

Perception in Ice Hockey Referees

Examining Perceptual Differences Amongst Elite, Intermediate, and Novice Ice
Hockey Referees: Visual Attention and Eye Movement Recordings

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Dissertation Introduction

This is a five-part document detailing my doctoral dissertation. Part I includes my updated thesis proposal. In Part II, I present three articles that I have submitted to scholarly journals. Part III consists of an integration of the three articles. Part IV lists the statement of contributions for the individual articles. Finally, part V is a list of references included for all parts of the dissertation.

It is important to note at this time that the University of Ottawa Research Ethics Board approved the research that I conducted herein.

Dissertation Abstract

Perceptual-cognitive skills are important characteristics for sport participants, which have been shown to contribute to the expert advantage (Abernethy, Baker & Côté, 2005; Mann, Williams, Ward, & Janelle, 2004; McPherson, 2000). One such skill is visual attention, which is beneficial for athletes, but less commonly researched for sport officials. For this dissertation, three data collection procedures assisted in examining the visual behaviors of elite, intermediate and novice ice hockey referees.

In phase one, 2 elite, 2 intermediate, and 2 novice referees wore helmet cameras for one game and subsequently participated in stimulated recall interviews to address visual behaviors that occurred during that game. The four resultant themes that emerged were: Divided Attention, Selective Attention, Positioning and Context, and Influences of Visual Attention. Within each of these major themes there were several similarities and differences amongst the referees.

In phase two, 2 elite, 2 intermediate, and 2 novice focus groups watched one elite and one intermediate helmet camera videotape and discussed what they thought the referee was attending to and where they would direct their visual attention. The focus group transcripts were deductively coded to search for potential differences between the elite and intermediate referees based on the themes identified in phase one. It was evident that the elite referee was superior to the intermediate in several areas including: Maintaining a focus on the majority of players, knowing when to focus away from the puck, having better post-whistle attention, and being better positioned. Discussion related to how these advantages might be gained by learning through experience.

For phase three, 10 elite, 10 intermediate, and 10 novice referees wore an eye-tracking device and made penalty decisions on ice hockey infractions presented on a computer screen. In this experiment, decision accuracy, decision type, number of fixations, and fixation duration were calculated. MANOVA results indicated that there were no significant differences across participant groups.

The global discussion includes data excluded from the three main papers, alternative methods for further interpretation of the results, integration of the results of the three papers, and proposals for future research.

Part I: Updated Thesis Proposal

Chapter One

Introduction

Expert performance can be defined as the successful end result of an individual's prolonged efforts to improve performance while negotiating motivational and external constraints (Ericsson, Krampe, & Tesch-Römer, 1993). These constraints often include effort, instruction, and resources (e.g., equipment and finances). The expert performance framework does not appear to be limited to one particular domain; rather, expert performers have been studied in several domains including chess (de Groot, 1965; Simon & Chase, 1973), music (Ericsson et al, 1993; Partington, 1995), mathematics (Gustin, 1985), and athletics (Starkes & Ericsson, 2003; Williams, 2000) to name a few.

Williams and Ericsson (2005) noted that the athletic domain provides a particularly productive environment to test theories of expertise, as the majority of sports have constantly changing environments under which the limits of athletic performance are repeatedly challenged. Thus, expertise theories and models can be created, applied, adapted, and reapplied in this environment. Fittingly, the athletic setting was the chosen environment for this research.

Within the athletic domain, expert performance definitions are more specific. Expert sport performance refers to consistent superior performance over an extended period of time (Janelle & Hillman, 2003) and is comprised of hardware and software characteristics, with the latter software elements relating to 'acquirable skills' (Starkes, 1987). Congruent with expertise researchers in other domains, several authors have suggested that 10 years or 10,000 hours of deliberate practice are necessary to achieve an expert level of sport performance (Baker, Côté, & Abernethy, 2003; Helsen, Starkes, & Hodges, 1998; Hodges &

Starkes, 1996; Monsaas, 1985). Deliberate practice is when an individual undertakes an activity for the primary purpose of improving performance (Hodges & Starkes, 1996). An example would be an ice hockey player who, after proper coaching, sets aside 30 uninterrupted minutes each day for practicing his or her shooting with the main purpose of improving his or her shot. Janelle and Hillman (2003) also indicated that expert sport participants must excel in four domains: (a) Physical, (b) technical, (c) cognitive, and (d) emotional. It is the perceptual-cognitive domain that was especially examined herein.

Despite the aforementioned value of testing expertise in the sport setting, the study of expert sport performers has focused primarily on athletes. Meanwhile, there is a relative dearth of research on other influential sport participants including coaches and sport officials. Though coaches have garnered more attention in the last 15 years (Bloom, Durand-Bush, Schinke, & Salmela, 1998; Côté, Salmela, & Russell, 1995a; Côté, Salmela, & Russell, 1995b; Côté & Sedgwick, 2003), research on sport officials is still scarce. This may be due to the fact that sport officials do not have prototypical practice or training sessions during which they can be studied, or it may simply be that there are relatively few sport officials as compared to athletes. To be clear, there have been studies conducted on sport judges (Bard, Fleury, Carrière, & Hallé, 1980; Damisch, Mussweiler, & Plessner, 2006; Findlay & Ste-Marie, 2004; Plessner, 1999; Ste-Marie, 1999; Ste-Marie & Lee, 1991); however, sport judges are distinctly different from team sport officials (this distinction will be made clear in the following paragraphs). Moreover, the literature on sport officials has been limited to personality (Koslowsky & Maoz, 1988), stress (Dorsch & Paskevich, 2007; Goldsmith & Williams, 1992; Rainey, 1995, Rainey & Hardy, 1999; Taylor, Daniel, Leith, & Burke, 1990) and bias (Jones, Paull, & Erskine, 2002; Plessner & Betsch, 2001).

Recently, researchers have begun to examine the tangible skills of sport officials such as perception and decision-making (MacMahon & Starkes, 2008; MacMahon & Ste-Marie, 1999; Mascarenhas, Collins, & Mortimer, 2005; Unkelbach & Memmert, 2008). However, it is vital that the perceptual skills of sport officials be studied further to understand what it is that makes certain officials better decision-makers than others.

Two key studies provide context surrounding the importance of studying the decision-making of sport officials. Helsen and Bultynck (2004) examined the number of decisions soccer referees made during games and discovered that head referees made, on average, 137 observable decisions per match. As non-observable decisions were also made (e.g., a referee decided to allow play to continue when a foul occurred but there was no advantage to the offending team), it was more likely that head referees made approximately 200 decisions per match. The authors speculated that this was the equivalent of three to four decisions per minute of playing time. Furthermore, as Mascarenhas and colleagues (2005) noted, correct decision-making discriminated rugby referees ranked in the top 20 in England and those referees ranked 21 to 65. These two studies exemplify that with the volume and importance of decisions, it is imperative to understand how sport officials' perceptions affect their decision-making.

Fittingly, this research examined expert sport officials. MacMahon and Plessner (2007) indicated that there are three types of sport officials. First are reactors, who have very few responsibilities and limited interaction with athletes. An example of a reactor is a tennis line judge whose role is to decide if a ball is hit in or out of bounds. The second category of officials is monitors, including gymnastic or figure skating judges. Monitors attend to several cues during an athletic performance and assess the quality of a

performance, but they still have limited, if any, interaction with athletes. Finally, there are interactors, the focus of the present study, and who include, for example, basketball, soccer, and ice hockey referees. Interactors attend to several cues during an athletic performance and have a high level of interaction with the athletes since they are typically in the field of play. Ice hockey referees in particular represent an interesting population for several reasons. First, ice hockey referees make decisions in the fastest team sport. Second, ice hockey referees must manage a game that has an ever-changing environment with space constraints. Finally, ice hockey referees are in the actual playing surface and often make physical contact with the puck or the players. Investigating the perceptual abilities of officials in such an environment is intriguing and potentially, quite beneficial for theories of perceptual expertise.

