CONTEXTUAL AND DISPOSITIONAL INFLUENCES ON NETBALL UMPIRES' DECISION MAKING.

A Thesis Submitted for the Degree of Doctor of Philosophy

By

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Abstract

Much of the sports officiating research literature has sought to understand environmental influences on officiating – most notably in soccer. The current body of work extends the existing literature, by investigating not only contextual influences on naturalistic decision making but also the influence of dispositional tendencies – specifically, umpires' predisposition to deliberate and reflect on their decisions, i.e., their tendency to *reinvest* and *ruminate*. Performance analyses of an entire Netball Superleague season demonstrated that netball umpires' decision making was influenced by several contextual factors, including crowd size and Decision Rumination. Reduced decision frequency – an avoidance-type behaviour – was associated with time elapsed, league position, crowd size, competition stage, and Decision Rumination. A lab-based investigation into the effects of crowd noise, a novel game management dual-task and pressure on decision making demonstrated that the intensity of the variables (under pressure, with crowd noise, with secondary task) reduced participants' decision making accuracy. Reduced processing efficiency was indicated by increased scan ratios gaze on informative areas of the display, and an increase in mental effort under pressure and dual-task conditions. A reversion to novice-like thoughts, and fewer cognitive/top down sources of information were used to make decisions. Contrary to previous research, Decision Rumination was associated with better performance under these conditions. A final study sought to understand whether the impact of Decision Rumination on performance was context-specific by manipulating the feedback participants received during a lab-based video decision task. Following negative feedback, High Decision Ruminators were less confident and less accurate compared to Lower Ruminators. It is possible that whether trait Decision Rumination is debilitative or facilitative may be context-specific. The discrepancies and commonalities of the present findings in relation to the extant literature are discussed.

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Poster Presentation

Chapter 3 presented at: North American Society for the Psychology of Sport and Physical Activity Conference 2016. Burnett, A. M., Kinrade, N. P. & Williams, A. M. (2016) Decision making behaviour of officials: Examining potential biases. *Journal of Sport and Exercise Sciences,* supplement, 38, S167.

Publications

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1. Chapter 1: Introduction

1.1. Context of the thesis

Sport provides an ideal setting to examine decision making, due to the variety of personnel involved (athlete, coach, sport official, etc.), the diversity and complexity of the inherent behaviours (e.g., passing, interception, team selection, rule-based infringement decisions) and the contexts in which decisions take place (live play, timeouts, etc.). Within any given sport, players, coaches and officials may share a common knowledge base (e.g., declarative knowledge of the rules and execution of the sport), but their roles require them to complete very different tasks. Judges, referees, umpires and officials are an essential component of any sports competition, as they are responsible for evaluating athletes' performances, enforcing rules, and game management, and often have a direct impact on the outcome of a competition (Plessner & MacMahon, 2013). For this reason, *inter alia*, this thesis focuses on the sports official; more specifically, its focus is on netball umpires.

Despite the necessity for officials in every professional sport, sports officiating research has emerged only relatively recently (Plessner & MacMahon, 2013). Sports officials strongly depend on their decision making skills to perform well (Lane, Nevill, Ahmad, & Balmer, 2006), making decisions within a complex and dynamic environment often with multiple distractors (MacMahon & Mildenhall, 2012) – particularly because the elite sport world has growing financial, commercial and media interests, leading to greater public scrutiny (Johansen & Haugen, 2013). Failure to cope with the psychological demands of the sport has been associated with referees making inaccurate decisions (Anshel, Sutarso, Ekmekci, & Saraswati, 2014) which can have a significant influence on not just the result of the competition, but also the careers of players, coaches and the referees themselves (Mellick, Fleming, Bull, & Laugharne, 2005)

The roles of a sports official vary across sports. Plessner and MacMahon (2013) suggested three general categories of officials' roles: *monitors*, *reactors* and *interactors*. Although the nature of these roles differs, certain similarities can be drawn: they all entail the observation and interpretation of perceptual events; and they require storage of information either concerning rules of a game (e.g., offside.), and/or level of difficulty and execution (e.g., attempted moves in gymnastics.). This declarative information will be retrieved along with episodic memory (MacMahon & Ste-Marie, 1999) during the analysis of complex movement

patterns for identification of subtle variations in movements or detection of errors and infractions. Netball umpires can most accurately be described as *interactors* – those who have a high level of interaction with athletes, have an impact on the pace of competition on a moment-by-moment basis, ensure that rules and laws of the game are enforced, and who are instrumental in ensuring competitors' safety (MacMahon et al., 2014). Netball umpires have a range of responsibilities, including a duty of care to the players ensuring a safe playing environment, match procedures initiating the start and end of the game. Moreover, and the focus of this thesis, rule implementation involving correct identification and sanctioning of infringements, and game management ensuring that players, coaches and spectators comply with the rules in a sporting and fair manner (Plessner & MacMahon, 2013).

The decisions that sports officials make may vary in complexity, but the most challenging decision making situations they face may exceed their information processing capacity; for example, when line judging in tennis, the speed of the ball means that it is not possible for the perceptual system to determine whether the ball is in or out (Jendrusch, 2002). Frequently, sports officials must make decisions in situations that are unclear or ambiguous; for example, only having a partial view of an infringement. Due to the speed of play, and the close proximity to the action, netball umpires only have a brief moment to determine whether an infringement has occurred. In this brief moment, umpires must consider several categories of rules (playing the ball, footwork, passing distances, offside, obstruction, contact etc.), to award one of three sanctions (free pass, penalty pass or advantage) or two types of play restarts (toss up or throw in) and additionally, any game management action (caution, warning, suspend a player, order a player off). Some rules are more complex to assess for example, although netball is considered a non-contact sport, opposing players may often come into physical contact with each other. Whereby umpires are required to continuously make split second decisions as to whether it was a contact, where a player's actions interfere with the opponent's play, or whether it was a fair contest, where no unfair advantage is gained by either player. To add to the difficulty level, umpires must be aware of not only the action occurring around the ball, but also the players contesting in the rest of their half of the court (up to 12; 14 players in total on the court). The situational and organisational constraints of netball umpiring pose an interesting naturalistic decision making environment in which to explore decision behaviours and performance, and dispositional susceptibility to underperformance.

1.2. Netball and the Netball Umpire

Netball is a game of two teams of seven players whose aim is to gain and keep possession of the ball in order to score more goals than the opposition. The seven players on the team have different positional responsibilities (e.g., defence, midcourt, and shooters) and are restricted to certain areas of the court. A netball match is made up of four quarters of 15 minutes, in which teams change ends each quarter. At the elite level, quarter times are 4 minutes in duration and half time is 12 minutes. The Superleague Netball season follows a normal home and away league phase where teams are aiming to place in the top 4 for play-offs. The four teams that finish in top 4 at the end of the regular season then play seeded semi-final matches (e.g., 1st v 4th, 2nd v 3rd); the winners of these matches then play off for the final, and losers for the 3rd/4th place play off.

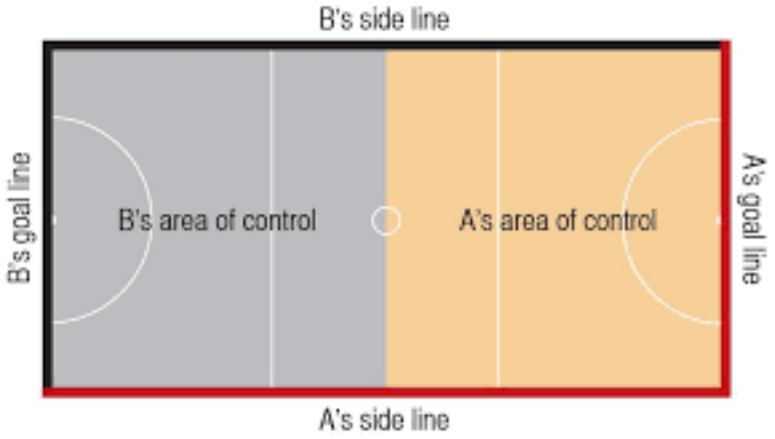

Figure 1.1. The umpire's area of control (International Netball Federation, 2018).

In the game of netball there are two umpires present, each umpire is responsible for, and has control, over decisions for one half of the netball court, an entire sideline and goal line (see Figure 1.1.) for the whole duration of the game. A netball umpire's movement is off court and in an '*L'* shape from the transverse line beyond their half, to their goal line, staying in line with the ball as it progresses through court. It is reported that elite netball umpires cover approximately 3850m during a 60 minute match, including movement patterns of walking, jogging, side stepping and changing direction, and 140 sprints for a mean duration of 2.8s (Spencer, McErlain-Naylor, Paget, & Kilding, 2019). A netball umpire's responsibilities include starting and ending each quarter, restarting play after a goal is scored, indicating when an infringement has occurred and awarding the penalty, indicating when a ball is out of court, signalling to timekeepers when

to pause and restart timing, maintenance of on-court safety, and game management (i.e., managing player behaviour and *repeat infringers*). In England, there are three levels of national umpire award available: beginning at C award (local or county league), B Award (regional league), A award (National league), and International Umpire Award (International). Umpire development is centred on attendance at award courses, theory tests, mentoring (by volunteers), assessment days, and match experience.

1.3. Structure of the thesis

This introduction is followed by a critical review of the literature relevant to the present work (Chapter 2). The aim of this section is to introduce the pertinent theoretical constructs and perspectives investigated in each of the three study chapters of the thesis to the reader. The review summarises the literature on decision making and working memory to provide a foundation for understanding the factors that affect decision making; notably, biases, pressure, and dispositional influences. Chapters 3 to 5 represent the three studies of the present programme of research, presented as standalone papers. Therefore, each chapter encompasses an introduction that reviews the relevant literature specific to the study. Consequently, some key content underlying this thesis is repeated. Finally, Chapter 6 provides a general discussion that summarises the main results of the three studies. Directions for future research and the practical implications of the findings are also discussed.

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2. Chapter 2: Literature Review

This chapter outlines the core themes and theoretical concepts to fulfil the aims of the thesis. The first section outlines key decision theories applied to sports decision making. The next section considers the sources of pressure, contextual influences, and biases on sports officials' decision making to date. The preceding section outlines two concepts central to this thesis: attention and working memory. The remainder of the chapter synthesises research on the individual differences concept of dispositional decision Reinvestment and Rumination. Finally, the aims of the thesis are stated.

2.1. Decision making

Decision making has been defined as the capability of individuals to select functional actions to achieve a specific task goal from a number of action possibilities (Hastie, 2001). The speed and accuracy of the decision is dependent on the information acquired through perceptual skills and its appropriateness for effective response selection (Janelle & Hillman, 2003). Effective decision making requires the integration of perceptual information with knowledge obtained from previous experiences and places varying demands on cognitive resources, depending on the complexities of the task (Raab, 2003) and the extent to which performance depends on working memory (Jameson, Hinson, & Whitney, 2004). If we take netball umpires as an example, their decisions occur in a time-constrained, dynamic environment, in which the complexity may vary. Raab (2003) describes environmental complexity as the amount and connectivity of available information. In the context of netball umpires, complexity may vary as a result of the level they are officiating, the ambiguity of the situation, and the consideration of game management factors. Although team sports officials' decisions have an immediate effect on the game, the decision may ultimately have significant consequences for the outcome of the match (e.g., awarding a penalty for a foul, and that penalty is the winning goal in the match).

Decision making research has resulted in several groups of theories. Classical Decision Making (CDM, Savage, 1954) theories were developed as normative models of rational behaviour, highlighting deliberate and analytic processes to make a choice among a set of available options. Behavioural Decision Theory (BDT, Edwards, 1954) and Judgement and Decision Making (JDM, Meehl, 1954) were developed to overcome the main limitation of CDM: an inability to explain why people deviate from rational choices. BDT and JDM assume that

there are rational reasons for the choice, and that an optimal decision exists. Organisational Decision Making (ODM, Simon, 1957) explained, through bounded rationality, that decision makers seek a solution that satisfies the situation, rather than the optimal one, as a consequence of time constraints, cognitive limitations and the decision problem itself. Conversely, theories of Naturalistic Decision Making (NDM, Klein, 2008) aim to understand how people make decisions in real world contexts and acknowledges that the decisions they make is the subject of their experiences. To provide an overview of all decision theories is beyond the scope of this thesis. However, the next section provides a brief description of decision theories that have been applied in sports contexts.

2.1.1. Decision making Theories in Sport.

2.1.1.1. Information Processing Model.

Within sport, a social cognitive information-processing model has been applied. The framework states that decision making involves several subtasks – perception, categorisation, memory, and information integration (see Figure 2.1) – to address social information which leads to a behavioural response, i.e., the decision (Bless & Fiedler, 2014). At the first stage, the stimulus is perceived (e.g., the netball umpires attends to the contact situation). Following, the stimulus is encoded and given meaning (e.g., it is characterised as a transgression against the opposing player). At this stage, prior knowledge is essential in order to identify the infringement (e.g., the umpire must retrieve knowledge from long-term memory for decision criteria). Thus, this stage is susceptible to influences via the retrieval of episodic memories. Finally, the perceived and encoded information is integrated with retrieved memories, along with any other available information, and results in a decision (e.g., awarding a penalty pass). Erroneous decisions can occur at different stages of the information-processing model. At the perceptual level, focusing on a different region of the visual scene could lead to missed information or misperception (incorrect interpretation), crucial for determining the outcome of a decision. For example, the misperception of the opposing player knocking the ball out of hands, rather than a dropped ball; or at the information integration stage, where the false memory that a player has persistently infringed and requires harsher punishment. Applying this model to sport enables identification of the specific stage at which information processing errors occur (Plessner &

Haar, 2006). However, information processing models have been criticised due to the failure to adequately explain how cognition links with emotion, perception and action (Moran, 2009).

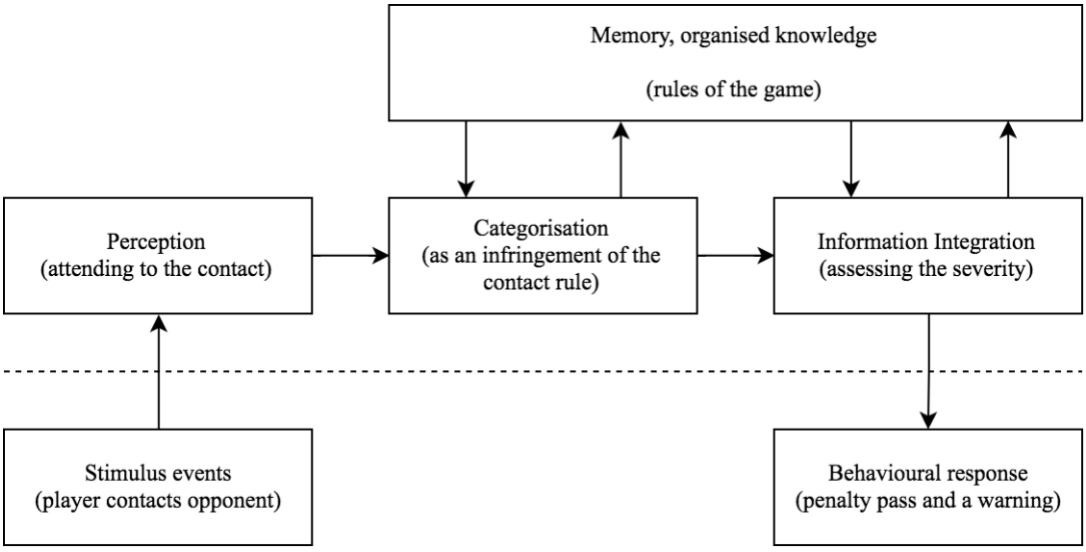

Figure 2.1. Social information processing model (Bless & Fiedler, 2014) applied to a netball umpire's decision situation.

2.1.1.2. Long Term Working Memory Theory

Long Term Working Memory Theory (LTWM) suggests that, rather than relying on intuitive processes to generate options, skilled decision makers develop elaborate mental representations of their domain (Ericsson & Kintsch, 1995; Ericsson, 1998). This situational information is constantly stored, integrated, and updated, and is accessible for retrieval during performance (Ericsson, 1998). Experts acquire flexible and detailed representations that promote rapid encoding of information in long-term memory, circumventing the limitations of short-term working memory, which allows successful anticipation of future retrieval demands (Ericsson & Kintsch, 1995). A key feature of LTWM theory is that there is no prescribed response to a situation. Each representation that is retrieved represents several available options to be evaluated, resulting in improved decision quality (Ericsson, Patel, & Kintsch, 2000). At the expert level, complex retrieval structures enable the performer to predict future retrieval demands (Ericsson & Kintsch, 1995). LTWM therefore predicts that experts would verbalise more evaluative and predictive information when making decisions. Evaluation statements relate to the consideration of multiple options and courses of action. Prediction statements consist of anticipatory encodings and refer to potential future events. In comparison, lesser-skilled

performers' verbalisations rely on monitoring statements related to immediate perceptions of the environment.

LTWM theory has been applied in the healthcare domain, in a comparison of expertise differences in emergency medicine physicians (McRobert et al., 2013). Skilled physicians made more accurate diagnoses and were more able to extract contextual information. Consistent with LTWM theory, skilled physicians made more evaluation and prediction statements. Furthermore, skilled participants demonstrated superior domain-specific knowledge and retrieval structures, through their ability to diagnose accurately with less contextual information, which suggests that they retrieved declarative knowledge of similar situations to make decisions in the absence of contextual information. Similarly, in sport, skilled players have exhibited superior anticipation skill and greater use of predictive statements compared to less skilled players in a simulated cricket batting task (McRobert, Williams, Ward, & Eccles, 2009).

2.1.1.3. Heuristics

Whilst LTWM explains option generation and selection as a rational, economic process, others suggest simpler strategies for decision making – heuristics. The fast and frugal heuristics approach views a heuristic as a basis for intuition and suggests that the use of intuitions and heuristics to produce decisions results in choices as good as those made with more deliberative approaches. Heuristics generally are composed of rules, including search rules (where to look for the solution), stopping rules (that initiate the end of the search), and decision rules (that specify how to make a decision). For example, in sports, the use of the take-the-first heuristic explains how players choose between options (e.g., pass or shoot). The heuristic generates options in order of their validity. The order of validity is dependent on previous experiences, and the option that will generate the highest probability that success is produced first. The option selected is the best decision that can (a) be selected fast enough and (b) resolve the current situation sufficiently, given existing circumstances and constraints (Raab, de Oliveira, & Heinen, 2009).

For athletes, the development of heuristics is dependent on past experiences, situational contexts, and developed skills (de Oliveira, Lobinger, & Raab, 2014). Whilst the three heuristic rules above apply to sport, a fourth execution rule is also applicable. The execution rule relates to how to execute an action. Experts make use of simple heuristics in order to make fast judgements, to anticipate and initiate appropriate action responses (de Oliveira et al., 2014). Both

handball (Johnson & Raab, 2003) and basketball (Hepler & Feltz, 2012) players have been shown to apply a take the first heuristic, such that earlier generated options were better than later ones, and that an increase in the number of generated options reduced final decision quality. Moreover, the emotional state of the decision maker affects the selection of the first generated option, such that neutral conditions (opposed to positive or negative) resulted in better and faster decisions in a video handball task (Laborde & Raab, 2013). Despite the applicability of heuristics to conditions in which cognitive capacity, time and/or prior knowledge are limited, simple heuristics have been criticised for the inability to describe perceptual or motor behaviours, or high forms of cognition, such as creativity, within sporting environments (Raab, 2012).

Heuristic models have been compared to LTWM theory, which proposes a greater number of options generated links to better performance – the opposite prediction to that of the take the first heuristic (Belling, Suss, & Ward, 2015; North, Ward, Ericsson, & Williams, 2011). North et al. (2011) recorded soccer players' thoughts in an anticipation task via verbal reports. Skilled players had greater anticipation accuracy and were better at recognising previously viewed stimuli. Heuristic strategies should yield fewer prediction and evaluation statements in verbal reports collected. However, their results offered support for LTWM theory, insofar as skilled participants' anticipatory encodings allowed future planning. Skilled participants utilised more evaluation statements, in line with LTWM; choices were not associated with an automatic response. Belling et al. (2015) made similar comparisons with soccer players' performance during assessment and intervention phases of decision making during an online task. Skilled participants were better at anticipating (assessment phase) and choice selection (intervention) and selected more task-relevant options – which is suggestive of a LTWM strategy. However, in time-constrained environments, fewer task-relevant options were produced in the intervention phase compared to other phases, consistent with the notion that one should take the first generated option. This finding potentially highlights that the most appropriate decision strategy may be dependent on the context in which the decision is made.

2.1.1.4. Dual-process theory.

According to dual-process theories, both heuristic and analytic processes support decision making (Epstein & Pacini, 1999). Heuristic decision making relies on fast automatic processes, based on learned associations, and would often be utilised in situations of uncertainty or where

decisions are ambiguous (Epstein & Pacini, 1999); for example, reliance on the crowd noise when judging foul severity (Unkelbach & Memmert, 2010). Conversely, analytic decisions consist of rational, effortful, control processes involving working memory, guided by rules and principles. Dual-process theory suggests that some individuals adopt an intuitive decision making style, while others prefer a deliberative, more reflective style. Intuition differs from the heuristic model suggested by Epstein, Pacini, Denes-Raj, and Hejer (1996), in that it is a purely affective mode, which correlates with fast decision making, extraversion and agreeableness, with little awareness of their formations or origin (Plessner, Betsch, & Betsch, 2011). Meanwhile, deliberation is understood to be a reflective, cognitive-based mode that correlates with conscientiousness, perfectionism and the need for structure (Kahneman, 2003).

Raab and Laborde (2011) analysed preference for intuition or deliberation in a handball decision task. Their results indicated that intuitive decision makers made faster decisions, generated better first options, and produced superior best options than deliberative decision makers. Furthermore, experts had a higher preference for intuition. However, for coaches it was demonstrated that a more deliberative decision style may be preferable. Giske, Benestad, Haraldstad, and Høigaard (2013) examined elite and non-elite soccer coaches' decision styles. Using the General Decision Making Style Scale (Scott & Bruce, 1995), their participants demonstrated a stronger preference for rational decision making. Like deliberation, a rational style reflects a logical and structured approach to decision making. Intuition was also used and was positively correlated with rationality of their decision style. In the multifaceted role of coaching it is possible that different decisions require different styles (Giske et al., 2013). Indeed, Collins, Collins, and Carson (2016) identified that, whilst a deliberative decision approach to coaching was necessary (e.g., in planning for the season), intuition was also often necessary in certain situations (e.g., the need to rapidly adapt a session). Similarly, sports officials also have a diverse role for which a variety of decision styles may be appropriate; for example, a deliberative approach may be necessary when dealing with player safety and injuries, whereas an intuitive approach may be needed to make snap judgements in regard to rule infringements.

2.1.1.5. Naturalistic Decision making

The field of naturalistic decision making (NDM) aims to understand how people make decisions in applied, real-world environments, as opposed to artificial laboratory settings (Klein,

2008). The NDM approach takes into account several key aspects of complex real world settings, such as ill-defined goals, high personal stakes, uncertain dynamic environments, organisational goals and norms, and time pressure. NDM researchers have demonstrated that individuals rely on intuition in naturalistic settings to make decisions (Klein, Calderwood, & Clinton-Cirocco, 2010). However, in contrast to how intuition is defined in heuristics, NDM researchers suggest that individuals acquire a vast number of patterns through direct and vicarious experiences, and collections of these patterns enable rapid and intuitive decision making, without requiring the need to explore and consider multiple options (Klein, 2008).

To understand decisions in natural settings, Klein developed the recognition-primed decision (RPD) model of rapid decision making. Klein (2008) has shown that in dynamic environments, experts tend to make decisions based on previous experiences and recognition of a situation, rather than rational deductions or exhaustive analyses of expectancies. It is therefore argued that the best decisions are well-informed by many previous experiences, such that there is a comprehensive internalised understanding of the response to the situation. Three variants of RPD exist, according to the familiarity and complexity of the situation. In the simplest case, whereby the decision maker is faced with a familiar situation, recognition of the scenario occurs, activating and implementing the associated response from memory (i.e., simple match). This automatic perception-action implementation is dependent on one's recognition of decision cues. Cues hold significant meaning or value to the individual, consisting of features that link to previous events in memory. In less simple circumstances, mental simulation of the response may occur to check the decision effectiveness, and if appropriate, the choice is carried out (i.e., simulating options). In complex scenarios, several reassessments of the situation may occur until enough information has been acquired that the situation is then recognised (i.e., information gathering). Unlike other theories where multiple options are generated, in each RPD scenario, just a single response is first quickly produced and often selected.

NDM approaches have been used to understand decision processes in sport. Using the RPD model, Kermarrec and Bossard (2014) investigated the relationship between recognition processes and the use of salient situational features in soccer players' decision making. Using retrospective experiences, it was demonstrated that elite soccer defenders based their decisions on several salient features, which were associated with the three types of recognition processes of the RPD model outlined above. The salient features were categorised as information, action,

knowledge, expectancies, consequences of action, and goals. These salient features, which can be more accurately categorised as contextual information, were considered a recognition criterion to enable effective decision making. In line with RPD, players reported the immediate matching of perception and action particularly when defenders were close to opponents in possession of the ball (i.e., the use of simple match strategy). The use of salient features to enable rapid recognition of the situation supports Klein's (2008) suggestion that previous experiences support decision making. In the second instance, when not currently involved in the action, players were able to observe, imagine their own action, and their opponents' options, reflective of simulating in the RPD model. Finally, on some occasions, players reported waiting for the course of action to evolve in order to collect more information before being able to select a course of action.

Rugby league players were interviewed using a variation of cognitive task analysis to investigate how player abilities impacted on the use of cues in the decision making process (Johnston & Morrison, 2016). Support for the RPD model was demonstrated in players' comments, depicting a reliance on past experience, first option selection, and an intuitive decision approach. Although several individual cues were identified, associations between cues were also shown to be an important factor. Previously, it has been suggested that cues correlated together to form cognitive links, thereby reducing the cognitive resources used (Wickens & Hollands, 2000). The creation of cognitive links enables the development of higher order cognitive representations of items within long-term memory structures. Additionally, higher-level players showed greater cue discrimination, assigned different meanings to the cues, and processed cues in a different manner than those with lower expertise. Specifically, higher-level players referred to cues globally, similar to 'chunking' (Chase & Simon, 1973), potentially enhancing their pattern recognition.

2.1.2. Attentional Processes in Sports Decision Making.

In sport, the term decision making has often been used to encompass judgements, decisions, and anticipation. However, researchers have differentiated between a judgement and a decision (Dosseville & Garncarzyk, 2007; Koehler & Harvey, 2008). A decision represents a process of choosing from a set of options, whilst a judgement is a collection of evaluative and inference procedures (Johnson & Raab, 2003). Anticipation refers to acting on predicted

information on the outcome of an observed event to guide actions (Loffing & Cañal-Bruland, 2017). The capability of the decision maker has been highlighted to play a significant role in goal achievement during sports performance (Bar-Eli, Plessner, & Raab, 2011). Consequently, a vast amount of research exists in evidencing decision making skill as a criterion of expertise in sports. It has been demonstrated that experts have superior anticipation skill and greater awareness of the information on which they base anticipatory judgements (Jackson & Mogan, 2007), can better anticipate deceptive movements (Jackson, Warren, & Abernethy, 2006), generate more accurate predictive judgements of player positioning (Bertrand & Thullier, 2009), and make more appropriate tactical decisions (del Villar, González, Iglesias, Moreno, & Cervelló, 2007).

Others have sought to understand the underlying mechanisms of sports decision making. For example, in two experiments skilled and less-skilled soccer players were required to judge action sequences as the central defender, anticipating the intentions of their opponent (Roca, Ford, McRobert, & Williams, 2011). Skilled players were more accurate and employed a visual search strategy involving more fixations of shorter duration in a different sequential order, towards more informative areas of the display. The skilled players also generated a greater number of verbal report statements with a higher proportion of evaluation, prediction, and planning statements than less skilled players. The more elaborate domain-specific memory representations used by skilled players allows the consideration and assessment of current events and future outcomes, compared to monitoring by less skilled players (McPherson, 2008).

Researchers have explored the types of information used by decision makers, examining the use of situational probabilities (or contextual) information, including information related to scorelines (Farrow & Reid, 2012) and knowledge of action preferences (Mann, Schaefers, & Cañal-Bruland, 2014). Investigations have also examined how contextual information influences the cognitive processes underpinning anticipatory skill (Runswick, Roca, Williams, McRobert, & North, 2018) and gaze behaviour (Murphy et al., 2016). Farrow and Reid (2012) examined anticipatory responses in relation to event probability information of skilled tennis players. Specifically, the authors tested the relationship between serve location and relationship to game score. Unknowingly to participants, the first serve of every game was hit in the same direction. Older players demonstrated an awareness of the consistent placement of the first serve of the game and were able to use pre-contact kinematic information from the service action. In comparison, younger players relied on ball flight information to respond, and were unaware of

the probability information available. Mann et al. (2014) analysed how handball goalkeepers' anticipation was influenced by opponent action preferences following a training intervention. When the presented scenario was congruent with action preferences in training, goalkeepers' anticipation performance improved. But when the opponent countered their action preferences, goalkeepers were less accurate.

Murphy, Jackson and Williams (2018) analysed the influence of contextual information in tennis anticipation, showing that contextual information, derived from the shot sequence leading to an occluded shot, improved shot anticipatory judgements. In order to fully understand how contextual information use influences performance, Murphy et al. (2016) collected verbal reports and gaze data. Their results showed that skilled tennis players more effectively processed contextual information compared to less-skilled players. Skilled participants also used more domain-specific keywords and evaluation statements – indicative of more advanced domain-specific memory representations. Expertise differences in gaze were also present, showing skilled players fixated on the ball for greater amounts of time than less-skilled. The authors suggested that this visual anchoring strategy enabled participants to extract pertinent information via peripheral vision. More recently, Runswick et al. (2018) used verbal reports to examine the visual and contextual sources of information in cricket anticipation. The skilled group had greater anticipation capability than the less skilled group across all occlusion conditions. Specifically, the skilled performers were more capable at anticipating more accurately when only contextual information (position of fielders, game situation, information gained from preceding events) was available. Furthermore, they showed the temporal importance of information use. As visual information became available in the lead-up to ball release, anticipation accuracy decreased, potentially due to predictions made on kinematic as opposed to tactical information.

Like athletes, sports officials are required to make their decisions in dynamic time-constrained environments. Dissimilarly though, instead of predicting an opponent's behaviour, and generating options that result in movement execution, sports officials are required to make several simultaneous binary rule-based choices to identify a rule violation according to the laws of the game. Sports officials will first perceive the situation or action, then make a judgement (identifying what infringement has occurred). In comparison to the creative option-generation process of team sport athletes, which results in motor action, sports officials make a decision (e.g., selecting the appropriate sanction).

2.1.3. Sports Officials' Decision Making

The study of sports officials has recently expanded, typically focusing on the sources of pressure and influences on decision making. Whilst various influences have been identified including kit colour (Barton & Hill, 2005), sequential bias (Brand, Schmidt, & Schneeloch, 2006; Plessner & Betsch, 2001; Schwarz, 2011), height bias (Van Quaquebeke & Giessner, 2010), and player reputation bias (Jones, Paull, & Erskine, 2002), the following review of the literature is in relation to the content of the experimental chapters presented later in this thesis. These influences include, home advantage, crowd bias, reputation bias, contextual influence of scoreline and time.

Researchers have used qualitative measures to identify several sources of pressure and anxiety such as game importance (Hill, Matthews, & Senior, 2016; Tsorbatzoudis, Kaissidis-Rodafinos, Partemian, & Grouios, 2005), timing (Morris & O'Connor, 2016), level of competition and competency (Johansen & Haugen, 2013), and social pressure (Schnyder & Hossner, 2016). High-level soccer referees reported higher anxiety levels as a stressor affecting decision making, than those working at a lower level (Johansen & Haugen, 2013). Furthermore, referees who reported higher perceived competence generally had a lower anxiety score. Interview data from soccer referees also identified social pressures – from media, teams, football associations, and themselves – as a difficulty they face when officiating a match (Schnyder & Hossner, 2016).

Hill et al. (2016) identified multiple stressors that influenced expert rugby referees' performance. These included game factors such as unfamiliarity (e.g., new situations), interpersonal conflict (e.g., managing player hostility), and game importance (e.g., when the match outcome held significant consequence for players such as a final, or for themselves such as games close to renewal of contracts). In addition, personal factors such as performance errors (e.g., mistakes that 'harm' players, coaches and own career prospects) and self-presentational concerns (e.g., fear of negative evaluation by selectors, avoiding criticism that could damage their confidence and reputation) were highlighted as stressors. An investigation of key attributes contributing to expert National Rugby League referees' performance showed that referees identified timing as an important factor impacting their game management strategies in competition (Morris & O'Connor, 2016). Specifically, referees highlighted the importance of

knowing ‘when to inject yourself’ as an attribute of elite performance. Although these studies highlight a number of self-reported factors affecting decision making, they do not demonstrate what effect they have on decisions made within a match environment. This thesis attempts to examine some of these factors quantitatively in naturalistic settings, to afford some insight with regard to factors affecting netball umpires’ decision making. There has been a plethora of research examining each of these stressors in more detail, which the following sub-sections briefly summarise.

2.1.3.1. Contextual Influences.

Researchers have suggested that officials are influenced by several stereotypes or reputation biases when making their decisions, including competition level (Souchon, Cabagno, Traclet, Trouilloud, & Maio, 2009; Souchon et al., 2016), expectation bias (Plessner, 1999), 1999), and time (Emmonds et al., 2015; Mallo, Frutos, Juárez, & Navarro, 2012). An investigation into the effect of competition level on handball referees’ decision making showed that referees appeared to be more lenient at a higher level of competition (Souchon et al., 2009; Souchon et al., 2016). It was suggested that an ability stereotype might exist, whereby more expert players are perceived by referees to be capable of continuing their actions, despite being fouled. Similar stereotype biases exist in relation to player gender (Cabagno, Rascle, & Souchon, 2005; Souchon et al., 2010). Despite males displaying more aggressive acts on the pitch, females are penalised more frequently. Gender stereotyping has been used to explain player aggression and referee decisions in soccer such that soccer is perceived as a masculine sport, and aggression as a masculine characteristic (Cabagno et al., 2005). With reference to sporting sanctions in handball, referees intervened more frequently with female players, and the ball was returned to females more frequently in unsuccessful situations. It is thought that referees use a judgement heuristic, in line with gender stereotypes that female players are less able to continue their actions when contacted.

Similar reputation biases have been demonstrated in individual sports. In gymnastics, an expectation bias was found in relation to the rank ordering of performances and points awarded (Plessner, 1999). Gymnastic coaches tend to order their athletes’ performances from poorest to best. As predicted, in the examination of target routines placed first or fifth in within-team order, performances were judged differently, accordingly. The authors suggested that biases based on

prior knowledge arise at the early stages of information processing, so that little can be done to adjust decisions based on their perception of the subsequent performance. In ice-skating, performances of ice skaters with a positive reputation were scored more favourably (Findlay & Ste-Marie, 2004). The authors suggest that the expectation bias occurs at the evaluation stage of information processing rather than the encoding phase, due to known athletes being awarded more points on their technical mark. To date, research has not addressed whether a reputation bias exists in netball.

Researchers have shown that the scoreline of a game affects soccer referees' behaviour, in terms of the amount of injury time awarded, depending on whether the home team is leading or trailing (Dohmen, 2008; Garicano, Palacios-Huerta, & Prendergast, 2005; Scoppa, 2008). For example, Dohmen (2008) showed that soccer referees favoured the home team by awarding more stoppage time in close matches, particularly when the home team were trailing. More recently, the impact of scoreline has been shown to influence AFL umpires' decisions (Corrigan, Dwyer, Harvey, & Gastin, 2018). It has been shown to affect the error rate of umpires, including both missed and unwarranted decisions, such that as the score differential increases, the umpires' accuracy improves. Similar to avoidance explanations in anxiogenic conditions (Hill et al., 2016), the cause of the scoreline effect has been attributed to an impact aversion phenomenon, which refers to the preference for selecting decisions that have a minimal impact on the match (Corrigan et al., 2018). It is possible that similar effects on decision behaviour exist in netball umpires in relation to scoreline differentials. Similarly, but in relation to level of team instead of home teams, Lago-Peñas and Gómes-López (2016) showed that referees shortened close games when the big team was ahead and lengthened when they were behind. The findings were attributed to the unconscious bias in line with either home teams or successful teams. Corrigan et al. (2018) also showed that decision accuracy was consistent across matches, but there was a reduction in decision frequency in the final quarter and final quarter segments. Due to the consistency in accuracy, this finding was attributed to the style of play of the elite game. Others have suggested that physical attributes of referees' performance are responsible for differences in decision making performance. Mascarenhas, Button, O'Hare and Dicks (2009) suggested that poorer opening 15-minute decision accuracy was a result of warm-up decrements, whilst Mallo et al., (2012) and Emmonds et al. (2015) attributed poorer decision making at the end of a game to physical and mental fatigue.

2.1.3.2. Environmental Influences.

Researchers have demonstrated that sports officials' decisions are influenced by home advantage (Boyko, Boyko, & Boyko, 2007; Dawson & Dobson, 2010; Sutter & Kocher, 2004) and crowd noise (Downward & Jones, 2007; Nevill, Balmer, & Williams, 2002; Nevill, Hemingway, Greaves, Dallaway, & Devonport, 2016; Unkelbach & Memmert, 2010). Several explanations have been postulated for the debilitative decision making found when officials experience crowd pressure or other extraneous influences, which will now be reviewed.

Recent examples of the home advantage in soccer have shown that it exists across the major European leagues (Inan, 2018; Leite, 2017); that there are lower level effects of home advantage at professional, compared to amateur level (Almeida & Volossovitch, 2017); that a greater home advantage effect exists at the second level of domestic leagues than in the top tier (Leite & Pollard, 2018); a transient effect of home advantage exists, such that it reduces as the game goes on (Lago-Peñas, Gomez, & Pollard, 2017); there is a greater home advantage effect in Africa and South America (Pollard & Armatas, 2017) and that it also exists in youth sport (Staufenbiel, Riedl, & Strauss, 2018). Furthermore, Pollard and Gómes (2015) showed that a home advantage exists in baseball, basketball, American football, hockey, lacrosse, and soccer, at both college and professional level. Home-biased decision making by referees has been linked to the awarding of penalties (Boyko et al., 2007; Dohmen, 2008; Sutter & Kocher, 2004), extra time (Dohmen, 2008; Scoppa, 2008; Sutter & Kocher, 2004), and yellow cards (Boyko et al., 2007; Buraimo, Forrest, & Simmons, 2007). In an examination of the decision making behaviour of English Premier League soccer referees, it was shown that despite no favourability in the total number of decisions awarded to home teams, this effect did exist in the number of contentious and incorrect/missed decisions (Lovell, Newell, & Parker, 2014). A home advantage in netball has also been shown in the National League of Australia where there was a home goal advantage of 1.9 goals and a greater home win advantage; however, there was no home advantage in leagues based in New Zealand or England (Pledger & Morton, 2010). This thesis investigates home-biased decisions in netball umpires in relation to the frequency of decisions. Several reasons account for the home advantage effect including crowd support, referee bias, travel effects, team tactics, familiarity, and psychosocial factors (Carron, Loughhead, & Bray, 2005). More recently, Dosseville, Edoh, and Molinaro (2016) developed a new framework to account

for sports officials in the home advantage phenomenon, beyond the sole influence of crowds as proposed by Carron et al. (2005). The four factors include situational, contextual, individual, and ethical & economic factors. Dosseville et al. (2016) further highlighted that the home advantage is likely to be multidimensional (e.g., not just crowd influences), and that these dimensions may interact with one another.

2.1.3.2.1. Crowd Influences.

To demonstrate the importance of crowds in home biased decision making, Pettersson-Lidbom and Priks (2010) compared matches played in empty stadia versus matches with spectators. They showed that away team players were punished more harshly when in the presence of crowds as a consequence of the social pressure exerted by spectators. Several researchers have explored this effect in laboratory settings (Nevill, Balmer, & Williams, 1999; Nevill et al., 2002; Nevill et al., 2016; Unkelbach & Memmert, 2010). Nevill et al. (1999) presented an equal number of foul situations in soccer committed by home and away players, in crowd noise and no crowd noise groups. Foul decisions against away players were more likely when viewing challenges in the crowd noise condition. Similarly, Nevill et al. (2002) analysed referees' decisions in either a crowd noise or silent condition on foul situation; referees in the silent condition adjudged a greater number of fouls by home players.

