A test of the predictions of processing efficiency theory during elite team competition using the Thought Occurrence Questionnaire for Sport

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The current study aimed to test the predictions of processing efficiency theory (PET) (Evjen & Calvo, 1993) in an ecologically valid, team sport competition. Eighteen elite female hockey players taking part in an international competition were categorised as either high- or low-task anxiety (HTA, LTA). Games were categorised as being either of high- or low-intensity, and players' individual performance was assessed independently by two senior international coaches. Cognitive state anxiety, as indexed by the frequency of 'performance worry', cognitive intrusion, and subsequent mental effort cognitions were assessed using the Thought Occurrence Questionnaire for Sport (Lathiropoulou & Riddle, 2000). While anxiety (p < 0.01) and effort (p < 0.05) were significantly greater in high-intensity games, there was no significant change in performance (p > 0.05). As predicted by PET, performance was maintained at the expense of processing efficiency, and this effect was more marked in HTA individuals.

Key words: Anxiety, Attention, Cognitive Interference, Mental Effort, Performance Effectiveness.

One of the major research interests of sport psychologists continues to be the influence that anxiety exerts on performance (Janelle, 2002; Woodman & Hardy, 2003). Several theories have argued that negative performance effects of anxiety are largely due to the manner in which worry and other forms of cognitive interference such as self-preoccupation influence attention (e.g., Sarason, 1988). These theoretical approaches are based on the assumption that a key aspect of successful task performance is the ability to attend to task-relevant cues, process andbehaviours while ignoring task-irrelevant, or task-disturbing cues (Kaboom, 1973; Lewin & Linder, 1997).
One theory which provides an explanatory account of the mechanisms involved in the performance-anxiety relationship is processing efficiency theory (PET; Eysenck & Calvo, 1992). According to PET, state anxiety, which in turn is determined by the interaction of trait anxiety and the level of perceived threat in any performance setting, plays an important role in influencing performance (Eysenck, 1996). PET predicts that cognitive anxiety in the form of worry subverts the processing and storage capacity of working memory, therefore reducing the resources available for the task in hand.

Working memory acts as a temporary storage and manipulation system for information and is assumed to comprise three distinct, and linked capacity sub-systems: the articulatory loop; the visuo-spatial sketchpad; and the central executive (Baddeley, 1990). The articulatory loop is responsible for the brief storage and manipulation of verbal information while the visuo-spatial sketchpad is an equivalent sub-system concerned with visual and spatial information. 'Overseeing' these two sub-systems is the central executive, essentially a type of capacity limited attentional system which functions to control the other two systems (Baddeley, 1990). Research implicating the effects of anxiety on the working memory system was initially carried out on digit span and reading span tasks (see Eysenck, 1992 for a review). Findings suggest that worry mainly pre-empts the resources of the central executive, which is involved in the performance of most complex cognitive and motor tasks (e.g., Calvo & Ramos, 1989; Eysenck, Payne & Derakshan, 2005; Rapee, 1995).

While PET accepts that worry pre-empts resources of working memory, Eysenck (1996) argues that attentional theories of anxiety exaggerate the role worry plays in impairing performance. A central cost of PET is that there is a control or self-regulatory system (Hodder, 1986), which is involved in mediating the effects of anxiety on processing and performance (Eysenck & Calvo, 1992). This system performs the task of co-ordinating resource allocation based on outcome probabilities and relies on negative feedback resulting from the detrimental effects of anxiety on performance as a trigger for its activation. According to PET therefore, worry can have a motivational role; as well as occupying working memory capacity, worry may also stimulate increases in on-task effort, which may partially or totally compensate for reduced performance effectiveness (Calvo, 1985). One of the principle predictions of PET is that the adverse effects of anxiety on performance effectiveness are often less than those on processing efficiency, where processing efficiency refers to the relationship between the effectiveness of performance and the effort or processing resources invested (Eysenck & Calvo, 1992).
Eysenck and Calvo (1992) argue that the exertion of compensatory effort will be more likely in high-trait anxious (HTA) as opposed to low-trait anxious (LTA) individuals. Research evidence supports this prediction and indicates that there are fundamental differences between such individuals (e.g., Eysenck et al., 2005). First, HTA individuals tend to devote more of their processing resources to worry, therefore increasing the probability of detecting a mismatch between expected and actual performance (Eysenck & Calvo, 1992). PET postulates that as HTA individuals are likely to respond to increased threat with higher levels of worry, state anxiety mediates the effect of trait anxiety on performance. Research in test situations (e.g., Jerussi, 1990), has demonstrated that compared to LTA individuals, HTA participants are also more sensitive to failure feedback. Within the framework of PET this means that HTA individuals are therefore likely to be more motivated than LTA individuals to allocate additional effort to task performance, especially in threatening environments.