In Canada, there are several ice hockey leagues in which to study referees. Of importance at this juncture are the Central Canada Hockey League (CCHL; one of 10 Junior A leagues in Canada) and the Ottawa District Minor Hockey Association (ODMHA; one of 13 minor ice hockey branches that fall under the jurisdiction of Hockey Canada). Corresponding with each one of these leagues is a classification of referees as designated by the researcher. CCHL referees are considered elite and ODMHA referees are considered intermediate or novice. These designations may seem arbitrary, but are meant to correspond with the level of hockey that the referee is officiating. The assumption being that with an increased standard of play, there are increased perceptual demands and increased demands to process more cues in a short period of time. Further operational definitions are provided in the method section.

It is also important to understand what an ice hockey referee does in his or her capacity. According to Hockey Canada (2008), a referee shall provide a safe and fair environment for all players. More literally, a referee watches a game and determines which infractions shall be imposed for rule violations, decides when a goal has been legally scored, and communicates with players and coaches. Meanwhile, they must skate around the ice to be afforded the best vantage point to see all plays. Thus, rule knowledge and positioning (technical skill), developing rapport (emotional skill), fitness (physical skill), and decision-making (perceptual-cognitive skill) are important skills of a good referee. Perceptual-cognitive abilities and specifically referees' visual attention as it relates to decision-making, was the focus herein.

Statement of the Problem

Presently, sport scientists do not fully understand the perceptual-cognitive skills of sport officials. Understanding what cues sport officials visually attend to, why they focus on certain cues, and how that contributes to their decision-making is an important step toward understanding the perceptual skills of sport officials. An expertise framework (Helsen & Starkes, 1999; Shank & Haywood, 1987; Williams, Davids, Burwitz, & Williams, 1994) has been successful in the past to assist researchers in such inquiry. Using an expertise paradigm, the aim of this research project was to investigate the perceptual skill differences of elite, intermediate, and novice ice hockey referees. Examining this topic is imperative to several parties. At an instructional level, one goal of every referee association is to improve referee performance. Determining the perceptual characteristics for which elite referees are superior (compared to their intermediate or novice counterparts) and the specific cues to which elite referees attend would provide referee supervisors and instructors with ideas on

how to improve individual refereeing performance. By improving such potential characteristics, the number of quality officials would surely increase. Furthermore, valuable information can be gleaned from this investigation regarding the perceptual skills of elite referees who perform at high standards of ice hockey, while experiencing the highest amounts of pressure and scrutiny. This information could then be applied to other referee investigations (including other interactors) as well as athletic environments.

This research is also important on a theoretical level. Sport officials do not have regular, frequent, organized training sessions, making it difficult to apply the deliberate practice framework. However, expert sport officials can be compared to expert athletes by applying perception and information-processing models. The similarities and differences between referees' and athletes' decision-making would prove very useful to expert perception theories.

Chapter Two

Literature Review

Expertise

De Groot (1965) was the first psychologist to investigate expertise. While de Groot avoided using the term expertise, he demonstrated that in chess, grandmasters (those with repeated national and international success) were vastly superior in memory recognition than amateurs. De Groot demonstrated this phenomenon by displaying chess positions to participants for 2 to 10 seconds and then asking them to reconstruct the positions from memory. Grandmasters reproduced the chess positions with nearly 93% accuracy whereas amateurs were limited to 50% accuracy. De Groot further demonstrated that grandmasters and amateurs showed no differences on memory tasks not related to chess. He concluded that grandmasters' superior perceptual skill was chess-specific and was a result of the immense amount of time spent studying chess as compared to amateurs.

Furthering this work, Simon and Chase (1973) displayed normal and random (positions a player would not typically encounter during a chess match) chess positions to chess players. When the chess positions were normal, grandmasters recalled 90% of the positions, yet recalled only three to four positions in the random situation—similar to amateurs' recall. Simon and Chase concluded that expert chess players' perceptual skills were a result of their vast repertoire of domain-specific patterns that they accumulated over many years of experience. Furthermore, Simon and Chase became the first to estimate the length of time required to become an expert in a domain. They indicated that there were no cases on record where a person had reached grandmaster status having less than 10 years of intense preoccupation with the game. They also estimated that grandmasters spent 10,000 to

50,000 hours in their lifetimes studying chess positions whereas Class A players allotted only 1,000 to 5,000 hours studying chess positions. Hence, Simon and Chase suggested 10 years and 10,000 hours were the minimum amount of time required to attain expert status in chess. The authors further hypothesized that a minimum of 10 years and 10,000 hours would be required for expert performance in other domains, such as sport.

This sort of perceptual expertise was also examined by Ericsson and Chase (1982), in particular with exceptional human memory. However, in their experiment, they were interested in whether memory was innate or if it could be acquired through training. One participant was trained in the recall of digits for a total of 230 hours. At the beginning of the experiment, the participant could recall seven digits. Through the use of proper training, specifically mnemonic strategies, the participant's digit span recall increased to 82 digits. Thus, Ericsson and Chase reaffirmed that superior domain-specific memory, such as that seen in chess grandmasters, was the result of dedicated and repeated training in the domain and not a result of innate ability.

Building from his earlier research, Ericsson and colleagues (1993) proposed a model to account for expert performance. The researchers purported that deliberate practice, not innate ability, was what made individuals experts in their chosen domains. More precisely, the authors indicated that expert performance was the result of an extended process of skill acquisition mediated by large, but not excessive daily amounts of deliberate practice. Ericsson and colleagues' proposed framework included the basic assumption that an individual's amount of deliberate practice time was positively related to that individual's acquired skill level. That is, as deliberate practice increased, performance increased. Moreover, given the previous domain-specific findings (i.e., de Groot, 1965; Simon &

Chase, 1973), expertise was considered the result of deliberate practice within a particular domain rather than general aptitude.

Though deliberate practice was not the focus of the current study, it is crucial to understand deliberate practice at a conceptual level, as it is a constituent component of expertise. According to the framework set forth by Ericsson and colleagues (1993), there are four guidelines for deliberate practice. First, engagement in deliberate practice is not inherently motivating; yet, performers considered it instrumental in achieving further improvements in performance. Second, deliberate practice is an effortful activity that can be sustained for only a limited time each day during extended periods without leading to exhaustion. Third, maximization of deliberate practice extends over a minimum period of 10 years. Fourth, deliberate practice requires available time and energy for the individual, access to social support resources such as teachers and coaches, as well as access to training materials and facilities.

There has been debate regarding whether sport officials engage in deliberate practice deliberate experience, as sport officials spend most of their time in competition (see MacMahon, Helsen, Starkes, & Weston, 2007). The purpose of the above paragraph, however, is to demonstrate the length of time, commitment, and resources required to achieve expert status in any domain—not to debate the differences between deliberate practice and deliberate experience.

There are important points to consider when summarizing the presented expertise studies (de Groot, 1965; Ericsson & Chase, 1982; Ericsson et al., 1993; Simon & Chase, 1973). First, perceptual-cognitive skills, and more inclusively, expert skills, appear to be domain-specific. Next, perceptual-cognitive skills such as memory can be acquired through

practice and training. Finally, a significant period of deliberate practice (usually 10 years) is required to attain expert status in any domain. The above studies laid the foundation for the current project.

Athletic Expertise

Though deliberate practice was not the focal point of the current study, it is important to validate the claim that deliberate practice is required to attain expert status, as years of deliberate practice assisted in determining the participant groups for this study.