Unkelbach and Memmert (2010) explored the effect of crowd volume on yellow card decisions in soccer. High volume crowd noise resulted in more yellow cards than did a low volume condition. They proposed that when referees need to make decisions with limited information, they may use external cues to assist their judgements. One explanation accounting for the influence of crowds is the Brunswikian cue learning approach (Brunswik, 1957). The cue learning hypothesis predicts that louder crowd noise would result in referees awarding decisions in line with the cue's correlation to the criterion behaviour; for example, in the case of fouls, louder crowd noises would be associated with more severe fouls. According to the cue-learning hypothesis, observable cues are used to make judgements on distal events that are otherwise inaccessible. For instance, officials may rely on more proximal, environmental cues, which may not be wholly relevant to the decision. So, when making future decisions, they draw on their memory of cue-outcome correlations from previous experiences. Additionally, in relation to judgements made by sports officials when judging distal criteria such as a foul decision, all the information may not be accessible due to positioning (Ghasemi, Momeni, Jafarzadehpur, Rezaee,

& Taheri, 2011; Mallo et al., 2012) and therefore they estimate, by using proximal cues such as crowd noise.

Alternatively, a motivational explanation has been put forward to explain the favourability of home teams in the presence of a crowd. It is thought that referees want to avoid the unpleasant crowd reaction that may follow their decision, and so gravitate towards decisions that are in line with the prevailing crowd noise, resulting in a home bias (Nevill et al., 2002). However, in a lab-based manipulation without the presence of a physical crowd, there is difficulty with this interpretation. One study that has addressed the limitations of the crowd presence in a lab-based investigation assessed decisions by three pairs of referees during live viewing of the Champions League Final (Nevill et al., 2016). Two referees watched the game with no support, two referees watched the game in the presence of Real Madrid fans, and two watched the game surrounded by Atletico de Madrid fans. The referees were required to decide whether the match referee's decision was correct or incorrect. Two inconsistencies were identified: first, the supporting crowds in both rooms influenced the referees to have fewer disagreements with the on-field referee, compared to the referees with no supporters present. Secondly, a home advantage bias was present, whereby the crowds influenced decisions in favour of their team, conflicting with the match referee. It was suggested that referees adopt an avoidance coping strategy and that when faced with contentious decisions, play is allowed to continue to avoid an unfavourable reaction to the decision.

Further addressing the lack of external validity in crowd noise studies, Myers and Balmer (2012) analysed Muay Thai Judges' decision making in a live tournament setting. Judges were placed in a crowd noise (live tournament noise) or no crowd noise (noise cancelling headphones and white noise) conditions. Their results showed a significant impact, with judges awarding half a point more per bout when crowd noise was audible. Myers and Balmer postulated that judges are subject to a conformity bias when faced with crowd pressures, awarding greater points to contestants with the biggest crowd support. It is possible that judges seek reassurance from the crowd, or alternatively, may want to avoid displeasing the crowd, either of which leads to a biased decision. In contrast, cognitive explanations have been suggested such as the use of decision heuristics (Raab, 2012), whereby, in order to reduce the difficulty of the decision in complex or ambiguous situations, officials make use of the most salient information – which is

often crowd noise. Thus far, there is little insight into the underlying mechanisms responsible for performance changes in the presence of crowds.

2.1.3.3. Situational Influences.

Several sources of stress and anxiety have been identified by referees such as conflict between officiating and family or work demands (Voight, 2009) making controversial calls (Voight, 2009), replay technology (Baldwin, 2013), players and coaches (Baldwin, 2013), commentators (Baldwin, 2013), and verbal abuse (Kilani, Altahayneh, & Oudat, 2013). Furthermore, these factors have a lasting effect leading into pre- and post-game stress (Baldwin, 2013), and have a negative impact on performance (Alavije, Gharote, Rahimi, & Rostami, 2014). This susceptibility to pressure-related performance decrements is discussed later in this thesis, but some researchers have identified coping mechanisms that sports officials use to manage performance pressure.

Interviews with soccer referees of varying levels demonstrated that crowds, previous mistakes, confrontation, players with bad reputations, and assessor evaluation were associated with stress appraisals, which were subsequently associated with negative emotions (Neil, Bayston, Hanton, & Wilson, 2013). For amateur referees, when facing these stressful scenarios, they reported poor coping in relation to the negative emotions they experienced, resulting in incorrect decisions caused by anxiety-induced reductions in concentration. Furthermore, they engaged in counterattacking decision making, giving decisions against the offending player or team. In contrast, the professional referees demonstrated better decision making via problem- and emotion-focused coping strategies. It has been suggested that rugby referees may adopt an avoidance strategy to cope with the pressures they experience (Hill et al., 2016). These avoidance behaviours manifest themselves as denying performance errors, failing to prepare adequately for performance, or rushing or withdrawing during a game. Although avoidance strategies may provide temporary relief from a stressful situation, such as blocking out an error, or removing oneself from a conflict situation. This kind of coping can become detrimental if one continuously avoids a situation (Polman, 2012), particularly if the type of avoidance involves disengagement from the event (Carver, Scheier, & Weintraub, 1989).

2.1.3.4. Attentional Processes in Sports Officials.

Verbalisation techniques have been used in athlete populations to provide an understanding of the cognitive processes that underlie decision making (Roca et al., 2011). Whilst rarely adopted in the examination of sports officials' decision making, Lane, Nevill, Ahmad, and Balmer (2006) have explored factors influencing experienced soccer referees using retrospective verbalisation. Lane et al. identified individual themes including experience, personality and personal life. It was highlighted that experience with dealing with challenging situations helped to reduce inaccuracies, and an individual's personality affected how the decision was conveyed to players. Crowd factors, environmental themes and player reactions all contributed to the higher-order situational themes. It was also acknowledged, that referees strived to make accurate decisions by performing strictly according to the rules and regulations, whilst trying to maintain error-free performance. However, referees accepted that human error could influence decision accuracy, stating logical causes of error such as the speed of the game, or incorrect positioning. Moreover, they acknowledged that crowds could subconsciously affect the decisions they make.

Hancock and Ste-Marie (2014) used a stimulated recall technique to describe the underlying cognitive processes used in in-game decision making. Elite, intermediate and novice ice hockey referees were asked questions relating to their decision making strategies while viewing footage from a head camera of a game they had refereed. Results demonstrated an expertise effect; elite referees demonstrating more refined knowledge structures. Other strategies influencing in-game decisions were identified, including game context, anticipation of game flow and prioritisation of certain decision making situations. More recently, concurrent and retrospective verbalisation methods were used to obtain verbal reports of the cognitive processes associated with decision making (Larkin, Mesagno, Berry, & Spittle, 2018). Three theoretical codes were identified. Primary referee strategies centred on the main play related to watching the players or pucks, or infractions. Secondary referee strategies pertained to scanning the ice and peripheral vision. Finally, referees highlighted that game context, positioning, anticipating game flow and prioritising situations all influenced their performance. In line with accounts in athletes (McRobert et al., 2009) the ability to predict or anticipate future actions demonstrates superior expertise. Furthermore, Mascarenhas, Collins, and Mortimer's (2005) Cornerstones of Performance Model of Refereeing highlights the ability of referees to alter their officiating style

according to the context of the game and that they should understand how the game is managed. Despite the acknowledged differences between levels of expertise, thought processes have not been analysed under different conditions – an aspect that this thesis addresses.

The analysis of gaze behaviour in the sport domain has been beneficial, providing insight with regard to athletes' overt allocation of attention (Ashby, Johnson, Ian, & Michel, 2016), expertise (Roca et al., 2011), and task-dependent visual search strategy (Roca, Ford, McRobert, & Williams, 2013). The absence of gaze behaviour paradigms is a noteworthy limitation of previous sports officiating decision making research; only a few studies have used gaze data to better understand sports officiating processes. Bard, Fleury, Carrière and Hallé (1980) tracked gymnastics judges' visual search patterns but found no significant differences between experts and novices. Second, Catteeuw, Helsen, Gilis, van Roie, and Wagemans (2009) studied international and national assistant soccer referees, noting that international assistant referees made more accurate decisions than national assistant referees, but the groups did not differ in their visual search patterns. Thirdly, Hancock and Ste-Marie (2013) investigated expertise differences in ice hockey referees. Results showed that experts were more accurate, but again there were no group differences in gaze behaviours which could be attributed to the narrower gap in experience level (lower-skilled versus higher-skilled) of participants compared to research in athletes. More recently, Spitz, Put, Wagemans, Williams, and Helsen (2016) examined the gaze behaviour of elite and sub-elite referees during foul play assessments during open play and corner kicks. Consistent with previous findings, no differences were apparent in the search rate between groups, despite greater accuracy of the elite group. The performance difference was attributed to the value of information gained from each fixation. However, during both open play and corner kicks, elite referees spent more time fixating the contact zone compared to the non-contact zone. The reliance of sub-elite referees' fixations on less relevant information may have restricted them from accumulating accurate representations (Spitz et al., 2016). Most recently, role-based differences were identified in rugby refereeing decisions of the scrum in rugby (Moore, Harris, Sharpe, Vine, & Wilson, 2019). Specifically, elite and trainee referees had lower search rates, spent more time fixating the central pack compared to players and was a predictor of decision accuracy. Despite a lack of evidence supporting the use gaze behaviours as a process tracing measure of decision making expertise in sports officials, as mentioned earlier a wealth of support exists in sports performers. Furthermore, it is evident that research is warranted to

understand sport officials' gaze behaviour changes between conditions in which decision accuracy is poorer (Murray & Janelle, 2003).

Although the field of sports officiating research is expanding, there are still several gaps. The vast majority of research has focused on football referees or assistant referees (Catteeuw et al., 2009; Nevill et al., 1999; Picazo-Tadeo, González-Gómez, & Guardiola, 2016; Scoppa, 2008); hence, it is not yet known whether the same biases and influences affect netball umpires. Furthermore, there are very few studies that have examined the mechanisms underlying officials' decision making (Spitz et al., 2016); we know what impacts decision performance, but not how it affects the decision process. Thirdly, there has been very little investigation to date of individual differences factors that may influence decision making processes; particularly, individual differences that may lead to poorer performance under pressure, and susceptibility to bias. Later in this chapter, one individual differences factor – Decision Specific Reinvestment and Rumination – is discussed and is subsequently applied to the domain of netball umpires in the experimental chapters. But in order to understand the effects of Dispositional Reinvestment and Rumination on performance under pressure, the concepts of working memory and attention must first be understood.

2.2. Working Memory and Attention

Cognitively demanding decisions (Jameson et al., 2004), manipulation of explicit information (MacMahon & Masters, 2002), and attention and perception (Knudsen, 2007) are all central to umpires' decision making performance and are thought to occur in the central executive module of working memory. Working memory refers to the mechanisms and processes involved in the control, regulation and active maintenance of task-relevant information in the service of complex cognition (Baddeley, 2003). Kane and Engle (2003) highlighted that working memory is important in our daily lives to allow for efficient information processing relevant to our task goals whilst ignoring or suppressing competing task-irrelevant information. Specifically, in sport, working memory has been highlighted as centrally important for decision making, performing under pressure and the development of expertise (Buszard, Masters, & Farrow, 2017).

2.2.1. Model of Working Memory.

Baddeley's (2000) updated version of Baddeley and Hitch's (1974) working memory model is divided into four subcomponents. The first and foremost of these is the central executive, which coordinates three slave systems: the visuospatial sketchpad, the phonological loop, and the episodic buffer. The central executive is assumed to be an attentional-controlling system, which processes, stores and regulates the flow of information, and retrieves information from alternative memory systems (i.e., long-term memory). The visuospatial sketchpad stores and processes information in visual or spatial form. The phonological loop provides temporary storage and manipulation of auditory or verbal material (Baddeley & Logie, 1999). The episodic buffer is responsible for linking information between the phonological loop, visuospatial sketchpad and long-term memory. Miyake et al. (2000) postulated that the central executive has three main functions: inhibition, shifting and updating. The inhibition function describes the ability to inhibit prepotent responses (e.g., resisting distractions such as crowd comments), whilst the shifting function refers to the ability to switch attention (e.g., switching between game management implementation and identification of rule infringements), and the updating function simply indicates the updating of information within working memory (e.g., updating information held in relation to persistent transgressors).

2.2.2. Working Memory Capacity.

In an active state, working memory can hold a limited amount of information with immediate relevance to the task whilst inhibiting irrelevant information (Engle, 2002; Miyake & Shah, 1999). Fundamentally, cognitive performance is constrained by limited working memory capacity. Supposedly, working memory capacity reflects domain-general executive attention (Conway et al., 2005) that is predictive of an individual's ability to stay task focused and avoid distraction (Engle, 2002). Furley and Memmert (2012) examined working memory capacity in tactical decision making while blocking out auditory distraction. Their results showed that high-working memory capacity individuals were more able to ignore the auditory distraction compared to individuals with low working memory capacity. In a second experiment, they further demonstrated that sufficient working memory capacity is necessary to resolve competing response tendencies. Specifically, individuals with low working memory capacity initiated decisions in line with coach instructions despite better options being present during the game

situation. In comparison, high working memory capacity individuals opposed coach instructions to use more appropriate tactical decisions.

There is evidence to suggest that both stress and anxiety reduce the availability of working memory capacity (Eysenck & Derakshan, 1998; Eysenck & Calvo, 1992). For example, Schoofs, Preuss, and Wolf (2008) demonstrated working memory impairments due to situational induced stress, and Leach and Griffith (2008) provide evidence for restriction in working memory capacity during parachuting. Beyond this, Klein and Boals (2001) found that life stress reduces working memory capacity and suggested that people might engage some of their mental resources in order to suppress negative thoughts and feelings. More recently, Wood, Vine and Wilson (2016) explored the relationship between working memory capacity and performance under pressure during a handgun-shooting task. Participants who had a lower working memory capacity displayed poorer performance under pressure, presumably as a result of anxiety disrupting attentional control. Specifically, low-working memory capacity individuals experienced greater reductions in goal-directed attentional control with pressure compared to high working memory capacity individuals (Wood et al., 2016).

2.2.3. Working Memory Load.

The capacity to plan and anticipate consequences and choose among competing options is an important element of decision making (Arce & Santisteban, 2006) but one that is affected by working memory load. Increases in working memory load can prevent an individual from holding necessary information in memory (Hinson, Jameson, & Whitney, 2003; Jameson et al., 2004). In a series of studies, Lavie (2005) showed that as working memory load was increased, fewer resources were available to support efficient target selection and distractor rejection. There is a paucity of research investigating the effects of increased working memory load via dual-task performance on decision making in sport. Zoudji, Thon, and Debû (2010) investigated the underlying decision making processes of expert soccer players when subjected to an increase in working memory load, using a dual-task protocol that required participants to memorise verbal or visual-spatial content. Consistent with accounts of the functional limitations of working memory, performance for both expert and novice groups decreased, and experts' response time increased under the dual-task conditions. However, a limitation of this study was the use of still images displaying the soccer situations. More recently, Runswick, Roca, Williams, Bezodis,

McRobert, and North (2018) investigated the effect of cognitive load and contextual information on anticipation performance in cricket. Their findings showed that the addition of contextual information did not excessively increase cognitive load and that skilled and less-skilled participant's anticipation performance was enhanced with the use of contextual information. The improvement of performance with the addition of a secondary task is in contrast with previous literature (Zoudji et al., 2010). The authors suggested that the addition of a secondary task potentially led to prioritisation of relevant information in working memory, in order to avoid overload of resources. There is a scarcity of research into the effects of increased working memory load and naturalistic secondary task effects on decision performance in sport; a deficiency that this thesis aims to address.

2.2.4. Attention.

Attention includes all cognitive processes leading to the increase or decrease in levels of activation of internal (e.g., goals and needs) or external (e.g., salient stimuli) representations (Knudsen, 2007). There is a reciprocal relationship between working memory and attention, such that the contents of working memory influence the guidance of selective attention, and attention guides access to stimuli in working memory (Awh, Jonides, & Reuter-Lorenz, 1998; Downing, 2000; Soto & Humphreys, 2008). Within an officiating environment, there is a vast array of stimuli to capture attention. Factors such as players' movements, co-officials' actions, scoreline, and coach interaction may all capture the umpire's attention, whether they are relevant or irrelevant to the task at hand.

Controlled attention or executive attention (Kane & Engle, 2003) theories of working memory highlight the processing aspect of working memory and its responsibility for continued active maintenance of information when in distracting environments. According to Corbetta and Shulman (2002), two systems within the brain control our attention. Top-down processing, or the goal-directed system is a conscious process, guided by knowledge derived from previous experience rather than sensory stimulation, situated within the dorsal posterior parietal and frontal cortices of the brain. This endogenous type of attention is concerned with simple behavioural goals such as searching for an object with specific features (e.g., looking for a contact on court), or at a particular location (e.g., searching for a player offside). Bottom-up processing, or the stimulus-driven system, relies on salient or threatening stimuli, and utilises the

temporoparietal and ventral frontal cortex. It is purported that the stimulus-driven system can interrupt the goal-directed system, acting as a 'circuit breaker', thus automatically reorienting attention. Cues with high sensory salience cause reflexive reorienting by exogenous attention to occur (Jonides & Yantis, 1988), but distinctive objects can attract attention more effectively when they are also behaviourally relevant (Yantis & Egeth, 1999), for example, crowd noise shouting 'contact'. Specifically, long-term memory may signal their importance because of stored associations, or the exogenous cues may match our goal type.

One theory of attentional control that accounts for both bottom-up and top-down factors is the biased competition theory (BCT; Desimone & Duncan, 1995). Internal representations related to our goals and objects in the environment are in constant competition for processing resources, and information that is highly relevant for our current behaviour biases attention as a result of this competition. According to BCT, objects held in working memory will automatically bias attention to objects that match the working memory representation in the visual scene. The biasing of umpires' decisions may be attributed to this process. Soto and Humphreys (2008) assessed the use of either visual or verbal primes in the guidance of top-down visual attention from working memory. Biased selection of distractors occurred with verbal and visual priming that was consistent with information held in memory, even when this was detrimental to the search. During sport-based decision tasks, Furley and Memmert (2013) asked participants to hold an image of a specific player in working memory. In the first experiment, participants were required to identify which player was in possession of the ball. In the second and third experiments, participants had to select who to pass the ball to. In the first experiment, attention was biased to the specific player held in working memory even when this player was not in possession of the ball, leading to decision errors. In experiments two and three, attention was automatically drawn to the player held in working memory despite better passing options being available. For sports officials, BCT may explain the observed reputation bias in decision making. Umpires may hold in working memory the aggressive reputations of players, and therefore when viewing a contest for the ball, the bias of attention may lead to the interpretation of a contact against the player held in memory.

Similar effects of attentional capture have been demonstrated with spoken words. Bishop, Moore, Horne, Tezka (2014) showed, using a visual detection, visual discrimination and a sports specific decision making task, that spoken words affected netball players' attention. In the visual

detection task, participants' performance was improved in the presence of valid cues compared to invalid and control conditions. Cues that were either spatially or semantically invalid resulted in slower detection times, and spatially invalid cues reduced accuracy in the discrimination task. Similar effects were present in the sport decision task, such that valid cues improved accuracy and speeded decision making time. The biasing of attention in sports officials may occur similarly in crowd scenarios, where crowd calls of 'contact' may match information currently held in working memory, leading to the umpire awarding a contact decision.

In spite of the prominence of Corbetta and Shulman's (2002) model of attention, Awh, Belopolsky, and Theeuwes (2012) have criticised it due to the explanatory gap in which strong selection biases cannot be explained by current selection or physical salience. Instead it is proposed that concepts such as 'selection history' can influence our current goals, leading to selection biases, and therefore should be a distinct concept within top-down attention (Awh et al., 2012). Selection history explains the bias to prioritise items that have been previously attended in a given context (e.g., perceiving a player to commit multiple fouls, leading to the official to make more foul decisions against them). This selection history mode of control may be appropriate in explaining some biases in sports officials' decision making. For example, this selection history in attentional control may be accountable for the sequential effects in penalty decisions (Plessner & Betsch, 2001) – whereby there are negative associations between same-team penalty decisions (i.e., referees are less likely to award additional penalties to a team that has already received one), and a positive association in opposing team penalty decisions (i.e., they are more likely to do so). The explanation of selection history may be appropriate in this instance where neither the referee's current goals, nor stimulus salience, affect selection priority (Awh et al., 2012).

2.2.5. Anxiety and Attention.

The application of decision rules (Bettman, Luce, & Payne, 1998) usually requires a selective focus on goal-relevant information while carrying out an ordered stream of operations and inhibiting irrelevant, or no longer relevant, information. However, some individuals may be drawn towards more threat-related irrelevant stimuli when anxious (Wilson, Wood, & Vine, 2009). Attentional Control Theory (ACT) explains that high anxiety leads to a shift from a predominantly goal-directed to a more stimulus-driven strategy. The reliance on the stimulus-

driven system is hypothesised to increase distractibility, with attentional shifts to task irrelevant stimuli, and decrease efficiency of switching between tasks (Derakshan & Eysenck, 2009). This change in attention has potential implications for decision making in anxious individuals, who may base their decisions on incomplete information. However, it is purported that such (Derakshan & Eysenck, 2009) individuals may adopt a compensatory strategy to cope with the additional demands on working memory by investing greater cognitive effort (Derakshan & Eysenck, 2009). This increase in mental effort is referred to as a decrease in processing efficiency. Depending on whether the extra effort was sufficient, there are varying effects on performance effectiveness. If the required effort is insufficient, then performance will deteriorate; if it is sufficient, then the performance level is maintained.

Wilson et al. (2009) tested the assumptions of ACT in high- and low-threat penalty kicks. Experienced soccer players took penalty kicks whilst wearing a gaze registration system. In support of ACT, anxious participants focused more on the goalkeeper, a threat-related stimulus, compared to the goal area. Moreover, under high-threat conditions, participants were quicker to fixate on the goalkeeper compared to low threat. Increased focus on threat-related stimuli led to a reduction in shooting accuracy, as a result of increased influence of the stimulus-driven attentional system. More recently, Cocks, Jackson, Bishop, and Williams (2016) tested the predictions of ACT by examining the impact of anxiety on a tennis anticipation task in skilled and less skilled players. Partial support for ACT was offered with anxiety leading to greater decrements in processing efficiency than performance effectiveness, evidenced by increased mental effort but consistent accuracy. This effect was suggested to be due to the reliance on the stimulus-driven attentional system. Several theories have been proposed to account for poorer performance under pressure. We now review the literature on one individual differences factor, which is applied in the experimental chapters later in this thesis – Dispositional Reinvestment.

2.3. Dispositional Reinvestment

Choking in sport has been identified as a significant drop in performance under perceived High-Pressure conditions (Hill, Hanton, Fleming, & Matthews, 2009; Mesagno & Mullane-Grant, 2010) and potentially extends beyond athletes to other personnel, such as sports officials, but has rarely been investigated. A number of theories have been proposed to account for debilitative performance under pressure. Considering the limitations of drive theories, notably

their descriptive nature and inability to explain skill failure in some situations, attentional theories attempt to describe the processes underlying choking (Hill, Hanton, Matthews, & Fleming, 2010). Attentional theories be they distraction- or self-focus-based accounts, outline the effect of pressure on memory structures and attention mechanisms and how these consequently affect performance (Beilock & Gray, 2007). Distraction theories propose that choking occurs because attention, needed to perform the task in hand, is consumed by task-irrelevant thoughts and worries (Beilock & Carr, 2001; Lewis & Linder, 1997; Wine, 1971). In contrast, self-focus theories suggest that pressure prompts individuals to attend closely to skill processes so that it disrupts automatic execution (Baumeister, 1984). One such self-focus theory is that of Reinvestment (Masters, Polman, & Hammond, 1993).

Theoretical accounts of skill acquisition have been closely linked with Reinvestment theory. At the cognitive stage, explicit encoding of knowledge is typically slow and erratic, requiring conscious effort (Anderson, 1982). Thus, spare processing capacity is considerably reduced and unavailable for interpreting and processing external stimuli. As learning progresses during the associative stage, components of the skill become proceduralised and the need to attend to step-by-step processes is reduced (Anderson, 1982). In the final, autonomous stage, skills run outside of conscious control, i.e., they are automated. Although learning may have progressed from simple to complex control strategies, it regresses back to earlier stages when under pressure (Fitts, Bahrick, Noble, & Briggs, 1961). This refocusing of attention on specific components of the skill interferes with the autonomous performance leading to a decline in quality of execution similar to that of a novice performer (Beilock, Carr, MacMahon, & Starkes, 2002; Lewis & Linder, 1997; Masters, 1992). Masters (1992) referred to this process as reinvestment, borrowing terminology from Deikman's (1969) concept of deautomatization process of "reinvesting actions and percepts with attention" (p. 31). Masters and Maxwell (2004) defined reinvestment as "the propensity for manipulation of conscious, explicit, rule-based knowledge, by working memory, to control the mechanics of one's movements during motor output" (p. 208).

2.3.1. Measuring Reinvestment.

Reinvestment was first measured using a 20-item Reinvestment Scale (Masters et al., 1993). The scale comprises 12 items from the private self-consciousness and public self-

consciousness subscales of the Self- Consciousness Scale, seven items from the rehearsal factor of the Emotional Control Questionnaire (Roger & Nesshoever, 1987), and one item from the Cognitive Failures Questionnaire (Broadbent, Cooper, FitzGerald, & Parkes, 1982). The Reinvestment Scale assesses a predisposition towards reinvestment of controlled processing and could be used as a tool to predict skill failure under pressure (Masters et al., 1993). Support for the validity of the reinvestment scale has been found across a number of sports tasks (Chell, Graydon, Crowley, & Child, 2003; Jackson, Kinrade, Hicks, & Wills, 2013; Maxwell, Masters, & Poolton, 2006). However, it suffers from a number of limitations, most notably the scale lacks face validity, in that it fails to specify movement when assessing motor skill breakdown (Jackson, Ashford, & Norsworthy, 2006).

To account for limitations in the reinvestment scale, other researchers have created both movement- (Masters, Eves, & Maxwell, 2005) and decision-specific (Kinrade, Jackson, Ashford, & Bishop, 2010) versions of the scale. Kinrade, et al., (2010) developed the 13-item two-factor Decision Specific Reinvestment Scale (DSRS) that "measures an individual's propensity for engaging in conscious decision making… which predicts susceptibility to impaired decision making under pressure" (p. 1129). The first factor, Decision Reinvestment, contains six items that assesses the conscious monitoring of processes involved in making a decision. The second factor, Decision Rumination, comprises seven items that refers to the focus on negative evaluation of previous poor decisions (Kinrade et al., 2010). Beilock and Gray (2007) referred to the two combined mechanisms (self-focus and distraction) of choking as 'pressure's double whammy'. The first mechanism involves reinvestment of attentional resources to the step-by-step execution, affecting automatic processes in sensorimotor skills. The second mechanism though, disrupts working memory dependent skills, consuming limited working memory capacity. For the initial assessment of predictive validity, DSRS scores of 59 skilled team sport players were correlated with coaches' peer assessments of participants' ability to perform under pressure (Kinrade et al., 2010). Their findings indicated a strong correlation between high reinvestment scores and greater susceptibility to poor decision making under pressure, as rated by coaches. Similarly, Jackson et al., (2013) examined netball players passing accuracy under pressure and the role of dispositional reinvestment. The results revealed a significant difference in performance between high- and Low-Pressure games and support for the moderating effect of

decision reinvestment, whereby Higher Reinvesters were more prone to skill failure under pressure.

In a lab setting, task complexity was manipulated by increasing the number of available options, using a computer-based choice reaction time basketball passing task (Kinrade, Jackson, & Ashford, 2015). Results showed response accuracy decrements under pressure, which were moderated by task complexity. The DSRS was a significant predictor of performance change under pressure in the high complexity condition. Specifically, the Rumination factor appeared to aid performance in the low complex task, evidenced by shorter response times whilst maintaining decision accuracy. But Rumination was disruptive in the high complexity trials, as evidenced by poorer accuracy, with no change in response time. Although the aforementioned studies (Jackson et al., 2013; Kinrade et al., 2010) have used real-world environments to investigate the predictive validity of the DSRS, it would be of benefit to use more naturalistic task designs, for example those that mimic real world decision tasks (e.g., not just a binary choice), create more realistic environments (Bishop, 2016), or incorporate the completion of secondary tasks in order to replicate real-world demands.

The examination of DSRS factors has primarily involved athlete or student populations. However, Poolton, Siu and Masters (2011) examined an individual's tendency to reinvest and ruminate on sports officials' decision making. In a lab setting, Poolton et al. (2011) examined soccer referees' tendency to ruminate and award foul decisions in favour of home teams. Their findings showed that referees who were identified as high decision ruminators made a disproportionate amount of decisions in favour of the home team. The authors suggested that an increased tendency to reflect upon previous poor decisions led to home-team biased decision making, such that worrisome thoughts reduced the availability of working memory resources for decision making. With limited resources available, the identification of the home player may have been the most pertinent feature on which to base their decision. This thesis extends the DSRS findings further in the sports officials' domain by examining dispositional tendencies of netball umpires.

Laborde and colleagues have sought to understand the associated underlying mechanisms of decision reinvestment and decision rumination. Laborde, Raab and Kinrade (2014) examined the influence of decision reinvestment on decision making performance using an option generation task, whilst also investigating its neurophysiological basis using heart rate variability.

Their results indicated that Low Reinvesters made faster decisions than their High Reinvester counterparts in the High-Pressure condition, suggesting that decision reinvestment impacts the response time, but not the decision quality, which could be explained by the lengthier process of consciously monitoring thoughts. Additionally, they found that the pressure-induced reduction in parasympathetic activity was more pronounced in High Reinvesters compared to Low Reinvesters, suggesting less effective cognitive functioning under pressure. Laborde, Musculus, Kalicinski, Klämpfl, Kinrade, and Lobinger (2015) have also gained insight into the underlying mechanisms by demonstrating a link between visual search strategies and reinvestment. They demonstrated that under High-Pressure, Higher-Reinvesters and Ruminators had poorer visual search in a concentration grid task than their low dispositional Reinvester counterparts. However, a major limitation of this study was that visual search performance was assessed through the concentration grid rather than via the use of eye-tracking technology (Wilson, Smith, Chattington, Ford, & Marple-Horvat, 2006).

Laborde, Furley and Schempp (2015) explored the relationship between working memory and Decision Reinvestment. Participants completed the DSRS and took part in an automated operation span score (as the measure of working memory) under High- and Low-Pressure conditions. They found a negative correlation between decision specific reinvestment and working memory performance in the High-Pressure condition, providing support for the proposed theoretical assumption that individuals who tend to reinvest have less available working memory capacity, likely resultant from working memory being consumed by rumination and worries. The notion that individuals who have a tendency to reinvest have less available working memory capacity, specifically under High-Pressure, may be able to explain performance failure in high stake tasks that are reliant on working memory. This could extend to sports officials' decision making – a task dependent on working memory – under pressure conditions, with crowd noise, and with responsibility for game management.

Laborde, Musculus et al. (2015), explored the construct validity of the DSRS, using both psychometric and behavioural measures. They investigated the association of decision reinvestment and rumination with personality-trait-like individual differences (Laborde, Breuer-Weißborn, & Dosseville, 2013). They evaluated the construct validity of the DSRS using the preference for intuition and deliberation (PID) inventory (Betsch, 2004). The PID distinguishes between two preferences for decision strategies: intuition and deliberation (as discussed in the

first section of this review), which are viewed as two distinct constructs that are situation-specific. Laborde et al. showed convergent validity between reinvestment and deliberation, and discriminant validity with intuition. These findings offer support for Reinvestment Theory insomuch that a high tendency for reinvestment is associated with the use of deliberative rules (Masters et al., 1993). A second study investigated the convergent and discriminate validity with self-consciousness (Fenigstein, Scheier, & Buss, 1975), and rumination style (Nolen-Hoeksema & Morrow, 1991). It was thought that the self-focused nature of reinvestment would lead to positive correlations with the self-consciousness sub scale scores. The response styles theory questionnaire contains two subscales: rumination, relating to the reflective thought on one's performance and experiences; and distraction, referring to thoughts and attention drawn to factors irrelevant to current performance. As predicted both self-consciousness subscales were positively associated with DSRS. There was evidence of convergent validity of the DSRS with the Rumination subscale, and discriminant validity with the distraction subscales of the response styled theory questionnaire. In relation to the decision styles discussed earlier, an intuitive decision making style and also lower tendency to reinvest have been linked to better decision making in sports and may also be beneficial to sports officials' decisions.

2.3.2. Rumination.

Despite the development of the DSRS, there has been relatively little focus on the role of rumination on decision making performance in sport. Outside of sport, a wealth of research exists analysing various rumination types (e.g., depressive, anger, etc.), which has often been linked with negative thoughts, consequences, and to worry (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Most commonly, rumination has been described as "the process of thinking perseveratively about one's feelings and problems rather than in terms of the specific content of thoughts" (p. 400, Nolen-Hoeksema et al., 2008). According to Response Styles Theory, it is characterised by self-reflection as well as a repetitive and passive focus on one's negative emotions (Nolen-Hoeksema, 1987). Both rumination and worry have been considered to serve as an avoidance function (Fresco, Frankel, Mennin, Turk, & Heimberg, 2002) such that Ruminators are motivated to withdraw from situations, as behavioural avoidance is less aversive than the uncertainty of dealing with their problems (Nolen-Hoeksema et al., 2008). Daily cognitive avoidance has been shown to predict increases in subsequent rumination and anxiety (Dickson,

Ciesla, & Reilly, 2012). These results support the conceptualisation of rumination as a cognitive avoidance strategy (Moulds, Kandris, Starr, & Wong, 2007; Newman & Llera, 2011). Treynor, Gonzalez, and Nolen-Hoeksema (2003) developed a two-factor model of rumination; the first factor of which is reflection, a purposeful inward engagement toward cognitive problem solving, to alleviate depressive symptoms. The second factor, brooding, reflects a passive comparison of one's current situation with some unachieved standard. Their analyses showed that the reflection factor was associated with less depression over time, although it was correlated with more depression concurrently. This suggests that reflection may be instigated by negative affect or lead to negative affect in the short term. However, reflection may eventually be adaptive in reducing negative affect, perhaps because it leads to effective problem solving. In contrast, the brooding factor of rumination was associated with more depression both concurrently and in the longitudinal analyses.

Despite these findings, there is growing literature demonstrating that repetitive thought can be adaptive, functional and beneficial, in the cognitive processing and recovery of upsetting events, adaptive preparation and planning for the future, and adaptive self-regulation (Tallis & Eysenck, 1994). In a meta-analysis of self-focus literature, it was highlighted that attention directed towards negative aspects of the self were strongly linked to greater levels of negative affect; whereas attention directed at positive aspects of the self was related to lower levels of negative affect (Mor & Winquist, 2002). Although rumination can be viewed as helpful or unhelpful, there are several factors that may account for the positive or negative consequences, including thought valence (positive vs negative), the cognitive-affective systems (positive vs negative mood; optimism vs pessimism), construal (abstract vs concrete), and the context of the situation (Ciesla & Roberts, 2007). For example, when controlling for levels of trait anxiety, worry has been associated with more active coping and greater information seeking (Davey, Hampton, Farrell, & Davidson, 1992), and predicts better prospective performance (Siddique, LaSalle-Ricci, Glass, Arnkoff, & Díaz, 2006). This suggests that, when levels of anxiety are low, worry may be constructive, but can become problematic as trait anxiety increases. Davey et al. (1992) hypothesised that whilst worry can be characterised by a problem-focused method of coping, anxiety results in a lack of confidence in the solutions generated. Thus, a cognitive-affective system, characterised by negative affect- such as low mood or, trait anxiety, leads to greater negative content during repetitive thought and ultimately unconstructive consequences.

The level of construal may influence the outcome of repetitive thought due to the emotional response linked to the processing of events. Higher level, abstract processing is characterised by general, superordinate, decontextualized representations of "why", resulting in reflexive processing, that is predominantly under stimulus control leading to automatic approach and avoidance behaviours (Freitas, Gollwitzer, & Trope, 2004; Trope & Liberman, 2003). In contrast, lower level concrete processing is characterised by mental representations that include subordinate, contextual, and incidental details of events and actions and the specific "how" that enable reflective processing, which is able to inhibit automatic approach and avoidance behaviours (Freitas et al., 2004; Trope & Liberman, 2003). In situations such as choking under pressure and test anxiety – where elevated self-focused attention and deliberate effort to control behaviour are often counterproductive – a concrete level of processing could facilitate self-regulation (Leary, Adams, & Tate, 2006). Processing abstract construals regarding the evaluative or interpersonal implications of one's behaviour, interrupts smooth performance. Conversely, in situations where rumination and worry are likely, concrete construals can be constructive to performance due to their focus on the immediate situation, thereby reducing their anxiety, and ultimately requiring less effort and fewer allocated working memory resources (Gollwitzer & Sheeran, 2006). From this standpoint, it is hypothesised that when faced with negative information concrete construals are more adaptive, by reducing negative overgeneralisations.

Although in the DSRS conceptualisation, Decision Rumination is a trait variable, researchers have also investigated state rumination. For example, Moberly and Watkins (2008) examined the influence of state and trait rumination on negative affect. This relationship was examined by asking participants to record their affect and thinking styles at random time points over the course of a week. Their findings supported the notion of Dispositional Reinvestment (Kinrade, Jackson, & Ashford, 2008), that a tendency to adopt a ruminative style is an individual difference variable. Moreover, it also predicted mean levels of ruminative self-focus over the sampling week and subsequent negative affect, and that within-person variability was greater than that between individualism, suggesting that momentary ruminative self-focus is influenced by context, increasing as feelings or problems become more salient.

2.4. Integrated Model of Anxiety and Motor Performance

Nieuwenhuys and Oudejans (2012) developed an Integrated Model of Anxiety and Motor Performance to explain the relation between anxiety and perceptual motor performance, which could be applicable to perceptual-cognitive skills such as decision making. The model, although predominantly based on ACT, does also take into account dispositional factors such as Reinvestment. Nieuwenhuys and Oudejans (2012) suggest that although distraction and self-focus accounts of skill failure propose different mechanisms concerning how anxiety affects skill execution, they can both be explained by distraction principles. They hypothesise that under anxiety, threat-based allocation of attention reduces resources available to process task-relevant information. This task irrelevant information could be skill-focused allocation of attention, shown to be debilitative to performance particularly in experts (Masters, 1992). Furthermore, the model considers the effect anxiety has on attention (e.g., threat-related directed attention) interpretation of information, and on behavioural responses (e.g., avoidance behaviour), which respectively link to a specific phase of the perception-selection-action cycle. The Integrated Model of Anxiety and Motor Performance and ACT both suggest anxiety can serve a motivational function to increase mental effort. More specifically, the Integrated Model of Anxiety and Motor Performance proposes that mental effort may be directed towards enforcing goal-directed behaviour, inhibiting stimulus-driven behaviour, or by attempting to reduce feelings of anxiety. Finally, the model accounts for both situational factors (e.g., task, environment) and Dispositional factors (e.g., trait anxiety, Dispositional Reinvestment). For example, High Dispositional Reinvesters are more likely to consciously control their movements (Jackson et al., 2006) and decision processes (Kinrade et al., 2015). Particularly relevant to the aims of this thesis is the notion that the individual's interpretation of the situation factors combined with their dispositional tendencies, will determine how they respond and perform despite some degree of anxiety. However, this model is directed at perceptual-motor performance and has rarely been investigated in the literature.

