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Influence of Crowd Noise on Soccer Refereeing Consistency in Soccer

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Recent experimental evidence suggests that the noise of a partisan home crowd may influence soccer officials to make an imbalance of decisions in favor of the home side (Nevill, Balmer, & Williams, 2002). The purpose of the present study was to test the notion that biased decisions in favor of the home team are associated with increased anxiety and arousal due to increased difficulty of making accurate decisions when refereeing in the presence of crowd noise. Using the same video footage used by Nevill et al. (2002), 26 participants recorded decisions when fouls occurred. Participants completed the Competitive State Anxiety Inventory–2 immediately after performing the refereeing task. Degree of mental effort was recorded using self-report and physiological measures. Logistic regression indicated that participants were biased in favor of the home team in their evaluation of fouls carried out by one visiting and one home team. Significant relationships were found between decision bias and increases in cognitive anxiety and mental effort with crowd noise. Hierarchical regression indicated that mental effort and cognitive anxiety combined to account for 36% of the variance in decision bias. Results suggest that crowd noise is associated with increased anxiety and mental effort, and that referees attempt to cope with this increased anxiety and effort by giving a more popular decision in favor of the home team.

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Home advantage in team games has been defined as "the consistent finding that home teams in sports competitions win over 50% of the games played under a balanced home and away schedule" (Courneya & Carron, 1992, p. 13). For major team games, this phenomenon is well documented (for a review, see Courneya & Carron, 1992; Nevill & Holder, 1999). The home advantage observed, although variable in magnitude between team sports, and somewhat reduced over the past twenty years is consistently significant in soccer and across all major North American team sports, ranging from home winning percentages (excluding draws) of around 55% in major league baseball (Adams & Kupper, 1994; Pollard & Pollard, 2005; Carron, Loughead, & Bray, 2005) to around 55-60% for ice hockey and football, 60-65% for basketball and 60-70% for soccer (Carron et al., 2005; Pollard & Pollard, 2005).

Courneya and Carron (1992) proposed a conceptual framework of five major components thought to have an impact upon home advantage. These were game location, game location factors, critical psychological states, and performance outcomes. The present study focuses predominantly upon the impact of crowd factors (a game location factor), where the imbalance of crowd support in favor of the home side is thought to enhance home advantage. Such factors are thought by both fans (Smith, 2005; Wolfson, 2005) and often the media (Smith, 2005) to be the main cause of home advantage. Early studies focusing on crowd size or density had contrasting findings, with little or no relationship to home advantage in soccer (Dowie, 1982; Pollard, 1986) to a positive relationship between crowd density and home advantage in professional major league baseball (Schwartz & Barsky, 1977). More recently, studies in both professional soccer (Nevill, Newell, & Gale, 1996) and amateur ice hockey games (Agnew & Carron, 1994) have demonstrated relationships between absolute crowd size and crowd density respectively with home advantage. It should be noted that the poor model fit in the Agnew and Carron study led the authors to conclude that crowd density accounted for only a small proportion of the home advantage. Further to crowd size and density, a number of studies have used the introduction of domed stadiums in North America, to demonstrate that the consequential increases in crowd noise result in enhanced home advantage in football (Zeller & Jurkovac, 1989). Acker (1997) confirmed these findings, though some reservations were made regarding an inability to differentiate between factors of team quality and location. Likewise, difficulties emerge when attempting to separate familiarity factors (domed stadiums having different conditions) from crowd factors (domed stadiums having louder home support). Several researchers have also established that sports officials make more subjective decisions in favor of the home team than of the visiting team (Greer, 1983; Lehman & Reifman, 1987; Varca, 1980). Nevill et al. (1996) went on to demonstrate that in English soccer, this imbalance of decisions (in this instance measured in penalties and 'sendings-off') increased with crowd size (Nevill et al., 1996).

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Such studies led to the conclusion that the crowd may either be influencing players to perform differently, or affecting the match officials' decisions to favor the home side (Nevill et al., 1996). However, recent evidence suggests that a supportive crowd may not result in superior home performance (Strauss, 2002). Further, home players' performance may even suffer when stakes are highest (Wallace, Baumeister, & Vohs, 2005). Recent experimental research has aimed to investigate the latter hypothesis, that crowd noise results in an imbalance of refereeing decisions in favor of the home side (Balmer, Nevill, & Williams, 2001a; Nevill, Balmer, & Williams, 1999, 2002).