There has been considerable support for the predictions of PET in mainstream psychology (see Eysenck, 1996 for review), but until recently it has received limited attention in the sport psychology literature (Janelle, 2002). These recent studies have examined the influence of anxiety on the performance of sporting skills manipulated in laboratory settings; simulated car racing (e.g., Murray & Janelle, 2003; Wilson, Smith, Chattington, Ford & Marple-Horvat, 2007); table tennis service return (e.g., Williams, Vickers & Rodrigues, 2002) and golf putting (e.g., Wilson, Smith & Holmes, 2006).

Despite this recent interest, only Smith, Bellamy, Collins and Newell's (2001) study of volleyball players has attempted to test the predictions of PET in an ecologically valid sporting environment. In this study, twelve male elite volleyball players, grouped as high or low trait anxious (HTA, LTA), were assessed over eight home matches involving thirty-one sets of volleyball. Three conditions of set criticality were identified from the point span data: low critical sets were those where more than six points separated the two teams at the end of the set; moderately critical sets were those where three to six points separated the teams and high critical sets were those where two points separated the two teams. The results only lent partial support to the predictions of PET. The LTA players showed continuous improvement in more critical sets while also reporting increased cognitive state anxiety and mental effort. However, the HTA individuals showed a stepwise decline in performance across the three criticality conditions, despite their increased effort in the moderate and high criticality settings.

In order to test the predictions of PET in competition settings, it is evident that appropriate measures of anxiety and effort are required. The most
typically adopted state anxiety measure in the sport psychology literature is the Competitive State Anxiety Inventory-2 (CSAI-2; Martens, Burton, Vealey, Bump & Smith, 1990). Despite its popularity, concerns with this instrument have been highlighted (e.g., Lane, Sewell, Terry, Bartram & Nesti, 1999; Woodman & Hardy, 2003). Of particular interest to the current investigation is the argument that an 'intensity-alone' approach to measuring anxiety may be limited; there may be a need to incorporate the dimension of frequency in making assessments of the anxiety response (e.g., Parfitt, Jones & Hardy, 1990; Swain & Jones, 1993). Parfitt et al. (1990) defined the frequency of competition-related cognitive intrusions in terms of the amount of time which cognitions about a specific competitive event occupied performers' thoughts. As Jones (1995) highlights, "Although the intensity of the symptoms may not change, a cognitive state in which 'worries' about an event are occurring 5 per cent of the time...is very different from one in which they are occurring 90 per cent of the time" (pp. 460).

While Jones and colleagues may have introduced the concept of the frequency of cognitive intrusions to the examination of competitive state anxiety in a sporting environment, this was already an important area of investigation in mainstream psychology (see Clark & Purdon, 1993; Sarason, Sarason & Pierce, 1990). In both test and social anxiety, self-preoccupying thoughts have been shown to contribute to performance degradation because of how they interfere with task-relevant thoughts. Research in test situations has highlighted that test anxiety is related to the frequency of occurrence of negative thoughts about personal abilities, as well as the perceived difficulty of questions during exams (e.g., Hunsley, 1987; Sarason et al., 1990). In the current study therefore, cognitive state anxiety is indexed by the frequency with which performers reported experiencing cognitive intrusions related to performance worry, not the intensity of that response (c.f. the CSAI-2)

A recently developed questionnaire, the Thought Occurrence Questionnaire for Sport (TOQS; Hatzigeorgiadis & Biddle, 2000) enables performers to report the frequency with which they experience a variety of negative cognitive intrusions (see Methods). It may therefore prove useful in examining anxious thoughts and their effect on subsequent effort in sport settings. First, a sport-specific measure of cognitive interference in sport could extend the literature from pre- to in-competition cognitive interference (Lane, Hardwood & Nevill, 2003). The measurement of anxiety states and performance in sport has tended to take place asynchronously, with pre-competitive state anxiety measures (e.g. the CSAI-2) being computed to later performance (Jaquet, 1999). Second, as the measure explores both the potential negative
effect of cognitive intrusions on performance (due to distraction) and the potential for effort to compensate for this, it is ideally suited for testing the predictions of PET.