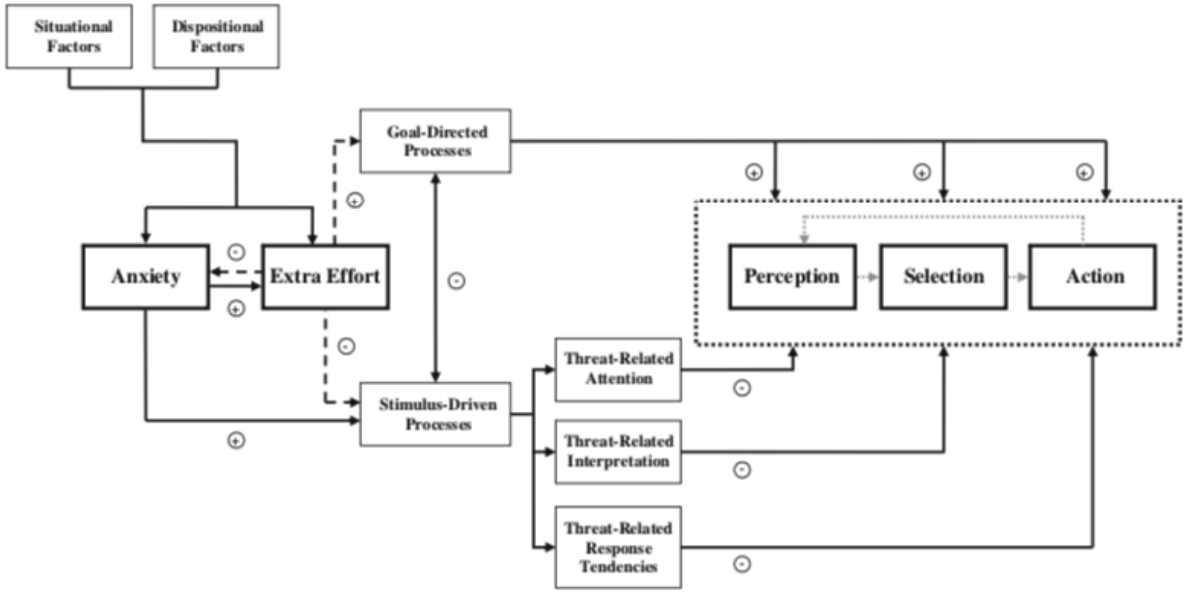

Figure 2.2. Integrated Model of Anxiety and Motor Performance.

2.5. Rationale for the Present Work

Decision making is fundamental to officiating across all sports. Much of the research thus far has focused on the role requirements of sports officiating (Mascarenhas et al., 2005). Others have identified sources of bias or influence on decisions (Nevill et al., 2016), and primarily the soccer referee has received the greatest research attention to date (Balmer et al., 2007; Dawson & Dobson, 2010; Johansen & Haugen, 2013). This thesis addresses the gaps in literature by exploring whether the same influences (home advantage, crowds, reputation, level of competition, time) are applicable in a different population –netball umpires. Specifically, there is a paucity of research in relation to understanding contextual influences (Hill et al., 2016), the impact of game management, and the effect of individual differences factors (Poolton et al., 2011) on decision making performance in other team sports, under various conditions.

Often sport-based research has lacked representative task designs (Travassos et al., 2013); for example, in the presentation of stimuli (Catteeuw, Helsen, Gilis, & Wagemans, 2009), and have required binary choice responses (Spitz et al., 2016). We address this by firstly investigating decision making in a real-world environment. Secondly, we present a variety of unpredictable scenarios (e.g., decisions across a full range of rules that are not previously outlined), in different situations (e.g., centre passes, backlines, penalties, open play), and positions on court (mid-court, goal third, circle), from several off-court positions reflective of an

umpire's viewpoint. Naturally, the variety of scenarios presented leads to multiple-choice responses, firstly in the infringement decision (e.g., footwork, contact, obstruction, etc.), and secondly the sanction decision (free pass, advantage, penalty pass, etc.). Many real-world roles and situations require the maintenance of information and response to multiple tasks. However, in sports decision making this dual-tasking situation has only rarely been investigated (Runswick et al., 2018; Zoudji et al., 2010). Moreover, it has not been investigated in the sports officiating domain, using realistic dual-task scenarios. Accordingly, in Chapter 5, umpires were required to perform a primary decision task and a secondary game management task in parallel.

There have been very few investigations aimed at understanding the cognitive-perceptual skills underpinning sports officials' decision making (Spitz et al., 2016) and also the underlying mechanisms responsible for poorer decision making performance under certain conditions. This thesis extends existing gaze paradigms used in sports officiating research (Spitz et al., 2016) (Spitz et al., 2016) to examine the gaze behaviour and information reports used by netball umpires in the presence of crowd noise, and under dual-task and pressure conditions, to gain a more comprehensive understanding of why performance breakdown occurs. Finally, research investigating the predictive validity of the DSRS is limited primarily to an athlete population and the link with underlying mechanisms has rarely been made (Laborde, Dosseville, & Kinrade, 2014).

2.6. Aims of this Thesis

The present body of work was designed to explore the contextual and dispositional factors influencing netball umpires' performance. This work presents the first investigation of netball umpires' decision making, and as such, the first objective was to gain a comprehensive understanding of the decision environment through analysis of umpires' behaviour throughout an entire Netball Superleague season. A second aim was to determine the various contextual influences that have been identified in other sports, which may affect the occurrence of decisions in real-match environments. Specifically, this thesis examines the influence of crowd (Unkelbach & Memmert, 2010), scoreline (Lago-Peñas & Gómez-López, 2016), league position (Souchon et al., 2016), time (Corrigan et al., 2018), stage of competition, and home advantage (Poolton et al., 2011). Thirdly, due to the limited research investigating the dispositional influences on sports

officials' behaviour, the influence of decision-specific reinvestment on decision frequency was examined.

Having established dispositional and contextual influences on decision behaviours in Chapter 3, this informed the selection of key contextual influences and decisions investigated in the subsequent studies. Specifically, this thesis sought to experimentally investigate different pressures to understand the impact on performance (i.e., decision accuracy and time) and underlying mechanisms (information reports and gaze behaviour). Chapter 4 presents examines how characteristics of the environment (i.e. crowd noise), and the individual (e.g. tendency to ruminate) affect netball umpire decision making with varied working memory loads and under pressure induced anxiogenic conditions. Firstly, pressure and crowd noise were manipulated, and the moderating effects of reinvestment and rumination on decision making performance were investigated. Previous investigations have lacked representative task designs that replicate an actual role of sports officials. Researchers have previously highlighted the multifaceted nature of the sports official's role, which includes responsibility for game management (Mascarenhas et al., 2005). Despite this acknowledgment of the importance of game management to the role of an official, research to date has not yet examined the impact of this role on rule-infringement decision making. To this end, Chapter 4 additionally examined the impact of a novel game-management dual-task on performance in a pressure manipulated decision task. Chapter 4 employed eye-tracking and information report protocols to determine the underlying mechanisms for any performance change in the manipulated conditions.

Despite previous research indicating that a tendency to ruminate has negative outcomes on performance, the findings from Chapter 4 demonstrated that Higher Ruminators outperformed their Lower Ruminator counterparts. However, it is purported that ruminative thought can be helpful or harmful to performance as a result of the valence of cognitive thought. To this end, Chapter 5 sought to understand the impact of dispositional rumination on decision making performance following positive and negative feedback.

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Chapter 3:

Decision making of English Netball Superleague Umpires: Contextual and Dispositional Influences

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3.1. Abstract

The decisions made by officials have a direct bearing on the outcomes of competitive sport contests. In an exploratory study, we examine the interrelationships between the decisions made by elite netball umpires, the potential contextual and environmental influences (e.g., crowd size), and the umpires' dispositional tendencies – specifically, their propensity to deliberate and ruminate on their decisions. Filmed footage from 60 England Netball Superleague matches was coded using performance analysis software. We measured the number of decisions made overall, and for home and away teams; league position; competition round; match quarter; and crowd size. Additionally, 10 umpires who officiated in the matches completed the Decision-Specific Reinvestment Scale (DSRS). Regression analyses predicted that as home teams' league position improved the number of decisions against away teams increased. A model comprising competition round and average league position of both teams predicted the number of decisions made in matches, but neither variable emerged as a significant predictor. The umpire analyses revealed that greater crowd size was associated with an increase in decisions against away teams. The Decision Rumination factor was strongly negatively related to the number of decisions in Quarters 1 and 3, this relationship was driven by fewer decisions against home teams by umpires who exhibited higher Rumination subscale scores. These findings strengthen our understanding of contextual, environmental, and dispositional influences on umpires' decision making behaviour. The tendency to ruminate upon decisions may explain the changes in decision behaviour in relation to the home team advantage effect.

3.2. Introduction

In competitive sports, officials are required to make rapid and complex decisions, often in a highly pressured environment (Helsen & Bultynck, 2004). Moreover, their decisions often directly affect the outcome of competitions (Plessner & MacMahon, 2013). For example, during the final minutes of the 2015 Rugby World Cup (Plessner & MacMahon, 2013) quarter-final between Scotland and Australia, referee, Craig Joubert, decided to award a controversial penalty to Australia for a deliberate knock-on, resulting in a 35-34 victory for Australia, which enabled them to progress to the semi-final of the competition. Such decisions invariably attract negative evaluations by aggrieved players, coaches, spectators and the media, so the importance of consistent and impartial officiating is unquestionable (Stulp, Buunk, Verhulst, & Pollet, 2012).

Decision making can be influenced by a variety of factors, such as home advantage and crowd noise (Nevill, Hemingway, Greaves, Dallaway, & Devonport, 2016), competition level (Souchon, Cabagno, Traclet, Trouilloud, & Maio, 2009; Souchon et al., 2016), reputation (Plessner, 1999), and time (Emmonds et al., 2015; Mallo, Frutos, Juárez, & Navarro, 2012). In the current paper, we employ an exploratory approach to examine the decisions made by netball umpires and the influences of contextual and environmental factors on the number of decisions made. Moreover, we investigate umpires' self-reported tendency to reinvest in, and ruminate upon, their decisions.

Many researchers have focused upon the home advantage in sports – a phenomenon whereby there is an apparent advantage conferred to the home team. Four major determinants have been suggested to cause the home advantage effect namely, familiarity, territoriality, travel fatigue, and crowd noise (Pollard, 2008). It has been suggested that home advantage fluctuates throughout the game. For example, in basketball, Jones (2007) demonstrated that the home advantage (difference in points scored by the home and away teams) was greatest in the first quarter. In volleyball, home teams had a greater advantage at the beginning (1st set) and towards the end of the game (4th and 5th sets); this effect has been attributed to familiarity with the venues and crowd effects (Marcelino, Mesquita, Palao, & Sampaio, 2009). In relation to the referee's influence on the home advantage, Boyko, Boyko, and Boyko (2007) examined data from 5,244 English Premier League soccer matches involving 50 referees. They found that referees differed in their susceptibility to the home advantage effect; hypothesising this was due to variations in

the referees' ability to deal with social pressure. However, Johnston (2008) replicated Boyko et al.'s (2007) approach and found no evidence of such individual differences when removing referees who only officiated a few matches. To investigate this discrepancy further, Page and Page (2010) analysed footage from 37,830 national and international soccer matches across 58 competitions, between 1994 and 2007. Their analyses showed that not only did the size of the home advantage differ significantly between referees, but also, in line with Boyko et al. (2007), their decisions were moderated by crowd size – lending support to the notion that referees cope differently with the social pressure exerted by home crowds.

Using a video-based protocol, Nevill, Balmer, and Williams (2002) manipulated crowd noise presence ("loud" or none) and found that soccer referees made more decisions in favour of the home team, and in line with the original match referee. Unkelbach and Memmert (2010) identified the inherent limitation of testing crowd noise ("natural conditions") versus no crowd noise ("unnatural conditions"). The authors highlighted that Nevill et al's (2002) findings merely indicate that home crowd noise biases decisions compared to no crowd noise, rather than crowd noise influencing referee decisions in favour of the home team. Subsequently, Unkelbach and Memmert (2010) tested the hypothesis that louder crowd noise would lead to more yellow cards awarded compared to low crowd noise. Twenty referees viewed 56 foul scenes, in which 50% led to the award of a yellow card and 50% did not. The high-volume crowd noise led to substantially more yellow cards than low-volume crowd noise. Further evidence in soccer indicates that home teams were awarded more penalties (Nevill, Newell, & Gale, 1996; Scoppa, 2008; Sutter & Kocher, 2004), and fewer yellow and red cards (Buraimo, Forrest, & Simmons, 2010) with the size of the attending crowd moderating these effects (Boyko et al., 2007).

The mediating effect of competition level has received scant attention, whilst stage of competition (e.g., Round 1, playoffs, finals, etc.) has yet to be investigated. Souchon et al. (2009) proposed that the level of competition is a stereotyping heuristic used by referees to form their decisions, interpreting fouls differently according to their preconceptions regarding the standard of play. Souchon et al. (2009) investigated this notion in handball (e.g., lower versus higher standard), predicting the level of competition effects would be greater for more difficult, ambiguous handball transgressions ("pushing offences", opposed to clearer "holding back" offences) and anticipating that referees would be more lenient in higher-standard competition. They reported that referees intervened less frequently at higher levels of competition and allowed

play to continue without intervention more frequently following more ambiguous transgressions (pushing offences compared to holding offences). Similarly, Souchon et al. (2016) observed that referees intervened less often when higher-level players transgressed. The authors suggested that a reduction in decisions made may be the culmination of a number of factors: referees trying to maintain the flow of a match; referees making fewer calls to maintain the game's value as a spectacle (Mascarenhas, O'Hare, & Plessner, 2006); that a greater number of fouls may be more ambiguous in high-level competition, due to the high speed of play; that greater levels of player aggressiveness may make it more difficult to identify transgressions; or that referees may assume that certain players can continue their actions despite the seriousness of the foul committed (Souchon et al., 2010). In this study, we aim to examine potential changes in the number of decisions made across progressive competition rounds (perceived match importance arguably increases as the rounds progress).

Few researchers have focused on the effect of the competing teams' abilities on sports officials' judgements. However, Plessner (1999) examined the idea of an expectation bias in team gymnastics, where gymnasts normally perform in a ranked order, worst to best. Plessner predicted that when the same routines, placed in either first or fifth position, will score higher when the judges view them in the latter position. Forty-eight gymnastic judges, with prior expectations of coaches' rank order of the gymnasts, judged videotapes of a men's team competition. Their results supported the notion of an *ability expectation bias*, whereby, for difficult tasks (e.g., pommel horse, vault, and horizontal bar) the judges awarded greater scores when the target routines were presented fifth than if they were presented first. Findlay and Ste-Marie (2004) explored athlete reputation bias in figure skating judgments. Twelve judges evaluated performance of 14 skaters, half of whom were known to the judges. The performance of skaters with a pre-existing positive reputation were scored more highly than those of the unknown skaters. It is possible that similar unconscious biases relating to perceived athlete ability may also exist in team sports; hence, we also took the competing teams' pre-eminence (i.e., their league position) into account in this study.

To date, a limited body of research has investigated the effect of the match period on sports officials' decision making. Mallo et al. (2012) assessed the soccer referees' decision quality and quantity in relation to match periods. Mallo et al. reported that a greater number of incidents occurred in the last 15-minute period of matches – but the lowest referee decision

accuracy (77%) was also observed during this period. They suggested that physical and mental fatigue occurs during the final stages of a match leading to impaired decision making. Similarly, Emmonds et al. (2015) found a drop in penalty judgement accuracy in rugby league referees in the last 10 minutes of matches. Conversely, Mascarenhas, Button, O'Hare, and Dicks (2009) reported that soccer referees were less accurate in the opening 15 minutes of each half than they were at any other period. They attributed poorer decision making to warm up decrements, whereby their physical warm-up was not accompanied by a mental warm up technique. Finally, Elsworthy, Burke, and Dascombe (2014) investigated decision making demands of Australian Football referees and reported that the number of free kicks awarded, and free kick accuracy did not differ across each quarter of the match. Accordingly, in the present study, we analysed differences in the number of decisions made by netball umpires across each of the four match quarters.

Published reports using qualitative methods have identified several sources of pressure and anxiety for sports officials (Hill, Matthews, & Senior, 2016; Morris & O'Connor, 2016; Schnyder & Hossner, 2016). Morris and O'Connor (2016) found that National Rugby League (NRL) referees identified the time during a match as an influence on their game management strategies and decision making ability. For example, one referee stated "certain decisions can have a greater impact at different stages in a game which can increase media scrutiny" (Morris & O'Connor, 2016). Schnynder and Hossner (2016) interviewed high-level soccer referees regarding decision making and the difficulties they face. Several of the referees identified social pressures, including pressure from the media, teams, football associations and even themselves. Hill, et al.(2016) interviewed seven expert rugby referees and noted that avoidance coping behaviours were regularly employed to deal with multiple stressors that influence their performance including: unfamiliarity (e.g., new situations); performance errors (e.g., mistakes that 'harm' players, coaches and own career prospects); interpersonal conflict (e.g., manging player hostility); game importance (e.g., when the match outcome held significant consequence for players such as a final, or for themselves such as games close to renewal of contracts) and self-presentational concerns (e.g., fear of negative evaluation by selectors, avoiding criticism that could damage their confidence and reputation). The avoidance behaviours manifested themselves as denial after performance errors, rushing or withdrawal during the game, and a lack of preparation leading into games. Similarly, overt and maladaptive changes in behaviour under

anxiogenic conditions have been observed in soccer (Jordet & Hartman, 2008) in climbing (Nieuwenhuys, Pijpers, Oudejans, & Bakker, 2008), dart throwing (Nibbeling, Oudejans, & Daanen, 2012), golf (Hill, Hanton, Matthews, & Fleming, 2010), and police arrest procedures (Renden et al., 2014).

Decision avoidance has been described as "a tendency to avoid making a choice, by postponing it or by seeking an easy way out that involves no action or no change" (Anderson, 2003). Selection difficulty has been identified as a major contributor to decision avoidance including factors such as: reasoning; preference uncertainty; attractiveness of options; attentional focus; time limitation; negative emotion (associated with blame and regret); and conflict type (Anderson, 2003). Researchers have shown that decision averseness occurs when situations have inequitable outcomes for others – particularly when the decision maker is held accountable (Beattie, Baron, Hershey, & Spranca, 1994); and the likelihood of negative outcomes also increases negative emotions associated with such decisions (Luce, Bettman, & Payne, 1997). In this study, we explored the notion that withdrawal of decisions (fewer decisions made) may be an example of decision avoidance behaviour.

Several theories have been proposed to explain performance decrements under pressure. A prominent example is Reinvestment Theory (Masters, 1992). Reinvestment is defined as the "propensity for manipulation of conscious, explicit rule-based knowledge, by working memory, to control the mechanics of one's movements during motor output" (Masters & Maxwell, 2004). Consequently, the use of explicit knowledge to consciously control normally automatic movements typically results in performance decrements or outright failure. Researchers have demonstrated that, when performing well-learnt motor skills or complex cognitive tasks, individuals who have a strong tendency to reinvest (Masters, Polman, & Hammond, 1993) are more susceptible to poor performance under pressure (Jackson, Kinrade, Hicks, & Wills, 2013; Kinrade, Jackson, & Ashford, 2010). To address potentially differential effects of reinvestment on motor skill execution and decision making, Kinrade, Jackson, Ashford and Bishop (2010) modified the original scale to create a decision-specific version focusing on individuals' propensity to deliberate, and ruminate, on their decisions – the Decision-Specific Reinvestment Scale (DSRS). Kinrade et al. (2010) proposed two explanations for the breakdown of decision making under pressure. First, that conscious processing of explicit information results in poor decision making, by interfering with normal automatic processes (Decision Reinvestment; e.g.,

"I'm aware of the way my mind works when I make a decision"). Secondly, ruminative thoughts (e.g., over past poor decisions) lead to poor decision making by drawing processing resources away from the task at hand (Decision Rumination; e.g., "I remember poor decisions I make for a long time afterwards"). Kinrade et al., (2010) described rumination as a thought process that typically involves repetitive negative thoughts about past events or current mood states. Higher Decision Reinvesters and Ruminators tend to exhibit poorer working memory task performance, (Laborde, Furley, & Schempp, 2015) and poorer decision making performance in complex tasks (Kinrade, Jackson, & Ashford, 2015). Kinrade et al., (2015) suggested that ruminative thoughts may occupy working memory capacity at a time when executive functions are already in great demand to complete the primary task. Poolton, Siu and Masters (2011) used the DSRS to examine soccer referees' susceptibility to the home advantage effect. Twenty-eight experienced referees were asked to make decisions when viewing game footage of two opposing players competing for the ball, by stating which player committed the foul. Referees that emerged as 'High Decision Ruminators' disproportionately made decisions in favour of the home team. We aim to explore this link further in the present study, in the context of netball officiating.

In order to more fully understand contextual and dispositional influences on the decision making of netball umpires, we used performance analysis to examine decisions made by umpires during matches in the England Netball Superleague – the highest echelon of competitive netball in the UK. We explored not only environmental and contextual influences such as crowd size, but also the umpires' self-reported tendency to reinvest in, and ruminate upon, their decisions. The number of decisions (referring to both the infringement decision and sanction choice) made provided an overt manifestation of the observed umpires' behaviour, a technique previously used to categorise observational data into approach- and avoidance-type behaviours (Jordet & Hartman, 2008). In accordance with previous research (Anderson, 2003; Jordet & Hartman, 2008; Nevill et al., 2002; Poolton et al., 2011; Souchon et al., 2016), we tentatively hypothesised that umpires' number of decisions would be mediated by environmental/ contextual influences such as home team status, crowd size, match prominence, league position, and time during the match. More explicitly, we predicted that, home teams in the presence of larger crowds, greater match significance, more prominent teams, and early match quarters would each be associated with lower decision frequencies (i.e., avoidance behaviour). We also predicted that a tendency to reinvest and ruminate would be associated with inhibited decision making.

3.3. Method

3.3.1. Participants

Altogether, 15 umpires officiated in the Superleague during the 2014 season, umpiring approximately eight matches each (M = 8.067, SD = 3.77). From this original sample 10 umpires (M age = 39.6 yrs, SD = 9.38 yrs) with a mean total years' experience of 14.5 years (M = 14.5 yrs, SD = 7.66 yrs), qualified at international (International Umpire Award) or national level (A-award), completed the DSRS. On average, they officiated almost nine matches each throughout the season (M = 8.80, SD = 2.859).

3.3.2. Measures

3.3.2.1. Data Acquisition.

Video footage from sixty Netball Superleague 2014 season matches was obtained. Crowd size (number of people present in the crowd) data were collected from the individual teams for their home fixtures and from England Netball for all 'neutral' venues (i.e., those for which there was no home team). League table data for each round were obtained from England Netball. Approval was obtained from the lead institution's local ethics committee.

3.3.2.2. Variables.

All coded variables were derived from discussions with a panel of experts (an England Netball Officiating Manager, a retired international umpire and assessor, a current national level umpire and tutor) and in accordance with variables previously shown to be pertinent with regard to sports officials' decision making (e.g., match importance, Hill et al., 2016; Decision Rumination and the home advantage effect, Poolton et al., 2011). The primary dependent variable was the number of observable decisions made (NoD). These observable decisions refer to the infringement decision and corresponding sanction. The authors acknowledges that an umpire can choose not to interfere with play; such non-observable decisions were not recorded (cf. Helsen & Bultynck, 2004). The NoD was split into three subcategories: overall; those against the home team (NoD Home); and those against the away team (NoD Away). Other coded variables included: infringement type (*contact*, *obstruction*, *offside*, *breaking*, *out of court*, and *other infringement*); and sanctions imposed (*penalty pass*, *advantage*, *throw in*, *advantage goal*, *other sanction.*). Additionally, we recorded six variables that were hypothesised to have a

potential influence on umpires' decision making: crowd size; competition round number (e.g., 1 = 1st round); league positions (of home teams, of away teams, and average; 1 = top of the league); and match quarter (e.g., Q1 = 1st quarter).

3.3.2.3. Decision Specific Reinvestment Scale.

Altogether, 10 umpires completed the Decision-Specific Reinvestment Scale (DSRS, Kinrade et al., 2010), a 13-item scale, comprising two subscales (Decision Reinvestment and Decision Rumination). Participants responded to each of the 13 items using a 5-point Likert scale anchored by 0 ("extremely uncharacteristic") and 4 ("extremely characteristic"). The Decision Reinvestment subscale comprises 6 items, assessing the individual's propensity to consciously monitor their decision making processes, with scores ranging from 0 to 24. The Decision Rumination subscale comprises 7 items, assessing tendency to negatively evaluate previous poor decisions, with scores ranging from 0 to 28. Kinrade et al. (2010) reported an internal consistency of .89 for the Decision Reinvestment subscale items and .91 for the Decision Rumination subscale items.

3.3.3. Procedure

The matches were analysed using digital performance analysis software (Sportscode Elite Version 9, Sportstec, Australia). A self-devised code window was designed to collect the number of observable decisions, based on arm signals and vocalisations made by the umpires during the matches. Observable decisions were infringements that were registered and acted upon by the official by either a whistle blow or signalling advantage (this did not include time calls e.g., injury, blood). Also, umpires can decide not to interfere with play (Helsen & Bultynck, 2004) and these non-observable decisions were not recorded. Situations in which decisions were unclear were coded separately (accounting for 1.4% of total decisions made). Two researchers independently coded all the footage; intraclass correlation coefficients were used to test for inter and intra-observer reliability (ICC >.90 for all).

3.3.4. Data Analyses

Preliminary screening of all data, using univariate z-scores (> ± 3.29) and multivariate Mahalanobis distance values revealed one outlier from both the match and umpire data set which were removed. The data were normally distributed. A repeated-measures ANOVA was

completed to compare differences in the NoD made across quarters. The relationships between contextual/ environmental influences, dispositional tendencies, and decision making were examined using two different analyses: one in which matches were treated as cases (n = 59), and another in which umpires were cases (n = 15 [all umpires] or n = 10 [DSRS completer's only, accounting for 72% of all matches, n = 42]). Pearson's product moment correlation coefficient was calculated for all bivariate combinations of the following variables in the match analyses: NoD; per match and per quarter; overall, in favour of home teams and in favour of away teams; crowd size; competitive round number; and home, and away team league positions, and their average. For the umpire analyses, bivariate correlations included total years of experience, Reinvestment, Rumination and number of games umpired. For the match-level analysis, all variables that were significantly related to NoD were entered as predictors into two stepwise multiple regression analyses and one linear regression, in which backward elimination was used in order to find a model that best explained the data. NoD, NoD Away, and NoD Home were the criterion measures for each of the three models. Alpha was set at .05 for all statistical tests. Due to the exploratory nature of the study, and accordingly tentative but directional nature of the hypotheses, we made no correction for multiple comparisons.

3.4. Results

3.4.1. Descriptive statistics

The descriptive statistics are presented in Table 3.1. On average, umpires made 120 observable decisions per game (M = 120.41, SE = 4.07). A repeated-measures ANOVA indicated that more decisions were made in the first quarter (M = 33.02, SE = 1.14) than in the third (M = 29.63, SE = 1.16) and fourth (M = 27.72, SE = 1.61) quarters, (F (3, 39) = 4.811, p = .006, η_p^2 = .270). The most common infringement type was contact (M = 45.69, SE = 1.04), and the most frequently awarded sanction was a penalty (M = 48.77, SE = 1.37). Descriptive statistics revealed that DSRS scores ranged from 15 to 35 (DSRS Global M = 25.50, SD = 6.67), and Reinvestment subscale score from 7 to 16 (Reinvestment M = 12.8, SD = 2.82), and Rumination subscale score from 4 to 20 (Rumination M = 12.7, SD = 5.42).

Table 3.1. Descriptive statistics-by umpire

Variable		Mean	Std Error	Range
Total number of decisions (NoD)		120.41	4.07	98.54 - 158.03
	Q1	33.02	1.14	26.71 - 40.38
	Q2	30.04	1.43	20.72 - 46.00
	Q3	29.63	1.16	23.67 - 38.13
	Q4	27.72	1.61	15.00 - 42.50
Decisions against home team (NoD Home)		59.74	1.80	43.00 - 68.57
	Q1	17.80	1.19	12.14 - 27.17
	Q2	13.74	0.82	8.83 - 18.42
	Q3	15.04	1.16	10.00 - 23.50
	Q4	13.17	1.06	5.00 - 18.56
Decisions against away team (NoD Away)		60.31	2.96	45.27 - 90.83
	Q1	15.18	.784	9.33 - 22.00
	Q2	16.38	1.87	7.09 - 37.16
	Q3	14.39	.684	9.33 - 18.14
	Q4	14.36	1.758	7.64 - 35.00
Neutral venue team match decisions		68.05	2.87	60.5 - 73
Simultaneous match decisions		0.13	0.07	0 - 0.33
Infringement	Contact	45.69	1.04	39-52.3
	Obstruction	39.83	3.07	19-63.8
	Offside	6.68	0.48	4.11-10.2
	Breaking	6.21	0.62	2.2-10
	Out	17.29	0.70	13.7-24
	Other Infringement (n = 11)	6.07	0.41	2.56-8.44
Sanctions	Penalty	48.77	1.37	39-61.2
	Free	8.43	0.37	6.30-11.60
	Advantage	35.48	2.81	21.33-62.8
	Advantage Goal	9.02	0.83	3.00-16.13
	Throw in	17.27	0.71	13.4-24.00
	Other Penalty (n = 6)	1.43	0.34	0-4.5.00

Note. Neutral venue team match decisions refer to the average number of decisions against teams at neutral grounds (n = 2, final and 3rd/4th play off matches). Simultaneous match decisions refer to the number of decisions whereby no clear sanction could be awarded against a specific team, and results in a toss-up.

3.4.2. Match-level Analysis

3.4.2.1. Total NoD.

All match-level bivariate correlations are presented in Table 3.2. As the teams progressed through the competition rounds, NoD increased (r = .266, p = .042, Table 3.2. (a)). NoD increased as the average league position of the two teams increased (r = -.269, p = .040, Table 3.2. (b)); that is, the higher the positions of the two teams, the greater the NoD. Similarly, the higher the home team league position (NB: top position in the league = 1), the greater the NoD (r = -.258, p = .047, Table 3.2. (c)). A backward stepwise regression was completed to identify the best predictors for NoD (variables entered: average league position, round, and home league position). The model that best predicted NoD included round and average team position (F (2, 58) = 3.919, p = .026, R^2_{Adjusted} = .091), although, when considered individually, neither predictor contributed significantly; they only approached significance (round p = .078, average team position p = .074) (see Table 3.3).

3.4.2.2. NoD Home.

NoD Home increased with the away team's league position (r = -.340, p = .008, Table 3.2. (d)) that is, more decisions were made against home teams when the away teams league position was higher. A linear regression indicated that away league position was a significant predictor of NoD (Home) (F (1, 54) = 6.255, p = .016, R^2Adjusted = .089) (see Table 3.3).

3.4.2.3. NoD Away.

NoD Away increased as home teams' positions improved (r = -.424, p = .001, Table 3.2. (e)), that is, the higher the home teams' position, the larger the number of decisions against away teams. As away teams progressed through rounds (r = .344, p = .008, Table 3.2. (f)) or played in front of larger crowds (r = .312, p = .023, Table 3.2. (g)) the NoD against them increased. A multiple regression was run to identify the best predictors for NoD Away (variables entered crowd size, round, and home league position) using the backward method. After the exclusion of crowd size and round, home team league position was shown to best predict NoD Away (F (1, 48) = 7.940, p = .007, R^2Adjusted = .126). (See Table 3.3).

Table 3.2. *Correlational Analysis – by Match (n = 59)*

	Total NoD					NoD (Home)					NoD (Away)				
	Match	Q1	Q2	Q3	Q4	Match	Q1	Q2	Q3	Q4	Match	Q1	Q2	Q3	Q4
Round Number	[a] .266*	.188	.173	.279*	.191	.042	.046	.045	.064	-.048	[f] .344**	.220	.170	.276*	.256
Home League Position	[c] -.258*	-.152	-.233	-.211	-.231	.069	-.027	.171	-.060	.129	[e] -.424**	-.188	-.413**	-.200	-.362**
Away League Position	-.063	-.215	.069	-.116	.116	[d] -.340**	-.285*	-.232	-.258*	-.147	.186	-.043	.266*	.052	.244
Average Team Position	[b] -.269*	-.305*	-.139	-.273*	-.098	-.223	-.258*	-.048	-.263*	-.013	-.203	-.193	-.128	-.126	-.104
Crowd Size	.236	.205	.171	.194	.170	.025	.128	-.160	.174	-.118	[g] .312*	.167	.337*	.099	.286*

Note. Q= Quarter.*p < .05, ** p < .01.

Table 3.3. *Multiple and Linear Regression Data*

		b	*SEB*	β	*p*
NoD					
Step 1	Constant	255.360	21.205		.000
	Average League Position	-5.160	4.685	-.175	.276
	Home League Position	-1.724	2.850	-.098	.548
	Round	1.974	1.213	.212	.109
$R^2_{Adjusted} = .081$, $\Delta R^2 = .129$					
Step 2	Constant	253.939	20.955		.000
	Average League Position	-6.840	3.752	-.231	.074
	Round	2.122	1.181	.228	.078
$R^2_{Adjusted} = .091$, $\Delta R^2 = -.006$					
NoD Home					
	Constant	135.102	6.641		.000
	Away League Position	-3.299	1.319	-.325	.016
$R^2_{Adjusted} = .089$, $\Delta R^2 = .106$					
NoD Away					
Step 1	Constant	116.949	27.269		.000
	Crowd Size	.013	.027	.085	.642
	Home League Position	-3.711	2.289	-.297	.112
	Round	1.399	.971	.195	.156
$R^2_{Adjusted} = .186$, $\Delta R^2 = .186$					
Step 2	Constant	128.369	12.000		.000
	Home League Position	-4.430	1.679	-.355	.011
	Round	1.396	.962	.195	.154
$R^2_{Adjusted} = .182$, $\Delta R^2 = -.004$					
Step 3	Constant	140.132	8.950		.000
	Home League Position	-4.746	1.684	-.380	.007
$R^2_{Adjusted} = .126$, $\Delta R^2 = -.037$					

3.4.3. Umpire Level Analysis

3.4.3.1. Total NoD.

As the average league position improved the number of decisions were greater in Q3 (r = -.573, p = .032, Table 3.4. (a)).

3.4.3.2. NoD Home.

NoD Home increased as the competition progressed (i.e. later rounds, r = -.618, p = .018, Table 3.4. (b)) and the away team's league position became more prominent (r = -.603, p = .022, Table 3.4. (c)).

3.4.3.3. NoD Away.

As crowd size increased so did the NoD Away (r = .560, p = .037, Table 3.4. (d))

3.4.4. DSRS.

The correlations completed with the DSRS subscales include only the data from the ten umpires who completed the scale. The Rumination subscale score was significantly negatively associated with NoD Q1 (r = -.795, p = .006 Table 3.4. (e)), NoD Q3 (r = -.709, p = 022, Table 3.4. (f)), NoD Home Q1 (r = -.717, p = .020, Table 3.4. (g)) and NoD Home Q3 decisions (r = -.660, p = .038, Table 3.4. (h)); that is, higher Rumination subscale scores were associated with fewer decisions. Reinvestment subscale scores were not significantly correlated with any NoD variables.

Table 3.4. *Umpire dataset correlations*

	Total NoD					NoD (Home)					NoD (Away)				
	Match	Q1	Q2	Q3	Q4	Match	Q1	Q2	Q3	Q4	Match	Q1	Q2	Q3	Q4
Years Exp	-.099	-.044	-.096	-.129	-.172	-.048	-.284	.390	-.304	.461	-.222	.107	-.198	.177	-.254
Number umpired	-.128	-.094	-.383	-.170	.207	.230	-.392	.564*	-.218	.633*	-.363	.625*	-.602*	.177	-.318
Reinvestment	-.221	-.088	-.252	-.124	-.218	-.081	-.346	.474	-.204	.288	-.318	.549	-.397	.061	-.313
Rumination	-.586	e -.795**	-.361	f -.709*	-.334	-.550	g -.717*	.567	h -.660*	.621	-.584	.179	-.505	.032	-.530
Crowd Size	.346	.383	.443	.202	.104	-.094	.298	-.409	.263	-.467	d .560*	.100	.492	.020	.367
Round	-.152	-.095	.185	-.102	-.441	b -.618*	-.101	-.281	-.209	-.488	.201	-.112	.346	.078	-.010
League Position	-.406	-.254	-.330	a -.573*	-.151	-.255	-.321	.149	-.399	.250	-.324	.248	-.291	-.102	-.306
Home League Position	.136	.140	-.015	-.146	.410	.458	-.012	.375	-.004	.503	-.064	.299	-.202	-.096	.011
Away League Position	-.209	-.183	.092	-.399	-.225	c -.603*	-.051	-.420	-.226	-.393	.164	-.125	.309	-.174	.070

Note. Q = Quarter. *p < .05, ** p < .01

3.5. Discussion

In an exploratory study, we examined the influence of contextual and dispositional differences on decision making of umpires in actual match settings. We hypothesised, based on existing literature, that environmental and contextual influences (i.e., larger crowds, more prominent teams, greater match significance, and early quarters) would be associated with lower decision frequencies. Furthermore, we predicted that inhibited decision making would be associated with a dispositional tendency to reinvest and ruminate. In line with our hypotheses, match prominence and league position were associated with a reduction in the number of decisions. The Decision Rumination factor was linked with inhibited decision making; but contrary to our hypothesis, the Reinvestment factor was unrelated. In contrast to our hypotheses, increasing crowd size was associated with a greater number of decisions, particularly against away teams; and the number of decisions diminished throughout a match.

Our data indicated that more decisions were made in Q1 (33 decisions) than in Q3 (29 decisions) and Q4 (27 decisions), incongruent to our hypothesis and the findings by Mallo et al. (2012) and Elsworthy et al. (2014). These differences could be related to physical fitness and fatigue of umpires; for example, Paget (2015) found that the distance covered by netball umpires was significantly reduced in the fourth quarter. It is possible that, if umpires are physically fatigued and not covering the same distances as they did in the early stages of a match, the fewer decisions later in the game could be those missed or avoided as a result of incorrect positioning. Multiple researchers have highlighted the link between position (distance and angle) of soccer referees and decision performance (Gilis, Helsen, Catteeuw, & Wagemans, 2008; Mallo et al., 2012; Oudejans et al., 2000; Oudejans et al., 2005). For example, Mallo et al. (2012) demonstrated referees had a lower number of incorrect decisions when the referees were positioned in the central area of the field. Research in medical and military settings has shown that fatigue and physical exertion have a detrimental effect on decision making (Kovacs & Croskerry, 1999; Larsen, 2001). However, in sport contexts, decision making performance was shown to be unaffected by physical exertion in Australian football umpires (Elsworthy et al., 2014; Paradis, Larkin, & O'Connor, 2015), fatigue in English Premier League assistant referees (Catteeuw, Gilis, Wagemans, & Helsen, 2010) or physical performance of New Zealand Football Championship referees (Mascarenhas et al., 2009). Thus, it is possible the change in the number of decisions is in response to the reducing work rate of the players or level of performance. For

example, Weston and colleagues (Weston, Bird, Helsen, Nevill, & Castagna, 2006; Weston et al., 2012) found that soccer referees and players high intensity running distance, ball travel, and total distance covered were correlated. However, further research is required to understand the link between player and referee physical performances and their impact on referee decision making.

As suggested by Poolton et al (2011), higher Rumination subscale scores, and not Reinvestment scores, were strongly associated ($r > -.7$) with fewer decisions in Q1 and Q3. Notably, Higher Ruminators made fewer decisions against home teams during those quarters. Burke, Joyner, Pim, and Czech (2000) demonstrated that basketball officials' cognitive anxiety was higher pre-game, and at half time when compared to post-game. It is possible that prior to the start of the game, where officials arrive at the venue early and watch the teams' warm-up pre-game, and during the half-time break, there is greater potential for officials to engage in ruminative thoughts than during the smaller breaks taken between Quarters 1 and 2, and 3 and 4. To our knowledge, no researchers have investigated the timing of sports officials' decision ruminations. However, Roy, et al. (2016) explored the timing of rumination by asking hockey players to rate on a 5-point scale whether they would continue to think about the play when it was over and their role in the play (past play), and how the team and individual would perform in the rest of the match (future play). Their results indicated that participants were unlikely to think about previous play after it was over, or about how the game would unfold; however, they were more likely to think about past play than future play. The authors suggested that the low rumination observed in successful field hockey players could reflect that people low in rumination do best in tasks requiring quick shifts of attention (such as dynamic team sports). Alternatively, a possible explanation might be that umpires engage in avoidance behaviours to reduce the chance of scrutiny of their decisions (Anderson, 2003). Contrary to our hypothesis, but consistent with Poolton et al. (2011), Reinvestment subscales scores were not related to the number of decisions.

A home advantage effect was observed; the descriptive statistics indicated that more decisions were awarded against away teams, supporting findings in soccer, that home teams were awarded more penalties (Nevill et al., 1996) and that more yellow cards were awarded to away teams (Goumas, 2014). Factors purported to contribute to the home advantage include travel (i.e. greater time and distances for the away team), referee bias, familiarity and crowd size (Pollard,

2008). Furthermore, the correlations suggested that for matches in later rounds, where there is often greater importance due to more matches influencing final placings, play-offs and finals, fewer decisions were awarded against home teams. One explanation could be that officials exhibit avoidance-type behaviours to cope with the increases in anxiety resulting from increased perceived importance. Hill et al. (2016) found that rugby referees highlighted the importance of the game as one of the stressors affecting their performance, and that some referees use avoidance coping methods (Jordet & Hartman, 2008) to manage this stressor. It is possible that umpire experience could have confounded these figures, however a correlation between round and the umpire's years of experience, where you might expect the most experienced umpires to officiate the latter rounds, was non-significant (r = .126, p = 728).