Investigating the influence of crowd noise on referees' decision-making in actual match settings is problematic since it would be extremely difficult to effectively compare referee decisions in different games. Crowd noise and other situational factors may influence a decision specific to each game. In an attempt to overcome this limitation, experimental work has provided strong evidence that crowd noise plays a major role in this imbalance (Balmer et al., 2001a; Nevill et al., 1999, 2002). In these studies, participants were required to make judgments on pre-recorded incidents, either with or without crowd noise. In all cases, crowd noise as opposed to silence, resulted in an imbalance of decisions in favor of the home side. Participants reported significantly more decisions in favor of the home side in a crowd noise condition compared to a silent condition, either by penalizing the home side less or by penalizing the away side more, or both. The present study extends this line of investigation by exploring the factors associated with inconsistent decisions. One possible explanation for giving more decisions in favor of the home team could be that inconsistent decisions under the presence of a vociferous crowd, in compared to refereeing in quiet conditions, can be attributed to increased stress.

Officials have been shown to exhibit significantly more cognitive anxiety before games than after (Burke, Joyner, Pim, & Czech, 2000). Officials feel that fans are often unsympathetic towards problems associated with officiating (Mitchell, Leonard, & Schmitt, 1982). Evidence demonstrates that making an incorrect decision is the single most important stressor in sports officiating (Kaissidis & Anshel, 1993; Stewart & Ellery, 1998; Taylor, 1990). A referee who gives a contentious decision against the home team is likely to incur vociferous crowd noise. Despite the overriding pressure on officials to avoid "making bad calls", errors are optically inevitable due to limitations in perceptual function (Sanabria, Cenjor, Márquez, Gutierrez, Martinez, & Prados-Garcia, 1998). Examples include assessing first base calls in baseball (Rainey, Larsen, & Willard, 1987; Larsen & Rainey, 1991) 'leg before wicket' decisions in cricket (Craven, 1998) and 'offside' decisions in football (Oudejans, Verheijen, Bakker, Gerrits, Steinbrückner, & Beek, 2000; Sanabria et al., 1998).

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Research evidence suggests that when sources of stress are difficult to control (e.g., crowd reaction to a contentious decision) individuals often deal with them proactively via the use of an avoidance coping strategy (Anshel & Weinberg, 1999; Kaissidis-Rodafinos, Anshel, & Porter, 1997). Soccer referees cannot simply remove themselves from potentially stressful situations, such as whether to penalize the home team in the presence of a vociferous home crowd. Instead, when a situation is perceived as stressful, and where there is at least a moderate probability of achieving a successful outcome, anxious individuals are likely to invest more on-task effort until such a time that increased effort no longer mediates the negative consequences of sustained engagement. In stressful situations where there is a low probability of decreasing the effects of anxiety with increased effort, anxious individuals are likely to engage in a coping strategy that allows them to avoid the likely aversive consequences (e.g., avoidance) (Eysenck & Calvo, 1992). For example, when faced with a decision to penalize the home side, an anxious referee might avoid this decision by allowing play to continue (either no foul or playing an advantage). Furthermore, this effect might be more pronounced among referees who are particularly prone to high levels of anxiety (Eysenck, 1992).

The purpose of the present study was to assess whether participants' decisions could be influenced by partisan crowd noise. If partisan crowd noise were to increase levels of stress, this would likely be indicated by changes in physiological arousal (e.g., heart rate), or anxiety. First, it was hypothesized that the addition of crowd noise would result in a significant imbalance of decisions in favor of the home side. Second, it was also hypothesized that participants with the greatest decision bias in favor of the home side would exhibit higher levels of anxiety and allocate more cognitive resources (i.e., mental effort) to the task. Consequently, the home side would be 'under-penalized' in order for the referee to avoid negative consequences from the partisan crowd. This study also investigated the extent to which trait anxiety was associated with state anxiety scores. Trait measures were taken before participation in the experiment to provide an indication of those individuals who were predisposed to respond with higher levels of state of anxiety under test conditions.

Method

Participants

Twenty-six male participants (M age = 31.23 yrs.; SD = 6.34) volunteered to take part in the study. All participants regularly watched soccer (a minimum of watching 20 live games per season (range 20 – 42 games per season) and had coaching, playing and/or refereeing experience (M = 10.50 yrs.; SD = 2.30). Nevill et al. (2002) used a sample of forty qualified referees (ranging from newly qualified to 43 years of refereeing experience) and found that experienced

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referees were as susceptible as less experienced referees in terms of giving biased decisions in favor of the home side. Informed consent was obtained prior to participation. Participants were briefed on the nature of the task before prior to the first test period. The task did not involve the application of complex laws, and decisions were restricted to three simple options (either a home foul, away foul or no foul).