The current study therefore aimed to utilise the TOQS as a means of assessing the frequency of cognitive intrusions and the subsequent influence on effort of a group of hockey players, representing their country at an international tournament. First, as little research has examined the anxiety response of elite female athletes in pressure environments (Woodman & Hardy, 2003), the TOQS frequency scores from this group were compared to findings from previous research using the TOQS. Second, similar to Smit et al. (2001), the current study compared the state anxiety, effort and performance ratings of high and low trait anxious players in high and low critical games. Hypotheses related to the predictions of PET were that; 1. HTA individuals would report more frequent worrisome thoughts (i.e. higher cognitive state anxiety) and higher levels of compensatory effort than their LTA counterparts, particularly in games of high criticality. 2. The frequency of worrisome thoughts would have less effect on performance than processing efficiency due to the influence of compensatory effort; and 3. HTA participants would exert higher levels of mental effort than LTA participants when their performances were comparable (i.e. lower processing efficiency).

Methods

BACKGROUND

Eight countries had pre-qualified for a major international hockey tournament which was run in two groups of four teams followed by play-off matches. The top two teams in each group qualified for a semi-final situation, with the top team in one group playing the second placed team in the other group. After the semi-final there was a final to determine gold and silver medal positions and a third and fourth position play-off. The bottom two teams in each group played off in a similar manner to determine the fifth to eighth places in the tournament. Each team therefore played five matches at the tournament and was allowed a squad of sixteen players for each game.

PARTICIPANTS

Eighteen women, mean age 19.1 years (SD = 0.83) selected to represent their country at an international hockey tournament agreed to participate in the study. All players had at least 8 years experience of playing hockey and 2 years of international experience at various age group levels. Two women were omitted from the subsequent analyses as they did not take part in all the games. All players completed informed consent forms before taking part.
MEASURES

The Sport Anxiety Scale (SAS; Smith, Smoll & Schwartz, 1990) was used to measure multi-dimensional, sport competition trait anxiety. The SAS consists of 21 items which measure reactions to competitive situations rated on a four-point scale (1 = not at all; 2 = somewhat; 3 = moderately so; 4 = very much so). There are three subscales contained within the SAS, consisting of nine items measuring somatic anxiety, seven items measuring worry and five items measuring concentration disruption. The subscales demonstrate high internal consistency and test-retest reliability has been reported to be 0.77 for the full scale and 0.71, 0.70 and 0.68 for the somatic anxiety, worry and concentration disruption scales respectively (Smith et al., 1990). For the purpose of this study, only the cognitive anxiety subscale of the SAS was used to classify participants either high or low in trait cognitive anxiety (c.f. Smith et al., 2001).

The Thought Occurrence Questionnaire for Sport (TOQS; Hatzigeorgiadis & Biddle, 2000) was used to assess the frequency of cognitive intrusions (particularly worry-related thoughts) and their effect on subsequent effort. The instrument was based on Searley, Sutten, Keeffe, Hayes, and Sheerin’s (1986) Thought Occurrence Questionnaire (TOQ), but applied to a sporting, as opposed to educational, environment. The factor structure of the TOQS reflected that of the original TOQ, indicating that patterns of interfering thoughts under evaluative situations in the two settings were similar (Hatzigeorgiadis & Biddle, 2000).