Our results are consistent with previous research (Boyko et al., 2007; Page & Page, 2010) where increases in crowd size were associated with an increase in the number of decisions against away teams. One possible explanation is that when faced with a difficult decision, officials draw on other salient cues (e.g., crowd noise), particularly when placed under time constraints (Balmer et al., 2007). In order to reduce the complexity of a decision (Souchon et al., 2010) umpires may use simple heuristics (Raab, 2012). For example, if two opposing players contested a ball and the umpire was unsure of the penalty decision, they may place equal weight on the auditory crowd cues as they do their visual information. Crowd noise typically favours the home team, resulting in more decisions against away teams (Nevill & Holder, 1999). This finding is reflected in our data, with larger crowd sizes associated with more decisions against away teams. Alternatively, researchers have reported that crowd noise induces a reluctance to penalise the home team (Nevill et al., 2002) (i.e., an absence of crowd noise indicates to the referee that no serious offence has been committed).

The number of years' experience was not associated with the number of decisions made. This may be due to the number of years' experience umpiring at Superleague level (which was not recorded) or that there was little to no difference in qualification (Hancock & Ste-Marie, 2013). Other researchers have found the referee's experience to influence decision making. Nevill et al. (2002) found as referees experience increased, that more fouls were awarded against home players, until a peak of 16 years, where upon a decline was then observed. However, the number of games umpired was positively associated with Reinvestment subscale scores.

Potentially, those umpires who deliberate more on their decisions are deemed more effective and are therefore requested to umpire more often.

League position predicted fewer decisions against home teams when playing lower positioned away teams, and for away teams playing lower positioned home teams. This finding may be similar to the reputation bias of judges found by Findlay and Ste-Marie (2004) and Plessner (1999) whereby teams with a better performance reputation may be sanctioned less. Alternatively, it is possible that the results of this study could be explained by the differences in players (e.g., lower ability teams or less competitive matches), or players' susceptibility to pressure, and not that of the officials. Previously, researchers have reported that yellow cards against away players in soccer could be a consequence of a poorer psychological state when compared with playing at home (Bray, Jones, & Owen, 2002; Terry, Walrond, & Carron, 1998). Contrary to research by Souchon et al. (2016), umpires intervened more when the average league position of both teams was higher. It may be possible in the netball context that the higher competitiveness between top teams leads to more contested situations that require umpire intervention.

There were several limitations that need to be acknowledged. First, we had incomplete data for crowd size, resulting in six matches being excluded from the crowd size analyses. Similarly, not all umpires who officiated the season completed the DSRS and were therefore excluded from the correlational analyses. However, those who did complete the DSRS officiated 72% of the matches analysed. Second, the accuracy of decisions was not recorded, preventing insight into the performance change of umpires exposed to different contextual and environmental conditions or comparisons between those with greater or lesser disposition to ruminate. However, it was not practically possible to obtain objective assessments of every decision made by the officials across the season. We also acknowledge that rumination is often seen as a negative process (referring to passive self-critical worrisome or anxious thinking, (Treynor, Gonzalez, & Nolen-Hoeksema, 2003), whereas self-reflection (Treynor et al., 2003) on performance is an important post-game learning tool used by sports officials (MacMahon et al., 2014). Although the DSRS items refer to negative ruminative thoughts, our study design did not allow us to collect data on the types or timings of rumination/reflection. Further investigation is required to examine the relationship between rumination and performance in sports officials,

with reference to the types (rumination versus reflection) and timings (before, during, and after performance) of ruminations officials' make through self-report or stimulated recall.

Third, we cannot isolate the influence of each potential bias using the current study design. The number of decisions umpires make may be a result of a combined effect of crowd sizes, league position, round, and time. For example, you might expect later rounds to have greater crowd sizes, which could have confounded our data. However, a correlation between round and crowd size, was not significant (r = .136 p = .326). It would be beneficial to investigate these effects in isolation in a controlled environment in order to draw clearer conclusions regarding the potential influence of these factors. Furthermore, we cannot be certain that the players' performance was not affected by the same contextual, environmental or dispositional influences, leading the umpires to adjust their decision making accordingly. The analysis performed in the present study was not exhaustive, and it is possible that further analyses could be made to assess other biases or enhance the understanding of umpire's decision making. For example, in relation to biases, it may be possible to examine the effect of scoreline on the number of decisions made, with close games presenting potentially higher pressure scenarios. Additionally, a comparison of the number of decisions in televised versus non-televised games (as not all games in the Netball Superleague are televised), could present a unique analysis given the presence of cameras in lab-based studies have been shown to heighten pressure. Similarly, previous research (Van Quaquebeke & Giessner, 2010), has investigated height bias, which might be of interest to investigate specifically in contact and obstruction decisions. Finally, we used observational data and descriptive and correlational analyses. An advantage of the use of observational data is the high external validity, making the results easily interpretable and applicable in the real world. While our approach is novel, and the study presents the first empirically based analysis of netball officiating behaviour we cannot infer causality from the findings. In future, controlled experiments are required to establish any causal links that may be implied in our data. For example, future research should examine the specific crowd factors that lead to changes in decision making behaviour such as examining the impact of volume on decision making, where crowd size has been linked to crowd noise (Hayne, Taylor, Rumble, & Mee, 2011); or investigating the semantics of crowd members (Bishop, Moore, Horne, & Teszka, 2014). Specifically, it would be of benefit to understand how crowd noise

impacts the underlying mechanisms (e.g., visual search and information use) during the decision process.

In summary, we explored putative contextual/environmental and dispositional influences on netball umpires' decision making. We observed a home advantage effect, whereby more decisions were awarded against away teams when crowd sizes were greater. We found a reduction in the number of observable decisions made, against teams with higher status, in more important matches, as the time played in a match decreased and as a function of increasing levels of Decision Rumination. Our study presents the first empirically-driven task analysis of the demands of refereeing in netball and highlights a number of key areas for which follow-up research comprising experimental designs (e.g., eye-tracking) and manipulations (e.g., volume and pressure) may be employed.

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4. Chapter 4

Dispositional Rumination Moderates the Effect of Contextual Influences on Netball Umpires Decision Making

4.1. Abstract

The ability to make accurate decisions under pressure is essential for sports officials. However, not only are sports officials' decisions susceptible to bias, but also, they are potentially mediated by their decision making personality. Furthermore, sports officials frequently perform rule-based decision making and game management processes in parallel. Accordingly, this study examined the interaction of pressure, crowd noise and Decision Rumination tendency on experienced netball umpires' decision making performance. Additionally, this study evaluated the impact of a novel game-management secondary task on netball umpires' decision making performance and associated processes. Specifically, this study assessed umpires' decision speed and accuracy, their gaze behaviour and the sources of information they used to make their decisions. Netball umpires were presented with video-based decision making scenarios, with Single- and Dual-task demands, Crowd noise and Silent, under both Low- and High-Pressure conditions. In line with the Integrated Model of Anxiety and Motor Performance, umpires experienced less efficient gaze behaviour indicated by increased scan ratios and mental effort under Pressure and Dual-task conditions. Performance effectiveness was not maintained, demonstrated by poorer decision accuracy under Pressure, Dual-task and, Low-Pressure Crowd conditions. At the interpretational level, under Pressure fewer cognitive statements were used. Unexpectedly, higher trait Rumination was associated with greater decision accuracy. It is possible that a ruminative decision making style may enhance, not hinder, sports officials' performance. Impaired decision making performance when completing a secondary game management task poses significant practical implications for the training of sports officials.

4.2. Introduction

For interceptive team sports officials, the decision making process is a highly demanding one, which requires rapid integration of multiple crossmodal information sources, option generation, action selection and initiation, and decision evaluation. A cycle that occurs hundreds of times during a match (Burnett, Bishop, Ashford, Williams, & Kinrade, 2017, Chapter 3; Helsen & Bultynck, 2004), in complex and distracting environments (Balmer et al., 2007; Burnett et al., 2017). These decisions are often made in ambiguous situations (e.g., intentional deception; Souchon et al., 2013) where information may be missing, and task demands may overwhelm resources in highly pressured situations often resulting in decisions that affect the outcome of competitive matches (Plessner & MacMahon, 2013). One such source of pressure identified by sports officials' is the social pressure of spectators (Schnyder & Hossner, 2016). Although, multiple studies (e.g., Balmer et al., 2007; Burnett et al., 2017) have demonstrated the effect of crowds on sports officials' decision making, currently there is no evidence for the underlying mechanisms responsible for performance changes under pressure or in crowd noise conditions.

In addition to their primary task of making these decisions in pressurised environments, sports officials such as netball umpires must also keep track of the number of persistent rule infringers, in order to follow the sanctioning system and take further disciplinary action as required (International Netball Federation, 2018). This aspect of game management has a major impact on the flow of the game and often the result. One recent prominent example of game management is that of referee Qin Liang in the England versus Cameroon 2019 Women's Soccer World Cup competition. Liang was heavily criticised by the media for the lack of control following video assistant referee (VAR) decisions ruling goals in favour of England and disallowing one for Cameroon. Behaviour of spitting, dissent and refusing to begin play, usually bookable offences, were allowed to continue resulting in 15 minutes of added time and no disciplinary sanctions. There has been little investigation into the role of individual differences, or the effect of both crowd noise and the increased working load imposed by game management factors in sports officials' decision making under pressure. The aim of this study is to address this dearth.

4.2.1. Crowd influences on sports officials' decision making

Research into sport officials' decision making has investigated crowd effects on the home advantage (e.g., Myers & Balmer, 2012), primarily in soccer (e.g., volume; Nevill, Balmer, & Williams, 2002) including the influence of crowds on the frequency of rule infringement decisions (Balmer et al., 2007; Burnett et al., 2017). Nevill, Balmer, and Williams (2002) examined soccer referees' decision making under conditions in which crowd noise was either present or absent, and found that referees awarded fewer fouls to the home team in the presence of crowd noise. Balmer et al. (2007) extended these findings to investigate the contributions of anxiety and arousal to referees' decision making. Their results suggested that crowd noise was associated with increased anxiety and mental effort, and that referees attempted to cope with these increases by giving decisions in favour of the home team.

Unkelbach and Memmert (2010) proposed that the noise from the home crowd biased officials' decisions per se, rather than decisions in favour of the home team. They examined referees' decision making performance when they adjudged fouls and found that loud crowd noise led to the award of more yellow cards than a quiet crowd noise condition. One explanation for these inconsistencies is that, when faced with a difficult decision, referees may adopt a *decision avoidance strategy*, whereby they avoid displeasing the crowd by allowing play to continue (Burnett et al., 2017; Hill, Matthews, & Senior, 2016). Alternatively, it has been suggested that when faced with a difficult decision, officials rely on the most salient cues available, particularly when placed under time constraints (Balmer et al., 2007). The Brunswikian approach to cue learning, used to explain the crowd bias in referee decision making, explains that when assessing distal properties, to which people have no direct sensory access, people rely on proximal cues (Brunswik, 1957). One such proximal cue –that constantly impinges on the officials' attention – is the noise of the crowd. It has been suggested that referees learn that the noise of the crowd reflects the severity of the foul made (Unkelbach & Memmert, 2010). As sports officials develop an association between noise and foul severity, they use the crowd noise as an additional cue in their judgment process, resulting in biased decision making.

Souchon, Fontayne, Livingstone, Maio, Mellac, and Genolini (2013) suggested that referees might use either an audience response heuristic (Axsom, Yates, & Chaiken, 1987) or a consensus heuristic (Giner-Sorolila & Chaiken, 1997) to help them make a decision. Souchon et al. investigated the influence of coaches' exhortations on judo referees' decision making. In a

time-constrained video task, sixty-five experienced referees judged throw situations that varied in their ambiguity (low vs. high) and strength (minor vs. hard), both in the presence of supportive exclamations, and when there were none. Referees awarded higher scores when the coaches' comments were audible; additionally, the influence was greater for minor sanctions and ambiguous scenarios.

The past few decades has seen a wealth of research into the exogenous capture of attention. Much of this work has focused on the capture of attention by visual cues (Causer, McRobert, & Williams, 2013), but an increasing number of studies have investigated the attention-capturing properties of auditory cues (Bishop, 2016; Ho & Spence, 2005). For example, Bishop, Moore, Horne, and Teszka (2014) investigated the effects of spoken cues on experienced netballers' performance during demanding visual tasks. Specifically, participants completed visual detection, visual discrimination and sport-specific decision making tasks, each of which required a binary (left/right) response. In all conditions a spoken word (left/right) was presented monaurally at the onset of each visual stimulus. Their results demonstrated that spoken cues affected target detection: cues that were either spatially or semantically invalid (e.g., a call of "left" when the target was on the right) slowed target detection time; and spatially invalid cues reduced discrimination task accuracy. However, in a follow-up study, Bishop (2016) found no corresponding changes in gaze behaviour, suggesting that any shifts in attention were likely to be covert. This study investigates gaze behaviour to broaden the understanding of crowd biased decision making. Despite a wealth of research showing the impact of crowd noise on sports officials' decision making performance, to date there has been little insight into the underlying mechanisms.

4.2.2. Dual-task impact on decision making

Working memory supports active maintenance of task relevant information during the performance of ongoing tasks. If necessary, when there is a secondary task to complete, monitoring of potential secondary task-associated information and task switching can occur (Miller & Cohen, 2001; Plessow, Fischer, Kirschbaum, & Goschke, 2011). However, working memory can be overloaded or taxed by attempts to focus one's attention on multiple simultaneous tasks (i.e., increasing cognitive load; Unsworth & Engle, 2007). Often the performance of two cognitively demanding tasks leads to interference. Consequently, Baddeley

(1998) has shown that the performance of two tasks involving the central executive of working memory leads to decreased performance in both tasks. For example, Baddeley, Emslie, Kolodny, and Duncan (1998) showed that several cognitively demanding tasks – such as serial recall, semantic category generation, and concurrent digit generation – impacted on the participants' ability to randomly generate numbers, presumably due to the additional load on the central executive.

Several researchers have investigated the link between decision making processes and executive functions in neuroimaging research (De Martino, Kumaran, Seymour, & Dolan, 2006), behavioural experiments (Hinson, Jameson, & Whitney, 2003) and sport studies (Laborde, Furley, & Schempp, 2015). In their examination of executive functions in decision tasks, Del Missier, Mantyla, and Bruine de Bruin (2010) showed that the successful application of decision rules requires the capacity to selectively focus attention and inhibit irrelevant stimuli. Gathmann et al. (2015) investigated the underlying executive functions of a dual-tasking situation involving a decision making and working memory task and found that monitoring is involved in the simultaneous performance of the two tasks. Researchers have demonstrated that decision making performance is compromised under greater cognitive load, and when overall processing capacity is reduced (Hinson et al., 2003). In general, increases in cognitive load negatively affect attention, accuracy, dual-task performance, and task execution time (e.g., Ackerman, Beier, & Boyle, 2002). In a study of delay discounting judgments – a task that measures participants' preference to select a large reward at variable delays compared to immediate delivery of a small reward – Hinson et al. (2003) showed that higher working memory load led to greater discounting of delayed monetary rewards. The authors suggested that the limits of working memory function are predictive of a more impulsive decision making style. More recently, Wood, Hartley, Furley, and Wilson (2016) explored individual differences in working memory capacity on hazard perception performance in a simulated driving task in both control and dual-task conditions. Results demonstrated that individuals had poorer hazard perception performance under dual-task conditions. The performance decrements were paired with changes in the gaze strategies for the low working memory capacity group, such that, under dual-task conditions, they made shorter-duration fixations on the hazard, which was likely detrimental to their ability to interpret and react to the developing danger.

In a sport related decision making task (soccer choice task: pass, keep, or shoot), participants were tested under dual-task conditions with either a verbal or visual memorisation secondary task (Zoudji, Thon, & Debû, 2010). Zoudji et al's (2010) results showed a decrease in accuracy under dual-, as opposed to single-task conditions. Such negative effects are consistent with the well-documented functional limitations of working memory under dual-task conditions (Baddeley, 1998). The decreases in performance are most likely due to the additional processing load imposed under dual-task conditions, wherein attentional resources are necessary not only for maintaining items in the appropriate sub-system, but also for processing the soccer related decision with the help of these sub-systems. In addition, for experts, but not inexperienced players, reaction time in the decision making task also increased under dual-task conditions following the first occurrence of the situation. This is in agreement with the results of Beilock and Carr (2005) regarding performance under pressure, whom reported a decrement in expert performance when the capacity of working memory available for skill execution was reduced. They concluded that, if the ability of working memory to maintain immediate task-relevant information is disrupted, then performance might suffer. Similar links have been made with relation to Reinvestment Theory (Masters, Polman, & Hammond, 1993). Laborde, Furley, and Schempp (2015) investigated the effect of dispositional reinvestment on working memory performance under pressure. They found Decision Specific Reinvestment was negatively correlated with working memory performance under High-Pressure. These results suggest that those with a tendency to reinvest have less available working memory capacity due to the consumption of working memory resources by ruminations or worries. Thus, these results confirm that a dual- task procedure was effective in perturbing working memory function.

4.2.3. The Integrated Model of Anxiety and Motor Performance

Despite the wealth of research on the various pressures and task complexities of umpires' decision making there is not yet one unifying theory to account for the underlying mechanisms, dispositional influences, decision environment and reduced performance under these pressures or anxiogenic conditions. However, the Integrated Model of Anxiety and Motor Performance (Nieuwenhuys & Oudejans, 2012) may be suitable in understanding the complex environment in which umpires experience debilitative decision making. Nieuwenhuys and Oudejans (2012) model incorporates elements of Attentional Control Theory (ACT), information processing

theory, self-focus and distraction models of choking. In ACT, and the integrated model, it is highlighted that anxiety can affect both processing efficiency and performance effectiveness. When anxious increased mental effort can be applied, and if auxiliary attentional resources are available, performance effectiveness may be maintained but at the expense of reduced performance efficiency. For example, Vater, Roca, and Williams (2016) demonstrated that when anticipating opponents' actions in a temporally occluded task, skilled participants were able to maintain the effectiveness of their performance in high anxiety conditions by reducing their processing efficiency, evidenced by increased response times and mental effort.

ACT purports that anxiety and worry impair the efficiency of the central executive and disrupt the balance between the goal-directed and stimulus-driven attentional systems (Corbetta & Shulman, 2002). Specifically, anxiety leads to an attentional bias for threat-related stimuli and enhanced distractibility in the presence of task-irrelevant information (Eysenck & Derakshan, 2011). However, investment of additional resources (e.g., cognitive effort) in order to maintain performance can counteract this tendency. However, our resources are typically limited; and if these additional resources are unavailable then performance effectiveness will too be impaired. This hypervigilance towards threatening stimuli leads to greater distractibility – which is often manifested in maladaptive gaze behaviour. For example, in their study of soccer penalty kick scenarios, Williams and Elliott (1999) showed that anxious participants were more likely to focus on the 'threat' posed by the goalkeeper, than at their intended target. Similarly, maladaptive gaze under anxiogenic conditions has been demonstrated in other sports (Nieuwenhuys, Pijpers, Oudejans, & Bakker, 2008).

Nieuwenhuys and Oudejans (2012) note three operational levels at which goal-directed behaviour is affected by anxiety leading to threat-related attentional, interpretational, and behavioural tendencies. It is suggested that anxiety induced performance decrements are affected by the limited working memory capacity and the increased reliance on the stimulus-driven system. Runswick, Roca, Williams, Bezodis, and North (2018) tested the Integrated Model of Anxiety and Motor Performance by examining how anxiety and contextual information affected perceptual-motor performance at these three operational levels in an in-situ cricket task. Support for the model was demonstrated by the participants reduced processing efficiency reflected in the greater number of fixations of shorter duration to less relevant locations under high anxiety conditions. Although anxiety affected batting performance, they did not find any effect of

anxiety at the interpretational or behavioural level. Alder, Ford, Causer, and Williams (2018) analysed badminton players anticipation in high- and low- anxiety conditions, and on selected trials during a secondary task. In line with the integrated model, anticipation performance deteriorated in the high anxiety condition. Visual search behaviour showed a decrease in processing efficiency with reduced fixation durations under high anxiety. In relation to the secondary task, novices exerted greater mental effort than experts, and were unable to maintain secondary task performance whilst under high-anxiety.

However, the Integrated Model of Anxiety and Motor Performance has not yet investigated the impact of dispositional influences. Poolton, Sui and Masters (2011) suggested that a referee's decision making behaviour is likely to be influenced by their propensity to Reinvest or Ruminate, and therefore may explain the susceptibility of soccer referees to the home advantage effect – the phenomenon whereby home teams tend to win more matches. It was suggested that referees with a high tendency to reinvest or ruminate would result in poorer performance as a result of either conscious processing of explicit information results in poor decision making, by interfering with normal automatic processes (*Decision Reinvestment*). Or alternatively, ruminative thoughts relating to past decisions lead to poor decision making, by drawing processing resources away from the task at hand (*Decision Rumination*). Poolton et al. asked 28 experienced referees to make decisions when viewing game footage of two opposing players competing for the ball. They found that referees categorised as *High Decision Ruminators* disproportionately made decisions in favour of the home team. It was suggested that Ruminators might reflect on negative experiences when officiating in a hostile environment, limiting the resources available to process an impending decision, thereby leading the referee to avoid the same negative experience by awarding decisions in favour of home teams. Despite findings such as these and those in Chapter 3, the combined effect of Decision Rumination and crowd noise on sports officials' decision making is yet to be examined. The interaction of Rumination propensity with pressure and susceptibility to biases (Burnett et al., 2017; Helsen & Bultynck, 2004) and additional task demands – in this case, crowd noise and game management – is central to the present study.

4.2.4. Aims and Hypotheses

This current chapter aims to examine how characteristics of the environment (i.e. crowd noise), and the individual (e.g. tendency to ruminate) affect netball umpires' decision making with varied working memory loads and under pressure induced anxiogenic conditions. Furthermore, this chapter examines the mechanisms employed at attentional (perceptual), interpretational (cognitive), and behavioural (decision response) operational levels using a lab-based video decision task. It was hypothesised that in more anxiogenic conditions (e.g., under pressure) higher threat (e.g., crowd noise), and increased load (e.g., dual-task) that umpires would have decreased processing efficiency (e.g., higher scan ratio's). In line with Nieuwenhuys and Oudejan's model (2012), it was further hypothesised that the interpretational level will be affected as indicated by informational reports collected, specifically, that a decrease in cognitive statements will occur under pressure but greater with changes in context (e.g., crowd noise) (McRobert, Ward, Eccles, & Williams, 2011). Furthermore, that greater perceptual statements (vs cognitive (e.g., evaluative or planning) type statements) would be used under High-Pressure, crowd and dual-task conditions, due to a shift away from goal-directed attention and increased attention to threat-related stimuli (Nieuwenhuys & Oudejans, 2012). It is predicted that decision accuracy will be reduced. In line with previous literature and Chapter 3, it was hypothesised that Higher Ruminators would be more susceptible to the processing and performance deficits.

4.3. Method

4.3.1. Participants

Twenty-one qualified netball umpires (all female, mean age = 33.90, SD = 11.69; mean years' experience = 8.26, SD = 5.09, A award n = 3, B award n = 8, C award n =10) participated.

4.3.2. Design

A repeated measures design was used whereby participants completed all conditions. Three conditions, 1. neutral (i.e., silent, single-task), 2. crowd noise, and 3. dual-task, existed in both Low-Pressure and High-Pressure conditions. Twenty-four trials were present in each of the six conditions. All trials within a condition were randomised, and the order of pressure blocks and experimental conditions was partially counterbalanced across participants.

4.3.3. Test Stimuli

Video footage of matches from national and international competitions was acquired. Four-hundred video clips representing a variety of decision making scenarios were selected by the researcher according to their representativeness of a courtside umpire's vantage point. Two independent experts (both ex-international umpires, and current umpiring award tutors and assessors) evaluated all clips, in order to confirm/disconfirm the correctness of the match umpires' decisions. Furthermore, they assigned scores according to three 10-point scales (1 = not at all; 10 = extremely), for vantage point suitability (how well the sightline matched that of an on-court umpire), decision straightforwardness (extent to which their infringement decision corresponded to that of the original on-court umpire), and likelihood of infringement occurrence (referring to the their perception of the typical frequency with which the infringement occurs in competitive matchplay) (cf. Hancock & Ste-Marie, 2013). The purpose of this process was to ensure that the clip selection comprised situations that were not only measurable (e.g., had a correct and incorrect response), but also a variety of decision scenarios that frequently occur at all competitive levels. This scoring process yielded a composite score out of 30 for each clip, allowing identification of the most suitable clips for the test stimuli. Consequently, 144 clips with the highest composite scores (> 23; range = 23-29) were ultimately selected; 18 additional clips were selected for use in familiarisation trials. Clips were edited to show some game context in the lead-up to a decision; specifically, the first 4 seconds comprised a still image upon which position-specific alphabetical labels were assigned to each player (Figure 4.1); this allowed the participants to identify player and ball locations. Following the still image, the clip played out (duration = 2–14 s) until another still image appeared for 1 second, along with corresponding alphabetical labels.

4.3.4. Auditory Stimuli

In the crowd noise conditions, a constant crowd background noise was present for the duration of each trial; one that did not relate to the unfolding of play.

4.3.5. Dual-task Manipulation

In order to increase their cognitive load, prior to the dual-task blocks, participants were asked to keep a count of the "number of decisions you make against the blue team" and "the

number of those decisions that were contact infringements". This task was selected to replicate a similar game management protocol umpires would complete in actual match scenarios, whereby "any player who infringes any part of the foul play rule will be disciplined" (International Netball Federation, 2018). Foul play refers to players delaying play, intentional infringing, persistent infringing, dangerous play and misconduct. Following the completion of the dual-task block trials, participants were asked to recall the two totals.

Figure 4.1. Example video still with alphabetical positional labels.

4.3.6. Pressure Manipulation

Prior to the High-Pressure condition, participants were informed that the next three conditions formed the experimental trials and that their decision performance was crucial to the success of this study and future training of sports officials. It was also explained to them that previous research has shown that the extent of bodily movement changes with decision difficulty, and that a video camera will be set up to record and analyse their movements accordingly; videotaping in such contexts has previously been shown to heighten self-consciousness and increase self-presentation concerns (Kinrade, Jackson, & Ashford, 2015). Finally, a monetary incentive was used: participants were informed that the highest accuracy scores in this block would win a £50 cash prize.

4.3.5. Measures

4.3.5.1. Pressure Rating Scale.

Following the Low- and High-Pressure conditions, participants were asked to rate the amount of pressure they experienced. They were required to answer the question "how much pressure did you feel in the last set of trials?" using a seven-point Likert scale anchored from 1 (no pressure) to 7 (extreme pressure) (Kinrade et al., 2015).

4.3.5.2.Rating Scale of Mental Effort.

The Rating Scale of Mental Effort (RSME; Zijlstra, 1993) was used after each set of trials, to compare the invested effort in both anxiety conditions and across tasks. Mental effort is defined as the amount of processing resources invested in the task (Williams, Vickers, & Rodrigues, 2002). The RSME was presented as a single continuum scale ranging from 0 to 150 with nine validated reference points along the scale (e.g., "Absolutely No Effort", "Some Effort", "Extreme Effort", etc.). Researchers have demonstrated that the scale provides a valid and reliable indicator of mental effort (0.88; Veltman & Gaillard, 1996).

4.3.5.3. Mental Readiness Form-Likert.

In order to explore the effects of the pressure manipulation more fully, participants also completed two scales of the Mental Readiness Form- Likert (MRF-L; Krane, 1994) to understand their anxiety under pressure. The MRF-L was developed to be a shorter and more expedient alternative to the Competitive State Anxiety Inventory-2 (CSAI-2; Martens, Burton, Vealey, Bump, & Smith, 1990). The two MRF-L bipolar 11-point Likert scales used are anchored as follows: *worried-not worried* (cognitive anxiety), *tense-not tense* (somatic anxiety). Participants were asked to rate how they feel "right now" when completing the scales prior to each condition. Krane's validation of the MRF-L revealed correlations between the MRF-L and the Competitive State Anxiety Inventory-2 subscales of .76 for cognitive anxiety, .69 for somatic anxiety and .68 for self-confidence.

4.3.5.4. Decision Specific Reinvestment Scale: Decision Rumination.

The Decision-Specific Reinvestment Scale (Kinrade, Jackson, Ashford, & Bishop, 2010) is a 13-item scale, comprising two subscales that predict an individual's propensity to reinvest when making decisions. Participants responded using a 5-point Likert scale anchored by 0

("extremely uncharacteristic") and 4 ("extremely characteristic"). Following results from Chapter 3, only Decision rumination was analysed in the present study. The Decision Rumination subscale comprises 7 items, assessing tendency to negatively evaluate previous poor decisions, with scores ranging from 0 to 28 (see Table 4.1). Kinrade et al. (2010) reported an internal consistency of .91 for the Decision Rumination, subscale items. Internal consistency for our study was .91 for Decision Rumination. Descriptive statistics revealed that participants' DSRS Rumination subscale scores ranged 0 to 21 (M = 9.52, SD = 6.02).

Table 4.1. *Decision Rumination subscale items.*

DSRS Item No.	Item
Item 4	I remember poor decisions I make for a long time afterwards
Item 5	I get "worked up" just thinking about poor decisions I have made in the past
Item 7	I often find myself thinking over and over about poor decisions that I have made in the past
Item 8	I think about better decisions I could have made long after the event has happened
Item 11	I rarely forget the times when I have made a bad decision, even about the minor things
Item 12	When I am reminded about poor decisions I have made in the past, I feel as if they are happening all over again
Item 13	I'm concerned about what other people think of the decisions I make

4.3.5.5. Decision Responses.

Umpires were asked to respond as they would in a game by blowing their whistle and verbalising their decision. Decision time (in ms) of participants' whistle blows were registered

via a serial response box (Psychology Software Tools, Sharpsburg, PA) in experiment generator software (E-Prime; Psychology Software Tools, Sharpsburg, PA). To determine decision time, the lead researcher completed frame-by-frame monitoring to identify the time of infringement as the reference point. Decision time was then calculated as the difference between this time and the whistle blow of the participants. Participants wore a lapel microphone that was connected to a compact diversity receiver, a body-pack transmitter (ew112- p G3; Sennheiser, Wedemark, Germany) and recording device (Zoom H5; Zoom Corporation, Tokyo, Japan), so that their decision accuracy – recorded as a percentage for each condition as ([total number of correct decisions/24] x 100), or in volume comparisons ([total number of correct decisions/12] x 100) – could be analysed post hoc.

4.3.5.6. Gaze Behaviour.

Eye movements were recorded using the ASL MobileEye XG (Applied Science Laboratories, Bedford, MA). A simple eye calibration procedure, using a five-point grid projected on to the screen, was performed before testing commenced; the accuracy of this calibration was rechecked prior to each condition. Scan ratio was calculated and was defined as the number of fixations divided by the total duration of fixations across all predetermined regions of interest (Nibbeling, Oudejans, & Daanen, 2012) (ROIs; see Data Analyses section).

4.3.5.7. Information Source Reports.

Participants were required to provide retrospective reports for the preceding trial, on six occasions within each condition when the word ‘Report’ appeared on screen; this occurred at pseudorandom intervals. A ‘source of information’ could be any information they used to make their decision (e.g., game context factors, rules, observations etc.). Prior to the conditions, participants were instructed to “rank the sources of information you used to make your decision in your previous trial, starting with the information you consider to be most important, and – if you used several sources – to continue with the second most important and so on”.

4.3.6. Procedure

Subsequent to institutional Research Ethics Committee approval, written consent was obtained from all participants. After the participants had completed a demographics questionnaire and the DSRS, the lapel microphone was attached to their upper garments, they put

on the eye tracking glasses, and calibration was performed. Participants stood 3m in front of a screen (2.25m x 1.65m) onto which the video clips were projected. Eighteen familiarisation trials were then presented, six in comparatively Silent/ Single-task conditions, six with the presence of crowd noise, and six with the secondary task, presented as three separate blocks of trials. Participants were instructed to respond as accurately as possible, as they would in an actual game, and to state the information sources they had used in order to make their decisions in the preceding trial whenever the word 'Report' appeared on screen. This protocol was repeated for all experimental conditions. Before the Crowd noise conditions, on-screen instructions explained that the participants would also hear crowd noise, but to continue to respond as they would in a match. Prior to pressure conditions (familiarisation, Low-Pressure and High-Pressure) the MRF-L was administered; and following each pressure condition, pressure rating scale data were collected. After each crowd and task-load condition RSME scores were collected. Following the familiarisation, participants completed all conditions, but the order of presentation was counterbalanced, firstly by pressure (either Low- or High-Pressure condition first), and then within the pressure condition, by noise (either Crowd noise, Silence/Single-task, or Dual-task first).

4.3.7. Data Analyses

Gaze data were analysed using ASL Results Plus (Applied Science Laboratories, Bedford, MA). In relation to the integrated model of anxiety (Nieuwenhuys & Oudejans, 2012), three regions of interest (ROIs) were defined: Decision Zone (the zone in which an infringement occurs, and the umpire needs to intervene) Non-decision Zone (court areas in which no infringements occurs) (Figure 4.2.), and Outside (areas outside of the court). Attention to the Decision zone indicates more task focused goal-directed attention, whereas the Non-Decision and Outside zones indicate stimulus-driven attention to threat-related stimuli. Similar ROIs were used by Spitz, Put, Wagemans, Williams and Helsen (2016) to examine time fixating on the most informative area of the display (e.g., contact zone) and time fixated on the action not involved in the infringement (non-contact zone). ANOVAs were used to examine the changes in scan ratio across conditions for the decision and non-decision zones.

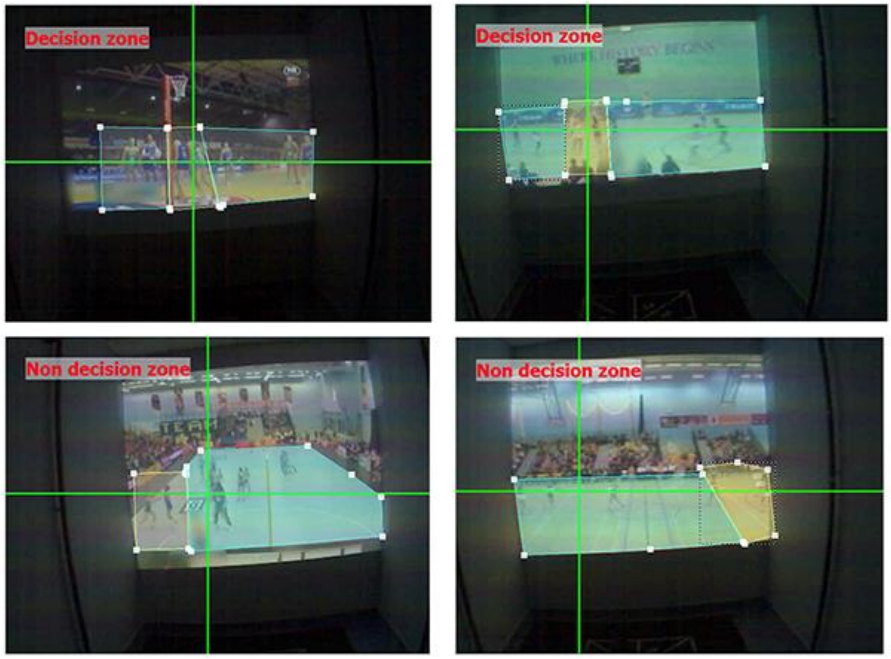

Figure 4.2. Example ROIs. These sample Decision- and Non-Decision Zones provide an illustration of task-relevant, informative areas of the display, and decision irrelevant areas, respectively. These regions vary in each clip due to the different scenarios, player positions, time leading into the infringement, and the infringement decision involved in each situation.

Information source reports were originally transcribed and coded into seven categories and collapsed into two: perceptual and cognitive for analysis similar to those used in previous studies (e.g., Roca, Ford, McRobert, & Williams, 2013). *Perceptual*, which refers to statements that identify or interpret sensory information; or *Cognitive*, for those that relate to existing knowledge structures, memory, judgement and reasoning. Within the *Perceptual* category there were four subcategories: *Player Cues* (all statements referring to cue sources emanating from bodily form or player positioning), *Court Geometry* (statements reflecting spaces on court), *Sensory* (references to the participants' vision and/or auditory cues used), and *Ball* (statements regarding placement or movement of the ball). Subdivisions of the *Cognitive* category included *Pattern Recognition* (statements referring to positional interdependencies between players), *Situational Probabilities* (reference to the likelihood of a particular event occurring in future), and *Rule Referral* (all statements referring to the rules of the game). The lead researcher, together with an independent experienced netball player and umpire, coded the information source reports. At a later date, a subsample of data was selected to code for a second time to test

intra-reliability. Intraclass correlations for each category demonstrated good intra- and inter-reliability (ICC >.85 for all).

Data were screened and checked for normality; no outliers existed so parametric methods were used throughout. Recall deviations scores were analysed by calculating the difference in the score recalled in the dual-task versus the total number of decisions and contact decisions actually made. To check the effectiveness of the pressure manipulation, and mental effort, paired sample t-tests were run to compare MRF-L scores, pressure ratings, and recall deviation scores between across blocks. Mixed ANOVAs (2 [Low v High-Pressure] x 2 [single- v dual-task, or crowd v silent] x 2 [High vs. Low Decision Rumination]) were conducted to examine decision accuracy, decision time, scan ratios and information reports, with Decision Rumination entered as a between-subjects factor and all other variables entered as repeated measures factors. Participants were assigned to High (n = 6, M = 16.17, SE = 1.30) or Low Ruminator (n = 7, M = 7.86, SE = 1.06) groups by conducting a median split on the Decision Rumination subscale scores. The alpha level of statistical significance was set at .05, and in line with recommendations from Frane (2015) exact *p*-values and 95% confidence intervals are provided. Partial eta squared (η_{p^2}) values are reported throughout for all main effects; pairwise comparisons and follow-up t-tests were carried out in the case of significance interaction effects.

4.4. Results

4.4.1. Manipulation checks

4.4.1.1. Anxiety and Pressure

Participants MRF-L scores showed they were more worried, (*M* = 5.81, *SD* = 1.86, vs *M* = 4.26, *SD* = 2.13, *t*(20) = 3.269, *p* = .004), felt greater tension (*M* = 5.52, *SD* = 2.21, vs *M* = 4.49, *SD* = 2.51, *t*(20) = 3.099, *p* = .006), and ratings of Pressure indicated they felt greater Pressure, (*M* = 5.19, *SD* = 2.35, vs *M* = 4.33 *SD* =1.46, *t*(20) = 3.408, *p* = .003) under High-Pressure conditions in the crowd analyses. In the Dual-task analyses, participants were more worried (t(20) = -3.269, *p* = .004), felt greater tension (t(20) = -3.099, *p* = .006), and Pressure (t(20) = -3.408, *p* = .003) under High-Pressure (Worry *M* = 5.81, *SE* = .41; Tense *M* = 5.52, *SE* = .48; Pressure *M* = 5.19, *SE* = .24) compared to Low-Pressure (Worry *M* = 4.29, *SE* = .46; Tense *M* = 4.24, *SE* = .55; Pressure *M* = 4.33, *SE* = .32).

4.4.1.2. Cognitive load.

All effects were non-significant for Crowd analyses. Participants reported greater mental effort in Dual-task blocks (M = 97.36, SE = 6.83) compared to Single-task blocks (M = 85.07, SE = 6.83) (F (1, 20) = 13.42, p = .002 η_p^2= .402). Reported mental effort for Pressure approached significance, with greater mental effort under High-Pressure (M = 94.02, SE = 7.03) compared to Low-Pressure (M = 88.41, SE = 6.50) (F (1, 20) = 3.88, p = .063 η_p^2= .162). There was no interaction effect between Pressure and WM conditions (F (1, 20) = 2.89, p = .105 η_p^2= .126). Recall deviation scores showed a greater deviation from their actual decisions made for the contact recall (t(20) = -2.50, p = .021) under High-Pressure (M = 1.86, SE = .24) than under Low-Pressure (M = 1.14, SE = .221) conditions; however, these differences only approached significance for the recall of number of decisions t(20) = -1.92, p = .070).