Measures

Test film. As the purpose of the study was to investigate factors associated with the effects of crowd noise, a competitive game was selected in which a home advantage was anticipated. The present study used a competitive game from the English Premier League between Liverpool (home) and Leicester City (away) from the 1998/99 season.

The incidents were block randomized by half (first vs. second) and back projected onto a 3-m x 3.7-m screen (Cinefold) using a video-projection system (Sharp XG-NV2E) and video-cassette recorder (Panasonic NV-HD680). The videotape comprised of 47 incidents each lasting approximately 9 secs. Each incident was edited to occlude the match official's decision. An inter-trial interval of 6 secs was employed. In both silent and noise conditions, each participant made a total of 47 decisions divided amongst the three options. Noise level was measured using a digital sound level meter (Tenma 72-680), with a 1 kHz test tone yielding 75 dB (absolute) at 1 m. A three-lead electrocardiogram was taken throughout the duration of all incidents using Maclab for Macintosh, and the data were analyzed using Chart software.

Trait anxiety. Participants' trait level of anxiety was measured using the trait component of the State Trait Anxiety Inventory (STAI) (Spielberger, Gorusch, & Lushene, 1970). The inventory comprised 20 items, with intensity of response for each item rated on a 4-point Likert scale ranging from 1 '*Not at all*' to 4 '*Very much so*'. This scale yielded a single measure of trait anxiety for each participant.

State anxiety. Participants also completed a modified Competitive State Anxiety Inventory-2 (CSAI-2; Martens, Burton, Vealey, Bump & Smith, 1990) incorporating Jones and Swain's (1992) directional scale before the first test period (baseline), and following testing in both conditions. The modified post-test CSAI-2 questionnaires were adapted to gauge participants' feelings during testing in which present tense was converted to past tense.

The CSAI-2 (Martens et al., 1990) is comprised of 27 items, with 9 items on each of three separate sub-scales of cognitive anxiety, somatic anxiety, and self-confidence. Intensity of response for each item was rated on a 4-point Likert scale ranging from 1= '*Not at all*' to 4 = '*Very much so*'. This measure yielded scores ranging from 9 to 36 on each sub-scale. The modified inventory included a directional scale to assess participants' perception of state anxiety as either debilitative or facilitative to performance (Jones & Swain, 1992). The direc-

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tional items comprised of a 7-point Likert scale ranging from –3 ='*Very Negative (Debilitative)*' to 0 ='*Undecided*' to +3 ='*Very Positive (Facilitative)*'. This inventory yielded a range of scores from –27 to +27 on each sub-scale.

Rating scale mental effort. The Rating Scale Mental Effort (RSME; Zijstra, 1993, also see Williams, Vickers, & Rodrigues, 2002) was used to assess mental effort. The RSME consisted of a vertical scale ranging from absolutely no effort (0) to complete effort (150). Nine additional descriptive indicators on the scale (e.g., some effort, extreme effort) describe these quantities as a measure of effort.

Electrocardiogram data. Electrocardiogram (ECG) data were recorded using a standard three lead set up. Baseline data were collected for approximately four minutes, and for the duration of the test tape in each condition (silent and noise). The time of each R-peak (i.e., polarization of the left ventricle) was calculated separately for baseline and test period, following manual correction of detection parameters. This correction ensured that R-peaks were correctly detected without false detection of artifacts. Spectral analysis of the inter-beat intervals (time between each R-peak) was split into three bandwidths (Mulder, 1979), and the heart rate variability for the mid-range frequency (0.07-0.13 Hz) extracted. Extraction of this mid-band was used to provide an index of effort/mental load (Jorna, 1992) both between baseline and test periods and more importantly between conditions. Mean heart rate values for each participant were also recorded for the baseline period and during the test tape in both conditions.