Examples of deliberate practice as a discriminator of expertise in athletics are plentiful. In a comparison of international and club wrestlers, Hodges and Starkes (1996) established that international wrestlers began accumulating more hours of deliberate practice six years into their careers. This difference became significant by age 20 (approaching 10 years of deliberate practice). The authors concluded that deliberate practice, not innate ability, was the main predictor of expert performance. Similarly, Helsen, Starkes, and Hodges (1998) tracked deliberate practice hours in international, national, and provincial soccer and field hockey players. Congruent with Ericsson and colleagues' results (1993), the researchers discovered that international players accumulated more hours of deliberate practice than their national and provincial counterparts and that these deliberate practice hours were significantly higher in international players after 10 years. Deliberate practice advantages have also been shown in expert team ball athletes (field hockey, netball, and basketball; Baker, Côté, & Abernethy, 2003), expert triathletes (Baker, Côté, & Deakin, 2005), and expert tennis players (Monsaas, 1985). Suffice it to say that the advantages of deliberate practice for expert athletes held true across the several different sports in these studies. It is also interesting to note that Baker, Côté, and Abernethy (2003) suggested that

deliberate practice in a similar field (i.e., a netball player with basketball experience) accelerates the expert process. For that reason, referees' experience in related fields were investigated herein.

Moving into the crux of the present study, a number of studies have been conducted regarding perception, visual attention, and decision-making in the athletic setting. While it is imperative to gain an understanding of the history of this line of inquiry, it is beyond the realm of this literature review to include every study that has been conducted. Thus, in the following paragraphs, those studies deemed the most important and relevant to sport officials regarding expert perception will be discussed.

In any study of perception in sport, it is vital to begin by distinguishing hardware and software characteristics. Starkes (1987) made this distinction and noted that hardware characteristics referred to stable, pervasive perceptual and visual components required for expert performance that theoretically resulted from a superior central nervous system. Examples of hardware components include general reaction time and visual acuity. Starkes defined software characteristics as perceptual and visual components that were acquirable, domain-specific, and resulted from superior information-processing. Utilizing a sport example, this could include a badminton player using advanced perceptual cues to react to an opponent's serve. Starkes was the first researcher to examine hardware and software characteristics in the same study. Examining field hockey players, Starkes tracked several physiological and psychological factors among experts, moderates, and novices. From the results, it was indicated that there were no differences for visual acuity, basic decision speed, or perceptual sensitivity (hardware characteristics) among the different levels of expertise. However, experts were more accurate in their decisions, superior at recalling game-

structured information, and better at predicting the location of shots (software characteristics) than their non-expert counterparts. Starkes concluded that software characteristics, acquired through experience, were the determining factor for perceptual expertise—not hardware.

Several authors have demonstrated similar results confirming that experts possess no hardware advantages, only software advantages, over novices. For example, expert youth basketball players made better decisions based on better declarative knowledge (knowing rules and facts) and procedural knowledge (knowing how to execute) compared to non-experts (French & Thomas, 1987). Abernethy and Russell (1987) demonstrated that expert badminton players were better than novices at predicting landing positions of shots because they extracted information earlier than the novices and focused on more relevant cues (for similar results, see Paull & Glencross, 1997). Williams, Davids, Burwitz, and Williams (1993) indicated that when viewing soccer plays, expert soccer players made less recall and recognition errors than novices, likely due to their soccer-specific knowledge (see also Poplu, Baratgin, Mavromatis, & Ripoll, 2003). Similar to Starkes' (1987) earlier paper, Helsen and Starkes (1999) identified no differences between expert and intermediate soccer players' hardware characteristics (central reaction time, peripheral reaction time, visual correction time, and visual acuity). However, experts were superior on software characteristics, including speed and accuracy of decisions. The authors attributed these advantages to the experts' contextual experience. From these studies it is clear that experts' superior software is the main discriminator for expert perception. Logically, since no previous literature has demonstrated a hardware advantage for expert performers, only the ice hockey referees' software characteristics were examined for the present study.

In theory, if the above perceptual advantages were genuine software characteristics, it would be possible to train these characteristics in athletes. As evidence of this, Starkes and Lindley (1994) examined decision-making in basketball players to ascertain whether decision-making skills could be taught through watching simulations. Participants were divided into two groups: Video training or no training. A pre-intervention perceptual task determined that there were no group differences for decision speed or accuracy. Subsequently, the video training group received six 30-minute training sessions while the control group received no training. Participants were then required to watch a live presentation that tested their decision-making skills. Individuals who received the video training witnessed larger improvements in the quality and speed of their decisions than the control participants, thereby suggesting that perceptual skills could be trained. Abernethy, Wood, and Parks (1999) further demonstrated this point. The authors examined athletes who had no experience in racquet sports. Participants were divided into three groups: A perceptual training group who received perceptual and motor training, a placebo group who received fake perceptual training and real motor training, and a motor group who received only motor training. Following the interventions, participants watched a squash player on video and predicted the landing position of a squash shot. It was revealed that the perceptual training group significantly outperformed the placebo and motor groups. This led the authors to conclude that the increased perceptual skills evidenced in expert performers were due to perceptual skills training. These two studies indicated that perceptual skills can, in fact, be trained, and are likely a constituent software characteristic.

The final aspect of athletic expertise pertinent to the proposed research is the literature regarding expert perception captured while using eye-tracking devices, as the

present study used such a device. Eye-tracking devices enable researchers to identify precisely where individuals focus their attention, the duration of eye fixations, and visual search patterns. This literature provides an understanding of the way in which experts may use different cues or alternate visual search patterns than novices to perform perceptual tasks. Those most influential to the current study's theoretical and methodological frameworks shall be the focus of this next section.

To begin, Shank and Haywood (1987) required expert and novice baseball batters to wear an eye-tracking device, watch a videotape of several pitches, and decide the pitch type. From analyzing the eye movements, the authors indicated that experts, who were more accurate in their decisions than novices, focused on the pitcher's release point and had longer eye fixations (implied as focused attention on a particular point on the display) with fewer eye movements. The authors proposed that this viewing pattern was a necessity for expert decision-making. Goulet, Bard, and Fleury (1989) studied eye movements and decision-making in tennis players. The experimental task required expert and novice tennis players to view tennis serves on film and predict the type and location of the serve while wearing an eye-tracking device. Similar to Shank and Haywood, Goulet and colleagues noted that experts made more accurate decisions than novices, had longer eye fixations with fewer eye movements, and focused on the tennis server's shoulder, head, trunk, and racquet more than novice players.

To advance eye-tracking methods, Williams and colleagues (1994) used a wide-angled camera lens to capture the entire field of play and projected the video clips onto a 3-metre by 3-metre life-sized projection screen. Experienced and inexperienced soccer players wore eye-tracking devices, watched soccer sequences, and decided where the final

pass destination would be. The authors discovered that experienced players had quicker reaction times and more frequent fixations with shorter durations. Remaining in team sports, Martell and Vickers (2004) had ice hockey players perform in live, on-ice situations while wearing a helmet camera that tracked eye movements. Participants watched a play develop in front of them and had to physically react to the play. Results indicated that elite players had shorter fixation and tracking durations when they made correct decisions as opposed to incorrect decisions.

The results from these four studies are quite interesting. Shank and Haywood (1987) and Goulet and colleagues (1989) noted similar results whereby experts had longer fixations with fewer eye movements. In contrast, Williams and colleagues (1994) and Martell and Vickers (2004) concluded that experts had shorter, more frequent fixations. This difference may be attributed to the different experimental tasks. The former two studies had only one actor in the environment to which the experts had to direct their attention, whereas the latter two studies had multiple actors. It is possible that elite ice hockey officials follow the latter perceptual pattern, as they are required to focus their attention on multiple individuals as well as the puck.

It is important to note that during the past 20 years, the methodologies used to test expert perceptions have become increasingly ecologically valid. This is likely a result of one tenet of the expert performance approach, which was proposed by Ericsson and Smith (1991). Ericsson and Smith proposed that expert performance should, ideally, be captured during actual competition. When this is not possible, an in-situ task (realistically reproducing the task in a laboratory setting) can be substituted, but precautions must be made to make the task seem as real as possible (e.g., viewing situations on life-sized screen).

This tenet of the expert performance approach is important, as in the present study both a live method and an in-situ method were implemented. Further details are provided in the method section.