4.4.2 Decision Accuracy

4.4.2.1. Crowd.

Umpires' were less accurate under High-Pressure (M = 56.58, SE = 1.70, 95% CI [53.02, 60.15]) compared to Low-Pressure (M = 63.24, SE = 1.99, 95% CI [59.09, 67.40]) (F (1, 19) = 11.20, p = .003 η_p^2= .371) (see Figure 4.3a). Higher Ruminators (M = 64.41, SE = 2.15, 95% CI [59.90, 68.91]) were more accurate than Lower Ruminators (M = 55.42, SE = 2.26, 95% CI [50.69, 60.14]) (F (1, 19) = 8.30, p = .010 η_p^2= .304) (see Figure 4.3a). There was a significant interaction effect of Pressure and Crowd for decision accuracy (F (1, 19) = 17.02, p = .001 η_p^2= .473). Follow up t-test demonstrated poorer decision accuracy under Low-Pressure in the crowd noise condition (M = 60.32, SE = 2.14), compared to no crowd noise (M = 66.49, SE = 2.43) (t(20) = 3.23, p = .004, 95% CI for difference [2.19, 10.16]). Furthermore, there was a significant interaction effect of rumination and pressure (F (1, 18) = 10.36, p = .005 η_p^2= .365), t-test showed differences between rumination groups approached significance under both Low-Pressure (t(19) = -1.90, p = .073) and High-Pressure (t(19) = 1.91, p = .073).

4.4.2.2. Dual-task.

Similarly, umpires were more accurate under Low-Pressure (*M* = 60.96, *SE* = 1.73, 95% CI [57.33, 64.59]) than High-Pressure (*M* = 50.53, *SE* = 1.69, 95% CI [46.98, 54.08]) (F (1, 19) = 36.57, $p < .001$ $\eta_p^2 = .658$) and Higher Ruminators (*M* = 59.20, *SE* = 2.05, 95% CI [54.92, 63.48]) were more accurate than Lower Ruminators (*M* = 52.29, *SE* = 2.14, 95% CI [47.80, 56.80]) (F (1, 19) = 5.43, $p = .031$ $\eta_p^2 = .222$) (see Figure 4.3b). Umpires were also more accurate in Single-task (*M* = 60.88, *SE* = 1.80, 95% CI [57.12, 64.65]), compared to Dual-task conditions (*M* = 50.61, *SE* = 1.53, 95% CI [47.41, 53.80]) (F (1, 19) = 44.65, $p < .001$ $\eta_p^2 = .701$) (see Figure 4.3b). Additionally, an interaction effect of WM and rumination group approached significance (F (1, 19) = 4.30, $p = .052$ $\eta_p^2 = .185$) showed Higher Ruminators were more accurate in Single-task conditions compared to Lower Ruminators (t(19) = 2.86, $p = .011$, 95% CI for difference [2.56, 17.60]).

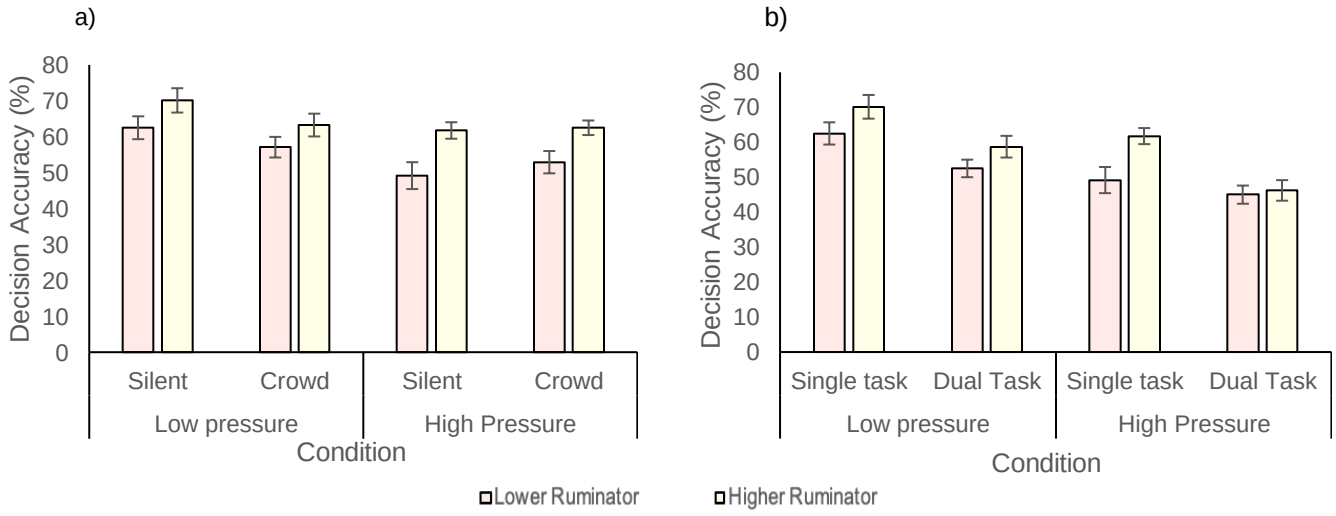

Figure 4.3. Mean decision accuracy across Pressure, Crowd (a) and Task (b) blocks (SE bars, *$p < .05$, ***$p < .001$).

4.4.4. Decision time

4.4.4.1. Crowd.

There was a significant interaction effect between Rumination and Pressure (F (1, 18) = 10.36, $p = .005$ $\eta_p^2 = .365$): follow up t-test revealed close to significant differences between

Rumination groups in both Pressure conditions. Under Low-Pressure, Lower Ruminators had a longer decision time (t(19) = -1.90, p = .073, 95% CI for difference [-419.87, 20.27]), but under High-Pressure, they had a shorter decision time compared to Higher Ruminators (t(19) = 1.91, p = .073, 95% CI for difference [-15.21, 315.25]). Additionally, there was an interaction effect of Pressure and Crowd (F (1, 18) = 8.16, p = .010 η_p^2= .312). Follow up t-test for decision time approached significance but means indicated there were longer decision times in the silent (M = 821.54, SE = 99.19) compared to Crowd condition (M = 593.56, SE = 53.38) (t(19) = 2.01, p = .058, 95% CI for difference [-8.99, 464.96]) under low pressure.

Figure 4.4. Mean decision and time across Pressure, Crowd (a) and Task load (b) blocks (SE bars, *p < .05, ***p < .001).

4.4.4.2. Dual-task.

There was a main effect of Pressure (F (1, 19) = 10.62, p = .004 η_p^2= .371), umpires had a shorter decision time under High-Pressure (M = 611.40, SE = 62.58, 95% CI [479.93, 742.87]) compared to Low-Pressure (M = 949.28, SE = 91.07, 95% CI [757.95, 1140.602]) (see Figure 4.4. b).

4.4.5 Gaze data.

4.4.5.1. Crowd Non-Decision Zone.

A main effect of Pressure (F (1, 19) = 19.59, $p < .001$ $\eta_p^2 = .508$) revealed higher scan ratios on the Non-Decision Zone under High-Pressure ($M = .604$, $SE = .022$, 95% CI [.558, .649]) compared to Low-Pressure ($M = .509$, $SE = .021$, 95% CI [.466, .552]) (see Figure 4.5a). There was an interaction effect of Crowd and Rumination group (F (1, 19) = 4.95, $p = .038$ $\eta_p^2 = .207$), both follow up t-tests were non-significant, however, means show that Lower Ruminators had greater scan ratios in Crowd conditions, whereas Higher Ruminators had greater scan ratios in Silent conditions. Follow up analysis to the interaction effect of Pressure and Crowd (F (1, 19) = 8.72, $p = .008$ $\eta_p^2 = .314$), showed that under Low-Pressure higher scan ratios were present in the Silent condition ($M = .55$ $SE = .03$) compared to Crowd ($M = .47$ $SE = .03$) (t(20) = 2.12, $p = .047$, 95% CI for difference [0.001, 0.145]), but under High-Pressure higher scan ratios were present in the Crowd ($M = .65$ $SE = .03$) than Silent ($M = .56$ $SE = .02$) condition (t(20) = -3.04, $p = .007$, 95% CI for difference [-0.143, -0.265]).

4.4.5.2. Crowd Decision Zone.

The main effect of Pressure showed a higher scan ratio under Low-Pressure ($M = .382$, $SE = .016$, 95% CI [.350, .415]) compared to High-Pressure ($M = .325$, $SE = .016$, 95% CI [.291, .359]) (F (1, 19) = 12.18, $p = .002$ $\eta_p^2 = .391$) (see Figure 4.5a).

4.4.5.3. Dual-task Non-Decision Zone.

The main effect of WM showed greater scan ratio in Dual-task ($M = .684$, $SE = .022$, 95% CI [.639, .730]) compared to Single-task ($M = .554$, $SE = .019$, 95% CI [.515, .594]) (F (1, 19) = 46.64, $p < .001$ $\eta_p^2 = .659$) (see Figure 4.5b).

4.4.5.4. Dual-task Decision Zone.

The main effect of WM (F (1, 19) = 11.48, $p = .003$ $\eta_p^2 = .377$), showed there was higher scan ratio in Dual-task ($M = .387$, $SE = .012$, 95% CI [.362, .412]) compared to Single-task ($M = .340$, $SE = .018$, 95% CI [.302, .378]) (see Figure 4.5b)

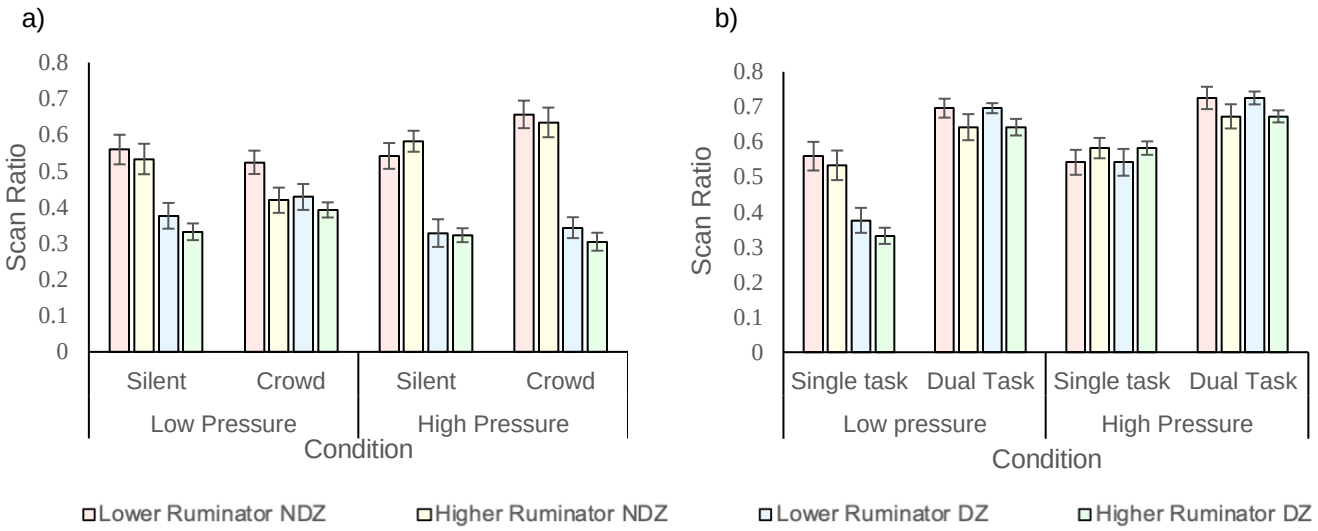

Figure 4.5. Mean scan ratio in Pressure, Crowd (a) and Task load (b) conditions (SE bars, *p < .05, ***p < .001).

4.4.6. Information Reports.

4.4.6.1. Crowd.

There was a main effect of Pressure (F (1, 19) = 16.40, p = .001 η_p^2= .463): fewer cognitive statements were generated under High-Pressure (M = 1.05, SE = .12, 95% CI [.824, .1.28]) compared to Low-Pressure (M = 1.40, SE = .16, 95% CI [1.07, .1.73]) (see Figure 4.6a). Additionally, a main effect of Crowd (F (1, 19) = 5.21, p = .034 η_p^2= .215) showed more cognitive statements in Crowd (M = 1.29, SE = .13, 95% CI [1.03, 1.55]) conditions than Silent conditions (M = 1.16, SE = .14, 95% CI [.87, 1.45]) (see Figure 4.6a). There was an interaction effect of Crowd and Rumination group (F (1, 19) = 6.50, p = .020 η_p^2= .255), t-tests showed that the number of statements of Higher Ruminators did not differ between conditions, (t(10) = .204, p = .843) but Lower Ruminators used more cognitive statements in the Crowd (M = 1.28, SE = .16) condition than in the Silent (M = 1.01, SE = .21), (t(9) = -3.16, p = .012). The main effect of pressure showed fewer perceptual statements were used under High-Pressure (M = 1.34, SE = .16, 95% CI [1.00, 1.67]) compared to Low-Pressure (M = 1.89, SE = .25, 95% CI [1.37, 2.41]) (F (1, 19) = 13.43, p = .002 η_p^2= .414) (see Figure 4.6a).

4.4.6.2. Dual-task.

All effects were non-significant for cognitive statements. The main effect of pressure showed that fewer perceptual statements were used under High-Pressure (*M* = 1.32, *SE* = .17, 95% CI [.973, 1.67]) than Low-Pressure (*M* = 1.61, *SE* = .20, 95% CI [1.19, 2.03]) (see Figure 4.6b) (F (1, 19) = 4.46, *p* = .048 η_p^2 = .190). Follow up t-tests for an interaction effect of pressure and WM (F (1, 19) = 7.34, *p* = .014 η_p^2 = .279) showed under Low-Pressure that more perceptual statements were used in the Single-task (*M* = 1.79 *SE* = .22 condition compared to Dual-task *M* = 1.44 *SE* = .21, t(20) = 2.15, *p* = .044). In comparison, although non-significant, the means show the reverse pattern under High-Pressure. Despite the significant interaction effect of rumination group and WM (F (1, 19) = 4.86, *p* = .040 η_p^2 = .204), both follow up t-tests were non-significant, and the means showed that Lower Ruminators reported a greater number of perceptual statements in both Single-task and Dual-task conditions compared to Higher Ruminators.

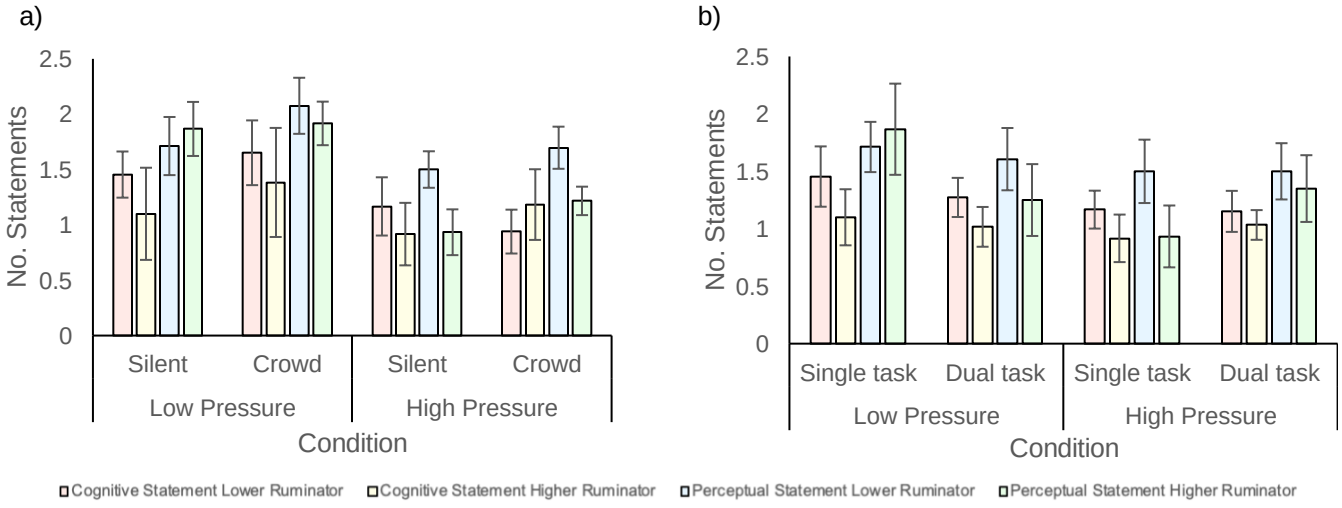

Figure 4.6. Mean number statement types in Crowd (a), and Task load (b) conditions for Higher and Lower Ruminators (SE bars, **p* < .05, ****p* < .001)**.**

4.5. Discussion

This study examined the role of individual differences factor Rumination, and context specific factors, including pressure, game management and crowd noise, on netball umpires' decision performance. In line with the Integrated Model of Anxiety and Motor Performance,

reduced processing efficiency was evidenced at the attentional level by increased scan ratios and mental effort. Specifically, higher scan ratios were present under pressure and in dual-task conditions, and participants experienced increased mental effort in Dual-task conditions. In addition to the reduced processing efficiency, at the behavioural level performance effectiveness deteriorated, with poorer decision accuracy under Pressure, Dual-task, and Low-Pressure Crowd conditions. At the interpretational level, in the Crowd/ Silent conditions fewer cognitive statements were used under Pressure. However, contrary to the hypotheses fewer perceptual statements were used under High-Pressure. In relation to the investigated dispositional characteristics, opposing previous research and the hypotheses, Higher Ruminators were more accurate than Lower Ruminators.

Firstly, in line with our predictions, less efficient search behaviours were demonstrated by higher scan ratios (Nieuwenhuys et al., 2008; Williams & Elliott, 1999) under Pressure and Dual-task conditions. Similar, inefficiencies have recently been reported by Runswick et al. (2018) in high anxiety conditions, suggesting that less efficient visual search is likely due to a reduction in the inhibition function, resulting in attention directed towards threat-related stimuli opposed to task-relevant stimuli. Participants in the present study tended to demonstrate greater scan ratios in the Non-Decision Zone, rather than the Decision Zone particularly under Pressure (in the crowd analyses) demonstrating the shift towards stimulus-driven processes as suggested in the Integrated Model of Anxiety and Motor Performance (Nieuwenhuys & Oudejans, 2012). The present study showed greater scan ratios in Dual-task compared to Single-task conditions for both Decision and Non-Decision Zones. The adoption of alternate gaze strategies under dual-task conditions have previously been demonstrated (Wood et al., 2016) in a lab based driving and distractor task. Specifically, the participants of Wood et al. (2016) took longer to fixate, and had a shorter fixation duration on the hazard, attributed to the reliance on stimulus-driven processes. Contrary to the findings present in the dual-task analyses, Alder et al. (2018) did not find significant changes in visual search between high and low anxiety in the presence of a secondary task. The authors suggested that increased mental effort could have been directed to reinforcing goal-directed attentional-control to account the lack of differences in visual search. Interestingly, greater scan ratios were present in the silent condition under Low-Pressure, but the crowd condition under High-Pressure. It may be possible that given the lower mental effort in the Low-

Pressure Silent condition that participants felt that they had the attentional resources available to scan the field without incurring a cost to their decision making performance.

Secondly, increases in mental effort were expected under High-Pressure conditions compared to Low-Pressure, but this only approached significance in the Dual-task analyses. Increases in mental effort occur as the individual attempts to compensate for the debilitative effects of anxiety (Eysenck & Calvo, 1992). It is possible that the already increased demands on working memory by the distraction of crowd noise and a secondary task in the Low-Pressure conditions may have heightened the mental effort leading to the non-significant results. Alternatively, for the Crowd noise condition, the presence of the crowd noise may have more closely resembled the normal decision making environment faced in matches.

In line with our predictions, a greater number of cognitive statements were used in Low-Pressure conditions. Potentially, the greater use of cognitive statements may indicate effective goal-directed attention by umpires, and the reduction of cognitive statements when under pressure may indicate a shift from goal-directed to stimulus-driven attention when anxious (Eysenck & Derakshan, 2011). Specifically, the Integrated Model of Anxiety and Motor Performance suggests that anxiety leads to an attentional bias towards task irrelevant information (Nieuwenhuys & Oudejans, 2012). For the umpires in the present study, fewer cognitive statements may be the result of failing to inhibit distracting information, thus reducing the umpires' capacity to evaluate or predict the phase of play (Roca et al., 2013).

Contrary to the hypotheses, fewer perceptual statements were used under High-Pressure in the crowd analyses, and additionally fewer under Dual-task conditions. It is possible that the additional processing load imposed by the secondary task – as evidenced by greater mental effort ratings – affected the statements reported by umpires. Particularly, Zoudji et al. (2010) suggest that the additional attentional resources required for updating and maintaining information in the secondary task therefore meant resources are compromised for the processing of the decision. This reduced ability to hold items in memory relevant to the decision may explain the fewer perceptual statements used by umpires. It is possible that working memory resources may have been susceptible to distracting thoughts in the form of worry, again taking task essential resources away (Laborde et al., 2015), and reducing the content umpires could report. Lower Ruminators reported a greater number of perceptual statements in both Single- and Dual-task conditions which may indicative of stimulus-driven decision making. Alternatively, previous

research (Gathmann et al., 2015) has shown that effective monitoring is required in order to maintain decision and dual-task performance. The perceptual type statements in the present study are representative of monitoring type statements in previous research (McRobert et al., 2011; Roca et al., 2013). The reduced usage of perceptual statements may indicate an inadequate ability to monitor the environment effectively whilst under Dual-task conditions. Considered together with the higher scan ratios in Dual-task conditions, inefficient gaze and fewer statements – whether task relevant or reduced because of distracting thoughts – may reduce umpires' ability to interpret and react to make the correct decision.

Despite the reduced processing efficiency and/or increased mental effort the compensatory effect was not enough to maintain task performance effectiveness under Pressure, Dual-task or Crowd conditions under Low-Pressure. Umpires were less accurate under Pressure, particularly Lower Ruminators, conflicting with previous research. Previous research has typically demonstrated a negative relationship between Rumination sub-scale scores and performance under pressure (e.g., Kinrade et al., 2015). For example, Rumination was a significant predictor for poorer performance under pressure in a basketball decision making task (Kinrade et al., 2015), and Higher Decision Ruminators were more susceptible to home-team biased decision making (Poolton et al., 2011). It is possible that Lower Ruminators' quicker decisions under pressure conditions may reflect an attempt to withdraw/move on from the situation as quickly as possible. Supposedly, Rumination reduces performance by consuming working memory resources with worries about previous poor decisions in similar situations (e.g., hostile home crowds). However, the greater accuracy association with Higher Ruminators herein may be linked to a reflective type of rumination opposed to a brooding type (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). A reflective type of rumination involves repetitive thought in a contemplative and active manner, in an attempt to assess and solve a problem type (Treynor et al., 2003). In this context, it is possible that umpires who were Higher Ruminators reflected on their previous crowd and pressure experiences and were consequently more able to perform in similar conditions. It is also conceivable that rumination occurs between, as opposed to during trials, and would therefore not compete for working memory resources, and instead is part of an active learning process. Furthermore, Roy et al. (2016) suggest that dispositionally Higher Ruminators perform better in tasks that require persistence (Altamirano, Miyake, & Whitmer, 2010), and may be beneficial to those in sport due to the acquisition of skill required.

Alternatively, it is possible that umpires interpreted the situation positively; previous work has demonstrated that rumination can either be helpful or unhelpful to performance, depending on the valence of the associated thoughts (Watkins, 2008).

Umpires were less accurate in the presence of crowd noise (compared to Silent conditions) in the Low-Pressure condition. Furthermore, under low pressure crowd noise led to quicker decision times. Crowds are thought to influence sports official's decision performance via cue learning (Unkelbach & Memmert, 2010), by leading to avoidance of the situation (Burnett et al., 2017), or by unconsciously biasing the decision process (Myers & Balmer, 2012). In the case of cue learning (Brunswik, 1957) umpires may learn that a greater crowd response is associated with the importance of the decision. For example, when integrating multiple cues judging contact situations, they learn that crowd noise correlates with the severity of a contact, and consequently influences normal decision making. An alternative explanation is the umpire's motivation to avoid 'displeasing' the crowd, which has been shown to yield decisions in favour of the home side (Nevill et al., 2002; Nevill, Hemingway, Greaves, Dallaway, & Devonport, 2016). It is possible the quicker decision times under low pressure, are as a result of umpires seeking a quick solution to please the crowd. Alternatively, when under pressure and with the influence of the crowd, the umpire's slower decision times may be due to longer processing times as a result of the consumption of working memory or seeking approval of their decision. For example, previous research demonstrates pressure exerted by the crowd leads to judges seeking reassurance from the vocal majority in ambiguous or complex situations (Myers & Balmer, 2012) – what has been described as a conformity bias (Boen, Van Hoye, Vanden Auweele, Feys, & Smits, 2008).

It should also be noted that crowd noise appeared to ameliorate the effect of Pressure, such that the same trend witnessed under Low-Pressure (i.e., reduced accuracy with crowd noise) was not present in the High-Pressure condition. It is possible that under heightened pressure, the presence of crowd noise provided a more naturalistic decision making environment compared to the unrealistic relative silence. Alternatively, the auditory stimuli selected were those of a supportive crowd, as opposed to a hostile crowd that might be experienced in the field. Hostile crowds have been interpreted as a threat by referees and reportedly result in loss of concentration, performance and motivation (Friman, Nyberg, & Norlander, 2004). Research on the perceived valence and level of construal suggests that negatively interpreted situations and

abstract processing of events and linked ruminative thought may lead to unconstructive consequences (Watkins, 2008). Thus, supportive crowd noise, as present in this study, may not elicit the negative responses experienced by sports officials in the field.

In agreement with the well-documented limitations of working memory in dual-task conditions (Baddeley, 1998; Hinson et al., 2003) participants were less accurate in Dual-task than Single-task conditions. This decrease in performance is likely due to the additional processing load – evidenced by greater mental effort ratings – imposed by the game management task. It may be that attentional resources were required for maintaining and updating information in the game management task, resulting in reduced resource availability for processing the in-game rule infringement decisions (Gathmann et al., 2015). Our findings were similar to those found by (Zoudji et al., 2010) who suggested that the additional processing load imposed under dual-task conditions, meant resources are compromised by maintaining items for the memory task and also processing information for the decision. They concluded that if the ability of working memory to maintain information is disrupted performance may suffer. It is worth highlighting that the recall deviation for umpires was poorer under pressure. When there is a secondary task present, monitoring of potential secondary task-associated information and task switching is possible (Miller & Cohen, 2001; Plessow et al., 2011). However, when working memory is overloaded (i.e., increasing cognitive load, Unsworth & Engle, 2007) attempts to focus one's attention on multiple simultaneous tasks, plus competition from distractors when under pressure, may lead to task interference and decreased performance in both tasks (e.g., Baddeley et al., 1998). It is essential for netball umpires to accurately recall repeat infringers in order to issue the correct disciplinary action on court. Inability to balance the competing demands of in game decision making and game management responsibilities could have severe consequences in real-world competitive scenarios and warrants future research attention.

4.5.1. Limitations

There were several limitations that need to be acknowledged. Like previous work (Laborde et al., 2015; Unkelbach & Memmert, 2010), the ecological validity of the setting is a limitation. Asking umpires to judge video-based scenarios presents a considerably simpler task than that required of on-court umpires, where other demands, such as physical fitness are also crucial to their role. For example, Burnett et al. (2017, Chapter 3) found that Decision

Rumination was linked to avoidance type behaviours in relation to the frequency of decisions in actual matches, compared to the positive association of rumination to performance found here. It is therefore possible that performance and an individuals' behaviour in the field may be different to that displayed in a lab setting as a result of physical fatigue, differences in the visual scene presented, or the perceived importance of decisions in an actual match scenario versus lab-based decisions. It would therefore be interesting to understand if this effect of greater game management (e.g., matches whereby umpires' have had to issue warnings to repeat infringers and send players to the *sin bin* etc.) has an impact on the decision accuracy in comparison to games where it was not required in a real-world environment. Similar cumulative effects have been shown in awarding of soccer penalty decisions (Plessner & Betsch, 2001). The secondary task here was selected to reflect a similar process that umpires would utilise in game, however, to fully understand the effects on decision accuracy it would be beneficial to present footage (e.g., of one single match), whereby umpires are able to officiate and apply game management strategies in the same manner they would in the field. Furthermore, this study used a neutral crowd noise that did not relate to the action unfolding on screen. This type of crowd noise is not representative of that experienced in the real world, and so it would be beneficial in future research to explore the effects of crowd responses on sports officials' decision making.

This study demonstrated lower decision accuracy scores compared to other decision-making type tasks in the sports domain (e.g., Gilis, Helsen, Catteeuw, & Wagemans, 2008). Simplified binary choice tasks utilised by others (e.g., a binary choice; Spitz, Put, Wagemans, Williams, & Helsen, 2016) present a more simplistic decision than that faced by officials in actual match scenarios. In an attempt to improve ecological validity, umpires in the present study were presented with decisions that encompassed the full range of rules and the response method was reflective of actual match performance. Alternatively, the lower decision accuracies could be related to the speed or competitive level of the game footage used: All clips were taken from top-flight netball matches, however the umpires who participated in this study had not previously officiated at this level, so it is possible that this affected their accuracy potentially due to the faster tempo of the game, or different patterns of play at a higher level (Cormack, Smith, Mooney, Young, & O'Brien, 2014).

4.5.2. Future Research

It was suggested that the observed performance decrements may be a result of changes in allocation of both overt and covert attention, as manifested in altered gaze patterns and self-reported sources of information used in order to make decisions; this is consistent with the notion of reduced processing efficiency when anxious. Future research could examine allocation of attention in other sports officiating tasks under pressure and in the manipulation of working memory demands. In future, it would be beneficial to gain further understanding of the influence of dual-task situations on umpires' decision making performance. It would be interesting to investigate if similar effects are found in other sports or in relation to real match scenarios as these have major implications for how sport is officiated, and for the training of sports officials. Game management decisions are not isolated to netball umpiring. In basketball for example, the table officials are responsible for recording a foul count, reducing the cognitive load for the on-court officials. Furthermore, the umpires' ability to accurately recall the game management task was hindered under pressure. So, in a high-pressured scenario, ineffective or inaccurate game management could have serious consequences, for players, teams and the umpires in real competition. Given the effect of crowd noise on the decision accuracy with a neutral background crowd noise, it would be interesting to investigate the type of crowd noise (supportive vs unsupportive) and the congruency with the decision (in line with the correct decision vs against the correct decision, e.g., Bishop, 2016; Bishop et al., 2014). Moreover, it may be of interest to analyse the impact of crowd, pressure, and dual-task effects in a comparison of expert novice differences. By gaining insight into the decision processes between these groups and the impact on the underlying mechanisms under these varying conditions may have practical implications for the training and development of netball umpires.

Researchers should focus on examining potential training strategies for sports officials to overcome the effects of pressure and increased cognitive load. One novel insight that warrants attention is the positive relationship of Rumination to decision accuracy under pressure. Sports officials arguably have more time to make their decisions, than the athletes for whom they officiate. Hence, the effects of Rumination could be highly context-specific: Whilst it might enhance officials' decision making, it could be detrimental to performance in rapid interceptive sports. It would be interesting to understand whether the valence of cognitive thought has a positive or negative effect on performance and could be manipulated by false feedback.

Furthermore, future research could examine the timing and type of ruminative thought that occurs on a decision-by-decision basis or more globally (pre-game, post-game, quarter-times) and the associated changes in attention allocation and consequently the effect on decision performance. Additionally, researchers could examine whether rumination benefits/detriments are context specific; whilst it may be debilitative to performance of athletes in interceptive team sports (Roy et al., 2016), it may be beneficial to performance for sports officials. Finally, research investigating the Integrated Model of Anxiety and Motor Performance may beneficial to understand the individual differences and complex role and environment that sports official's work within.

4.5.3. Conclusion

In summary, this study examined contextual characteristics (e.g., crowd noise, pressure, and dual-task) and individual differences in a novel umpire decision making task. The present studies extend the recent body of research of the Integrated Model of Anxiety and Motor Performance, showing that anxiety potentially affects performance by altering the mechanisms at the attentional level via less efficient scan ratios. Furthermore, at the behavioural level, reduced performance effectiveness when subjected to Pressure and Dual-task conditions. The findings demonstrate an influence of dispositional rumination on complex decision making performance. However, contrary to previous findings, a ruminative decision style was facilitative. These findings suggest that the contributions of ruminative tendencies are not straightforward ones and may interact with environmental and task constraints in a nuanced manner. For example, officials with strong ruminative tendencies may be the most suitable options to officiate highly pressured and cognitively demanding sports settings (e.g., a World Cup Final), due to their apparent robustness. The present findings have implications for the training of coping mechanisms for sports officials, but additionally the ability to dual-task when game management strategies are required.

4.6. References

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5. Chapter 5

Dispositional Influences on Decision Making Under Uncertainty During a Naturalistic Sport Task

5.1. Abstract

In the previous studies of this thesis, and elsewhere, the effect of Decision Rumination has been demonstrated to have both beneficial and detrimental effects on decision performance and accurate decision making. Purportedly, the context and valence of the situation (e.g., positive or negative) may influence the effect trait rumination has on decision making. Sports officials frequently perform in highly critical environments, experiencing feedback from a number of sources including crowd, coaches, players, mentors, and assessors. Accordingly, this study examined the effect of negative and positive feedback on decision making performance of low and high trait Decision Ruminators. Participants were presented with video-based decision scenarios filmed from an umpire's perspective, and were exposed to either positive, negative of neutral (false) feedback following each block of trials. This study assessed the decision accuracy and speed, decision confidence, and gaze behaviour changes between neutral and positive or negative blocks related to the decisions made. Results showed that Higher Decision Ruminators had lower decision confidence, and a significant drop in decision making performance following negative feedback compared to Lower Ruminators. Higher Ruminators had less efficient gaze patterns following positive feedback with shorter fixation durations on informative areas of the display. It is likely the inability to disengage from task irrelevant information by Higher Ruminators led to the poorer decision performance following negative feedback. The present findings have implications for the development of coping mechanisms of trait Ruminators.

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According to the Integrated Model of Anxiety and Motor Performance and perceptual-motor performance (Nieuwenhuys, Arne & Oudejans, 2017, see Figure 5.1.) when anxious, individuals are likely to perform worse unless they have the available resources to exert greater effort to compensate for the effects of anxiety (i.e. reducing processing efficiency to maintain performance effectiveness). However, the model suggests individual differences must be accounted for. One such individual differences factor – Decision Rumination – suggests some individuals are dispositionally more susceptible than others to performance decrements in their decision making performance. Purportedly, deterioration in performance occurs when essential processing resources are drawn away from the task, particularly when under pressure (Jackson, Kinrade, Hicks, & Wills, 2013; Kinrade, Jackson, & Ashford, 2010). In a recent study (Burnett, Bishop, Ashford, Williams, & Kinrade, 2017, Chapter 3), it was shown that the tendency to ruminate was strongly related to the number of decisions made by netball umpires – i.e., those with a self-reported predisposition to ruminate tended to withhold their decisions more frequently than those who did not. Equivocally in Chapter 4, experimental manipulations of pressure, working memory load, and crowd noise all interfered with netball umpires' decision making – and that this interference was compounded by high Rumination subscale scores.

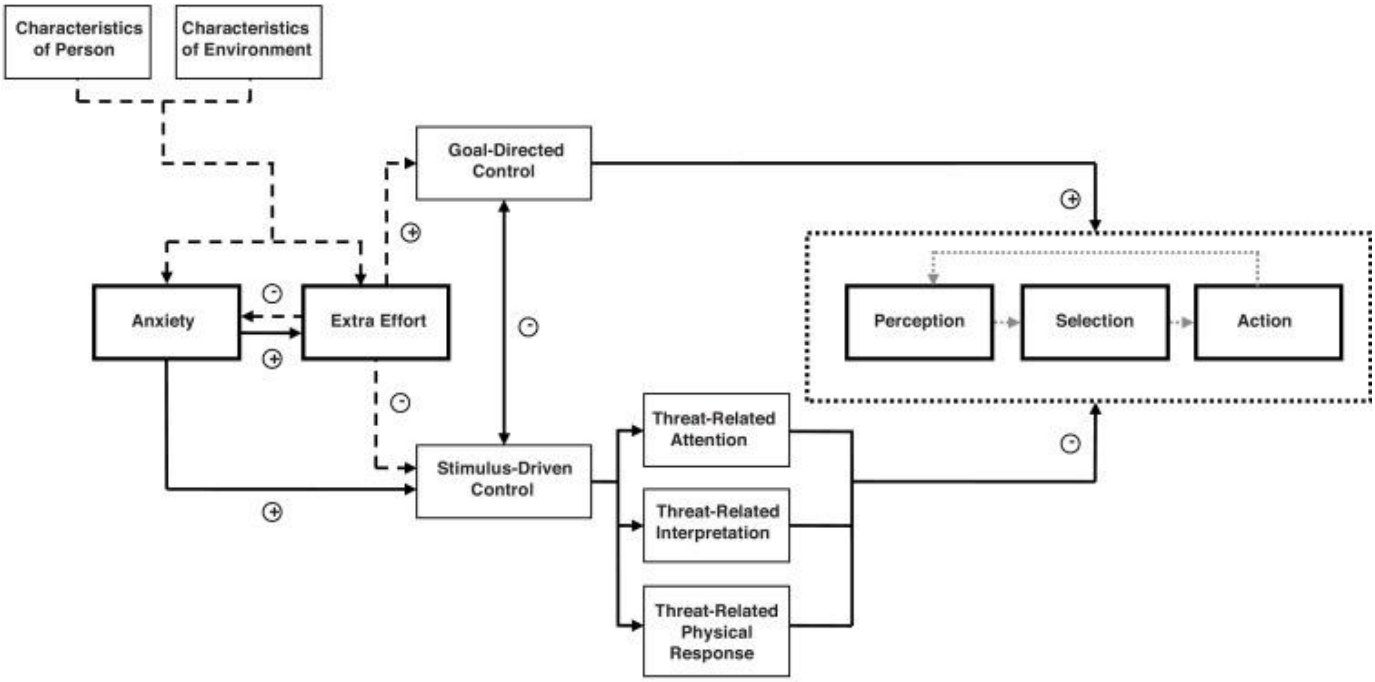

Figure 5.1. The Integrated Model of Anxiety and Motor Performance (Nieuwenhuys & Oudejans, 2017).

Previously, Decision Rumination has been negatively associated with performance under pressure (Kinrade et al., 2010; Kinrade, Jackson, & Ashford, 2015; Poolton, Siu, & Masters, 2011). In the validation of the DSRS Kinrade et al. (2010) demonstrated a strong correlation between DSRS scores and coaches' ratings of players' tendency towards decision performance breakdown under pressure. Poolton, Siu, and Masters (2011) showed that the tendency to ruminate was associated to home team-biased decision making by referees making a greater number of decisions in favour of the home team. In a field-based investigation, individual propensity to reinvest was a predictor of poorer netball performance under pressure (Jackson et al., 2013). Kinrade et al. (2015) showed that rumination was a significant predictor of poorer performance under pressure in a basketball decision task. The premise of ruminators' poorer performance under pressure follows the assumption that essential working memory resources, necessary for the decision process, are consumed by worrying thoughts. However, in an investigation of the influence of crowd noise on netball umpires' decision making (Chapter 4), the findings revealed that although performance under pressure and in the presence of crowd noise was debilitated, Higher Rumination was associated with better performance under these conditions. Similar results were also demonstrated in the analysis of a game management dual-task. Despite overall reduction in accuracy in dual-task conditions as expected, umpires who self-reported higher Rumination Scale scores, performed better. It was suggested that a ruminative decision making style (opposed to an intuitive or heuristic style) might be beneficial to netball umpire's performance. Or alternatively, that the perceived valence of the situation may affect decision making.