Procedure

The participants were randomly assigned to one of two groups, a noise group (without commentary), or a silent condition group, with a retest on the opposite condition following a one-week 'washout' period. None of the participants reported having previously observed the game under investigation. Half of the participants were exposed to the crowd noise audible (noise condition), while half initially viewed the video in silence (silent condition). Preceding the presentations, participants were informed as to the identity of the two teams and the location of the match. Throughout the 6 sec inter-trial interval, participants indicated their decision, with the experimenter recording the responses. Participants were asked to make one of three decisions in response to each incident. These were Liverpool foul (a foul committed by a Liverpool player), Leicester foul (a foul committed by a Leicester player), or no foul. Following presentation of the test tape, all participants were asked to rate their effort on the Rating Scale Mental Effort and complete the CSAI-2.

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Analysis

Multinomial nominal logistic regression was used to test the first hypothesis that the addition of crowd noise would result in a significant imbalance of decisions in favor of the home side. Multinomial nominal logistic regression assesses the effect of crowd noise on participants' decision-making related to home foul, away foul, no foul, simultaneously. Binary logistic regression was used subsequently to assess the effect of crowd noise on each of the three response categories separately. Logistic regression estimates the probabilities, or more correctly the odds ratios, associated with the three categorical options and the variability of these probabilities due to differences in the predictor/independent variables (see Kleinbaun, 1994). Similar to previous experimental studies, e.g., Nevill at al. (1999, 2002), responses were not catergorized as either 'correct' or 'incorrect', but were examined by assessing the changes in numbers of the three response categories between silence and noise conditions. This avoided questionable classification of 'correct' decisions in often highly contentious incidents.

It should be noted that relative proportions of each of the three options (in silence) are primarily a function of the set of 47 incidents presented on the test tape. For example, a different test tape may yield far more home fouls simply due to the nature of the incidents. There should be no expectation that participants should award a similar number of fouls against home and away teams. Moreover, results from Nevill et al., (2002) suggest that the test tape contains more home fouls overall, regardless of noise condition. Consequently, neither the silent nor noise conditions should result in isolation can yield any information about decision bias. Of interest to the present study is how the frequency of response changes between noise conditions, with decision bias assessed on this basis.

The second hypothesis, predicted that participants with the greatest decision bias in favor of the home side would exhibit higher levels of anxiety and allocate more cognitive resources (i.e., mental effort) to the task. To address this hypothesis, differences between scores taken in silence and noise conditions for CSAI-2, mental effort and heart rate variables were calculated. A measure of bias was calculated for each participant, relating to the change in number of decisions in favor of the home side as a result of crowd noise. Data were coded '1' (home foul), '0' (no foul) and '-1' (away foul). These values were summed across all challenges for each participant and for each noise group. Subtracting noise from silent condition values yielded each participants' bias toward the home side. A value of +4, for example, would indicate a participant giving four more decisions in favor of the home side in the noise compared with the silent condition. Similarly, –2 would indicate the noise condition resulting in two more decisions in favor of the away side. Where the decision was changed from 'no foul' to 'home or away foul' or vice versa, for any given challenge, a score of +1 or –1 was awarded, respec-

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tively. Changing between 'home foul' to 'away foul', or vice versa (i.e., overlooking 'no foul'), would yield scores of +2 or –2. This procedure generated a single measure of bias for each participant, which could be related to various continuous measures of anxiety and mental effort.

The second hypothesis was tested using correlational and hierarchical multiple regression methods. Correlation was used to identify significant univariate relationships between bias and stress-related predictor variables. The difference between noise and silent conditions was calculated for CSAI-2 scores, RSME, heart rate, and heart rate variability. Hierarchical multiple regression was used to predict bias scores using a linear combination of those variables identified as significant in the correlation matrix. The variables with the weakest significant relationship were entered into the regression model first, whereas those with stronger relationships were entered subsequently (see Tabachnick & Fidell, 1996). Previous research has used this approach when there is not a clearly defined theoretical framework or where research is partly exploratory (Treasure, Monson, & Cox, 1996).

Results

Hypothesis One

The multinomial and binomial logistic regression analyses revealed a significant ($p < .05$) main effect for 'noise condition', confirming the importance that crowd noise has on participants' decisions. As Figure 1 illustrates, in comparison with the silent condition, under noise conditions, participants awarded fewer fouls against the home side ($M = 11.0$ vs $M = 13.9$, Odds ratio, Exp (β) = 0.51, $p < 0.001$), a similar number of decisions against the away side ($M = 11.1$ vs $M = 10.4$, Odds ratio, Exp (β) = 1.20, $p > 0.05$), and more 'no foul' decisions ($M = 24.9$ vs $M = 22.7$, Odds ratio, Exp (β) = 1.35, $p = 0.003$).