The questionnaire comprises seventeen items which are pre-fixed with the phrase, “During the game I had thought…” These items are arranged into three subscales which, in the development studies, revealed satisfactory internal consistency (Cronbach’s α = 0.78 to 0.90). The subscale measures ‘perceived effectiveness’ (six items), e.g. ‘these are not going to achieve our goals’; ‘about previous mistakes I have made’; ‘situation irrelevant thoughts’ (five items); e.g., ‘about personal worries’; ‘about what I am going to do later in the day’; and ‘thoughts of escape’ (six items; e.g., ‘about stopping’; that I do not want to take part in this game anymore). The findings of Lane et al. (2005) study provide further support to these reported by Hatzigeorgiadis and Biddle (2000) that the TOQS is a valid measure of interfering thoughts in sport and suitable for use with adolescents as well as adult athletes.

For each of the seventeen items, participants were asked to rate the frequency of thought occurrence, the perceived effects on concentration (distraction), and the perceived effects on effort. To assess frequency of thought occurrence, athletes were asked to report on a 7-point scale how frequently they experienced the listed thoughts during the games (1 = never; 7 = very often). To assess effects on concentration and subsequent effort athletes were asked to rate, for the thoughts they reported experiencing in the initial context (i.e. rating higher part 1), the degree to which these thoughts distracted their concentration (1 = not distracting; 7 = very distracting) and affected subsequent effort input (1 = made me give up trying; 7 = made me try harder). For the purpose of testing the predictions of PET, only the frequency of thoughts related to performance worries (considered as an index of cognitive state anxiety) and the subsequent effort ratings were analyzed. While the two other subscales reflect cognitive intrusions which may demand attention, PET’s predictions are only relevant to the role of worry in pre-empting working memory resources.

A ‘not applicable’ option was included in the columns asking how athletes perceived the effects of their thoughts on effort (for athletes not reporting such listed thought. Participants were instructed to indicate ‘N/A’ (not applicable) if they had scored ‘1’ (i.e. never) in the ‘frequency’ column. In addition, they were asked to complete all three questions (columns) for each item before proceeding to the next item. At the bottom of the questionnaire, players were
asked to put their initials and the opposition team, so that results could be compared between games and between athletes.

Performance was measured using ratings (1-10) derived from independent judgements of player performance from the two senior coaches responsible for the team, after each game. This process is part of the standard assessment and monitoring procedure set in place by the National Governing Body (NGB). Coaches were familiar with and proficient in the use of this rating technique and were blind to the specific purpose of the study. The coaches based their scores on a range of behavioural repertoires of each player given their position (including technical, tactical, and work rate considerations).

PROCEDURE

TOQS data was collected by the first author, who had been working with this team at the sport psychologist for two years prior to the study. Written permission to carry out the research was provided by the NGB’s Performance Director and Sport Science Coordinator. With the management team’s written permission, the researchers familiarised the players with the TOQS measure at the end of a workshops on concentration, held two weeks before the tournament. Players were then asked to score the TOQS following a training game and were encouraged to seek any clarification if they were unsure about any scale item. Previous research in sport (Thomas, Hanlon & Jones, 2002) has shown that this type of education is important when using self-report inventories in competition settings. The players were informed that their individual results would be kept confidential and would not be shared with other members of the management team. The players also completed the SAS at this stage.

During the tournament itself, sixteen copies of the TOQS measure and sixteen pens were kept in the changing room at the start of each game and were completed by the players before they left the changing room at the end of the game. Completed questionnaires were returned to the researcher as the players left the building. In this way, the researcher tried to ensure that the questionnaire was completed within thirty minutes of the end of each game.

Game criticality was used as an index of threat and was linked to perceptions of importance and uncertainty (c.f. Smith et al., 2001). It was determined by asking the coaches to independently rank the five games in the tournament in order of criticality (operationalised in terms of game importance and outcome uncertainty) after the tournament had finished. This classification was viewed as appropriate as although all games in an international tournament might be important, some are more critical than others and their outcome more uncertain. Both coaches ranked the games in the same order and based on this ranking of the five games, two were considered of high criticality and two of low criticality.