Researchers (for a review see Watkins & Roberts, 2020) have shown that repetitive thought can be either helpful or unhelpful to performance; and one of the determinants of this is the valence of cognitive thought. In a large meta-analysis of self-focus literature, attention to negative aspects of the self were strongly related to increased levels of negative affect, whereas attention to positive aspects of the self were related to lower levels of negative affect (Mor & Winquist, 2002). One mechanism by which valence may moderate the consequences of repetitive thought is by determining the direction of action for the magnifying effects of repetitive thought on mood and cognition (Ciesla & Roberts, 2007; Nolen-Hoeksema & Morrow, 1991). It is argued that repetitive focus on affect and cognition serves to make them more salient and, to further elaborate, consolidate, and strengthen them. A considerable body of research has

demonstrated that self-focus amplifies the effect of negative thoughts on mood (Ciesla & Roberts, 2007; Mor & Winquist, 2002), negative mood on thinking (Ingram, 1990; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008) and rumination, exacerbating pre-existing anxious mood (Nolen-Hoeksema et al., 2008; Watkins & Roberts, 2020). Thus, for negatively valenced cognitions, repetitive thought would amplify the negative consequences, exacerbate existing negative mood, resulting in more unconstructive outcomes. Furthermore, the level of construal may influence the outcome of repetitive thought due to the emotional response linked to the processing of events. Higher-level abstract construals, are characterised by general, decontextualised mental representations that seek to explain the causes and implications of goals and events. Abstract rumination leads to "why" questioning, for example in an umpiring context, "why was my decision making performance poor?", or "why did the crowd react that way?". This abstract processing results in reflexive, stimulus controlled, automatic approach and avoidance behaviours (Thomsen, Tønnesvang, Schnieber, & Olesen, 2011). In contrast, lower-level concrete construals are characterized by mental representations that include specific, contextual, and incidental details of events. These mental representations directly address goals and actions, that enable reflective processing to inhibit automatic approach and avoidance behaviours (Thomsen et al., 2011). Concrete processing prompts "how" questioning, for example, "how do I manage repeat infringers more effectively?".

Researchers have highlighted (Watkins & Roberts, 2020) that rumination can have adaptive consequences. For example, the Higher Ruminators better decision performance than Lower Ruminators in Chapter 4. Ruminative thought can result in adaptive preparation and planning, and extensive analysis to solve problems. The processing style (e.g., abstract or concrete) may explain whether rumination is adaptive or maladaptive. Some researchers have suggested that abstract processing is beneficial as it involves generalized representations opposed to including specific contextual details, and as such can make useful inferences across situations and can enable transfer of learning (Förster & Higgins, 2005). Particularly, when following success or positive mood abstract processing can be adaptive, supporting goal pursuit over time and result in positive generalisations (Watkins, 2011), for example, "I can deal with player dissent". Furthermore, Kross, Ayduk, and Mischel (2005) found that an abstract focus enabled a reflective processing of emotions, in which individuals were able to focus on their experience without reactivating excessive negative affect. However, others have suggested that higher-level

abstract processing is likely to produce negative overgeneralisations (e.g., “I always make mistakes”), such that a single failure is generalised to a global sense of personal inadequacy rather than situation specific difficulties (Rimes & Watkins, 2005). Additionally, abstract processing provides fewer context specific guides to action and problem-solving and can exacerbate emotional reactivity (Philippot, Schaefer, & Herbette, 2003; Philippot, Baeyens, & Douilliez, 2006), relative to processing characterised by lower-level concrete processing.

From this standpoint, researchers suggest that when faced with negative information, concrete processing is more adaptive by reducing negative overgeneralisations and promotes active problem-solving (e.g., I made a mistake in that decision, how can I improve?). This specific, detailed recall produces less emotional response (Philippot et al., 2006). Furthermore, practice at recalling specific, contextualised memories reduces the negative experience to subsequent stressful, general, decontexualised memories (Raes et al., 2006). Moberly and Watkins (2006) asked participants to repeatedly focus on both positive and negative scenarios in either a lower-level, concrete construal mode, or a high-level, abstract construal mode, prior to a failure experience. Following the failure experience, high levels of trait rumination were associated with lower levels of positive affect, but only for participants in the high-level abstract construal condition. Thus, processing mode moderated the effect of trait rumination on emotional reactivity following a failure. In relation to self-regulation, Leary, Adams and Tate (2006) hypothesised that in situations such as choking under pressure and test anxiety – where often, elevated self-focused attention and deliberate effort to control behaviour is counterproductive – a concrete level of processing could facilitate self-regulation. Leary et al. (2006) argued that abstract processing of construals regarding the evaluative or interpersonal implications of one’s behaviour interrupts smooth performance. Whereas, concrete construals can be constructive to performance, in situations where rumination and worry are likely, due to the focus on the immediate situation presented, reducing anxiety, and furthermore, require less effort and therefore less working memory resources are allocated (Brandstätter, Lengfelder, & Gollwitzer, 2001; Gollwitzer & Sheeran, 2006; Webb & Sheeran, 2003). Furthermore, previous research indicates that referees who have problem focused coping strategies (e.g., more concrete construals) to manage threat appraised stressors, and emotion-focused coping to decrease the intensity of negative affect experienced, reportedly promoted more accurate perceived decision making (Neil, Bayston, Hanton, & Wilson, 2013).

Alternatively, control theory (Martin & Tesser, 1996) may explain the Ruminators better performance in Chapter 4. Control theory posits that rumination is a process of active thinking about unsatisfactory goal progress and that rumination occurs particularly when progress is perceived to be slower than anticipated. Rumination will therefore continue until progress towards goals has been made or the individual disengages from the goal (Martin & Tesser, 1996). In line with previous research (e.g., Bartoskova et al., 2018), Control Theory accounts for state rumination, and in some circumstances can be adaptive as a means to problem solve and address goal discrepancies. However, if rumination results in disengagement from the goal, and fails to resolve the goal discrepancy, it may result in task avoidance and intensify negative affect (Moberly & Watkins, 2008). Furthermore, the types of goals may influence the ruminative response to goal progress, for example, autonomous reasons (e.g., enjoyment) or for controlled reasons (e.g., goal pursuit for extrinsic outcome). Controlled motives result in less goal progress (Moberly & Dickson, 2016), and greater trait and goal-focused rumination (Thomsen et al., 2011). For umpires in Chapter 4, their participation in research and goal to engage in the decision making task may have been for their own enjoyment as no explicit controlled goals were instructed. However, this study provides an explicit controlled goal to perform better than a pilot group which may lead to the goal orientation of avoiding an undesirable feedback rather than task focused, concrete guidance to resolve the goal (Thomsen et al., 2011). Specifically, ruminative thoughts persist longer when related to unresolved goals than those associated with a resolved goal (Roberts, Watkins, & Wills, 2013) and may account for Ruminators responses to positive and negative feedback in the present study.

Ruminators bias for engaging in negative information-processing including preferentially attending to negative information, and poorer disengagement from negative content (Everaert, Koster, & Derakshan, 2012; Watkins & Roberts, 2020) may highlight the sensitivity to feedback for Ruminators. Evidence for the effect of performance feedback on Ruminators has rarely been investigated (e.g., Anand, Oehlberg, Treadway, & Nusslock, 2016). However, others have investigated the effect of performance feedback in relation to other personality traits. For example, neurotic individuals who share characteristics with ruminators (e.g., experience more negative affect, Larsen & Ketelaar, 1989; maladaptive coping, Matthews & Campbell, 1998; increased sensitivity to threats, Rusting, 1998). Specifically, that neurotic individuals are sensitive, particularly to, negative performance feedback (Swift & Peterson, 2018). Research has

shown that for difficult tasks, negative feedback had a demotivating effect for neurotic people, which can lead to task abandonment (Swift & Peterson, 2018). Multiple studies have shown the attentional bias towards negative stimuli for Ruminators (Beckwé & Deroost, 2016; Grafton, Southworth, Watkins, & MacLeod, 2016; Sanchez-Lopez, Koster, Van Put, & De Raedt, 2019).

Previous research (Salovey, 1992; Silvia & Abele, 2002) suggests – in line with the model of *affect-action sequences* – that affect, whether negative or positive, changes the way that individuals organise information about, and how they evaluate, themselves. Specifically, there is an inward shift of attention, which alters the way one thinks about oneself. This self-focused thought can either promote or inhibit behaviours. Finally, these behaviours then serve to maintain positive affect and cognitions or to repair negative affect and cognitions, leading back to the original affect experienced. Alternatively, the *impaired disengagement hypothesis* (Koster, De Lissnyder, Derakshan, & De Raedt, 2011) explains that internal (e.g., negative affect or negative recall of events) or external (e.g., negative feedback) negatively valenced conditions cue rumination when they interrupt individuals' progress towards goals. For high trait Ruminators, conflict signalling to disengage attention from negative thoughts is disrupted. It is possible for trait Ruminators, who hold negative self-schemas, that negative thoughts reduce the cognitive conflict and therefore reallocation of attentional resources (back to task-relevant stimuli) does not occur. Or, due to impaired attentional control, attention is sustained on negative stimuli. Inability to disengage from negative thoughts affects goal-directed attention to task-relevant stimuli or to positive distractors would lead to the expectation that Ruminators will perform more poorly following negative feedback, a notion that is investigated in this study.

Previous research has demonstrated that individual propensity to ruminate has adverse consequences on performance; however, the findings from Chapter 4 showed that Higher Ruminators outperformed Lower Ruminators in an umpiring decision task under pressure conditions. It has been suggested that ruminative thought can be beneficial or detrimental to performance as a result of the valence of cognitive thought (Watkins, 2008). Thus, to understand the equivocal findings of Chapter 4, the aim of this study was to examine the effects of positive and negative feedback on Lower and Higher Ruminators when required to make rapid decisions. Firstly, it was expected that all participants would experience similar levels of pressure following positive and negative feedback regardless of their ruminative tendency. Secondly, it was expected that, following positive feedback, participants would have greater decision confidence,

but, following negative feedback, the reduction for Higher Ruminators would be greater (Ward, Lyubomirsky, Sousa, & Nolen-Hoeksema, 2003). It is hypothesised that those with a greater tendency to ruminate will exhibit a greater reduction in accuracy following negative feedback. It is expected that Higher Ruminators will additionally have a longer decision time following negative feedback about their performance. Finally, and in line with the Integrated Model of Anxiety and Motor Performance and perceptual-motor performance (Nieuwenhuys & Oudejans, 2017), reduced gaze efficiencies were expected following negative feedback. Specifically, that as a result of stimulus-driven processing (Thomsen et al., 2011), Higher Ruminators will have less efficient scan ratios, exhibit a reduced number of fixations and shorter fixation durations on the informative areas (i.e., Decision Zone), and an increase on less informative areas of the display (e.g., Non-Decision Zone).

5.2. Method

5.2.1. Participants

Thirteen females (age *M* = 30.54 years *SE* = 2.68, range: 19-52) with 4.00 years' (*SE* = .93, range: 0-10 years) umpiring and 16.46 years' (*SE* = 2.27, range: 5-35 years) playing experienced participated.

5.2.2. Design

Participants completed four blocks of trials: one practice block (18 trials), and three counterbalanced experimental blocks (*3* x *24* trials, neutral, positive, and negative) presented in experiment generator software (E-Prime, Psychology Software Tools, Sharpsburg, PA). For each trial, the participant viewed, and responded to, the randomised clips described in the next section.

5.1.3. Stimuli

Participants viewed video clips depicting competitive netball match scenarios in which an infringement did or did not occur. Video footage was filmed at county league level matches from courtside positions that represent the view of an umpire's vantage point. The matches were then edited (in Adobe Premiere Pro CC) to show some game context in the lead up to an umpire's decision (clip duration *M* = 10.38s). Presented video clips represented a range of decision scenarios (i.e., non-infringement, offside, obstruction, contact etc.) from four courtside positions where decisions are frequently made (backline, corner, mid-goal third, halfway, see Figure 5.2.).

Participants' responded as if in a game scenario by blowing the whistle and verbalising their decision.

Figure 5.2. Example video stimuli perspectives.

5.2.4. Feedback

Before taking part, participants were told that they would receive in-task feedback about their performance, relative to that of a group of ten novice netballers without umpiring qualifications, on the same task. However, this feedback was false, and was, *positive* prior to one experimental block, *negative* prior to another, or *neutral* in the final block. Performance feedback was independent of their actual level of performance and was identical for all participants. The order of feedback conditions was partially counterbalanced across participants. Feedback was presented visually via a traffic light system in reference to the novice netballers performance. A green screen with an upward arrow represented *positive* feedback, indicating they had performed better than the novice group. A red screen with a downward arrow indicated they performed worse than the novice group and constituted the *negative* feedback condition. A yellow screen with a horizontal line was used to indicate *neutral* feedback and indicated that performance was on par with the novice group. This feedback was further supported via verbal

feedback from the researcher. For the *negative* condition, participants were informed that "unfortunately, a poor score in this block, your performance was worse than that of the novice group". In the *positive* condition, participants were told "Well done! Excellent, your performance was better than that of the novice group". In the *neutral* condition, participants were told "Okay, your score was on par with that of the novice group".

5.2.5. Measures

5.2.5.1. DSRS.

The Decision-Specific Reinvestment Scale (DSRS, Kinrade et al., 2010) is a 13-item scale, comprising two subscales (Decision Reinvestment and Decision Rumination) that predicts an individual's propensity to reinvest when making decisions. Participants responded using a 5-point Likert scale anchored by 0 ("extremely uncharacteristic") and 4 ("extremely characteristic"). The Decision Rumination subscale comprises 7 items, assessing tendency to negatively evaluate previous poor decisions, with scores ranging from 0 to 28. Kinrade et al. (2010) reported an internal consistency of .91 for the Decision Rumination subscale items.

5.2.5.2. Decision Responses.

Umpires were asked to respond as they would in a game by blowing their whistle and verbalising their decision. Decision time was recorded in ms with participants' whistle blows being registered via a serial response box (Psychology Software Tools, Sharpsburg, PA) in experiment generator software (E-Prime; Psychology Software Tools, Sharpsburg, PA). Decision accuracy was recorded as a percentage ([total number of correct decisions/24] x 100). Following ten pseudorandom trials, a rating of decision confidence was taken. Participants were asked "How certain are you that this is the best decision for this situation?" (Hepler & Feltz, 2012). Ratings were based on an 11-point scale (0 = not at all confident; 10 = extremely confident).

5.2.5.3. Pressure Rating Scale.

Following each block, participants were asked the question "how much pressure did you feel in the last set of trials?" and responded using a seven-point Likert scale anchored from 1 (no pressure) to 7 (extreme pressure) (Kinrade et al., 2015).

5.2.5.4. Gaze behaviour.

Eye movements were recorded using the ASL MobileEye XG (Applied Science Laboratories, Bedford, MA). A simple five-point eye calibration grid projected onto the screen, was used before testing commenced; the accuracy of this calibration was rechecked prior to each block of trials. The mean number of fixations per trial and mean fixation duration (ms) on predetermined regions of interest (ROIs; see Data Analyses section) were used as an index of overt visual attention. Scan ratio, defined as the number of fixations divided by the total duration of fixations across all predetermined regions of interest, was also calculated (Nibbeling, Oudejans, & Daanen, 2012).

5.2.6. Procedure

Subsequent to institutional Research Ethics Committee approval, written consent was obtained from participants. After the participants completed a demographics questionnaire and the DSRS, they put on the eye tracking glasses, and calibration was completed. Participants stood 3m in front of a projection screen (3.3 × 1.9 m) on which the trials were projected using an Optoma HD20 DLP projector (Optoma, New Taipei City, Taiwan). Participants were instructed to respond as accurately as possible, as they would in an actual game, and to report their decision confidence when prompted, then eighteen familiarisation trials were presented. These instructions were reinforced prior to each block of trials. Following, the three counterbalanced experimental feedback blocks were presented. After each condition, the pressure rating scale score was collected.

5.2.7. Data Analyses

Data were screened and checked for normality; no outliers existed, and parametric methods were used throughout. A median split was performed on the Decision Rumination scores to create Higher Ruminators (n = 6, M = 16.17, SE = 0.53) and Lower Ruminators (n = 7, M = 7.86, SE = 0.40) groups. The change scores for every measure were calculated to find the difference between Neutral and Positive and Neutral and Negative feedback blocks, referred to as Perceived Improvement and Perceived Deterioration respectively in the Results and Discussion sections. To analyse decision confidence and performance measures, the change

scores were inputted into independent samples T-tests with Decision Rumination as a between-groups measure. The alpha level was set at .05 and confidence intervals are provided.

Gaze data were analysed using ASL Results Plus (Applied Science Laboratories, Bedford, MA). Three regions of interest (ROIs) were defined: *Decision Zone* (the zone in which an infringement occurs, and the umpire needs to intervene) *Non-Decision Zone* (court areas in which no infringements occurs), and *Outside* (areas outside of the court). Similarly, to the other measures change scores were calculated between neutral and feedback conditions, and these scores were inputted into independent samples t-tests were used to examine differences in number of fixations, fixation duration conditions, and scan ratios for each of the three ROIs.

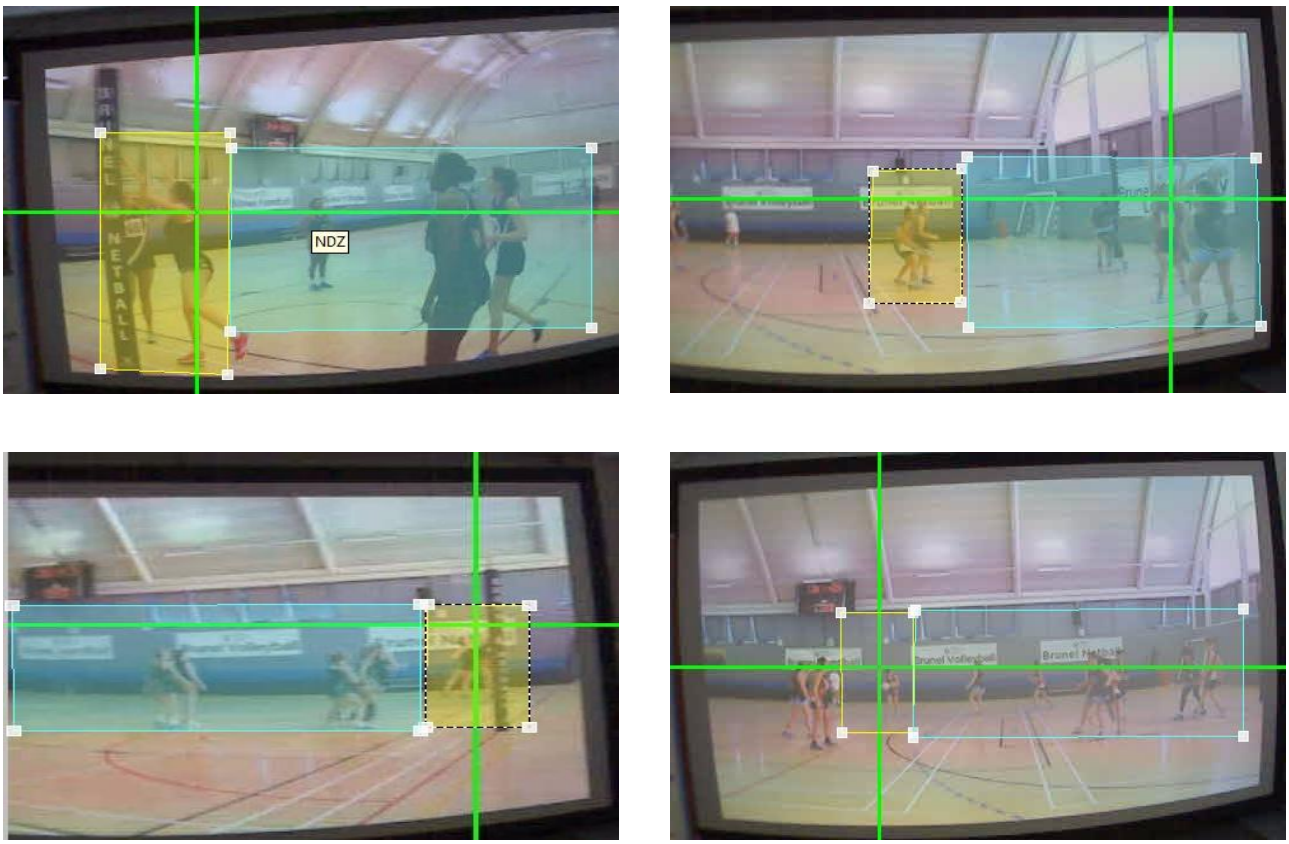

Figure 5.3. Example ROIs.

5.3. Results

5.3.1. Feedback Manipulation

There were no differences in the pressure experienced between Rumination groups between Perceived Improvement (t (11) = .708, p = .489, 95% CI [-1.23, 2.42]) or Perceived Deterioration (t (11) = .000, p = 1.00, 95% CI [-1.38, 1.38]) conditions.

5.3.2. Decision Confidence

Higher Ruminators (*M* = -.883 , *SE* = .23) had greater decrements (t (11) = 3.104, *p* = .010, 95% CI [.31, 1.80]) in decision confidence compared to Lower Ruminators who had a slight increase (*M* = .171 , *SE* = .24) in the Perceived Deterioration condition (see Figure 5.4). There were no differences in decision confidence in the Perceived Improvement condition (t (11) = 1.04, *p* = .321, 95% CI [-.64, 1.81]).

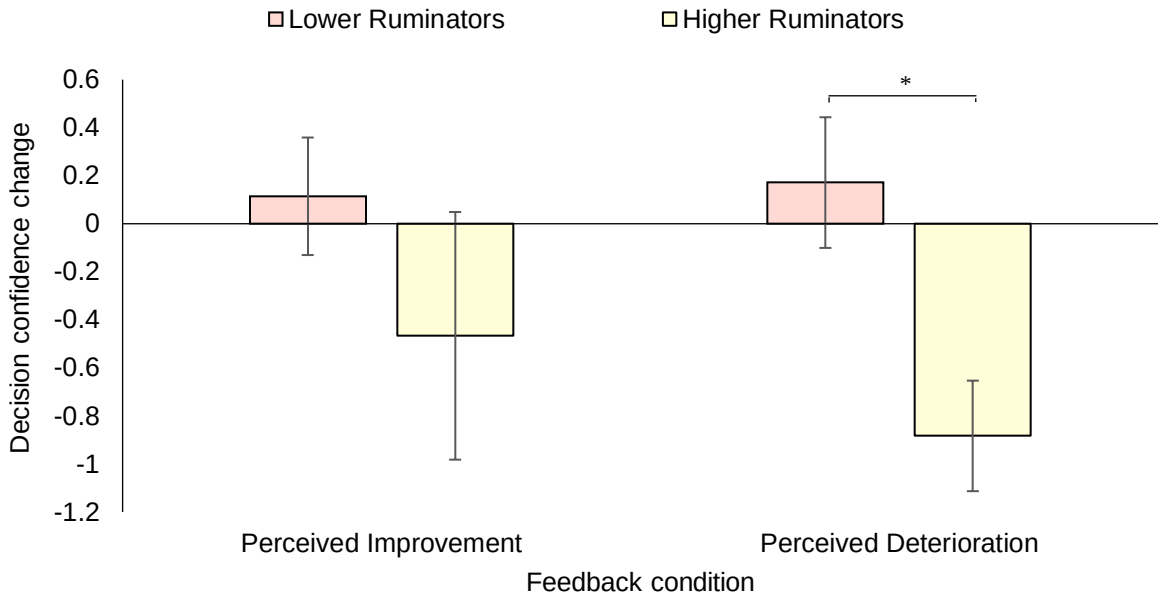

Figure 5.4. Mean change in decision confidence for Perceived Improvement and Perceived Deterioration conditions (and SE bars, *$p < .05$).

5.3.3. Decision Accuracy

Higher Ruminators (*M* = - 8.93, *SE* = 2.12) had greater performance decrements (t (11) = 2.63, *p* = .025, 95% CI [.98, 11.72]) from Perceived Deterioration condition than Lower Ruminators (*M* = -4.17, *SE* = 4.98) (see Figure 5.5). Higher Ruminators experienced performance decrements whereas Lower Ruminators improved from Perceived Improvement condition (t (11) = 2.43, *p* = .034, 95% CI [.95, 19.49]).

5.3.4. Decision Time

Higher Ruminators decision time increased, whereas Lower Ruminators' decision time decreased in the Perceived Deterioration condition (t (11) = -2.62, *p* = .024, 95% CI [-1174.07, -

100.98]). There were no differences in the Perceived Improvement (t (11) = -.909, p = .383, 95% CI [-1134.79, 471.37]) conditions (see Figure 5.5).

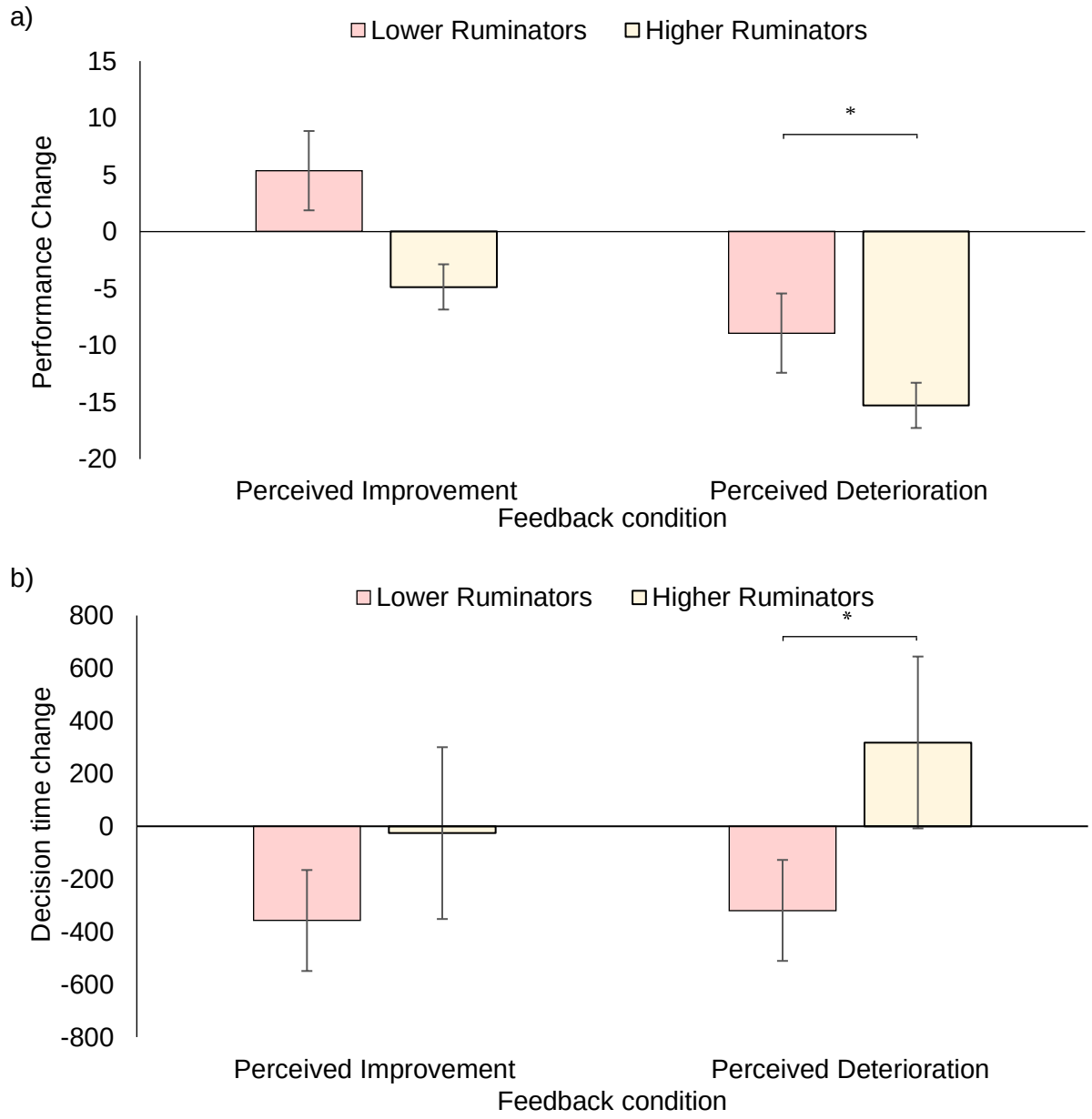

Figure 5.5. Mean change in decision performance (a) and decision time (b) for Perceived Improvement and Perceived Deterioration conditions (and SE bars, *p < .05).

5.3.5. Gaze

There were no differences in scan ratios between Higher and Lower Ruminators neither for the Decision Zone (Perceived Improvement t (11) = -.12, p = .9.09, 95% CI [-9.92, 8.93]; Perceived Deterioration t (11) = .792, p = .447, 95% CI [-11.34, 23.84]) nor the Non-Decision Zone (Perceived Improvement t (11) = -1.48, p = .169, 95% CI [-26.62, 5.33]; Perceived Deterioration t (11) = 1.34, p = .211, 95% CI [-13.43, 25.84]). Lower Ruminators (M = 1.36, SE = 1.14) exhibited an increased number of fixations whereas Higher Ruminators (M = -1.56, SE = .55) displayed a decrease in number of fixation durations in the Non-Decision Zone in the Perceived Improvement Block (t (11) = 2.31, p = .043, 95% CI [.106, 5.756]). The change in number of fixations in the Perceived Deterioration condition for the Decision Zone approached significance (t (11) = 1.96, p = .079, 95% CI [-.320, 4.970]), Lower Ruminators (M = .86, SE = .88) had an increase in number of fixations whereas Higher Ruminators had a decrease (M = -1.45, SE = .80). Higher Ruminators (*M* = -.147, *SE* = .008) had a decrease in fixation duration (t (11) = 2.42, *p* = .036, 95% CI [-.053, -.002]) on the Decision Zone in the Perceived Improvement block compared to Lower Ruminators who had an increase (*M* = .0128, *SE* = .008). The change in fixation duration in the Perceived Deterioration condition for the Decision Zone approached significance (t (11) = 2.07, *p* = .066, 95% CI [-.109, -.004]), Higher Ruminators (*M* = -.046, *SE* = .016) showed a decrease in fixation duration, whereas Lower Ruminators (*M* = .007, *SE* = .020) had a slight increase. There were no differences in Higher and Lower Ruminators' fixation duration for the Non-Decision Zone in the positive (t (11) = .055, *p* = .957, 95% CI [-.057, .032]), or negative (t (11) = -.506, *p* = .624, 95% CI [-.038, 0.040]) feedback conditions.

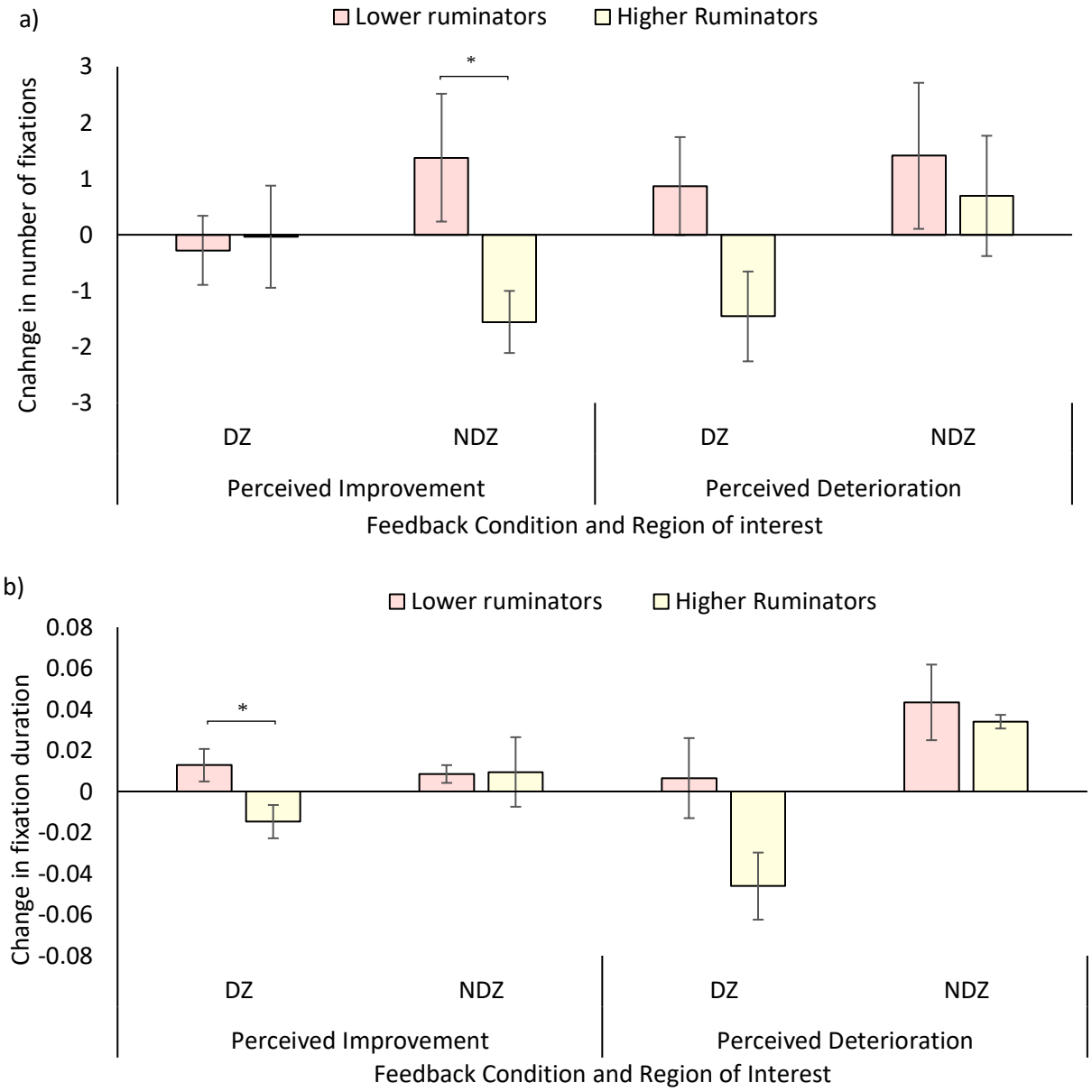

Figure 5.6. Change in the number of fixations (a) and fixation duration (b) for Perceived Improvement and Perceived Deterioration conditions (and SE bars, *$p < .05$).

5.4. Discussion

The present study examined the role of dispositional Rumination on decision making performance change following positive and negative feedback from a neutral condition. In line with the hypotheses, Higher Decision Ruminators had a significant decrease in their decision

confidence in the Perceived Deterioration condition. Higher Decision Ruminators also exhibited a significant drop in decision making performance in the Perceived Deterioration analyses compared to Lower Ruminators. Furthermore, Higher Ruminators also had performance decrements in the Perceived Improvement condition whereas Lower Ruminators improved performance. There were no differences in decision time between Rumination groups in the Perceived Improvement condition. However, in the Perceived Deterioration analyses, High Ruminators had a longer decision time, whereas Low Ruminators decision time decreased. Regarding gaze efficiency, interestingly, Higher Ruminators exhibited reduced fixation durations on the informative areas of the display in the Perceived Improvement, whilst this trend only approached significance following Perceived Deterioration. Furthermore, in the Perceived Improvement condition, Lower Ruminators had an increase in the number of fixations, whilst Higher Ruminators had a decrease on the Non-Decision Zone.

Following Perceived Deterioration, Higher Ruminators expressed greater decrements in decision confidence when compared to Lower Ruminators. Previous research (Ward et al., 2003) demonstrated that a ruminative response style was linked to reluctance to initiate behaviour, commit to a self-generated plan and expressed lower confidence regarding their plans than did non-ruminators. A lack of decision confidence has reportedly reduced coping abilities in referees to deal with crowds and situations of high match importance (Neil et al., 2013); failure to cope also caused incorrect or counter-attacking decision making (through giving decisions against the offending player). Referees identified crowds, mistakes, confrontation, players with bad reputations, and assessors as causes of stress. In turn these stress appraisals were linked to negative affect, which when not dealt with influenced poor decision making (Neil et al., 2013). The current results of poorer confidence in Higher Ruminators when dealing with negative feedback is reflective of this previous research. Therefore, the reduction in decision confidence has important consequences for on-court decisions in the real world environment, particularly as increases in one's self-confidence or self-efficacy have been shown to mitigate performance related stress and anxiety (Bandura, 1997).

The impact of negative feedback was in line with the hypotheses and previous research. Negative feedback in relation to difficult tasks has been demonstrated to have a demotivating effect and can lead to task abandonment (Swift & Peterson, 2018). Previous research has shown following failure feedback that those with a greater tendency to worry – involving rumination

over future events – performed worse on an anagram solving task, had elevated interference and greater cognitive interference compared to non-worriers (Thompson, Webber, & Montgomery, 2002). In the present study, the poorer decision performance following the Perceived Deterioration condition for Higher Ruminators may be explained by Ruminators attentional bias for engaging in negative information-processing. Moreover, preferentially attending to negative information and poorer disengagement from negative content may reduce processing capacity for decision information (Everaert et al., 2012; Watkins & Roberts, 2020). The present results are in line with previous research investigating the impaired disengagement hypothesis (Koster et al., 2011) showing that Ruminators poorer performance could be related to impaired attentional disengagement from negative information compared to positive (Southworth, Grafton, MacLeod, & Watkins, 2017). It is likely impaired disengagement from negative information was as a result of disruption of reallocation of attention back to task relevant stimuli, resulting in poorer performance of Higher Ruminators.

Higher Ruminators had greater performance decrements following Perceived Deterioration compared to Lower Ruminators. The present results are similar to previous work indicating that Higher Ruminators perform worse than Lower Ruminators (Burnett et al., 2017; Jackson et al., 2013). It is thought that Higher Ruminators' poorer performance is as a result of task-essential working memory resources consumption by worrying thoughts, resulting in interference with normal decision processes and thus impacting decision accuracy (Jackson et al., 2013; Kinrade et al., 2015; Laborde et al., 2015). It is thought that deficits in executive functioning no longer support goal-directed behaviour and restrict the ability to override habitual ruminative tendencies (Watkins & Roberts, 2020). Moreover, negative and task irrelevant information may be held in working memory as a result of difficulties in monitoring, shifting and updating working memory content. Rumination has previously been linked with a reduction in ability to shift attention away from negative stimuli (Watkins, 2008). This is particularly relevant when interpreting the results in line with the Integrated Model of Anxiety and Motor Performance (Nieuwenhuys & Oudejans, 2017). Referring back to Figure 5.1, if the characteristics of the individual are a ruminative disposition (e.g., Higher Ruminators in the present study), with a tendency to focus on negative stimuli, and the environment imposes negative feedback, extra effort exerted may be inadequate to counter the stimulus-driven control to threat related attention (e.g., negative feedback), interpretation (e.g., assessment of decision

situation in relation to previous performances) and response (e.g., avoidance of decision). The Integrated Model therefore offers support for the finding here that negative feedback only impacted Higher Ruminators' performance. Although not measured, the negative affect participants may have experienced could explain the poorer decision performance of Higher Ruminators following Perceived Deterioration. Purportedly, repetitive focus on negative affect amplifies the effect of negative thought on mood and results in unconstructive outcomes. Previous research (Moberly & Watkins, 2008) has shown that momentary ruminative self-focus was positively associated with negative affect. Furthermore, dispositional measures of rumination demonstrate a reciprocal relationship with negative affect. It is likely the negative feedback umpires received triggered a search for explanatory causes (Wood, Saltzberg, & Goldsamt, 1990), increased uncertainty and reduced confidence (Ward et al., 2003) and led to behavioural coping strategies (e.g., avoidance strategies, Moberly & Watkins, 2008) thus impacting their normal decision processes.

Alternatively, it is possible that Higher Ruminators used higher-level abstract processing compared to Lower Ruminators. These abstract construals have been shown to lead to global overgeneralisations and negative affect, and in particular, trait rumination has been linked to lower levels of positive affect when engaged in abstract construals (Moberly & Watkins, 2006). The use of abstract processing (e.g., "I always make mistakes") may explain the poorer performance of Higher Ruminators following the Perceived Deterioration condition. Specifically, engagement in abstract processing has been linked to stimulus controlled, automatic approach and avoidance behaviours (Thomsen et al., 2011). It is possible that for Higher Ruminators in the present study, this avoidance behaviour led to disengagement from the task (e.g., fewer decisions made, see Chapter 3), and thus resulted in poorer performance. Leary et al. (2006) supported this notion and argued that abstract processing of construals (e.g., questioning poorer performance following negative feedback) interrupts smooth performance, particularly in situations where rumination and worry are likely. Concrete processing in problem focused coping strategies have been demonstrated to manage threat appraised stressors and promoted more accurate decision making in for referees (Neil et al., 2013). It would therefore be of benefit to extend this research to understand the effect of construal type by prompting either abstract ("Why did this problem happen?" or concrete ("How are you deciding what to do next?") processing for both Higher and Lower Ruminators.

Alternatively, the rumination group based differences may be explained by Control Theory (Martin & Tesser, 1996). The experimental (false) feedback made comparisons to a novice group and may influence goal type to be a *controlled goal* with the extrinsic outcome to outperform this group. Specifically, in this context it is possible Higher Ruminators engaged in active and repetitive ruminative thought regarding unsatisfactory goal progress (i.e., poorer performance than the novice group). This explicit feedback regarding unsatisfactory goal progress may impact Higher Ruminators by increasing ruminative thought, leading to the inability to resolve the goal discrepancy (e.g., due to consumption of working memory resources), and/or disengagement from the goal (e.g., avoidance) resulting in the poorer decision performance following negative feedback (Thomsen et al., 2011).