Expert Sport Officials

In comparison to the literature presented on perceptual skills of athletes, the literature on the perceptual skills of expert sport officials is rather scarce. Much of the existing literature in this field has focused on sport monitors (e.g., Bard et al., 1980; Damisch et al., 2006; Plessner, 1999; Ste-Marie, 1999), who are arguably distinctly different from sport interactors (MacMahon & Plessner, 2007). Given the context of this research, only those studies examining the perceptual skills of interactive officials are discussed herein.

Oudejans and colleagues (2000) examined the perceptual skills of professional assistant soccer referees using videotape analysis. Interestingly, the authors discovered that assistant referees erred in offside situations 40 out of 200 times. Upon further analysis, it appeared that referees' position in relation to the offside line was vital to correctly perceiving an offside situation. Specifically, when assistant referees were positioned too far ahead of the last defender, the optical image projected on their retinas was not a true depiction of the actual situation. Thus, it was suggested that assistant referees ought to be positioned in line with—not ahead of—the last defender on the pitch. A second study of professional assistant soccer referees' perceptions (Oudejans et al., 2005) was also conducted, again using videotape analysis. In this study, assistant referees erred in offside situations only 6% of the time. However, the authors discovered that when assistant referees were running while making decisions, their error rate increased compared to when they were stationary or walking. These studies are interesting when applied to the sport of ice hockey

considering that ice hockey referees are often not in line with the players they are attending to and are frequently moving at high speeds while making decisions. Perhaps ice hockey referees use other visual information in order to overcome these challenges.

MacMahon, Starkes, and Deakin (2007) conducted a study that examined the decision-making skills of elite basketball referees. Using video simulation comprised of two sets of basketball clips, 44 participants were asked to determine if a foul occurred, and if so, what foul had occurred. Prior to the task, participants were divided into two groups: A knowledge primed group who took a knowledge and signal test prior to the task and an infraction primed group who were told to watch for a specific type of foul. From the results it was indicated that there were no significant differences on foul detection between the two groups (meaning priming did not affect results). However, the authors did suggest that overall performance was affected by which video clip referees watched. Specifically, when referees had more information to attend to and infractions were not in the foreground of the video clips, referees were less accurate in foul detection. Thus, it appeared that the amount of information that one had to attend to dictated referee performance.

Contextual influences and their relationship to sport officials' perceptual skills have also been researched. Unkelbach and Memmert (2008) analyzed the decisions of soccer referees by having them watch video simulations of soccer plays. One group of referees watched soccer plays in chronological order (in context) while the second group watched soccer plays in random order (out of context). Referees in the random condition awarded significantly more yellow cards (given to players committing overly aggressive fouls) than did those in the chronological condition. The authors suggested that because in-context referees awarded less yellow cards, game context (or game management) was a vital part for

the decisions that referees made. Particularly, referees used context to calibrate their decision-making regarding what was worthy of a yellow card.

Continuing with context influences, MacMahon and Starkes (2008) studied baseball umpires, baseball players, and control participants on ball-strike decisions. The authors posited that because calling balls and strikes often exceeds human processing limits (due to pitch speed), participants would be more likely to use contextual cues to assist in making their calls. Two such contextual cues were pitch sequence (seeing an obvious ball or strike on the previous pitch) and pitch count (3 balls 0 strikes, 3 balls 2 strikes, 0 balls 0 strikes, and 0 balls 2 strikes). In general, umpires and players were more accurate than their inexperienced counterparts. Furthermore, when viewing borderline pitches, participants used contextual information to aid their decision-making. Specifically, all participants called more borderline pitches as strikes when they viewed obvious balls on previous pitches and when the pitch count was 3-0 and 3-2. Unfortunately, MacMahon and Starkes' study did not measure the accuracy of the decisions for borderline pitches; thus, it cannot be concluded that contextual factors assisted or distracted participants from making correct decisions. Rather, umpires should simply be conscious of contextual factors that may influence their decisions.

While these studies clearly assist with understanding how sport officials make decisions, it is evident that a crucial aspect of perception has been continually overlooked. None of the aforementioned researchers have investigated the actual visual attention cues that sport officials perceive and attend to while making their decisions. Using the basketball referee study as an example (MacMahon et al., 2007), do basketball referees look at players' torsos or extremities when determining fouls? In baseball (MacMahon & Starkes, 2008), do

umpires watch the ball at the pitcher's release point or when it hits the catcher's mitt?

Moreover, none of the previous experiments have compared expert sport officials versus non-expert officials. These research questions must be addressed to gain a more comprehensive understanding of sport officials' perceptual skills.

The Project

Considering the dearth of research aimed at identifying the perceptual skills of sport officials, it seemed fitting that this research examined such characteristics. To summarize from the introduction, this line of inquiry would assist league executives in selecting the best officials for the most important games, would help referee development, and would provide sport scientists a better understanding of perceptual skills in sport officials.

Thus, the purpose of the current study was to understand the visual attention behaviors and visual search patterns that informed ice hockey referees' decision-making, as well as to identify any differences between elite, intermediate, and novice participants. The specific questions were as follows:

- 1) Are there identifiable differences in visual behaviors during a live scenario amongst elite, intermediate, and novice ice hockey referees?
- 2) Can third party analysis lead to a better understanding of ice hockey referees' visual behaviors?
- 3) Do elite, intermediate, and novice ice hockey referees differ in visual search patterns or decision-making accuracy during a laboratory experiment?

The way in which these groups were created, tested, and analyzed is discussed in the following section.

Chapter Three

Method

Researcher's Experience

For qualitative studies of elite populations, it is imperative that the researcher has a good understanding of the targeted population. Thus, my experience in ice hockey, and in particular, refereeing, is an important aspect of this research.

In my youth, I played intermediate ice hockey for 13 years. More importantly, I have refereed ice hockey for the past 17 years. I am a Level Four Hockey Canada referee, and have officiated Major Junior, Tier I and II Junior A, and Midget AAA ice hockey. I have also officiated multiple provincial championships in Ontario. This experience was beneficial to this investigation for several reasons. First, my experience and background in refereeing provided me with a declarative and procedural knowledge base that assisted me in understanding more about the participants. Second, the ice hockey world is known as a rather closed circle of individuals. In order to gain access to those in ice hockey, a background in ice hockey is an unwritten prerequisite. Finally, through my experiences as a referee, I have made contacts with CCHL and ODMHA referees, which were invaluable during the recruiting phase of the project.

Participants

The participant group was comprised of 56 referees, including 18 elite (CCHL), 20 intermediate (ODMHA), and 18 novice referees (ODMHA). In order to manage the numerous referees, delimitations were placed on each group. The delimitations ensured that the referee groups were distinctly different from each other. Moreover, the delimitations verified that the researcher-designated classifications matched the referees' skill levels.

The 18 elite referees were officials in the CCHL during the 2010-2011 season. Players from this league (aged 15-21) often advance to the Canadian Hockey League (the most competitive amateur hockey league in the world) or the NCAA to continue their ice hockey careers. Some graduates of the CCHL were drafted into the National Hockey League (NHL). All 18 elite referees had officiated Junior A ice hockey for at least 5 years, and had refereed the CCHL for a minimum of one full season (approximately 30 games).

The 20 intermediate ODMHA referees were those who regularly officiated Bantam competitive ice hockey (players aged 13 and 14 years). Intermediate referees had officiated minor ice hockey for at least 4 years, had officiated Bantam competitive ice hockey for at least 2 years, and had never refereed Junior A, B, or C ice hockey.

The 18 novice ODMHA referees were in their first or second year of officiating. These referees officiated younger children at lower competitive standards (i.e., Novice (7-8 years) and Atom (9-10 years) ice hockey) and had never refereed Bantam competitive ice hockey. By selecting CCHL and ODMHA referees, the participant groups remained distinctly different.