Hypothesis Two

Mean values for heart rate, heart rate variability, mental effort (RSME) and CSAI-2 can be found in Table 1. There were no significant differences ($p < .05$) on CSAI-2 scores, RSME, heart rate, and heart rate variability between noise and silent conditions ($p > .05$). Results indicated that delta values (differences) in cognitive anxiety intensity ($r = .55, p < .01$) and mental effort scores ($r = .54, p < .05$) between silent and noise conditions were the only significant correlates with bias. The direction of the relationship indicated that increases in cognitive anxiety in the noise condition were associated with bias scores. Cognitive anxiety intensity and mental effort were significantly related ($r = .44, p < .05$), suggesting the possibility of some common variance among the three variables. This was expected given that previous research suggests that

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cognitive mechanisms of anxiety and effort allocation are inter-related (see Eysenck, 1992; Eysenck & Calvo, 1992; Hockey, 1986). There were no significant relationships ($p < .05$) between trait anxiety scores and all other variables. Readers interested in examining the full correlation matrix should contact the corresponding author.

To predict bias scores from mental effort and cognitive anxiety, hierarchical multiple regression indicated that 36% of the variance ($Adj\ R^2 = .36, p < .05$) was explained. Mental effort accounted for 26% of the variance in bias scores with cognitive anxiety adding an additional 10%.

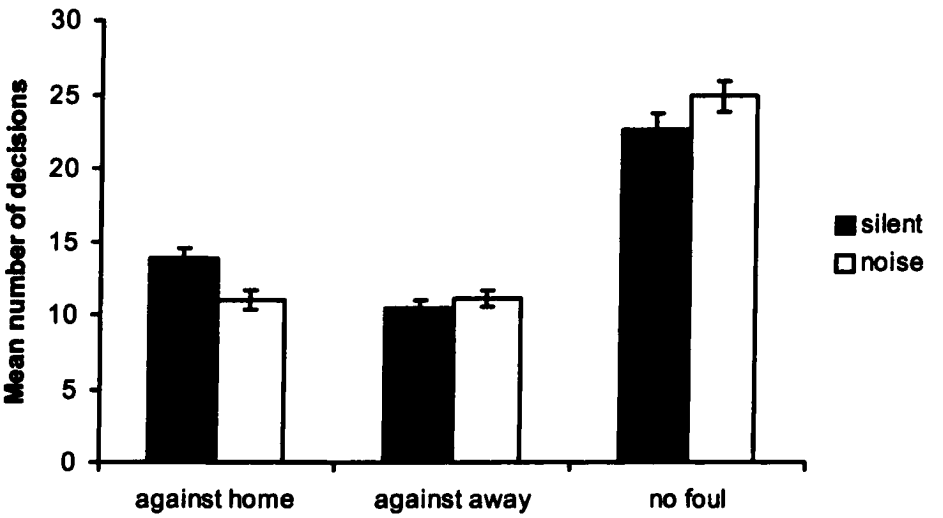

Figure 1. *Mean number of decisions for each of the three response options awarded in noise and silent conditions.*

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Table 1. *Mean Values (With Standard Deviations) For RSME, Heart Rate, Heart Rate Variability and CSAI-2 subscales.*

	Silent	**Noise**	**Baseline** (only one measurement)
RSME	64.4 (22.1)	63.9 (22.4)	-
Baseline heart rate	68.5 (9.29)	70.0 (9.0)	-
Test heart rate	67.6 (12.5)	70.4 (12.5)	-
Baseline heart rate variability	1143.8 (824.2)	920.0 (707.7)	-
Test heart rate variability	985.0 (689.6)	872.8 (537.0)	-
Trait Anxiety			36.32 (7.35)
Cognitive anxiety (intensity)	12.6 (3.1)	12.9 (4.0)	11.7 (3.2)
Cognitive anxiety (direction)	12.4 (12.2)	13.6 (11.4)	13.5 (11.8)
Somatic anxiety (intensity)	11.5 (3.3)	11.2 (2.5)	10.7 (1.8)
Somatic anxiety (direction)	15.3 (9.3)	16.5 (9.1)	17.1 (8.4)
Self-confidence (intensity)	26.2 (6.4)	26.2 (6.0)	27.5 (5.4)
Self-confidence (direction)	16.8 (7.9)	16.9 (7.6)	16.8 (8.4)