Higher Ruminators decision time increased compared to Lower Ruminators whose decision time decreased in the Perceived Deterioration condition. The present results are in line with previous research that suggested that ruminative thought increases processing time (Pe, Vandekerckhove, & Kuppens, 2013). Particularly, individuals with high levels of ruminative disposition have demonstrated increased slowing of central task performance when dealing with negative stimuli (Pe et al., 2013), and slower updating of action-outcome contingencies to shift from negative to positive information (Takano, Van Greiken & Raes, 2019). In the present study it is possible that Higher Ruminators were unable to disengage from negative feedback which therefore resulted in longer decision times. However, and in line with the proposal that abstract processing of construals leads to stimulus-driven approach and avoidance type behaviours (Thomsen et al., 2011), it could be expected that Ruminators would have a shorter decision time.

It was expected that Higher Ruminators would have greater reductions in visual search efficiency (Nieuwenhuys, & Oudejans, 2012), as a result of negative feedback. There was partial support for this prediction whereby Higher Ruminators had shorter fixation durations and fewer fixations in the Decision Zone following Perceived Deterioration compared to Lower Ruminators; however, these findings only approached significance. Less efficient visual search, particularly when attention is drawn away from task relevant stimuli, may indicate a shift towards stimulus-driven processes as suggested by the Integrated Model of Anxiety and Motor Performance (Nieuwenhuys & Oudejans, 2012). Equivocally to the hypotheses, Higher Ruminators had shorter fixation durations on the Decision Zone following Perceived

Improvement compared to Lower Ruminators. The inability to disengage from task-irrelevant information may explain the poorer decision making performance of Higher Ruminators following Perceived Improvement. It is thought that such inefficiencies occur in anxiogenic conditions due to a reduction in the inhibition function, therefore directing attention to threat related, opposed to task-relevant stimuli (Runswick et al., 2018). This may be particularly relevant for the Higher Ruminators in the present study, given the tendency to ruminate is related to poor inhibition task-irrelevant information (Whitmer & Gotlib, 2012).

It is worth noting that Higher Ruminators also exhibited a decrease in performance following the Perceived Improvement condition. Furthermore, Higher Ruminators also had fewer fixations in the Non-Decision Zone in the Perceived Improvement condition compared to Lower Ruminators. Rothermund's (2003) results indicated that success feedback actually reduced interference effects in a reaction time task with success and failure distractor stimuli. They suggested that this inhibitory mechanism efficiently prevented automatic vigilance for information relating to completed goals or task irrelevant information. However, Rothermund did not examine ruminators, and research has demonstrated that a tendency to ruminate is related to disengagement from, and poor inhibition of, no longer relevant information (Whitmer & Gotlib, 2012). It is possible the inability to disengage from feedback information, whether positive or negative, led to the Higher Ruminators poorer performance compared to Lower Ruminators in both conditions. This said, previous research (Salovey, 1992; Silvia & Abele, 2002) suggests – in line with the model of affect-action sequences – both the negative and positive feedback participants experienced, may have altered the way that individuals organise information about how they evaluate themselves thus causing an inward shift of attention. This inward focus maintains the impact of the original affect by promoting the positive feedback or attempting to inhibit the negative feedback experienced. Therefore, the affect experienced by dispositional Ruminators in the present study whether positive or negative, potentially restricts attention to affect-related stimuli (Salovey, 1992), consequently impacting decision performance.

5.4.1. Limitations

There were several limitations that need to be acknowledged. Firstly, a limitation of the current investigation is the small sample size which may reduce the power of the study. Due to the inclusion criteria for participants (i.e., netball experience) the potential sample population

was incredibly small, and recruitment of participants was incredibly difficult particularly at the time of data collection (outside of the netball season, and academic year). Future investigations should therefore seek to repeat and extend the results of this study. Participants in this study were of mixed playing and umpiring backgrounds, it would be of benefit to repeat this study with netball umpires and to the wider population so not to limit the generalisability of the findings. Similar to other lab-based investigations (Laborde, Furley, & Schempp, 2015; Unkelbach & Memmert, 2010), the ecological validity of the setting is a limitation.

The decision environment for umpires in a video-based decision task is a far less complex task than that experienced in the field. Additionally, the way in which sport officials receive feedback regarding their performance in a match, training or post-match environment, would not be in the same manner. In a game, the most immediate form of feedback is the reaction of the crowd (Myers & Balmer, 2012) and thus the positive and negative crowd feedback warrants investigation. Post-game, sports officials are likely to receive formal feedback from mentors and assessors, use video to assess their own performance, or discuss incidents with co-officials, players or coaches (Guillén & Feltz, 2011). Guillén and Feltz (2011) stated that feedback from these groups provided a source of referee efficacy and proposed that feedback would influence decision making performance, referee stress, and co-referee satisfaction. Additionally, participants only received feedback once at the beginning of each block of trials, in line with previous feedback applications (e.g., McKay, Leathwaite, & Wulf, 2012; Moles, Auerbach, & Petrie, 2017). It is possible that, as the trials continued and participants reflected on their own performance, the effects of feedback may dissipate. Although the negative feedback resulted in poorer performance and lower self-confidence for Higher Ruminators, this induction was a relatively minor stressful event. It would therefore be interesting to examine the effect of rumination in response to more stressful events that sports officials may face. Furthermore, given the range of netball umpiring experience and expertise in the sample, it is possible that the neutral feedback provided (i.e., “Okay, your score was on par with that of the novice group”) could have been interpreted either positively or negatively by the participants, according to their perceptions of their own level of expertise. For example, a participant with less than one year of umpiring experience may consider such feedback neutral, whereas a more experienced participant may deem this to be negative. A major limitation of this study is the lack of manipulation check to understand whether affective states changed as a result of feedback.

Previous research has used ratings of anxiety, sadness and irritation to measure negative affect (Moberly & Watkins, 2010), future research should use such manipulation checks. A further limitation of the study is the absence of understanding the impact of rumination on the level of construal. Despite previous research (Brandstätter et al., 2001; Gollwitzer & Sheeran, 2006; Webb & Sheeran, 2003) demonstrating the link between rumination tendency and use of abstract construals' when experiencing negative affect, this study did not assess the construals' used by participants.

5.4.2. Future research

Future research is required to further understand the role of dispositional decision rumination on sports officials' decision making performance. Firstly, it would be of benefit to extend the results of the present study, due to the small sample size, but also in other sports officials' populations. In light of the present findings it would be of useful to understand the type of ruminative thought that takes place by using verbal reports both in laboratory-based and real-world contexts. Specifically, future researchers could conduct an experience sampling study similar to that of Moberly and Watkins (2010) to understand levels of negative affect, ruminative thought, and goal appraisal in relation to pre-, during, and post-match performance. Similarly, to Moberly and Watkins' (2010) study, umpires could record their negative affect, ruminative self-focus, and goal appraisals before game, at quarter times, immediately post-match, and later post-match to understand whether ruminative thought and negative affect is linked to their individual goal appraisal in-game or post-game. Paired with video analysis of performance, these methods could gain insight into the decision environment that leads to state ruminative experiences in relation to their perceived and actual goal attainment. Previous research has shown that context influences momentary ruminative thought, particularly increasing as feelings or problems become more salient (Moberly & Watkins, 2008).

The use of verbal reports could help understand whether ruminative thoughts affecting umpire decision making is linked to abstract or concrete processing. Neil et al. (2013) showed that referees who used a concrete processing style – a problem focused coping strategy – were better able to manage threat appraised stressors, and when paired with emotion focused coping, experienced less negative affect, and had more accurate perceived decision making. Furthermore, it would be insightful to understand the coping mechanisms used by dispositional Ruminators.

Gaining insight into the feelings and problems that generate ruminative thought and the coping mechanisms, would have important implications for the development of coping strategies for sports officials.

Given the sensitivity to negative feedback by Higher Ruminators it may be of benefit to employ practices that redirect attention. For example, cognitive bias modification has been implemented to modify automatic processing by reinforcing attention towards positive rather than negative words (Hertel & Mathews, 2011). Using a gaze training paradigm in allocating attention towards positive words, while receiving gaze-contingent feedback has been effective in sustaining attention on positive information, better control over negative emotion and reductions in state rumination following negative content exposure (Sanchez-Lopez, Everaert, Van Put, De Raedt, & Koster, 2019). Reducing the sensitivity to negative feedback may benefit the development and performance of umpires due to the critical contexts the work within (e.g., crowd noise, verbal abuse from players and coaches, and feedback from mentors and assessors).

5.4.3. Conclusion

In summary, this study examined the effects of Decision Rumination on performance in an umpiring decision task, following positive and negative feedback. The present study extends the existing literature on Decision Rumination. The results showed that Higher Ruminators had lower decision confidence and poorer decision making accuracy following negative feedback compared to their Lower Ruminator counterparts. It was suggested that the inability to disengage from task irrelevant information resulted in the poorer performance of Higher Ruminators. The present findings have implications for the development of coping mechanisms for sports officials.

5.5. References

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6. Chapter 6:
General Discussion

This chapter presents the aims of the current body of work, a summary of the findings, and the theoretical and practical implications. Furthermore, the limitations of the programme of study are discussed along with proposed future research directions and concluding remarks.

6.1. Aims of the Thesis

The central aim of this thesis was to examine the dispositional and contextual influences on netball umpires' decision making. A series of three studies attempted to investigate the decision making of netball umpires in their naturalistic decision environment or representative tasks by investigating how pressure, contextual influences, dual-task, feedback, and dispositional tendencies affected underlying mechanisms involved in decision making. Chapter 3 specifically explored the contextual factors of league position, stage of competition, home/away venue, and time during the game on decision frequency in a field-based performance analysis of netball umpires' decision behaviour. In addition, DSRS scores were collected and the association of changes in decision behaviour with Decision Reinvestment and Decision Rumination were examined. Chapter 4 presented an investigation into the influence of pressure and crowd noise, on decision making performance in a video decision task. Unlike previous research, this chapter sought to investigate the moderating effect of dispositional Decision Rumination. Moreover, we examined the associated underlying mechanisms responsible for performance change between Pressure and Crowd conditions, namely gaze strategies and self-reported information use. Given the limitations of previous research presenting realistic task demands in studying sports, Chapter 4 also examined the impact of a novel game-management Dual-task, in both Low- and High-Pressure conditions. The game management task was designed to reflect a similar monitoring and updating task faced by umpires in real game situations by keeping track of repeat infringers. Again, the moderating effect of Decision Rumination was analysed in addition to both gaze behaviours and information reports. Given the opposing influence of Decision Rumination in Chapter 4 compared to previous research, Chapter 5 sought to understand the impact of contextual valence on Ruminators decision making. Participants took part in a video netball umpiring decision task. Chapter 5 manipulated the perceived valence of the situation via false

feedback including positive, negative and neutral. Decision rumination, decision accuracy, decision time, gaze behaviour and decision confidence were analysed.

6.2. Summary of Key Findings

Numerous biases and influences have been highlighted to impact referees' decision making, particularly in soccer (e.g., Leite & Pollard, 2018). The exploratory study presented in Chapter 3 used performance analysis software to record every decision made by elite umpires throughout an entire Netball Superleague season (sixty matches), and DSRS scores were collected. Similar to previous findings, decision behaviour was affected by home advantage (Pledger & Morton, 2010), crowd size (Downward & Jones, 2007), competition level (Souchon et al., 2016), reputation (Souchon, Cabagno, Traclet, Trouilloud, & Maio, 2009), and time (Emmonds et al., 2015). Regression analyses highlighted that the number of decisions against away teams increased as home teams' league position improved. Competition round and average league position were also negatively associated with the number of decisions made in matches. Analyses further revealed that crowd size was associated with an increase in decisions against away teams and more decisions were made in the first and third quarters, compared to quarter 4. Decision Rumination was strongly negatively related to the number of decisions in Quarters 1 and 3; with those umpires who exhibited higher Rumination subscale scores making fewer decisions against home teams.

In Chapter 4, decision making was analysed in a lab-environment to understand the effects of crowd noise (Crowd vs Silent) and Pressure in a video decision task. Participants viewed real-match decision scenarios presented on a large screen and responded as they would in an actual game, via a whistle blow and subsequently verbalising their decision. As expected, on the behavioural level the greatest decision accuracies occurred in Low-Pressure Silent conditions. Decisions in this condition were characterised by longer decision times and increased overt attention to decision-relevant information. Poorer performance occurred under pressure, and with crowd noise in Low-Pressure condition, and decision times were shorter under High-Pressure. At the attentional level the findings demonstrated reduced gaze efficiency, demonstrated by higher scan ratios in the Non-Decision Zone, under Pressure in Crowd noise conditions, but also under Low-Pressure Silent conditions. Pressure also impacted the gaze behaviour in the Decision Zone, umpires interestingly had reduced scan ratios under High-

Pressure. Chapter 4 also provides evidence that different cognitive processes occur at the interpretational level between conditions. The greater use of cognitive statements under Low-Pressure may indicate effective goal-directed attention. However, as a result of Pressure, fewer cognitive statements were reported, highlighting potential shift from goal-directed to stimulus-driven attention, and distractions away from relevant cues. Umpires also completed the DSRS, and in contrast to previous research, Higher Rumination was associated with better performance in both crowd, and High-Pressure conditions. Unexpectedly, Lower Ruminators were less accurate than Higher Ruminators, and also had shorter decision time under High-Pressure.

Chapter 4 also analysed the effect of pressure and a novel game-management dual-task on umpires' decision performance. The effect of increased working memory load on decision making performance in sports officials has yet to be examined and so the dual-task was created to reflect similar game processes experienced by netball umpires, by monitoring repeat transgressors (International Netball Federation, 2018). As expected, the most accurate performance was in the Low-Pressure Single-task conditions. Umpires took longer to make their decision and self-reported a greater use of perceptual statements when most accurate. Poorest performance occurred under pressure and when undertaking a secondary game management Dual-task. Umpires made faster, less accurate decisions under pressure, and less accurate decisions in Dual-task conditions. Gaze inefficiencies were present in dual-task conditions, reflected in greater scan ratios for both the informative Decision Zone, and task irrelevant Non-Decision Zone. The change in gaze strategy could be attributed to the reliance on the stimulus-driven attentional control. Analysis of the information reports showed no changes in use of cognitive statements. However, fewer perceptual statements were reported under pressure. Follow-ups of a task by pressure interaction indicated that fewer in Low-Pressure Dual-task conditions. Analyses of the DSRS data also revealed Higher Ruminators were more accurate than low, specifically, follow-ups to a Pressure and task interaction showed Higher Ruminators were more accurate in High-Pressure Single-task condition compared to Lower Ruminators.

Due to the equivocal results regarding Decision Rumination in Chapters 3 and 4, Chapter 5 analysed the effect of false feedback on netball umpiring decision making performance. Previous research (Watkins, 2008) has demonstrated that ruminative thought can be helpful (e.g., Chapter 4) or unhelpful (e.g., Chapter 3) to performance. Specifically, Chapter 5 implemented a lab-based manipulation of positive and negative feedback to create environments that encourage

both constructive and maladaptive ruminative thought. Participants viewed decision scenarios on a projected screen and responded as if umpiring a netball match by verbalising their decision. False feedback was positive, negative or neutral in nature in relation to a cover story of pilot group performance. False feedback was partially counterbalanced across participants such that each condition sequence (e.g., negative-neutral-positive) occurred at least once. Complete counterbalancing was not possible due to the number of participants. Research has shown that the negative or positive valence effects the thought processing of Ruminators, however, this has not yet been examined in a sports context. Findings showed Higher Decision Ruminators had a greater drop in decision confidence, poorer decision making accuracy, and longer decision times following the Perceived Deterioration condition compared to Lower Ruminators. Interestingly, Higher Ruminators also experienced performance decrements and exhibited reduced gaze efficiency evidenced by reduced fixation durations on the informative areas of the display following the Perceived Improvement condition. This same trend only approached significance for gaze measures in the Perceived Deterioration condition.

6.3. Implications of Research Findings

6.3.1. Decision Behaviour

Chapter 3 identified a number of contextual influences on netball umpires' decision behaviour, specifically the reduced frequency of decisions. Previously, the use of contextual information (e.g. action preferences) has been shown to be beneficial to athletes in anticipating opponent behaviour (Runswick, Roca, Williams, McRobert, & North, 2018). However, in some situations where the information is incongruent with the decision situation it can be detrimental to performance (Mann, Schaefers, & Cañal-Bruland, 2014). Similarly, for umpires the use of contextual information may lead to poorer decisions by basing information on expectations rather than the current action (e.g., reputation bias, Findlay & Ste-Marie, 2004; expectation bias, Plessner, 1999). An unconscious bias is a common theme in the sports officiating literature when examining different influences and may explain the fewer decisions made with contextual influences in Chapter 3 (Findlay & Ste-Marie, 2004; Plessner, 1999; Souchon et al., 2009; Souchon et al., 2010; Souchon et al., 2016). For example, reputation bias (Findlay & Ste-Marie, 2004; Plessner, 1999) in relation to league position, home advantage (e.g., Dawson & Dobson,

2010), time during the match (Lago-Peñas & Gómez-López, 2016), and crowd noise (e.g., Nevill, Hemingway, Greaves, Dallaway, & Devonport, 2016).

The aforementioned biases and findings of Chapter 3 may be best explained by Biased competition theory (BCT). Salient features (e.g., crowds, home team vs away team, quarter, etc.) in the environment compete for processing resources related to our goals (accurate rule infringement decision making). However, information that is held in working memory (e.g., aggressive reputation or superior ability of a team/player) will automatically bias objects within the visual scene to match the representations held in working memory (Desimone & Duncan, 1995). In sport decision tasks, BCT has shown biased pass selection in line with specific players held within working memory (Furley & Memmert, 2013), experimentally selected players memorised by participants captured attention even when they were not the best passing option. The same may apply to netball umpires for example, holding reputation biases for better teams when making contest versus contact decisions.

Umpires may have adopted a longer decision time strategy (although, only approached significance) in the silent conditions from Chapter 4 in order to try to make the most accurate decisions. Conscious control explanations would attribute longer decision times to less efficient processing, due to the consideration of explicit information in a step-by-step manner (Masters, 1992). Present results are contrary to previous work where it is suggested distractions such as the noise of the crowd could lead to increases in working memory load, where there is competition for resources between processing the decision relevant cues against the irrelevant crowd noise. Furley and Memmert (2012) showed the ability to inhibit auditory distraction in a tactical decision making task was dependent on an individuals' working memory capacity. Specifically, invalid auditory cues resulted in longer response times. The authors suggested that when cues were incongruent with those held in memory, and the correct option, there was a slower response time due to the imposed processing demands. Bishop and colleagues (Bishop, 2016; Bishop, Moore, Horne, & Teszka, 2014) also showed slower response times with invalid auditory cues in netball decision tasks.

Alternatively, the speeding of decisions may be rationalised by decision avoidance explanations in line with explanations in Chapter 3. Nevill et al. (2016), identified similar biases as Chapter 3 in an investigation of the influence of crowd presence and home advantage on referee decision making. They stated that when faced with a contentious decision, referees adopt

an avoidance coping strategy by allowing play to continue to avoid a critical reaction from the crowd for the decision. Alternatively, it is proposed that avoidance may manifest as umpires try to remove themselves from the decision situation as soon as possible by rushing decisions (Hill, Matthews, & Senior, 2016). Similarly, Corrigan, Dwyer, Harvey and Gastin's (2018) suggest an impact aversion phenomenon, which refers to the preference towards the least influential decision, that may explain the quick decisions umpires made in order to have a minimal impact on the match. Similarly, engagement in abstract construals has been linked with stimulus controlled processing and automatic and avoidance behaviours (Freitas, Gollwitzer, & Trope, 2004), however, there were no identified differences in decision time between Higher and Lower Ruminators in Chapter 5, likely due to the large inter-individual variation. Though, following the Performance Deterioration condition both Higher and Lower Ruminators made less accurate decisions, which could be as a result of engagement in avoidance behaviours (Freitas et al., 2004). Leary, Adams and Tate (2006) suggest that the abstract processing of construals interrupts smooth performance and may explain the poorer accuracy following negative feedback. Similarly, Wood, Saltzberg and Goldsamt (1990) suggest that negative feedback initiates a search for an explanatory cause to begin behavioural coping, thus interfering with normal decision processes.

In Chapter 4, a speed accuracy trade-off under pressure may explain umpires' less accurate but quicker decisions. Speed over accuracy has been shown in various time-constrained decision environments, including police officers' decision to shoot (Nieuwenhuys, Savelsbergh, & Oudejans, 2012). Nieuwenhuys et al. (2012) suggested police officers speeded decision to shoot when anxious was a result of faster responses to threat-related stimuli. According to ACT and the Integrated Model of Anxiety and Motor Performance, responses to threat-related stimuli are a consequence of a shift in attentional control from the goal-directed to the stimulus-driven system. This shift to the stimulus-driven system may explain the speeded decisions of the umpires under pressure.

Dual-task performance was in line with previous findings demonstrating performance decrements with a secondary task (Zoudji, Thon, & Debû, 2010) rather than aiding performance (Runswick et al., 2018). Increases in working memory load can prevent necessary information from being held in working memory (Hinson, Jameson, & Whitney, 2003; Jameson, Hinson, & Whitney, 2004). For example, Zoudji et al. (2010) demonstrated soccer players decision making

accuracy diminished when under dual-task conditions. Similarly, the reduced performance in Chapter 4 is likely due to the additional processing load imposed by the secondary task; where cognitive processes required for the primary decision making task compete for working memory resources with processes required for the game management task, reflected in the greater mental effort scores and longer decision times recorded. Furthermore, Beilock and colleagues (Beilock & Carr, 2001; Beilock, Kulp, Holt, & Carr, 2004) reported performance decrements when the availability of working memory capacity necessary for skill execution is reduced. Umpires may have potentially been unable to maintain information directly relevant to the decision task, due to the competition for resources with the game management task.

6.3.2. Attentional Processes

Consistent with LTWM accounts (Ericsson & Kintsch, 1995), when most accurate, umpires reported greater use cognitive type statements (Roca, Ford, McRobert, & Williams, 2011). The use of cognitive statements by umpires may be indicative of a superior ability to read the game – supported by the greater use of pattern recognition statements. Similarly, cognitive statements have been identified across domains as used by experienced emergency physicians (McRobert et al., 2013), law enforcement officers (Ward, Suss, Eccles, Williams, & Harris, 2011), and in sports by athletes (North, Ward, Ericsson, & Williams, 2011) and officials (Hancock & Ste-Marie, 2014). The ability to use advance cue information has been highlighted as characteristic of experts (Ste-Marie, 1999). Furthermore, an advanced aptitude to predict play may also demonstrate an ability to assess the impact of an infringement decision on the game to a better extent, leading to the greater accuracy in Chapter 4. Larkin, Berry, Dawson, and Lay (2011) highlighted this ability as essential for Australian Football umpires as it assists in their positioning in order to perceive the action sequence and view the ball contest necessary for decision making.

In contrast, when less accurate, there is a reduction in the use of these statement types. The progression-regression hypothesis (Fitts, Bahrick, Noble, & Briggs, 1961) explains that although learning may have advanced to autonomous expert performance, under pressure it may regress back to conscious step-by-step novice execution. Explicit rule use has been associated with poorer performance under pressure (Masters, 1992), and may provide insight linking poorer accuracy and changes in information reports found in Chapters 4. In Chapter 4, the shift of

information use in the presence of crowd noise may be as a result of a distracting effect where there was evidence of greater self-reported use of sensory statements that referred to the crowd noise. Contrary to the hypotheses fewer perceptual statements were used under High-Pressure Crowd, and Dual-task conditions. It is possible that the increased processing load affected the statements reported by umpires. For example, the inability to update and maintain information in working memory may explain the fewer perceptual statements reported. The reduced usage of both statement types may indicate use of decision heuristics, where little information was available to be reported (Raab, 2012). Despite the evidence highlighting the benefits of heuristics in time-constrained scenarios in athletic sport performance (Belling, Suss, & Ward, 2015; North et al., 2011), in sports officiating the use of decision heuristics in crowd contexts has been highlighted as a mechanism that aids decisions in complex or ambiguous situations (Myers & Balmer, 2012).

Poorer gaze strategies, characterised by higher scan ratio or reduced fixation duration in the Decision Zone, may have led to poorer performance under Pressure, Dual-task, Crowd conditions and following negative feedback. Less efficient visual search, where attention is drawn away from task relevant stimuli may be as a result of a shift to the stimulus-driven system (Nieuwenhuys, & Oudejans, 2012). A reduced focus on the Decision Zone would potentially detriment an umpire's ability to pick up relevant information, thus leading to decisions being made whilst missing key information. For example, analyses of elite and sub-elite soccer referees gaze showed greater accuracy of the elite group, facilitated by significantly more time focused on the informative contact zone (Spitz, Put, Wagemans, Williams, & Helsen, 2016). When paired with the information report findings, distraction from environmental factors (e.g., crowd noise) or worries may result in overt shifts of attention to irrelevant areas of the visual display. Similarly, researchers have shown that performers who are anxious adopt maladaptive gaze strategies (Murray & Janelle, 2003; Williams & Elliott, 1999). Despite a lack of evidence from the study population, research in athletes suggests that pressure and increased working memory load (Wood, Hartley, Furley, & Wilson, 2016) can influence the allocation of overt visual attention as suggested in the current findings. Under pressure, processing efficiency is decreased and has been reflected in gaze behaviours as shorter final fixations, fixations that deviate off target earlier (Nibbeling, Oudejans, & Daanen, 2012), decreased search rate (Nieuwenhuys, Pijpers, Oudejans, & Bakker, 2008), fixations directed towards threatening stimuli (Wilson,

Wood, & Vine, 2009), and dwell focused on irrelevant stimuli (Allsop & Gray, 2014). The less efficient gaze in the present findings may be as a result of increased anxiety experienced when under pressure which negatively influences the control of attention, causing a shift to the stimulus-driven system (Eysenck & Derakshan, 2011). In Dual-task conditions, it has been demonstrated that individuals with particularly low working memory capacity take a longer duration to fixate relevant information and have reduced fixation duration on relevant information (Wood et al., 2016). Reduced gaze efficiency in Dual-task conditions in Chapter 4 may demonstrate the limited capacity of participants' working memory to maintain goal-directed attention on the task (Wood et al., 2016). Interestingly in Chapter 5, following the Perceived Improvement condition, Higher Ruminators had a significant decrease in fixation duration on the Decision Zone. It is thought that in anxiogenic conditions that the shift of attention to threat related stimuli is due to a reduction in the inhibition function (Runswick et al., 2018). Rumination tendency has been linked to poor inhibition of task-irrelevant information (Whitmer & Gotlib, 2012). The lack of disengagement from task irrelevant information may explain the poorer decision making accuracy of Higher Ruminators.

6.3.3. Decision Reinvestment and Rumination

This body of work presented is only the second application of Dispositional Reinvestment in the domain of sports officials' decision making, extending the examination of the DSRS to different contexts, using naturalistic tasks, and a different population group. In doing so it has begun to address the gap in the literature regarding the underlying mechanisms associated with Decision Reinvestment and Decision Rumination. The current findings extend previous research on Decision Reinvesters visual search performance (Laborde et al., 2015) and working memory (Laborde, Furley, & Schempp, 2015). In light of the findings in Chapter 3, it was demonstrated that Decision Rumination was associated with reduced decision frequencies, and particularly associated with fewer decisions against home teams in quarters one and three. The negative association with these quarters in particular may be due to the longer lead-in time pre-game and at half time compared to quarter times. It was suggested that the fewer decisions made by umpires who scored higher on the Rumination subscale were an example of avoidance type behaviours. Due to the exploratory nature of the findings in this chapter, one can only speculate about the underlying mechanisms leading to reduced decision frequencies that

occurred in relation to greater Decision Rumination. However, rumination and worry have been considered to be mediators of avoidance behaviour (Fresco, Frankel, Mennin, Turk, & Heimberg, 2002). Previous research has shown sports officials adopt an avoidance strategy in order to cope with performance pressures (Hill et al., 2016) where decision avoidance may be described as avoiding making decisions, by delaying decisions or by seeking the easy solution (Nevill et al., 2016). In this context, avoidance-type behaviour may be presented as withdrawal from the game, making fewer decisions, or making quick decisions in order to escape the aversive situation.

The tendency to ruminate upon decisions may also explain the changes in decision behaviour in relation to the home team advantage effect (Poolton, Siu, & Masters, 2011). As Poolton et al. (2011) explain, ruminations about previous poor decisions against home team players, may consume working memory resources. With reduced availability for processing of decisions, umpires may rely on the most salient features such as knowledge of the teams, or the crowd noise, resulting in decisions against away players. However, without knowing the accuracy of decisions, and in the absence of other measures such as gaze and verbal reports, this explanation of how rumination may lead to fewer decisions is speculative. Alternatively, reduced decision frequency could imply missed decisions, as opposed to false alarms (e.g., making an infringement decision when no infringement has occurred) such that working memory resources are consumed by worries. Consequently, umpires may be unable to process the necessary information to make a decision leading to a missed decision, or a false alarm based on incorrect information. Avoidance may explain the association with crowd size and umpires, whereby umpires decisions are in line with the crowds' response, choosing the easy option to avoid hostile reactions (Nevill et al., 2016). Therefore, resulting in a greater number of decisions against away teams, in order to engender favour from the home crowd. Similarly, a coping categorisation specific to sport proposes three coping methods (Gaudreau & Blondin, 2002). Three coping methods specific to sport have been identified: task-, distraction-, and disengagement-oriented. The repetitive negative thoughts that impair performance characteristic of more ruminative individuals are associated with disengagement (Hong, 2007) and may be the coping methods adopted by the participants in Chapter 3.

In Chapter 4, Rumination had an unexpected relationship with decision accuracy, linking Higher Rumination to greater accuracy under both pressure and crowd noise conditions. It is

proposed that umpires may adopt a reflective style of rumination, consisting of contemplative thoughts that actively attempt to problem solve (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Ruminations here may reflect on previous crowd and pressure experiences, enabling umpires to perform better in similar conditions. Netball umpires, particularly, may develop a reflective ruminative style as a result of their lack of formal training, resulting in a need to reflect on their own performance in order to improve. Alternatively, links have been made between rumination and goal-maintenance, such that umpires who have a greater tendency to ruminate may be more able to stay task-focused (Altamirano, Miyake, & Whitmer, 2010). It is possible that other factors, such as mindfulness, will affect how Decision Rumination impacts decision performance. When individuals are faced with stressful situations, a mindful orientation has been shown to reduce the likelihood that individuals will regulate their emotions more effectively will engage in ruminative thought (Josefsson et al., 2017). In a student-athlete group (Kaiseler, Poolton, Backhouse, & Stanger, 2017) and a corporate group (Herring, Roche, & Masters, 2016), rumination was observed to be beneficial to decision making providing high levels of mindfulness are also present. It was suggested that the non-judging nature of mindfulness may supress reflection on previous poor decisions or may reduce the levels of stress experienced (Kaiseler et al., 2017) by umpires and lead to better coping; this may explain why umpires with greater propensity to ruminate had greater accuracies scores under pressure, and with crowd noise.

The present research cannot account for the timing and type of ruminations that occurred. Ciarocco, Vohs, and Baumeister (2010) showed that adopting an action ruminative state opposed to state rumination (that focuses on implications of failure) or task-irrelevant information, led to positive changes in participants performance. Active rumination involves a pattern of thought focusing on task performance, goal achievement, and actively fixing problems from previous performances in order to improve in the future. For example, rumination that occurs between trials, of a reflective and adaptive nature, may benefit performance. Conversely, when rumination occurs during performance, this may consume valuable working memory resources, resulting in poorer performance. Alternatively control theory may account for the Rumination group results (Martin & Tesser, 1996). Control theory postulates that ruminative thought accounts for active thinking regarding unsatisfactory goal progress and will occur until the goal has been met or the individual disengages from the goal. Therefore, for the participants in

Chapter 4 in aiming to achieve their goal of optimal performance, Ruminative thought may have been beneficial to performance as an adaptive thought process aiming to problem solve and address goal discrepancies. However, for participants in Chapter 5, following the Perceived Deterioration condition, Ruminators may have disengaged from their goal as they had failed to resolve their goal discrepancy (e.g., outperform the novice group) and resulted in poorer decision performance (Thomsen, Tønnesvang, Schnieber, & Olesen, 2011).

Research has shown that context and also the valence of the situation can determine whether Rumination is helpful or unhelpful to performance (Ciesla & Roberts, 2007). It is possible that, compared to the real-world high-pressure environment they are accustomed to officiating in, where performance is televised and there are meaningful and important outcomes for themselves and the teams they officiate, the lab-based task presents a more relaxed, fun, learning activity for umpires. The different interpretations of the context could account for the different associations of Rumination with performance found here and led to the investigation of Chapter 5. Due to the equivocal findings regarding Decision Rumination in Chapters 3 and 4, Chapter 5 sought to investigate the impact of positive and negative feedback on higher and Lower Ruminators decision making. The findings showed that Higher Ruminators had greater decrements in decision accuracy following the Perceived Deterioration condition compared to Lower Ruminators. The findings support previous research that rumination has been linked with the inability to shift attention away from negative stimuli (Watkins, 2008). Negative cognitions and low self-expectation are associated with reduced problem solving confidence, delays in decision making and poorer performance (Everaert, Koster, & Derakshan, 2012; Watkins & Roberts, 2020). It was suggested that the Higher Ruminators poorer performance is as a result of the consumption of working memory resources by worrying thoughts (Jackson, Kinrade, Hicks, & Wills, 2013; Kinrade, Jackson, & Ashford, 2015; Laborde et al., 2015). This consumption of working memory by worrying thoughts reportedly takes away essential resources necessary for accurate decision making and therefore results in poorer performance (Jackson et al., 2013; Kinrade et al., 2015; Laborde et al., 2015). Thompson, Webber, and Montgomery (2002) demonstrated similar results, where participants with a greater tendency to worry – including rumination over future events – performed worse on an anagram solving task following failure feedback. It was suggested that worriers experience greater negative affect, have greater negative

thought processes including counteractive beliefs, expectations and appraisals (MacLeod, Williams, & Bekerian, 1991).

Alternatively, it is possible that Higher Ruminators had higher level abstract processing, leading to global overgeneralisations and negative affect (Moberly & Watkins, 2006). Engagement in abstract processing has been linked to a shift to stimulus-driven perception and avoidance behaviours (Freitas et al., 2004). For Higher Ruminators in Chapter 5, it is possible that this disengagement from the task and avoidance of making decisions resulted in the poorer decision accuracy following the Perceived Deterioration condition. Furthermore, in Chapter 5, Higher Ruminators not only had poorer performance but also reported lower decision confidence compared to Lower Ruminators. The reduction of decision confidence for sports officials has profound consequences on performance, reportedly reduced coping abilities to deal with crowds and matches of high importance (Neil, Bayston, Hanton, & Wilson, 2013).

Furthermore, in Chapter 5 although not significant, following the Perceived Improvement condition Higher Ruminators had a decrease in performance. It has been highlighted that trait rumination is linked poor disengagement from and inhibition of task irrelevant information (Whitmer & Gotlib, 2012). It is possible that Higher Ruminators in this chapter had difficulty disengaging from feedback, whether positive or negative, this lack of inhibition takes essential working memory resources away from the present decision task. Similarly, the model of affect-action sequences suggests that when individuals experience affect (whether positive or negative) results in an inward shift of attention. This inward shift promotes or inhibits behaviours to maintain affect and cognitions, leading back to the original affect experienced (Salovey, 1992; Silvia & Abele, 2002). Thus, feedback experienced by participants in Chapter 5 could limit attention to affect related stimuli (Salovey, 1992), consequently negatively impacting decision performance. The results from Chapter 5 may be explained in line with the impaired disengagement hypothesis (Koster, De Lissnyder, Derakshan, & De Raedt, 2011), whereby Ruminators experienced impaired attentional disengagement from negative information compared to positive (Southworth, Grafton, MacLeod, & Watkins, 2017). It is likely impaired disengagement from negative information was as a result of disruption of reallocation of attention back to task relevant stimuli, leading to the poorer decision performance of Higher Ruminators following negative feedback.

It is worth noting the non-significant relationship of Decision Reinvestment and frequency of decisions in Chapter 3. It was expected that similar negative associations to decision behaviour as Decision Rumination would be present. Previously, non-significant findings exploring the DSRS have been attributed to low task complexity levels (Kinrade, Jackson, & Ashford, 2010). However, the umpires' decision environment was the top level of domestic competition and therefore complexity level cannot explain this finding. Potentially some explicit rule use may be beneficial to umpires. Umpires must refer to the laws of the game in order to make their decisions and so reinvestment in relation to the rules that govern the sport may be of benefit, as opposed to reinvestment in decision rules and processes. In Chapter 4 only, Reinvestment was negatively associated with poorer performance under High-Pressure dual-task conditions, demonstrating support for the proposition that a greater tendency to reinvest results in poorer performance. It is thought that when in pressure situations, consciously controlling skills makes them more susceptible to disruption and results in poorer performance (Masters, 1992). The reduced accuracy may be attributed to a serial, slower, more effortful, step-by-step allocation of attention to the visual environment and execution of decision processes. Alternatively, explicit processes used when reinvesting under pressure consume working memory and this reduced functionality interrupts automatic processing, resulting in skill breakdown (Beilock, Carr, MacMahon, & Starkes, 2002).

It has been shown that deliberative people score higher on the DSRS (Laborde et al., 2015), offering support for the assumption that higher dispositional rumination is linked to more analytical processes present when excessively worrying. However, according to Betsch (2004), intuitive versus deliberative decision making is state-specific. It is suggested that, particularly in situations with limited time available, an intuitive approach is most effective (Raab & Laborde, 2011); whilst in Chapter 4 it was suggested that a deliberative style may benefit performance, given the link between rumination and accuracy. It is possible that the addition of a dual-task element, which is more representative of real-world demands, meant that the time and/or working memory resources necessary were insufficient due to increased cognitive load. However, a deliberative style may be of benefit to sports officials in certain scenarios. For example, the introduction of video assistant referees in soccer provides ample opportunity to deliberate over a situation before making a decision. As is the case with sports coaches, a combined approach may be appropriate for sports officials, such that the decision situation

determines whether an intuitive or deliberative approach is beneficial (Giske, Benestad, Haraldstad, & Høigaard, 2013).

Whilst a strong Decision Rumination tendency has usually been associated with poorer performance under pressure, as interpreted in Chapter 3, the results presented in the dual-task investigation in Chapter 4 reveal that rumination benefitted decision performance. In Chapter 3, whilst the association between higher rumination scores and fewer decisions was interpreted as an avoidance behaviour and therefore a negative characteristic, it could be argued that fewer decisions may in fact be positive due to reduced game disruption allowing for greater flow. However, without a measure of decision accuracy this cannot be known. This difference between our findings may also be attributed to the level of expertise in the groups, in Chapter 3 the participant sample consisted of the best umpires in the country, whilst in Chapter 4 the sample was drawn from a mixed level of experience group of umpires. It may be that higher level umpires' ruminations are more negative because of the greater pressure they face, larger crowds they officiate in front of, and exposure to immediate feedback based on the crowd reactions (Myers & Balmer, 2012). Alternatively, the differences in rumination findings between chapters may be due to the perceived control. Perceived control is defined as the perception that one's resources are sufficient to cope with the demands of the situation, and attain goals under stress (Skinner, 1996). The notion of perceived control may be different between elite level umpiring compared to lab-based testing. It is therefore expected that stressful situations will lower an individual's perceived control, resulting in a poorer performance outcome (Nicholls, Levy, Grice, & Polman, 2009). The perceived controllability is also subject to dispositional influences: Laborde et al. (2014) showed that low Reinvesters had higher perceived controllability than high Reinvesters. Perceived control has been highlighted to be an important factor influencing decision making for referees. Specifically, reference was made to players threatening a referees' control and a lack of control were viewed as a sign of weakness (Lane, Nevill, Ahmad, & Balmer, 2006). Without the physical presence of players in lab environment, and absence of knowing the consequences of their decision (e.g., player reactions, crowd response, impact on the game), the umpires perceived control could potentially be higher. Further investigations of perceived control and Dispositional Rumination in both real-world and lab contexts are warranted.