Another important distinction at this juncture is that the participants were referees—not linesman. In ice hockey, referees and linesmen are both on the ice during play. However, the referee physically covers more of the ice surface, attends to more cues (penalties, goals, and other infractions), and has a higher amount of interaction with the players than do the linesmen. Meanwhile, the primary role of linesmen is to monitor offsides and icings. Clearly referees are interactors, but linesmen may very well be considered monitors. Thus, it was decided that referees were more suitable participants for this study. The implication of this was that there was less ambiguity with the referee

classifications (interactors versus monitors) and likely more within-group consistency regarding decision-making responses.

Recruiting

Not surprisingly, the most difficult phase of the research was recruiting participants. The original intent of this research was to recruit NHL referees. After several contacts with the Director of Officials for the NHL, I was informed that the NHL would not endorse this project at the current time. Thus, I focused on recruiting the most accessible, elite participants—CCHL referees.

The recruiting process was two-fold. First, permission was sought from the respective heads of officiating for each league. This included letters, phone calls, and in-person visits. The heads of officiating were provided with details of the project, which included the purpose, the procedure, the time commitment required from the officials, and the benefits of the research. Once permission from the heads of officiating was received in the form of letters of support, the second phase of recruiting commenced. At this point, individual referees were recruited using the researcher's contacts. Again, this included letters, phone calls, and in-person visits. These communications detailed the purpose, procedure, time commitment requirement, and benefits of the project. The benefit to the individual referees was in the form of personal improvement. Results of the study were shared among all the participants and in doing so, each referee had the opportunity to analyze their perceptual strengths and weaknesses and make any changes they saw fit.

Bracketing Interview

When conducting qualitative research, especially in an area that the researcher is quite familiar, it is important to expose the researcher's biases and assumptions prior to

collecting and analyzing data (Grindstaff & Fisher, 2006; Roper, Fisher, & Wrisberg, 2005). Therefore, a bracketing interview was conducted. During bracketing interviews, the researcher answers a number of questions regarding the intended research topic. In doing so, interpretive biases can be exposed to the researchers, who can then make adjustments during data collection and analysis in order to try and minimize bias. For this project, the researcher (the interviewee) and a Human Kinetics professor (the interviewer) from the University of Ottawa, who is familiar with qualitative methods, participated in the bracketing interview. Following the precedent set by both Grindstaff and Fisher, and Roper and colleagues, the following questions were addressed: (a) Reason for the project, (b) benefit of the project, (c) assumptions regarding the main findings, and (d) method to attempt to couch the researcher's biases.

Data Collection

To begin, all participants completed a brief demographic questionnaire that addressed their refereeing experience (see Appendix D). Following, there were three phases of data collection: Visual attention, focus groups, and eye movement recordings. A summary table of the data collection phases is provided at the end of this subsection (see Table 1). The first two steps of the expert performance approach (Ericsson & Smith, 1991) shaped the data collection phases: (1) Capture performance in-situ and (2) determine the mediating mechanisms that account for expert performance. Williams and Ericsson (2005) noted that field-testing (phase one in this project) is the best way to capture performance in-situ. A secondary method is to use video testing in a laboratory (phase three). Williams and Ericsson further explained that to account for expert performance, verbal reports (phase one

and two) and eye-tracking (phase three) are two excellent methods. The details of these data collection phases are described herein.

Phase One: Stimulated Recall for Visual Attention. The first phase examined referees' self-reported visual attention in relation to their decision-making. Visual attention is defined as being able to ignore vast amounts of information in the environment in favor of specific information (Vickers, 2007). Two elite, 2 intermediate, and 2 novice male referees participated in this phase. Participants wore a helmet camera for one game (36 to 60 minutes depending on the level of referee). The helmet cameras attached to the top of the ice hockey helmet and captured video in whichever direction the referee turned his head (visual attention). Using his experience, the researcher then selected the most compelling and beneficial 12-minute segment of the helmet camera videotape to be used for data analysis, based on number of decisions, types of decisions, and possible cues for which there were to attend. The researcher also ensured that these 12-minute segments had similar occurrences across the three skill groups (i.e., a number of face-offs, potential penalties, and goals).

McPherson (1999) studied the perception of expert tennis players by videotaping participants playing one set of tennis, during which time the participants answered one question between each point: What were you thinking during that play? While this would be the most desired method of recall, as it would increase the accuracy of the responses, it would be impossible to have referees answer questions during stoppages of play (a referee's responsibilities do not stop during breaks in the game and delaying the game in order to elicit this type of response would not be favorably viewed by the players and coaches).

Thus, there was a debriefing session for referees that occurred within 48 hours of the game ending and prior to refereeing another game.

To increase the validity of the participants' responses, a stimulated recall interview was implemented. There were two types of recall interviews that could have been used. First, in a stimulated recall interview, a participant views a videotaped segment of the performance and discusses the thought processes that occurred during the performance (Gilbert & Trudel, 1999). This is different from a verbal cueing stimulated recall interview (Wilcox & Trudel, 1998) where the researcher provides the participant with verbal cues about an event which enables stimulated recall by the participant without viewing the videotape. Only after this recall is the videotape shown to validate the participant's recall. It has been argued that the verbal cueing stimulated recall interview is more valid as there is limited visual pre-cueing (Yinger, 1986). However, as the primary goal of the visual attention phase was to have referees self-report their visual attention behaviors, it was necessary that the referees saw their videotapes and described their focus. Specifically, participants watched their individual helmet camera videotapes and were given three questions on a piece of paper to discuss: (a) What visual cues did you attend to? (b) Why did you attend to those cues? and (c) How did that help or hinder your decision-making? The researcher would also probe the participants in order to generate discussion or a deeper understanding of the participants' responses. The experimental task was pilot-tested with one minor ice hockey official (an intermediate) to ensure validity of the task.

Phase Two: Focus Groups. The second data collection phase was to conduct focus groups. The focus groups consisted of 2 elite, 2 intermediate, and 2 novice groups, with the intent to have 4 participants per group (the same participants were not used in phase one and

phase two). Due to limited available participants, however, the elite and novice groups had only 3 participants. Participants watched two 12-minute helmet camera videotapes—one from the elite referee, and one from the intermediate referee—as selected by the researcher. The novice tape was not included, as the desired length of the focus group sessions was 60 to 90 minutes. The helmet camera videotapes were projected onto a screen and the participants were given a sheet of paper with three questions on it: (a) What do you think the referee was visually attending to? (b) Do you think that was or was not beneficial to his decision-making? and (c) Do you think his attention should have been directed elsewhere? If necessary, the researcher would probe the participants in an effort to increase the discussion of interesting events. Furthermore, the researcher provided the focus groups with the score and the time of game so as to ensure that the participants understood the context of the videotaped referees' decisions. This stage of data collection allowed the researcher to examine any visual behavior differences as reported by third-party referee focus groups.

Phase Three: Eye Movement Recordings. The third data collection phase involved conducting an eye movement recording experiment. To monitor eye movements, 10 elite, 10 intermediate, and 10 novice referees (approximately half the participants were used in phase one or phase two) wore an eye-tracking device while watching video clips from various ice hockey games. This procedure was typical of a visual search paradigm whereby eye movements are tracked as participants watch a video while remaining stationary (Vickers, 2007).

The video clips were extracted from hockey games of varying competitive standards (NHL, CCHL, and ODMHA). The goal was to have 20-30 high quality video clips that included a variety of situations (one-on-one play, multiple players, infractions away from

the puck, infraction, and no infraction) and were filmed from cameras at or near ice level. The researcher began with nearly 150 video clips and vetted them with one referee supervisor based on sightlines, clarity, and overall appeal. Next, the researcher and two referee supervisors rated these clips to determine which clips were, or were not, penalties. Ultimately, consensus was formed on 13 ‘penalty’ clips and 13 ‘non-penalty’ clips.

Participants watched the video clips while wearing the eye-tracking device and decided whether an infraction occurred. Decision accuracy, decision type (sensitivity), number of fixations, and average fixation duration were recorded. An eye fixation refers to when gaze is held on an object or location for 100 ms or longer (McPherson & Vickers, 2004). This procedure was pilot-tested on two ice hockey officials (one elite and one intermediate) to ensure validity.