The two high criticality games were against the top two seeded teams in the tournament (the studied team was ranked third). The first game in the tournament was against the number two seed and a positive result would mean missing the top seeded team in the semi-finals. A draw in this critical first game and a poorer goal difference in the other two games meant that the semi-final was against the favourites. The bronze medal playoff was rated as the moderate criticality game, and the second and third group games (against lower ranked opponents) rated as low criticality. For testing the predictions of PET, only four of the five matches were considered, with the ‘moderate’ criticality game not included.
Results

Descriptive statistics were used to summarise the context of players' thoughts during all 5 games of the tournament. For the purpose of the descriptive statistics, each athlete's report for each game was viewed as a separate 'incident' and therefore there were a maximum of 80 data points analysed (16 players over 5 games). There were different sample sizes for the three subscales, as athletes did not always report experiencing all possible cognitive intrusions. At least one performance worry item was reported for each player in each game (80 occurrences out of 80), but there were only 67 situation irrelevant thoughts and 62 thoughts of escape reported during the tournament.

In order to test the predictions of PET it was necessary to group players as low or high trait anxious (LTA, HTA) and compare their anxiety (frequency of performance worry intrusions), effort and performance across games varying in the amount of threat experienced. These dependent variables were analysed using a mixed design 2 x 2 ANOVA (trait anxiety x game criticality). Trait anxiety was used as the grouping variable and game criticality was the repeated measures variable. Effect sizes (ω²) were calculated as outlined in Howell (2002) and significant interaction effects (trait x criticality) were followed up using Tukey HSD post hoc tests.

SPORT ANXIETY SCALE DATA

Participants' scores on the cognitive subscale of the Sport Anxiety Scale (SAS) were used to divide the group at the median point of the scores obtained (as Smith et al., 2001). As a consequence, two groups were identified: 'LTA' (n = 8) mean score 9.9 (SD = 1.45) and 'HTA' (n = 8) mean score 13.9 (SD = 1.77). An independent t-test on the two groups' scores confirmed the statistical significance of the low versus high group distinction, t(14) = 6.44, p < .001.

DESCRIPTIVE STATISTICS: FREQUENCY OF COGNITIVE INTRUSIONS

Performance worries were the most frequently reported type of cognitive intrusion, with a mean score of 2.3 (SD = 1.12), in contrast to situation irrelevant thoughts, mean of 1.6 (SD = 0.41), and thoughts of escape, mean of 1.4 (SD = 0.57). The three most frequently reported individual intrusions from the YOQS were also from the performance worry subscale: "During the game I had
thoughts about previous mistakes I have made", mean 3.4 (SD = 0.79); "During the game I had thoughts that I'm having a bad day", mean 2.6 (SD = 0.67); "During the game I had thoughts that I am not going to achieve my goals today", mean 2.0 (SD = 0.53). No other item from the three scales rated over 1.2.

When examining the two high criticality games in isolation, two other thoughts also rated highly: "During the game I had thoughts that we are not going to win this game", mean of 2.4 (SD = 0.76); and "During the game I had thoughts that the other team are better than us", mean of 2.2 (SD = 0.43). Rather than reflecting concerns over their own performance, these thoughts reflect concerns about the opposition. These thoughts are still from the performance worry subscale, supporting the collapsed data results that during competition, cognitive anxiety (as opposed to irrelevant thoughts or thoughts of escape) is the predominant negative cognitive intrusion experienced by elite athletes.

ANOVA DATA: FREQUENCY OF PERFORMANCE WORRY COGNITIVE INTRUSIONS

The analysis of variance on the self-reported frequency of thoughts related to performance worries demonstrated significant main effects for both trait anxiety, $F(1,14) = 21.34, p < .001, \omega^2 = .130$, and game criticality, $F(1,14) = 17.01, p < .001, \omega^2 = 1.29$. There was also a significant interaction effect, $F(1,14) = 5.01, p < .05$. Subsequent Tukey follow up tests revealed that there was no significant difference between the frequency of performance worries between HTA and LTA players in low criticality games ($p = .07, \omega^2 = .55$). However, HTA players had significantly more performance worry thoughts in high as opposed to low criticality games ($p < .005, \omega^2 = 1.70$), and compared to their LTA counterparts in high criticality games ($p < .005, \omega^2 = 1.76$). The self-reported frequency of performance worries ratings for the high and low anxious groups are presented in Figure 1.