6.3.4. Support for the Integrated Model of Anxiety and Motor Performance

The primary focus of this thesis has centred on interpreting results in line with Dispositional Rumination; however, there is a distinct lack of predictions in relation to how anxiety affects underlying mechanisms. To this end ACT offers potential in interpreting the present results, especially considering the observed findings of increased mental effort (central tenant of ACT to compensate for attention allocated to threatening stimuli); reduced gaze efficiency (focus on task irrelevant information); and greater use of sensory statements (reflective of use of the stimulus-driven system) (Eysenck & Derakshan, 2011). Indeed, an integrative approach that considers Dispositional Reinvestment and ACT may be more beneficial in accounting for the effect of anxiety on decision making skill.

Nieuwenhuys and Oudejans (2012) developed their Integrated Model of Anxiety and Motor Performance to explain the relation between anxiety and perceptual motor performance, which could be applicable to a perceptual-cognitive skill such as decision making. The model, although predominantly based on ACT, does also take into account Dispositional factors such as Rumination. They suggest that although distraction and self-focus accounts of skill failure propose different mechanisms concerning how anxiety affects skill execution, they can both be explained by distraction principles. They hypothesise that, under anxiety, threat-based allocation of attention reduces resources available to process task-relevant information. This task irrelevant information could be skill-focused allocation of attention, shown to be debilitative to performance particularly in experts (Masters, 1992). For example, the change in information use in the present thesis could be explained by distraction to threat-related stimuli, evidenced by increased use of perceptual statements (Chapters 4), or by self-focused attention, supported by increased explicit rule use (Chapter 4), which could both account for the debilitative effect of anxiety on performance. Furthermore, the model considers the effect anxiety has on attention (e.g., threat-related attention towards the Non-Decision Zone in Chapter 4, decreased goal-directed attention on the Decision Zone in Chapter 5), interpretation of information (increased used of perceptual statements in Chapter 4, reduced decision confidence in Chapter 5), and on behavioural responses (e.g., avoidance behaviour in Chapter 3), which respectively link to a specific phase of the perception-selection-action cycle. The Integrated Model of Anxiety and Motor Performance (Nieuwenhuys & Oudejans, 2012) and ACT both suggest anxiety can serve as a motivational function to increase mental effort. More specifically, the Integrated Model

proposes that mental effort may be directed towards enforcing goal-directed behaviour, inhibiting stimulus-driven behaviour, or by attempting to reduce feelings of anxiety. The umpires in Chapter 4 had reported greater mental effort scores under pressure, and dual-task conditions suggesting umpires may have exerted more effort in order to maintain goal-directed behaviour.

Finally, the model accounts for both situation factors (e.g., task, environment) and Dispositional factors (e.g., trait anxiety, Dispositional reinvestment). For example, high Dispositional Reinvesters are more likely to consciously control their movements (Jackson, Ashford, & Norsworthy, 2006) and decision processes (Kinrade et al., 2015). Of benefit to the particular findings is the notion that the individual's interpretation of the situation factors, combined with their Dispositional tendencies, will determine how they respond and perform despite some degree of anxiety. Specifically, the Higher Ruminators in Chapter 5 potential engagement in higher level abstract construals, may explain the greater susceptibility of this group to stimulus-driven processing, leading to threat related attention (Salovey, 1992), reduced decision confidence (Ward, Lyubomirsky, Sousa, & Nolen-Hoeksema, 2003), avoidance type behaviours, (Freitas et al., 2004) and the findings that they performed worse following the Perceived Deterioration condition. However, this model is directed at perceptual-motor performance and has rarely been investigated in the literature. Future research should consider testing the specific propositions put forward by the model in a variety of anxiety and perceptual-cognitive skills contexts, such as umpire's decision making. For example, research could investigate the operational level – attentional, interpretational, or behavioural – at which anxiety exerts its influence and ultimately detriments performance, or alternatively seek to understand how individuals compensate for the effects of anxiety through increased mental effort.

6.3.5. Practical Implications.

6.3.5.1. Role of the Netball Umpire.

In addition to the theoretical implications, there are a number of practical implications of the present findings. First, with reference to the findings in Chapter 3, on the most basic level this study identifies the decision making demands of top-level netball umpires. On average, a netball umpire makes 120 overt decisions game, or 2 decisions per minute; umpire intervention is frequent. Further consideration of the processes that an umpire goes through affords some insight with regard to the temporal pressures they are under and the concentration required in

order to make their decisions. Umpires continuously make a series of decisions that must occur rapidly (a player can only hold possession of the ball for 3 seconds) to assess infringements by not only the ball carrier and their defender, but up to an additional 10 players, throughout each fifteen-minute quarter, equating to thousands of covert decisions throughout a game. Umpires must maintain appropriate court positioning whilst keeping up with the speed of play in order to make a correct decision, thus highlighting the complex and demanding task that netball umpires are faced with. Gaining insight into the task demands of netball umpires can provide a foundation from which to design specific training programmes. In other sports it has been reported that training focuses on the theory underpinning the rules rather than improving decision making (Dell, Gervis, & Rhind, 2016). The umpires in the present thesis stated that their primary training activity was umpiring lower level competition, which is unlikely to prepare them for the speed of the game or situations they encounter at their usual performance environments. Moreover, it has been reported that a lack of training support influenced soccer referee's intention to quit the game (Dell et al., 2016). Therefore, specific decision training programmes, as outlined below, may not only enhance on court performance of umpires but increase umpire's self-worth and longevity in the game.

6.3.5.2. Insights and Recommendations for Decision Training.

6.3.5.2.1. Decision Training.

The participants in this thesis reported a lack of deliberate practice in decision making. It has been suggested that decision training must replicate the decision environment experienced (Kermarrec, 2015). Moreover, according to Klein's (2008) Naturalistic Decision Making (NDM) approach, experts use their experiences to make quick intuitive decisions in complex and dynamic environments. However, as umpires have reported, the experiences they gather are not reflective of the higher-level environment they officiate. To train rapid, intuitive decision making researchers suggest the following four factors should be considered: engaging in practice, obtaining accurate and quick feedback, compiling extensive experiences, reviewing prior experiences and learning from mistakes (Klein, 2017). Kermarrec (2015) recommended soccer training should use small-sided positional games, including video analysis, to review situations with feedback from coaches. Similar micro-game scenarios could be run with netball umpires in decision rich situations (e.g., circle play, centre passes). Specific focus should also be made to

incorporate regular exposure to crowd effects and dealing with game management situations, shown here as being detrimental to umpires' performance in order to develop the relevant coping mechanisms. Sports officials' have previously identified experience, particularly with challenging situations helped to reduce inaccuracies (Lane et al., 2006). For example, evidence for acclimatisation training suggests that training with mild anxiety (e.g., with video, Oudejans & Pijpers, 2009) aims to familiarise participants with pressure. Furthermore, when coping with contextual influences such as crowd noise, distraction based interventions could be beneficial by promoting task relevant attention (Gröpel & Mesagno, 2019). Such interventions may involve pre-performance routines, deep breathing, cue words or countdown to performance (Mesagno, Marchant, & Morris, 2009; Mesagno, Christopher & Mullane-Grant, 2010), aiming to prevent internal or external distractions and promote task relevant focus.

Alternatively, some researchers have developed video training tools to increase exposure to a wide range of decision scenarios to improve sports officials' decision making (Catteeuw, Gilis, Jaspers, Wagemans, & Helsen, 2010; Larkin, Paul, Mesagno, Berry, & Spittle, 2014; Put, Wagemans, Jaspers, & Helsen, 2013; Put, Wagemans, Spitz, Williams, & Helsen, 2016). Catteeuw et al. (2010) trained offside decisions in soccer assistant referees, whereby participants completed four training sessions consisting of video and computer animated scenarios. Feedback was provided identifying the correct frame containing the players' positions and the exact moment of the pass. Results showed that the training group, compared to a control group, improved response accuracy in a post-test video task. Similar protocols could be implemented to improve netball umpire's familiarity with decisions made in a range of situations. In contrast to the aforementioned approach, decision performance improvements have been made using observational learning via video training demonstrating observations of decisions may be sufficient to elicit better performance (Larkin et al., 2014). However, the improved performance occurred over a longer time period potentially due to the longer skill acquisition time in implicit learning. There is, however, a lack of research on the transferability of video training to on-field decision making. One exception trained assistant soccer referee's offside decision making and assessed on and off-field tests performance finding increased response accuracy in both on- and off-field test conditions and improved recall and recognition accuracy of the position of the receiving attacker at the moment of the pass for the training group (Put, Baldo M, Cravo,

Wagemans, & Helsen, 2013). Similar video training programmes could be developed for netball umpires.

The varied decision time results in Chapter 4, and influence of rumination across all three experimental chapters may suggest benefits to a dual-process approach to decision making. The dual-process decision type may be dependent on the context or decision situation and is consistent with findings in sports coaches (Collins, Collins, & Carson, 2016; Giske et al., 2013). Collins et al. (2016) suggest an Act on, Store, or Ignore heuristic for coaches which may be applicable to sports officials' decision making. Act on may refer to the need to intervene by awarding a penalty or free pass. Store may reflect occasions where a situation may be occurring (e.g. contesting for space, or contact) off the ball and does not currently interfere with play but may need attending to later. Finally, Ignore may refer to situations that are not relevant to their role (e.g., crowd noise), or action on court that requires no intervention. Schweizer, Plessner, Kahlert and Brand (2011) suggested that soccer referees' decision making in contact scenarios is reliant on intuitive processing and only accuracy feedback on the decision is required to improve this decision process. Soccer referees participated in video training in which they made decisions and received immediate correctness feedback. Compared to a control, delayed feedback group, the immediate feedback group demonstrated success as a result of their learning; thus, furthering support for developing intuitive decision making. There is a paucity of research investigating the use of intuitive and deliberative decision styles across different sports officiating domains, in addition to the situation specific integrative training of these styles. In particular, the need for deliberative training may be greater, given the increasing use of video assistance in officiating, such as the application of video assistant referees at the recent soccer World Cup.

6.3.5.2.2. Error Identification and Training.

Although errors can occur throughout the decision process, Chapter 4 demonstrated that errors may partly occur on a perceptual level in relation to information processing models (Bless & Fiedler, 2014) due to the reduced focus on the Decision Zone. Jendrusch (2002) trained tennis line judges' perceptual ability using accurate feedback about their decisions, during several sessions a week. The training group improved significantly compared to a control group. Interestingly though, their perceptual abilities did not improve, rather the line judges were more knowledgeable about where to look to make decisions. By understanding whether an exhaustive visual search pattern or a central fixation point and use of peripheral vision is most appropriate

and determining if expertise plays a role (e.g., expert vs novice), will aid training of future netball umpires and those working towards higher awards. Currently, the entry-level award umpires are trained to focus on decisions surrounding the ball, as you progress through the awards, you are trained to be aware of off the ball decisions. Researchers could investigate the impact on decision performance in visual search training of these two methods. In athletes, it has been shown that training visual search has been effective in coping better with anxiety. Vine and Wilson (2010) used quiet eye training to improve gaze control of participants on golf putting and basketball free throw tasks. Results showed that control groups had shorter quiet eye durations and performed worse in pressure tests compared to retention, whereas the training group maintained effective quiet eye duration and performance in both tests. Results suggest that performers were better able to cope with the adverse effects of anxiety by maintaining effective quiet eye durations. To our knowledge no gaze training has been implemented in the sports officiating domain; hence, this could be a useful line of future enquiry.

Chapter 3 identifies many decision contexts in which decision frequency is affected and it is possible that DM errors may also occur at the encoding/categorising stage (Bless & Fiedler, 2014). Officials may fill in gaps of missing information by using contextual information that is irrelevant to performance. Several studies have shown that reputations, expectancies and stereotypes influence judgements of sports performance. In Chapter 3, reputation bias (i.e., league position), competition stage, home advantage, and in Chapter 4, the impact of crowd presence and noise demonstrated debilitative performance. For assessors and umpires it may be that these factors generate an awareness of when decisions are swayed and may activate the use of inappropriate knowledge. The governing body should aim to provide appropriate training platforms to enable umpires to adapt and still maintain decision performance in these environments when in the field. It may be possible, via video-based feedback to improve accuracy via categorisation tasks. It would be desirable for governing bodies of sport and sports performers to reduce the sports officials' susceptibility to biases. But as Wilson, Kinrade, and Walsh (2019) highlight, instructions to avoid a bias may result in an overcompensation, reversing the original bias, or provoke an officials' attention. Often a sports officials' training is centred on self-reflection as a means to improve future performance, depending on the type of reflection, it may be adaptive to initiate thought-switching or thought-stopping strategies in order to concentrate on the good decisions they made rather than dwelling on the poor ones. Positive

self-talk, thought switching, and thought stopping have shown to reduce feelings of anxiety, increase self-confidence, and enhance performance (Hatzigeorgiadis, Zourbanos, Galanis, & Theodorakis, 2011; Mamassis & Doganis, 2004; Thelwell, Greenlees, & Weston, 2006).

Errors may also occur at the information integration stage of the decision (Bless & Fiedler, 2014). Chapter 4 showed that self-reported information use regressed to novice-like statements. Generally, in most accurate decision performance, information use included situational probabilities (prediction of future events or outcomes) and pattern recognition (Larkin, Paul, Mesagno, Berry, & Spittle, 2018; Roca et al., 2011); whilst under crowd, dual-task and pressure conditions there was a greater use of perceptual information (representative of distracting effects of pressure) that is more commonly associated with novice performance. To prevent the use of declarative knowledge under pressure, implicit learning has been proposed as a means to ensure resilience to the debilitative effects of pressure. For example, Smeeton, Williams, Hodges, and Ward (2005) used explicit, discovery, and guided discovery learning in young tennis players. The explicitly trained group had increased decision times, reduced accuracy and acquired a greater number of explicit rules during learning compared to other learning groups. In contrast to explicit processes, implicit processes are organised procedural knowledge, applied unconsciously, and are faster (Masters & Maxwell, 2008). However, it should be noted that implicit learning develops at a slower rate than explicit learning (Maxwell, Masters, & Eves, 2000). The nature of officiating may make implicit learning difficult to apply as the role of an official is to enforce rules and regulations of their sport, which manifest as explicit information. Larkin et al. (2014) propose their video training approach (without feedback) as a viable implicit learning method. Alternatively, it may be beneficial for umpires to develop and apply if-then rules, for example, if the ball is held for longer than three seconds then award free pass to opposing team. Raab (2003) demonstrated in a low complexity basketball decision task, that an implicit learning group, compared to an explicit if-then learning group, performed better. But when considering a more complex handball task, the explicit if-then group were more accurate. In the case of netball umpires, it may be that for the majority of decisions, the explicit if-then rules are appropriate whilst more subjective decisions, such as contacts, an implicit approach may be applicable. An alternative may be analogy learning, which has also been demonstrated to be resilient to pressure and secondary task loads (Masters, Poolton, Maxwell, & Raab, 2008). Wilson et al. (2019) suggest that analogies could be used to improve

tactical knowledge, by aiding pattern recognition. By being better able to recognise the state of play officials may better predict where decisions may occur and shift their gaze to the appropriate location. Wilson et al. (2019) also suggest that analogies could be used to improve perceptual skills, such that they could be used to describe the mechanics of players' movements when contacting or obstructing enabling better recognition of the current situation.

6.3.5.2.3. Pressure Training.

Across Chapters 3 and 4, performance was poorest under pressure. According to Berenbaum, Thompson, and Bredemeier's (2007) two-stage model of worry, anxiety is influenced by the perceived probability and perceived costs of future undesirable outcomes. For sports officials, poor decision making that leads to poor feedback from mentors and hostile crowd reactions are clearly undesirable outcomes. These costs may be perceived as more severe when under pressure and may potentially impact their future selection to officiate high-level matches. Therefore, it may be possible to intervene by training individuals to not interpret High-Pressure scenarios as threatening. For example, rational emotive behaviour therapies have been shown to successfully reduce the number of irrational beliefs and avoidance goals, whilst increasing emotional control to enhance performance (Wood, Barker, Turner, & Sheffield, 2018). Researchers have also shown that training with anxiety may lead to better performance when in stressful conditions (Oudejans & Pijpers, 2009). Participants practiced basketball free throws and dart throwing tasks with or without induced anxiety. Following training with anxiety, performers were able to maintain performance levels in a pressurised transfer test despite demonstrating similar heart rate, perceived effort, and levels of anxiety as the control group. It was suggested that having trained with anxiety enabled to be more efficient and effectively invest their increased mental effort.

The impact of the game management dual-task in Chapter 4 provides a new insight into a different aspect of sports officials' behaviour. Firstly, the ability of umpires to maintain the decision accuracy in the presence of the dual-task was not possible. This finding has significant implications for the rules of the sport, for example the rules could be changed so that the score table manage this aspect of the game as is present in basketball. It may also be pertinent to improve general functions of working memory. Ducrocq and colleagues have demonstrated that training general working memory functions improved task specific sport performance (Ducrocq, Wilson, Vine, & Derakshan, 2016; Ducrocq, Wilson, Smith, & Derakshan, 2017). Ducrocq et al.

(2016) designed a training paradigm that specifically targeted the improvement of the inhibition function, in order to protect tennis players susceptibility to anxiety-induced performance decrements. Training improved inhibitory control, which led to improved tennis performance and visual attention in a tennis volley task performed under pressure. Improved inhibitory control was reflected in the maintenance of longer fixations in the contact area of the ball and inhibition of directed gaze to outcome related target checks. Ducrocq, et al. (2017) trained general working memory capabilities using an n-back paradigm to improve tennis players' processing efficiency, by improving working memory capacity, therefore benefitting performance. The training group benefitted from increased working memory capacity and better volley performance under pressure. Perhaps similar working memory capacity training paradigms could enable sports officials to cope with the demands of decisions and game management when in complex of pressurised situations.

6.3.5.2. Interventions Related to Rumination

Previous research has shown that professional athletes have a lower level of rumination than non-athletes, and that low levels of rumination were associated with a longer career at a higher level in football players (Roy et al., 2016). For athletes and sports officials alike, early identification of individual dispositional rumination may enable a more effective support system and interventions to improve coping mechanisms throughout their career. Querstret and Cropley's (2013) systematic review of treatments to reduce rumination and/or worry suggested that both mindfulness based, and cognitive behavioural interventions may be beneficial. Querstret and Cropley (2013) highlight that treatments that target participants thinking style or attempt to disengage from emotional responses to rumination and worry through mindful techniques may be helpful. Specifically, interventions that engage participants to implement a more concrete thinking style (Leary et al., 2006) result in greater goal-directed attention, less effort, and fewer working memory resources allocated (e.g., in line with the Integrated Model of Anxiety and Motor Performance, Nieuwenhuys & Oudejans, 2017). It therefore may be of benefit for sports officials to develop coping strategies to actively deal with stressors that they appraise as threatening (e.g., pressure, feedback, crowds) through problem-focused coping (e.g., concrete construals). Furthermore, to develop emotion-focused coping mechanisms to decrease the intensity of how negative emotions are experienced. Neil et al. (2013) demonstrated that

referees who adopted problem- and emotion-focused coping strategies promoted more accurate perceived decision making.

In sports, researchers have examined rumination related interventions (Birrer, Röthlin, & Morgan, 2012; Josefsson et al., 2017; Mosewich, Crocker, Kowalski, & DeLongis, 2013). In a review paper, Birrer et al. (2012) summarise that dispositional mindfulness (enhanced through mindfulness interventions) is related to more flow, fewer task-irrelevant thoughts, and less fear. Furthermore, mindfulness is related to fewer performance worries and reduces the impact of worrying thought on athlete behaviour (Röthlin, Horvath, Birrer, & Grosse Holtforth, 2016). In a self-compassion intervention, that involved a psychoeducation session and writing components, resulted in higher levels of self-compassion, lower levels of state self-criticism, state rumination and concern over mistakes in female athletes (Mosewich et al., 2013). Similarly, but via a mindfulness intervention, Josefsson et al. (2017) showed that increasing dispositional mindfulness (by practicing mindfulness) can lead to reductions in rumination, and better capacity to regulate negative cognitions and emotions. It is thought that mindfulness results in positive outcomes due to the release of worry related thoughts (Frewen, Evans, Maraj, Dozois, & Partridge, 2008) and that mindfulness prevents deterioration of working memory capacity under pressure (Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010). By reducing worrying thoughts, and relieving working memory capacity, sports officials can allocate resources to goal-directed attention and the results may be beneficial to their decision making performance.

Sports official's training and the promotion of conscious reflection on decisions, may increase ruminative thoughts particularly for High Dispositional Ruminators. During a game it may be possible to counteract rumination about poor decisions by thought-switching, to shift focus onto good decisions, or to reduce ruminative thought and reflection by thought-stopping cognitive strategies (Poolton et al., 2011). Daches, Mor, and Hertel (2019) investigated the effects of inhibition training on ruminators via a three week computer-based negative affective priming paradigm, by increasing inhibition to negative words or attention to them. Participants saw two words a target and a distractor (identified by a different colour) and indicated the valence of the target while ignoring the distractor. During the experiment, the target was negative on most trials for the attend-negative condition group, whilst the distractor was negative on most trials for the inhibit-negative group. Daches et al. (2019) showed a reduced negativity bias, demonstrated by lower preference for recalling negative versus neutral content for the inhibition

group. The authors suggest that trained inhibition transferred to the encoding stage of the memory task, consequently affecting subsequent recall. Furthermore, findings demonstrate that training effects on inhibition were maintained for two weeks following training. Additionally, the follow up testing utilised a different set of emotional stimuli to training, offering support for generalisation of training. In relation to scale scores, training inhibition impacted state and reactive rumination but not trait rumination. If umpires' have improved ability to cope with rumination and negative thought content, it may enhance decision performance.

6.4. Limitations

Although Chapter 3 provides the first task analysis of netball umpiring and decision behaviours, a limitation of this study is the lack of a performance measure. The absence of decision accuracy prevents insight into potential performance changes resulting from the different contextual influences examined and also the potential impact of dispositional reinvestment. All three experimental chapters used self-report measures which have been noted to have several limitations including social desirability biases, acquiescence, and response distortions (Paulhus & Vazire, 2007). However, despite these criticisms, self-report is a commonly used tool in the behavioural sciences due to both its practical and conceptual advantages (Paulhus & Vazire, 2007). Whilst the information reports used in Chapter 4 provide some insight into the underlying mechanisms used by netball umpires, participants did not receive in-depth training like other process tracing methods in order to respond (Ericsson, 2006). The use of information reports may also interfere with performance and be subject to memory inaccuracies. Additionally, in relation to the methods used, the pressure manipulation selected in Chapter 4 were based on previously established methods (Beilock & DeCaro, 2007; Kinrade et al., 2015). Despite the methods producing significant differences in pressure ratings and MRF-L ratings between conditions, manipulating pressure in a lab-based setting inherently lacks ecological validity (Kingstone, Smilek, Ristic, Kelland Friesen, & Eastwood, 2003). Although attempts were made to address the multifaceted nature of pressure experienced in the real world by using multiple methods (e.g., monetary incentive, social evaluation etc.), it is unlikely the pressure induced by these methods replicate pressure experienced in the real world.

The viewing angle of the video clips presented in Chapter 4 could be noted as a limiting factor. Realistic replications of real-world viewing positions are required to effectively test

decision making skill (Savelsbergh, Van der Kamp, Williams, & Ward, 2005). Although, clips were selected by experts to best represent the view of umpires, clips were taken from TV and performance analysis camera angles at the elite level and therefore not filmed from an umpire's perspective. It would be beneficial to the research area to examine whether clips representing a more realistic umpire viewing angle produces similar results, considering positioning (Gilis, Helsen, Catteeuw, & Wagemans, 2008) and viewing distance (Ghasemi, Momeni, Jafarzadehpur, Rezaee, & Taheri, 2011) have an effect on real-world decisions. Although Chapter 5 utilised footage from an umpire's perspective, it would be beneficial to extend these findings.

Whilst the experimental design used in Chapters 4 and 5 represented scenarios in which umpires were required to make naturalistic infringement decisions (compared to binary choices; Spitz et al., 2016); rarely in a team sport is a single decision considered in isolation. Within a real match environment, the quality and relevance of a decision is based on the context of the play in action and significance of the event. The decision situation in real match scenarios evolves over time and often affects the overall outcome, which is likely to influence an umpire's decision. For example, for a persistent infringer, the issuing of warning and cautions early in the game will result in a sin bin and potential removal from the court, having significant consequences for the team and state of play. The present studies analysed each individual decision in isolation, and therefore the effect of pressure, crowds and dual-task drawing on more match-like stimuli warrants investigation (e.g., sequential effects; Plessner & Betsch, 2001).

Although the measure of decision accuracy in Chapters 4 and 5 had a correct answer as agreed by two experts or in line with the on court official and verified by the lead researcher, there is subjectivity to what constitutes a good or accurate decision in real-world sports officiating. For example, whether to award advantage to allow the game to flow, or whether game management strategies are required to intervene for persistent infringers or dangerous play. Moreover, whilst the presentation of a variety of decisions in Chapters 4 and 5 is more reflective of that experienced in the field compared to previous research (Spitz et al., 2016), the decision process in the field is far more complex. Each decision in a real match can be costly to the teams, such as the change in possession, but game management factors may have serious consequences for the players style of play (e.g., ability to contest for ball when having a warning), and ultimately the scoreline and the outcome of competition. These contextual factors must impact the decision and what constitutes a good decision at that time during the match. This additional

information present in the field is likely to have a greater attentional cost than presented in the current tasks. Additionally, the feedback manipulation in Chapter 5 is not what would be experienced by umpires in a typical match scenario; it is more likely they would receive feedback about particular decisions from players, coaches, co-umpires and assessors. Furthermore, participants only received feedback once at the beginning of each block of trials. Although this frequency of feedback has been used previously (e.g., McKay, Leathwaite, & Wulf, 2012; Moles, Auerbach, & Petrie, 2017), it is possible that the effects of the feedback might have dissipated as the trials continued due to participants' in task learning.

Although the research presented examined a rarely investigated group, netball umpires, the results may not be generalisable to other types of sports officials. Whilst, on the surface, all have primary roles centred on making decisions, the nature of the decisions varies greatly between sports, as does the visual environment they must attend to and the rules and regulations the performers abide by. Moreover, the temporal constraints of the role may vary greatly and have significant impact on the time to ruminate. Although similar contextual and dispositional influences may exist in other sports, the way they impact performance may be different.

6.5. Future Research Directions

Despite the limitations, the presented work provides an abundance of opportunities for future research inquiry. Future research is required to further understand the role of dispositional decision rumination on sports officials' decision making performance. Firstly, the present findings demonstrate both positive and negative relationships of trait Decision Rumination with decision making performance, the following are suggestions to further investigate these equivocal findings. Due to the small sample size in Chapter 5, it would be beneficial to extend these findings to further explore the effect of feedback types on dispositional Decision Rumination. It would also be interesting to manipulate the style of feedback to replicate more similarly to what is experienced in the field (e.g., assessor feedback, media criticism, player/ coach discussion, crowd reactions), and to investigate the impact on Higher Ruminators decision performance.

In light of the findings in Chapter 3, Rumination appeared to be linked with avoidance type behaviour particularly in certain quarters of the match. Future research could investigate the state rumination of umpires across matches and the association with their decision behaviour and

performance. This could be further extended to a longitudinal examination that considers ruminations focused on previous poor decisions which may influence current ruminations when officiating for the same team on a subsequent occasion within a season. Or indeed, the long term impact of pressure on Higher Ruminators could be examined. Previously, Hanton, Fletcher and Coughlan (2005) have highlighted that sports performers endure long-term pressure from financial worries, doubts about ability and commitment, and managing the expectations of others. Specifically, future researchers could conduct an experience sampling study similar to that of Moberly and Watkins (2010) to understand levels of negative affect, ruminative thought, and goal appraisal in relation to pre-, during, and post-match performance. Similarly, to Moberly and Watkins study, umpires could record their negative affect, ruminative self-focus, and goal appraisals before game, at quarter times, immediately post-match, and later post-match to understand whether ruminative thought and negative affect is linked to their individual goal appraisal in-game or post-game. Paired with video analysis of performance, these methods could gain insight into the decision environment that leads to state ruminative experiences in relation to their perceived and actual goal attainment. Previous research has shown that contextual influences momentary ruminative thought, particularly increasing as feelings or problems become more salient (Moberly & Watkins, 2008).

Researchers have made predictions about the content of ruminative thought which could be examined via verbal reporting. Retrospective verbal reports could be used to understand the reflections and ruminations on performance in both laboratory-based and real-world contexts. For example, Hancock and Ste-Marie (2014) used a stimulated recall technique to analyse the cognitive processes used in in-game decision making. Referees were questioned regarding their decision making strategies while viewing footage from a game they had refereed. Referees discussed strategies demonstrating their knowledge structures, understanding of game context, anticipation of game flow, and prioritisation of decision making situations. To extend their research, categorisation of verbal reports could involve ruminative and task irrelevant thoughts from which comparison of rumination groups could be made. Verbal reporting of ruminative thoughts may also be useful to identify whether Ruminators are more likely to use a higher level abstract processing style. Neil et al. (2013) showed that referees who used a concrete processing style – a problem focused coping strategy – were better able to manage threat appraised stressors, and when paired with emotion focused coping, experienced less negative affect, and had more

accurate perceived decision making. Questioning sports officials regarding their previous decision performances my indicate whether more abstract (e.g., I always make mistakes) versus concrete (e.g., I considered how to make the next decision) thought processing occurred for Higher or Lower Ruminators. Furthermore, it would be insightful to understand the coping mechanisms used by dispositional Ruminators. Gaining insight to the feelings and problems that generate ruminative thought, and the coping mechanisms would have important implications for the development of coping strategies for sports officials. It may also be of value to manipulate the type of ruminative thought sports officials take. For example, Ciaroocco, Vohs, and Baumeister (2010) manipulated the type of ruminative thought to be action-focused (focused on task performance and active problem solving), state-focused (focused on current feelings and failure implications) or task-irrelevant (distracting thoughts away from the task goal). Following false feedback related to a decision task, sports officials could be grouped into different ruminative thought focused groups to investigate the effect on performance. Cirarooco et al. (2010) showed that adopting an action-focused ruminative thought type improved performance relative to the other two conditions.

Of particular interest from the present findings is the positive and negative relationship of Rumination to decision accuracy under pressure that warrants further research attention. It is possible that the effects of rumination may be context-specific; whilst it may be beneficial to sports officials in some contexts, whilst in others its detrimental similarly to athletes in rapid interceptive team sports. However, given the sensitivity to negative feedback by Higher Ruminators it may be of benefit to employ practices that redirect attention. For example, cognitive bias modification has been implemented to modify automatic processing by reinforcing attention towards positive rather than negative words (Hertel & Mathews, 2011). Using a gaze training paradigm in allocating attention towards positive words, while receiving gaze-contingent feedback has been effective in sustaining attention on positive information, better control over negative emotion and reductions in state rumination following negative content exposure (Sanchez-Lopez, Everaert, Van Put, De Raedt, & Koster, 2019). Reducing the sensitivity to negative feedback may benefit the development and performance of umpires due to the critical contexts they work within (e.g., crowd noise, verbal abuse from players and coaches, and feedback from mentors and assessors).

Self-compassion interventions have been shown to reduce levels of self-criticism, state rumination and concern over mistakes in female athletes (Mosewich et al., 2013). Similar interventions may be used to reduce ruminative thought in sports officials and warrants research attention. Moreover, other factors, such as mindfulness, when present with rumination can be beneficial to performance (Herring et al., 2016; Kaiseler et al., 2017). Researchers could explore whether high mindfulness and high levels of rumination result in better performance in sport contexts to determine if findings in business and student athlete groups translate (Herring et al., 2016; Kaiseler et al., 2017). It is thought that mindfulness increases the ability to understand performance inhibiting emotions and maladaptive thoughts (Josefsson et al., 2017). To follow, given the known effects of mindfulness on coping via rumination and emotion regulation, mindfulness interventions could be applied to sports officials to reduce rumination and improve capacity to regulate negative emotions (Bernier, Thienot, Codron, & Fournier, 2009; Scott-Hamilton, Schutte, & Brown, 2016). Improving coping skills may enhance decision performance in complex environments such as experienced by umpires in Chapter 3. Furthermore, future research could seek to understand the relationship between deliberation and dispositional reinvestment in sports official's decision making (Laborde et al., 2015). Previous work has shown that a deliberative style is slower and less accurate than intuitive decisions in tactical decision making. However, the link between Decision Rumination with deliberation in sports official's decision making has yet to be explored.

Despite this thesis addressing the gaps in research examining the underlying mechanisms linked to dispositional Decision Rumination, there is still a lack of investigation. Therefore, there is scope to further understand why performance changes as a consequence of underlying mechanisms for dispositional Ruminators. Due to this gap in research, interpretation of the present findings were discussed in relation to ACT and the Integrated Model of Anxiety and Motor Performance as a shift to the stimulus-driven system and a reduction in processing efficiency. Future investigations could use sports officials as a population to test the predictions of the Integrated Model of Anxiety and Motor Performance. For example, similarly to the present research, video decision tasks could be presented to sports officials, with the addition of a bias manipulation (e.g., of player reputation or team status), under anxiogenic conditions. Visual search measures could be used to explore the attentional level, similarly to the present findings and in line with the Integrated Model of Anxiety and Motor Performance, less efficient

gaze strategies would be expected. Having conditions of prior knowledge of specific players or team status when compared to no prior knowledge would provide insight on an interpretational level. It would be expected that due to anxious conditions, and the biased knowledge that increased threat related attention will reduce the response options generated. Both the attentional deficits and the impacted decision processing at the interpretational level would be expected to then impact the decision behaviour and accuracy. Furthermore, given the reported working memory deficits of trait Ruminators (Koster et al., 2011), researchers could test the ability to switch between and update information using game management tasks and in-game infringement decisions to be made. Researchers could also examine increased distractibility and reduced inhibition of irrelevant crowd noise cues when anxious (e.g., Wood & Wilson, 2010). However, a high-level of experimental control is necessary to assess executive functions and testing these in applied contexts will be difficult (Behan & Wilson, 2008). There is also scope to investigate the application of biased competition theory (BCT) to the sports officials' domain. BCT could potentially extend the existing research on reputation bias, whether in relation to gender stereotypes, aggressive reputations, ability, or repeat transgressors subject to game management intervention, by explaining how these biases occur. Researchers could manipulate the image held in working memory, for example by stating a player's aggressive reputation, to explore the effects of BCT. Overall, future research should look to replicate and expand on the results currently presented.

It is also important to note that many other personality factors may impact a sports official's decision making, coping abilities and longevity in the game, and warrant research attention to improve training, development, and selection of sports officials and ultimately enhance performance. For example, recent work has investigated mental toughness, locus of control, assertiveness, and social comparison (factors considered to be important in the selection and assessment of referees) and demonstrated that professional soccer referees scored higher than lower level referees across all factors (McCarrick, Wolfson, & Neave, 2019). The roles of sports officials in each sport vary greatly, therefore different characteristics may be more important in one sport compared to another. Other factors may be important in relation to coping mechanisms of referees and ability to deal with pressure. For example, perfectionism, characterised by overly critical self-evaluations due to holding excessively high standards, has been linked to choking (Hill & Shaw, 2013), Decision Reinvestment (Laborde et al., 2015) and

Rumination (van der Kaap-Deeder et al., 2016). Research outside of sport (e.g., Besser, Flett, Hewitt, & Guez, 2008) has shown the individuals with high levels of perfectionism experience higher levels of anxiety and lower levels of self-esteem following negative feedback and therefore it may be of value to investigate this premise in the population of sports officials. It may also be relevant to investigate the relationship of rumination to other variables, for example passion in sports officials. Harmonious passion has been linked to positive emotions and experiences of flow whilst refereeing, however obsessive passion had been associated with negative emotional experiences during games and poor decision making (Philippe, Vallerand, Andrianarisoa, & Brunel, 2009). Passion has also been linked to higher level referees' motivation (Johansen, 2015) and may be an important factor in determining referee development and longevity in the game.

Dual-process accounts suggest intuitive or deliberative decision making is situation specific (Epstein & Pacini, 1999). Future research could investigate the types of decisions that are intuitive (e.g., held ball in netball, if held for longer than 3 seconds, then award a free pass) and which are deliberative (e.g., contact decision, interpretation of the situation determining whether an equal contest or whether there was contact, followed by analysis of whether the player can continue their action and advantage can be played or whether there is a greater impact on the game and a penalty pass is required) and when each decision style is beneficial to performance. Additionally, researchers could gain insight into the underlying mechanisms associated with each decision style, in order to develop specific training paradigms. Moreover, extending into other sports, researchers could investigate the benefit of deliberation for the video assistant referee compared to the intuitive processes used by the on-pitch match referee. By understanding the decision styles required for different contexts and roles could improve the training of sports officials.

Although Chapter 3 provided an informative insight into how the decision behaviours were affected by several influences, future research should delve deeper to understand the association between decision performance and contextual influences. For example, similar to the findings of sequential effects (Plessner & Betsch, 2001), lab-based manipulation of scoreline may gain insight into how changes in anxiety and perceived pressure affects underlying mechanisms (e.g., visual search, verbal report) and decision performance. The present findings could be extended to investigate the neural basis of umpires' decisions; for example, fMRI has

been used previously to understand anticipation in sporting tasks (Wright, Bishop, Jackson, & Abernethy, 2011). Investigations in Chapter 4 suggested that pressure, crowd, and dual-task impact perceptual cognitive skills by firstly affecting visual search behaviours and secondly by altering the type of information used when making decisions. In order to provide greater clarity of the observed effects, research should attempt to expand these findings. It could be beneficial to gain a more in-depth understanding of fixation locations extending the use of a Decision and Non-Decision Zone in investigations of biases. For example, if player biases exist, such as having an aggressive reputation, it could be interesting to examine if umpires allocate excessively more attention to the player that holds the reputation bias. Additionally, greater depth of analysis in future studies could explore the expertise effects of time-to-first fixate (e.g., Donovan & Litchfield, 2013), to understand if higher level sports officials identify the decision zone earlier than novice level umpires. Furthermore, to develop specific training programmes (as discussed in the practical implications), it would be beneficial to pair gaze behaviours with the types of decision errors that occur (e.g., missed decision, false alarm) to understand if errors are occurring at an attentional or interpretational level.

The effect of crowds on decision performance warrants further attention. Explanations suggest that sports officials may use crowds as a decision heuristic, but investigations should seek to understand the impact of crowd type (e.g., supportive versus unsupportive), crowd semantics (e.g., verbalisations congruent or incongruent with the decision) and their interaction with pressure to understand how they influence decision performance. In particular, Chapter 4 showed that gaze and information reports were affected with crowd noise presence, insight into how different crowds influence these mechanisms is worth investigating. Chapter 4 showed that umpires' ability to recall the game management task was hindered under pressure, and the dual-task affected decision making. Future researchers should aim to improve decision performance when coping with the multifaceted demands of sports officiating.

6.6. Conclusion

In conclusion, this thesis has furthered the knowledge and understanding of a sports officials' role and the impact of contextual and dispositional influences on their ability to make a decision. Specifically, this thesis provides an examination of netball umpires' decision making in naturalistic environments. Although interest in sports officials is growing, the current thesis

extends research in the sports officiating and decision making domains, whilst also addressing gaps in research, such as the role of dispositional influences in sports officials' decision making. The current thesis extends previous research from sports officiating identifying contextual influences in a different group of officials, the netball umpire. To this end, this thesis demonstrates netball umpire's decision behaviour is affected by crowds, competition, league position, and time during the game potentially as a result of avoidance coping. Furthermore, this thesis extends previous findings by identifying underlying mechanisms associated with performance change. Most accurate performance was paired with cognitive mechanisms in line with the proposed LTWM account of expert performance, particularly the use of predictive statements, whereas poorer performance was associated with a regression to novice-like performance evidenced by greater use of explicit rules. Moreover, with crowd noise, a shift to the stimulus-driven system may be indicated in greater use of sensory statements, whilst gaze efficiencies could be linked to changes in attentional control proposed by ACT and the Integrated Model of Anxiety and Motor Performance. Both gaze and verbal report findings could have theoretical and practical implications for future researchers and practitioners in the development and application of decision training paradigms. This thesis also adds support to the notion that ruminative thoughts may be facilitative to netball umpires' decision making but is potentially dependent on the interpreted valence of the situation. Overall, this thesis has identified contextual factors that affect decision making performance and provides an indication of how these factors may influence performance via underlying mechanisms and the associated dispositional tendencies. The present findings have both theoretical and practical implications and offers promising avenues for future investigation to further understand Decision Rumination, and to develop training and coping strategies for optimal decision making in netball umpires.

6.7. References

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