Table 1

Summary of Data Collection Phases

Phase	Collection Type	Purpose	Analysis
1: Self-Reported Visual Attention	Stimulated recall interview	Different visual attention behaviors?	Qualitative – Coding
2: Focus Groups	Group discussion	Different visual attention behaviors as reported by a third party?	Qualitative – Coding
3: Eye Movement Recordings	Eye-tracking device	Different visual search patterns or decision-making abilities?	Quantitative - MANOVA

Data Analysis

Phase One: Stimulated Recall for Visual Attention. As described in the data collection section, the visual attention phase implemented a helmet camera methodology. However, the resultant videotape was not analyzed, as it proved too difficult to verify where the participants were visually attending. In other words, if the videotape was focused on the

net, it could not be stated with certainty that that was where the referees was visually attending. Possibly, the referee could have been facing that direction, but using peripheral vision to focus elsewhere. Rather than analyze the videotapes, only the stimulated recall interview was examined for themes that differentiated perceptual ability amongst the referee groups. This included statements about what referees were attending to, the rationale for attending or not attending to certain situations, and how visual attention assisted or detracted from decision-making. The stimulated recall interviews were audiotaped, transcribed, and inductively coded. Coding is defined as labeling segments of data with a short name that simultaneously summarize and account for each piece of data (Charmaz, 2006). Charmaz (2006) listed three types of coding that were used herein: Initial, focused, and theoretical. For initial codes, the transcripts were broken down into segments that represent singular thoughts. These codes were referred to as meaning units. Following, focused coding involved finding similar initial codes amongst the participants and segregating these codes into several distinct categories. Finally, theoretical coding was achieved by specifying potential interactions between the focused codes and classifying the data into overarching themes. It is important to note that the entire coding procedure was conducted separately within each referee group so that elite, intermediate, and novice referees were all coded with their peers. Only after this was the data compared across groups to investigate different emergent themes.

Phase Two: Focus Groups. The second analysis examined the responses put forth in the six focus groups. The focus groups sessions were audiotaped, transcribed, and deductively coded to search for themes that differentiated the elite and intermediate helmet camera videotapes. Again, the elite, intermediate, and novice focus groups' data were

analyzed separately. Following, the data was compared across groups to determine if any differences in emergent themes existed.

Credibility. As the first two phases were analyzed qualitatively, the credibility of the data must be established. Creswell (1998) listed eight data verification procedures that assist in establishing credible data: (a) Prolonged engagement/persistent observation, (b) triangulation, (c) peer review, (d) negative case analysis, (e) clarifying researcher bias, (f) member checks, (g) rich description, and (h) external audits. Creswell recommended that of the eight procedures, at least two should be used in a given study. For the current study, the two procedures were clarifying researcher bias (which was described previously) and member checks. While rich description was strived for, the reader should ultimately decide if that criterion was met.

For member checks, each audiotape was transcribed and the written transcription was compared to the audiotape to ensure accuracy of the transcription. After the data was coded, the participants were sent their coded transcriptions to allow them to comment on the interpretations of their responses (member check). These steps increased the overall credibility of the resultant data.

Phase Three: Eye Movement Recordings. Four measures were recorded for each video clip: Decision accuracy, decision type, number of fixations, and average fixation duration. Decision accuracy was if the participant gave the correct answer, meaning if a participant stated “No penalty” in a ‘no penalty’ situation or identified the correct penalty during a ‘penalty’ situation. For decision type, the signal detection model was used (Macmillan & Creelman, 2005) to classify participants’ decisions into four categories. ‘Hits’ were when referees accurately assessed penalties during ‘penalty’ scenarios. ‘Misses’

were decisions in which participants did not call penalties during ‘penalty’ situations. ‘Correct rejections’ were when participants stated “no penalty” during ‘no penalty’ situations. ‘False alarms’ referred to when participants indicated a penalty should have been called when in fact no penalty should have been assessed. The number of fixations referred to the number of times a participant moved their eyes during one clip and fixated on a point for a minimum of 100ms. The average fixation duration was the average length of time participants focused on an area before fixating elsewhere. Using PASW 18.0, one MANOVA was conducted on decision accuracy, number of fixations, and average fixation duration with expertise (elite, intermediate, and novice) being the lone independent variable. A second MANOVA was then conducted on decision type, number of fixations, and average fixation duration, again with expertise being the lone independent variable.

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Part II: Thesis Papers Submitted to Journals

Article One

Visual attention behaviors of elite, intermediate, and novice ice hockey referees:

Self-reports and third-party analysis

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Keywords: Decision-making, visual cues, helmet cameras, stimulated recall interviews, sport officials

Abstract

In sport officials' research, there is a lack of understanding of decision-making and how visual behaviors might impact decisions. We investigated visual behaviors through two studies: Self-reports and third-party analysis. For the self-report study, 2 elite, 2 intermediate, and 2 novice referees wore helmet cameras for one game and subsequently participated in stimulated recall interviews. Coding the data revealed 2 visual behaviors: Selective Attention (referees focused on a particular situation) and Divided Attention (referees purposely moved their attention from one area to another). For the third-party study, focus groups composed of elite, intermediate, or novice referees watched the helmet camera videotapes of an elite and intermediate referee collected in Study 1 and discussed their perspectives on the referees' visual behaviors. Results focus on the differences in Selective and Divided Attention noted between the two videotapes, such as the elite referee's ability to keep the majority of players in his sightlines better than the intermediate referee. In the discussion, we compare the studies and offer suggestions for future research.

Literature Review

Sport scientists frequently attempt to understand characteristics that contribute to the expert advantage. Deliberate practice (effortful practice in which the primary goal is skill development), for example is a constituent component for achieving expertise (Ericsson, Krampe, & Tesch-Römer, 1993), and helps to explain how other expert characteristics are attained. These ‘other’ expert characteristics include perceptual abilities such as response accuracy (Jackson & Mogan, 2007), recognition and recall (Garland & Barry, 1991), and the focus of the present study, visual attention (Eccles, Walsh, & Ingledew, 2006). In fact, perceptual abilities, which appear to impact decision-making (Abernethy & Russell, 1987; Jackson & Mogan, 2007; Williams, Davids, Burwitz, & Williams, 1994), have been linked with knowledge bases and heuristics of expert performers (Allard & Burnett, 1985; French, Nevett, Spurgeon, Graham, Rink, & McPherson, 1996; McPherson & MacMahon, 2008; Paull & Glencross, 1997). Researchers have determined that part of the expert advantage is experts’ ability to focus on more relevant cues and to gain essential information through advanced cues and greater knowledge, which ultimately leads to better decision-making (Abernethy, Baker, & Côté, 2005; Abernethy & Zawi, 2007; McPherson & MacMahon, 2008; Savelsbergh, Williams, van der Kamp, & Ward, 2002). Decision-making studies, however, tend to focus on expert athletes, but often overlook another important group of decision-makers, sport officials. One exception was Bard and colleagues (Bard, Fleury, Carrière, & Hallé, 1980) who noted that expert gymnastics judges looked in different locations than non-experts, which may have led to superior error detection. Despite this promising result, further studies on sport officials’ decision-making have been fairly limited to soccer (Catteeuw, Gilis, Jaspers, Wagemans, & Helsen, 2010; Unkelbach & Memmert,

2008), dichotomous decisions (MacMahon & Starkes, 2008), and laboratory settings (Gilis, Helsen, Catteeuw, van Roie, & Wagemans, 2009; Oudejans et al., 2005). Clearly, further investigation is warranted on sport officials and perceptual-cognitive skills.