ANOVA DATA: EFFORT RATINGS FOLLOWING PERFORMANCE WORRY COGNITIVE INTRUSIONS

The analysis of variance on the self-reported effort ratings following thoughts related to performance worries demonstrated significant main effects for both trait anxiety, $F(1,14) = 13.34, p < .005, \omega^2 = 1.39$, and game criticality, $F(1,14) = 31.41, p < .001, \omega^2 = 1.58$. There was also a significant
interaction effect, $F(1,14) = 6.98$, $p < .05$. Subsequent Tukey follow up tests revealed that there was no significant difference in reported effort between HTA and LTA players in low criticality games ($p = .09, \omega^2 = .31$), or between the LTA players’ effort in low and high criticality games ($p = .21, \omega^2 = .40$). However, HTA players reported exerting significantly more effort in high as opposed to low criticality games ($p < .005, \omega^2 = 1.69$), and compared to their LTA counterparts in high criticality games ($p < .001, \omega^2 = 1.83$). The self-reported effort following thoughts related to performance worries, for the high and low anxious groups, are presented in Figure 2.

**ANOVA Data: Performance Ratings**

The independent coach ratings of player performance over the tournament were found to be significantly correlated, $r = .85$, $p < .001$. Coach 1 gave a mean rating of 5.9 ($SD = 0.99$), and coach 2 gave a mean rating of 6.3 ($SD = 1.13$). For this reason, a mean value of the two reports for each athlete in each game was used in the subsequent data analysis. The performance ratings provided by the coaches were then averaged for the pair of low and high critical games. The analysis of variance on the coach-reported performance ratings demonstrated no significant main effects for either trait anxiety.
Fig. 2. - Effort ratings following performance worry cognitive intrusions (-3 = made me give up, 0 = neutral, 3 = made me try harder) for high (n=8) and low (n=8) trait anxious players across games of low and high criticality.

$F(1,14) = 1.47, p = .25, \omega^2 = .17$, or game criticality, $F(1,14) = 0.07, p = .88, \omega^2 = .04$. There was also no significant interaction effect, $F(1,14) = 0.04, p = .75$. The performance ratings for the high and low anxious groups are presented in Figure 3.

![Graph showing effort ratings](image)

Fig. 3. - Coach rating of player performance (1-10) for high (n=8) and low (n=8) trait anxious players across games of low and high criticality.

![Graph showing performance ratings](image)
Discussion

The aim of this research was to test the predictions of PET (Eysenck & Calvo, 1992) in an ecologically valid sport setting of international standard. The study considered athletes' experiences of cognitive anxiety (the frequency of thoughts related to performance worries) during competition and how these thoughts influenced subsequent effort and performance. The Thought Occurrence Questionnaire for Sport (TOQS) was adopted as it provided athletes with the opportunity to report both how frequently they experienced anxiety-inducing thoughts during a match and how this influenced effort expenditure. No other validated single instrument considers this link between anxiety and effort, central to the predictions of PET.

Descriptive Statistics

The TOQS data from the tournament as a whole identified that cognitive intrusions related to performance worries were more frequently reported (mean 2.3, SD = 1.12) than situation irrelevant thoughts (mean 1.6, SD = 0.41) and thoughts of escape (mean 1.4, SD = 0.57). These results match those of Hatzigeorgiadis and Biddle's (2001) original TOQS study of volleyball players in terms of their rank order, but not in value. The volleyball players reported higher frequency of performance worry thoughts, mean 2.6 (SD = 0.98), situation irrelevant thoughts, mean 2.1 (SD = 1.11) and thoughts of escape, mean 1.9 (SD = 0.96). The 360 young team athletes measured by Lane et al. (2005) had even higher ratings for performance worries, mean 3.1 (SD = 1.16), and similar ratings for situation irrelevant thoughts, mean 2.1 (SD = 1.11) and thoughts of escape, mean 1.9 (SD = 1.04) to Hatzigeorgiadis and Biddle's (2001) university volleyball players.