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Discussion

The presented study tested the notion that biased refereeing decisions in favor of the home team are associated with increased anxiety and arousal due to increased difficulty of making accurate decisions when refereeing in the presence of crowd noise. Results showed support for the first hypothesis that refereeing in the presence of crowd noise was associated with a significant imbalance of decisions in favor of the home side. Results demonstrated that fewer fouls against home players was associated with crowd noise. The decrease in decisions against home players with crowd noise was highly significant and replicated the findings of Nevill et al. (2002). The observed imbalance in favor of the home side provides some support to the hypothesis that the crowd may be influencing officials to make an imbalance of decisions in favor of the home side (Nevill et al., 1996) rather than influence players to alter their performance. Support for the latter hypothesis is inconsistent, and while home performance has been shown to be superior with crowd noise (Greer, 1983), more recent evidence suggests the crowd has little positive impact upon home performers (Butler & Baumeister, 1998; Strauss, 2002; Wallace, Baumeister, & Vohs, 2005). Findings also agree with archival studies demonstrating significantly higher home advantage in sports where officials have a greater subjective input (Balmer, Nevill, & Williams, 2001b; 2003) and greater home advantage where outcome is judged by officials rather than decided directly by the competitors (i.e. points decision vs. knockout in boxing) (Balmer, Nevill, & Lane, 2005). It seems plausible that the imbalance shown in these studies could result from the impact of crowd noise upon officials, and that this is a major factor determining the magnitude of the home advantage.

Second, it was also hypothesized that participants with the greatest decision bias in favor of the home side would exhibit higher levels of anxiety and allocate more cognitive resources (i.e., mental effort) to the task. Findings suggested that decisions biased in favor of the home side were associated with cognitive anxiety and mental effort scores, whereas no such association was found for heart rate, heart rate variability, and somatic anxiety scores. It is important to note that this effect occurred in the absence of significant differences in mean scores in anxiety and effort scores. This finding highlights the relatively subtle influence of anxiety on the process of decision-making. It could be argued that failure to show significant differences in physiological and psychological scores indicates that the experimental condition did not induce stress. It should be noted that physiological measures were averaged over the entire experiment and psychological measures were taken retrospectively. It is possible that there was an increase in stress before contentious decisions but the number of different incidences precludes such an analysis. Future research could control for this effect by having fewer decisions and testing psychological and physiological responses on a decision-by-decision basis.

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In the present study, participants were unable to completely remove themselves from the decision-making situation to avoid the perceived stress of giving a legitimate decision against the home team (cf. Humphreys & Revelle, 1984). Instead, participants who exhibited higher levels of cognitive state anxiety, also increased their mental effort. According to Eysenck and Calvo (1992), increased state anxiety pre-empts the mobilization of cognitive resources or processing strategies to proactively cope with perceived stress (Eysenck & Calvo, 1992). Consequently, those individuals who experience higher levels of anxiety would be motivated to invest additional effort towards reducing any negative consequences associated with making a contentious decision.

These findings are in contrast to Humphreys and Revelle (1984) who found that when threatened by a perceived stressor, such as the reactions of a partisan crowd, worry can motivate a referee to adopt an avoidance motivation strategy by reducing on-task effort, which ultimately results in inconsistent decision-making. The present findings showed that mental effort increased rather than decreased, and this increase was associated with an imbalance of decisions in favor of the home side.

One limitation of the present study is the moderate level of ecological validity, particularly with respect to the interactive nature of crowd noise. Whilst there is a trade-off between external validity and the ability to control potentially confounding variables in laboratory-based research, many successful simulation-based research programs have utilized *in vitro* methodology (see Ericsson & Smith, 1991). To circumvent this debate, future research could interview referees after the game by eliciting verbal reports in a manner consistent with Ericsson and Simon (1993) to explore the interplay between affective states, cognitive processes, and decision-making during the game.

In summary, this study tested the influence of partisan crowd noise on refereeing decisions in soccer, and examined mechanisms underpinning such influence. First, the presence of crowd noise resulted in significantly greater leniency toward the home side. Furthermore, when exposed to crowd noise, participants who exhibited greatest leniency toward the home side were also likely to have greater anxiety and mental effort scores. Accompanying increases in cognitive anxiety and mental effort suggest participants anticipated, and attempted to avoid further negative consequences of anxiety produced by making an unpopular decision, resulting in fewer decisions awarded against the home side. It is suggested that future explores the strategies that professional soccer referees use to cope with stressors that can influence decision-making in the presence of a vociferous crowd.

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