Two studies outline the importance of a more elaborate examination of sport officials' visual attention behaviors and decision-making. The first one by Helsen and Bultynck (2004) discovered that head soccer referees made, on average, 137 observable decisions per match. As non-observable decisions were also made (e.g., the referee continued play when a foul occurred but there was no advantage to the offending team), it was more likely that head referees made approximately 200 decisions per match, or three to four decisions per minute of playing time. Secondly, as Mascarenhas, Collins, and Mortimer (2005) noted, correct decision-making discriminated between rugby referees ranked in the top 20 in England and referees ranked 21 to 65. Specifically, on a laboratory decision-making task, the top-20 group of referees was significantly more accurate than their lower ranked counterparts. These studies demonstrate not only the volume and significance of decisions made by sport officials, but also that decision-making accuracy is a key to success. It is, therefore, important to understand the factors that contribute to accurate decision-making by sport officials—we investigated this by examining how visual attention behaviors, the ability to focus on specific information while ignoring irrelevant environmental information (Vickers, 2007), informed the decision-making processes (e.g., where to look on the ice to make the best decision) of ice hockey referees.

Research on sport officials' visual attention is beneficial because it will allow us to better understand the complex decision-making sport officials use under temporal constraints. This is important as it would help inform theories of sport expertise beyond

those of athletes and coaches. A noted limitation in previous research is that the paradigms used may not have captured true expertise (e.g., exploring experts' recall using static photographs; Catteuw et al, 2010). The value of the present study was that sport officials' decision-making was examined in a different sport, that of ice hockey, where multiple decisions could be made in an ecologically valid environment—live ice hockey games.

We investigated ice hockey referees of varying expertise. Ice hockey referees are categorized as interactors as they attend to several cues during games, frequently interact with players, and are on the ice surface during play (MacMahon & Plessner, 2007). Ice hockey referees are an interesting population, as they make decisions in one of the fastest team sports, manage a game that has an ever-changing environment with space constraints, and often make physical contact with the puck or the players. Investigating visual attention in ice hockey referees provides insight into which visual cues are used during decision-making in a dynamic sport. This is an important step to understanding the contributions of perceptual-cognitive skills of sport interactors. An expertise framework (i.e., studying the differences between experts and novices; Helsen & Starkes, 1999; Williams et al., 1994), which was used here, has been successful in assisting researchers in such an inquiry. Thus, two studies were conducted to investigate the visual attention behaviors of elite, intermediate, and novice ice hockey referees. For the two studies, we were most interested in behaviors related to 'what' cues referees focused on.

Study 1

The purpose of Study 1 was to obtain a self-report measure of visual attention behaviors that referees used when making on-ice decisions. Ericsson and colleagues (Ericsson, Charness, Feltovich, & Hoffman, 2006) listed several ways to examine expert

performance including observation, psychometrics, laboratory methods, verbalizations, and simulations. As we captured expert performance during live ice hockey games, then recorded participants' verbalizations in the laboratory, we essentially combined the latter three methods, which are explained further in the method section.

Method

Researcher's Experience. For qualitative studies with elite populations, it is imperative that the researcher has a good understanding of the targeted sample. Thus, the principal investigator's experience in ice hockey and refereeing is important. The primary researcher played intermediate ice hockey for 13 years, refereed ice hockey for 17 years, and is a Level Four Hockey Canada referee. He regularly officiates Junior A ice hockey and has officiated multiple provincial championships in Ontario. This was beneficial as the researcher's experience provided him with a declarative and procedural knowledge base that assisted in understanding the participants, discerning when to probe responses, and allowed him to develop rapport with the respondents. Furthermore, through the researcher's experiences as a referee, contacts within the targeted referee populations were in place, which proved to be invaluable during recruiting.

Participants. With a qualitative comparison, it is important to ensure participants' skill levels were distinctly different. An appendix (see Appendix A) has been provided in order to assist the reader with understanding the participant group and their responses. The participant group was 6 male referees, including 2 elite referees from the Canadian Central Hockey League (CCHL), 2 intermediate referees from the Ottawa District Minor Hockey Association (ODMHA), and 2 novice referees from the ODMHA (see Table 1). The elite referees (EL – 1 and EL – 2) had refereed Junior A, B, and C ice hockey (players aged 15 to

21 years) for 8 seasons. The intermediate referees (INT – 1 and INT – 2) had regularly officiated Bantam competitive ice hockey (players aged 13 and 14 years) for at least 4 seasons and had never refereed Junior A, B, or C ice hockey. The novice referees (NV – 1 and NV – 2) were first-year referees and typically officiated children in Novice (players aged 7 and 8 years) ice hockey and had never refereed Bantam competitive ice hockey. First-year referees are typically young (13 and 14 years old), but we intentionally selected older novice referees to minimize age differences. By selecting long-standing CCHL and both upper- and lower-level ODMHA referees, the participant groups remained distinctly different.

Table 1

Demographic Information for Elite, Intermediate, and Novice Referees

Level	Age	Total Years Experience	Experience at Current Level
EL – 1	34	19	8
EL – 2	31	20	8
INT – 1	21	6	4
INT – 2	25	10	8
NV – 1	38	1	1
NV – 2	27	1	1

An important distinction is that participants were referees—not linesman. In ice hockey, referees and linesmen are both on the ice during play. The referee physically covers more of the ice surface, is responsible for more decisions (e.g., penalties and goals), and has more interactions with the players and coaches. Linesmen primarily monitor offsides and

icings. Clearly referees are interactors, but linesmen might be considered monitors (MacMahon & Plessner, 2007). Thus, referees were deemed more suitable for this study.

Bracketing Interview. For qualitative research in an area in which the researcher is quite familiar, it is important to investigate the researcher's biases before data collection. This is doubly important when implementing a constructivist epistemological approach (i.e., gaining a deeper and sophisticated understanding of a particular domain) whereby the principal investigator is a 'passion participant' (Guba & Lincoln, 1994). Thus, a bracketing interview was conducted with the lead researcher and a Human Kinetics professor, who is knowledgeable with qualitative methods, to address: (a) Reasons and benefits of the project, (b) assumptions regarding the findings, and (c) methods to couch the researcher's biases (Grindstaff & Fisher, 2006; Roper, Fisher, & Wrisberg, 2005). The principal investigator's experience in ice hockey and refereeing helped shape the research questions. Specifically, his previous experience led him to believe that visual behaviors were of the utmost importance for elite referees as opposed to referees' physical attributes. Beyond this, the bracketing interview exposed minimal biases and it was assumed that the researcher's experiences would have limited impact on the interpretations of the findings.

Data Collection. Two steps of the expert performance approach (Ericsson & Smith, 1991) shaped the data collection: (1) Capture performance in-situ and (2) determine the mediating mechanisms that account for expertise. Williams and Ericsson (2005) noted that field-testing is the best way to capture performance in-situ, while verbal reports help explain the mechanisms that account for expert performance. To capture performance in-situ, our participants wore helmet cameras (Contour HD Camcorder with a 500mm, 135° wide-angled lens) for one game (36 to 60 minutes depending on the level of referee). The cameras were

centered on the top of the participants' helmets and captured video in whichever direction the referee turned his head¹. Using his experience, the lead researcher selected a continuous 12-minute video segment where key decisions were made. The lead researcher ensured that there were similar plays across all 6 helmet camera videotapes. For example, all videotapes had at least three goals scored, five face offs, and five potential penalty situations. This enabled the lead researcher to generate self-reported information regarding participants visual behaviors.

McPherson (1999) studied expert tennis players' knowledge by videotaping participants, during which time the participants answered one question between points: What were you thinking during that play? This desired recall method increases response accuracy, but it is impossible to have referees answer questions during stoppages of play, as their responsibilities do not stop during game breaks. Furthermore, it was unlikely that permission from the governing bodies would be granted to allow referees to delay the game in order to report visual behaviors. Rather, stimulated recall interviews were conducted within 48 hours of the game ending and before refereeing another game. In stimulated recall interviews, participants view videotaped segments of their performances and discuss their thought processes (Gilbert & Trudel, 1999). Our goal was to have a participant-driven discussion about their self-reported visual attention behaviors. Therefore, participants watched their helmet camera videotapes on a laptop (HP Pavillion ze2000) and were provided with three written questions to discuss during the interviews: (1) What cues were you visually attending to? (2) Why were you attending to those cues? (3) How did that affect your decision-making? In particular, we focused on what cues referees visually attending to and how that informed their decision-making. At any time during the interviews,

¹ Our assumption was that when a participant turned his head, his attention also shifted (Vickers, 2007).

participants could stop or rewind the videotape and see a scenario multiple times.