These results are somewhat surprising, as previous research has suggested that high standard competition is associated with increased pressure (e.g. Woodman & Hardy, 2003). In comparison with the major international competition studied in the current research, Lane et al.'s (2005) data was collected from elite athletes during breaks in training and Hatzigeorgiadis and Biddle's (2001) data was collected at a university level competition. However, Woodman and Hardy (2003) also suggest that cognitive anxiety probably reflects athletes' ability to deal with the pressure experienced in competition. The difference in the frequency with which the hockey players experienced cognitive intrusions might reflect their greater ability to control their
thoughts and focus on task-related thoughts. Research (e.g., Krane & Williams, 1987) has suggested that more experienced and higher ability players are better able to control anxiety levels and maintain attention on relevant aspects of the task. It is possible that these elite players have developed coping strategies to help deal with the stresses of competition play which allows them to deal with cognitive intrusions in a more adaptive way than the athletes studied in previous research using the TOQS.

**PROCESSING EFFICIENCY THEORY**

It is possible to further explore the coping ability of the players in this study by examining the results in terms of the predictions made by PET. According to PET, state anxiety is determined by the interaction of trait anxiety and the level of perceived threat in any performance setting (Eysenck, 1996). Trait anxiety was assessed using the Spor Anxiety Scale (SAS; Smith et al., 1990) and perceived threat was categorized by the level of criticality (uncertainty and importance) inherent in the games played. State anxiety was measured in terms of the frequency of cognitive intrusions related to performance worries. As was predicted (hypothesis 1), the frequency of thoughts related to performance worries (Figure 1) were greater for the HTA players compared to their LTA counterparts. There was also a significant interaction effect, suggesting that the HTA participants found the high criticality games relatively more threatening than their LTA counterparts. This provides further support for PET's prediction that dispositionally anxious performers worry more in threatening situations than low trait anxious performers (Eysenck & Calvo, 1992).

The second hypothesis tested in this study concerned the performance of the two groups of players during the tournament. PET predicts that anxiety's influence on performance effectiveness might be less than expected because of the role of compensatory effort (Eysenck & Calvo, 1992). The findings of this study support the predictions of PET, although HTA players reported experiencing cognitive intrusions related to performance worries more frequently than LTA players (Figure 1), there were no differences in the coaches' ratings of their performance (Figure 3). Furthermore, there were no differences in player performance ratings in the high criticality games than in the low criticality games, despite performance worries being experienced more often.

The third hypothesis relates to PET's prediction that anxiety should typically impair processing efficiency more than performance effectiveness, as
effect more marked in dispositionally-anxious performers in threatening set-
tings. Comparability of performance effectiveness alone (Figure 3) may
therefore often camouflage reduced processing efficiency in HTA individu-
als (Eysenck et al., 2009). The results of this study support this prediction as
HTA individuals reported higher scores of effort than their LTA counter-
parts and therefore demonstrated lower processing efficiency. In addition,
there was a significant interaction effect, with HTA individuals exerting rel-
atively more effort in the games which were more critical (Figure 2). This
result for reports of effort following worrisome thoughts is similar to the
findings from Smith et al.’s (2001) study. These authors found that HTA vol-
leyball players also reported exerting more effort during high critical sets
compared to low critical sets, and compared to LTA performers during high
critical sets.
A potential limitation to the interpretation of the findings of this
study is that a sample size of sixteen players studied over four games could be
considered small. However, such limitations are not uncommon in research
into the effects of anxiety on performance involving elite performers. Such
studies also enable the testing of important theoretical predictions outside of
the confines of laboratory settings. Researchers adopting such settings (e.g.
Williams et al., 2002), have highlighted how laboratory based manipulations
cannot provide levels of ego-threat or anxiety commensurate with that expe-
rienced at major tournaments. Thus, the degree of internal control possible
with laboratory work needs to be weighed against the insights gained into the
coping strategies of elite athletes during more realistic sporting situations
(c.f. Woodman & Hardy, 2003).
There are two other potential explanations for the results found, beyond
the interpretation provided by PET, which need addressing. First, it could be
argued that a global performance measure may not be sufficiently sensitive to
the effects of anxiety on working memory (see Jones, 1995). However, recent
studies have employed similar expert judgements of performance (e.g.
Hardy, Mullen & Martin, 2003) to demonstrate the effects of anxiety on
sporting performance. The coaches in this study were experts in judging elite
performance and based their overall judgements on expected individual
position behaviours with respect to the requirements of the specific situation
(e.g., game objectives, level of opposition, game circumstance, etc.).
A second potential caveat to the interpretation of the results provided
here is that the lack of performance effect could be explained by the fact
that state anxiety may not have been sufficiently high to hinder perfor-
ance. If anxiety did not pre-empt sufficient working memory resources,
this could explain why only processing efficiency was impaired. State anxi-
cy was assessed by the frequency of cognitive intrusions related to performance worries and it was evident that these results were lower than for other team sport players who had completed the measure. Perhaps, despite the findings of Swain and Jones (1993), detailed measurement of the anxiety response needs an indication of the level of anxiety experienced, not just frequency. However, the differences in reported frequency levels may simply be due to the fact that the TOQS is a relatively new instrument and normative values may not be as reliable as for other, more frequently adopted scales (e.g., the CSAI-2).

