). The knowledge base of the oculomotor system. *Philosophical Transactions, Royal Society of London, Series B*, 352, 1231–1239.
- Martens, R., Burton, D., Vealey, R.S., Bump, L., & Smith, D.E. (1990). Development and validation of the Competitive State Anxiety Inventory-2. In R. Martens, R.S. Vealey, & D. Burton (Eds.), *Competitive anxiety in sport* (pp. 117–178). Champaign, IL: Human Kinetics.
- Masters, R.S.W., van der Kamp, J., & Jackson, R.C. (2007). Imperceptibly off-center goalkeepers influence penalty-kick direction in soccer. *Psychological Science*, 18, 222–223.
- Miller, R. (1996). Shooter vs. keeper: A tense battle. Games are won and lost by penalty kicks and PK tiebreakers. *Soccer Journal*, 41, 59–62.
- Nagano, T., Kato, T., & Fukuda, T. (2006). Visual behaviors of soccer players while kicking with the inside of the foot. *Perceptual and Motor Skills*, 102, 147–156.
- 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. (2009). Effects of anxiety on handgun shooting behavior of police officers: A pilot study. *Anxiety, Stress and Coping*, 22, 1–9.
- Nieuwenhuys, A., Pijpers, J.R., Oudejans, R.R.D., & Bakker, F.C. (2008). The influence of anxiety on visual attention in climbing. *Journal of Sport and Exercise Psychology*, 30, 171–185.
- Pelz, J.B., & Canosa, R. (2001). Oculomotor behavior and perceptual strategies in complex tasks. *Vision Research*, 41, 3587–3596.
- Pijpers, J.R., Oudejans, R.R.D., Holsheimer, F., & Bakker, F.C. (2003). Anxiety-performance relationships in climbing: A process-oriented approach. *Psychology of Sport and Exercise*, 4, 283–304.
- 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.
- Van der Kamp, J. (2006). A field simulation study of the effectiveness of penalty kick strategies in soccer: Late alteration of kick direction increase errors and reduce accuracy. *Journal of Sports Sciences*, 24, 467–477.
- Van der Kamp, J. & Masters, R.S.W. (2008). The human Müller-Lyer illusion in goalkeeping. *Perception*, 37, 951–954.
- Vickers, J.N. (1992). Gaze control in putting. *Perception*, 21, 117–132.
- 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.
- 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.R., & Pearcey, R. (2009). The visuomotor control of straight and breaking golf putts. *Perceptual and Motor Skills*, 109, 555–562.
- 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, 1–19.
- 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.
- Wood, G., & Wilson, M.R. (in press). Gaze behaviour and shooting strategies in football penalty kicks: Implication of a keeper-dependent approach. *International Journal of Sport Psychology*.

Copyright of Journal of Sports Sciences is the property of Taylor & Francis Ltd and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.