Further support for the likelihood of high experienced state anxiety for these players comes from the previously highlighted research which suggests that high level competition is likely to be more threatening than lower level competition (Woodman & Hardy, 2003). This was the biggest tournament most of these players had experienced, in terms of competition level, audience size and media interest. They were expected to do well as a team and as competition within the squad was strong (only 11 of the 18 players could start each game), each player was under pressure to perform well.

Notwithstanding these concerns, the results of this study reinforce recent findings from research conducted in more constrained sport settings that have tested the predictions of PET (e.g., Wilcox et al., 2006). Both these studies demonstrated that the effect of trait anxiety on performance was mediated by state anxiety, and the effect of worry on performance effectiveness was less than on processing efficiency. The results of the current study also provided further support for the validity of the TOQS as a measure that enables cognitive intrusions to be examined in ecologically valid settings.

There are also clear implications for support work with athletes. By examining the TOQS individual question responses it is possible to understand more about what the athletes attended to during competition. The three most frequently reported thoughts across all games were from the performance worry subscale and reflected concerns over aspects of their performance. The most intrusive thoughts related to previous mistakes made during the game, and other more general concerns about how they were playing. When examining the two high criticality games, thoughts became more focused on the opposition and the potential result (outcome) of the game as opposed to their own performance. These thoughts are, however, still from the performance worry subscale which suggests that practitioners should prioritise focusing on helping athletes block and/or rationalise these types of cognitive intrusions (Mace, 1990). While not discounting the potential for other forms of cognitive intrusions (e.g., thoughts of escape and situational irrelevant thoughts) to negatively influence performance, it would appear
that they are less frequent in their occurrence for elite athletes, perhaps due to the high levels of motivation and focus required to perform at the highest levels.

Although it is not possible to examine the individual question response in either Hasegeorgiadis and Biddle’s (2001), or Lane et al.’s (2005) study, these studies also suggested that thoughts associated with performance standards are the most frequently experienced. Indeed Lane et al. (2005) comments that such a finding reinforces the importance of giving primary attention to self-efficacy building strategies to help maintain high performance expectations in the athlete. Furthermore, given the increased frequency of thoughts related to outcome and the opposition in tight games or when the opposition is very strong, strategies to help athletes focus on their own performance in these situations would also be useful (Hardy, Jones & Gould, 1996).

PET may therefore provide a framework to support such applied work. It suggests that feeling nervous, anxious or concerned before competing should not necessarily be considered to be debilitating to performance (c.f. Hardy, 1997). Performers can apply compensatory effort to help maintain performance. For example, performers can use worry about upcoming threatening situations as an opportunity to work on “What if...?” strategies (e.g., Hardy et al., 1996, pp.170), for how they would like to deal with the situation. In event, performers can focus effort on ‘controlling the controllables’ in order to cope with the distracting nature of cognitive intrusions (e.g., Hardy et al., 1996).

To conclude, the findings of this study support the predictions of PET: the negative effects of anxiety were more evident on processing efficiency than on performance effectiveness. The findings suggest that PET holds promise as a theoretical framework for examining the relationship between anxiety and performance in sport. With its focus on compensatory effort, PET may also be a useful framework for applied psychologists working with clients performing in pressured situations.

REFERENCES