Furthermore, the researcher would also stop the videotape and probe the participants during interesting events (e.g., participants looking away from the puck). This method was pilot-tested on one minor ice hockey referee (an intermediate referee).

Data Analysis. The content of the stimulated recall interviews was examined for visual behaviors reported amongst participants. The stimulated recall interviews were audiotaped (Sony ICD-P320 Digital Voice Recorder), transcribed, and inductively coded by the principal investigator. Coding involves labeling segments of data with a short name that simultaneously summarizes and accounts for each piece of data (Charmaz, 2006). We used initial, focused, and theoretical codes (Charmaz, 2006). For initial codes, transcripts were broken down into segments that represented singular thoughts known as meaning units. Next, focused coding was the process of finding similar initial codes amongst participants and categorizing these codes into distinct categories. Finally, theoretical coding was the process of classifying the data into overarching themes. Elite, intermediate, and novice referees were all coded with their peers, after which, data was compared across groups to investigate similarities and differences in the emergent themes.

Credibility. Creswell (1998) listed eight data verification procedures that assist in establishing credible qualitative data and suggested that two should be implemented for qualitative research. Two procedures for this study were clarifying researcher bias, which was described previously, and member checks. For member checks, the data were coded and participants were sent their coded transcriptions to allow them to comment on the interpretations of their responses (though no changes were suggested). Other credibility procedures could also be considered. For example, it could be argued that prolonged

engagement was achieved in this study, as the principal investigator has been a referee for 17 years and had a full understanding of the culture of refereeing. Furthermore, rich description was strived for, though the reader ultimately decides if that criterion was met.

Results and Discussion

There were 165 initial code categories and over 700 meaning units derived from the interviews, an amount that is too overwhelming to present in one manuscript. Consequently, we focused on two theoretical codes that integrated well with a review by Memmert (2009), Divided Attention and Selective Attention. These theoretical codes composed 8 focused codes, which directly described the visual cues and behaviors that referees reported using during a game.

Divided Attention. Divided Attention refers to situations in which referees adjusted their vision to attend to more than one aspect of the game, but not necessarily at the same time (i.e., referee might look from the players to the coaches then back to the players). This yielded 4 focused codes: (1) Majority of players, (2) Away from the play/puck, (3) Post-whistle attention, and (4) Face-offs (see Table 2).

Table 2

Focused Codes That Constituted the Divided Attention Theoretical Code

Focused Codes	EL – 1	EL – 2	INT – 1	INT – 2	NV – 1	NV – 2	Total
Majority of players	7	16	3	18	2	6	52
Away from the play/puck	1	2	9	4	4	1	21
Post-whistle attention	3	7	2	4	2	3	21
Face-offs	7	6	0	0	4	2	19
GRAND TOTAL	18	31	14	26	12	12	113

Note. Numbers in each cell indicate individual meaning units for the particular focused code.

The most discussed focused code was when referees attended to the majority of players on the playing surface, as exemplified by the following novice referee quote: “I’m just looking to see where everybody is on the ice. I come from a soccer refereeing background where you’re the only person on the field so you’re constantly just trying to take in everything” (NV – 2). Intermediate and elite referees also focused on the majority of players:

Because the play’s moving up the ice, there’s only two [visiting team] guys that have the puck, all the players are behind the play. So I know there’s nothing really happening where the puck is, so I just want to make sure there’s nothing happening behind the play where the majority of the players are. (INT – 1)

In that situation the puck had gone back to the point, but there was no attacking player going back to the point, so I knew [to put] my attention to the net—where there’s one, two, three, four, five, six, seven players at the net with no puck—so if something’s going to happen in that situation, it’s more likely going to be with the seven players in front of the net rather than the one guy at the blueline shooting the puck all by himself. (EL – 1)

Responses such as these were numerous and indicated that referees reported that they often effectively attended to the majority of players on the ice. Though there is no overt directive from Hockey Canada dictating that referees should focus on the majority of players, it seems that all referees reported using this type of visual attention. Logically, focusing on the majority of the players would increase referees’ probability of witnessing an infraction during a game and it is not surprising that all referees described this visual attention pattern.

For ‘away from the play/puck’, respondents recounted a shift in attention away from the main play, but not toward the majority of players: “I’m just making sure there’s nothing going on behind the play. Making sure there [are] no cross-checks, or trips, or no rough play” (INT – 1); “Sometimes I like to just check...look for kids that are behind and see what they’re doing. Just any players basically just to see what they’re doing” (NV – 1). All referees noted that they used this type of visual behavior and it appeared that the purpose of looking away from the play or the puck was to gain information, when possible. This code occurred less than the majority of the players code, which might indicate that the priority for visual attention is the majority of the players, then referees scan peripheral areas.

The third focused code was post-whistle attention. This was pervasive amongst the referees and referred to how they watched players and coaches between plays, such as:

Well, obviously [I am] scanning the ice to see who’s where...I’m checking with the coaches; try[ing] to communicate with them just to make sure they know when to make the appropriate [line] change there. Watching the players coming on and off the ice too. (INT – 2)

In games with lower intensity, post-whistle attention varied:

In this game there wasn’t a lot of stuff after the whistle that I needed to key in on. So in this type of game it wasn’t necessary for me to be in a position where—after every whistle—I had to be there to use the vocals. I can pretty much just do my job with the line changes after every whistle because the game did not need me to be in there talking to the players, you know, sorting things out. (EL – 1)

All participants discussed post-whistle attention, noting similar visual behaviors.

Essentially, the priority after the whistle was to ensure there were no infractions between the

players. After that, visual attention was directed toward the players coming on and off the ice.

Divided Attention was also discussed during face-offs. Novice referees used visual attention to organize face-offs: “Now I’m just checking the kids—make sure they’re in the right spot” (NV – 1); “...Pointing out to the little kids where they’re going...so I got into the habit of pointing them to the right face-off dot” (NV – 2). Though intermediate referees did not discuss face-offs, elite referees indicated that they attended to face-offs to watch for penalties:

Again when the wingers in the back move in [on the face-off], I’m obviously watching for what the sticks are doing. Especially when it’s two wingers that cause an altercation or the face-off to be nullified. When there’s encroachment, when there’s anything else, if the back wingers are skating in, or if they’re slashing each other, or if they’re shoving each other, I’m paying more attention to them on the second face-off than I would on the first. I’m not worried about the centers at this point. I want to make sure that those two idiots don’t do something else in order to cause an infraction. (EL – 2)

The results from the face-offs focused code suggest that there are visual behavior differences between the referees. At the novice end of the continuum, it appears that referees assume the role of instructor to young ice hockey players and assist them in understanding the rules and their positions on the ice. At the elite end of the continuum, referees attend to players who might try to break the rules during face-offs. It is possible that intermediate referees do not implement this type of visual attention because the players

they officiate already know the rules of the face-offs and the referees have not yet learned to focus on face-off infractions.

Divided Attention encompassed attending to the majority of players, away from the play/puck, post-whistle attention, and face-offs. Referees reported using Divided Attention similarly, with the exception being visual attention on face-offs. In the future, it would be beneficial to explore how or why referees learned to attend to the majority of players and to understand the differences noted between referees during face-offs.

Selective Attention. Selective Attention was when respondents described homing in on a specific scenario on the ice, and in some cases, purposefully disregarding other visual information. Four focused codes constituted Selective Attention: (1) Puck carrier/puck, (2) Body-check, (3) One player, and (4) Penalty calls (see Table 3).

Table 3

Focused Codes that Constituted the Selective Attention Theoretical Code

Focused Codes	EL – 1	EL – 2	INT – 1	INT – 2	NV – 1	NV – 2	Total
Puck carrier/puck	2	3	4	6	8	3	26
Body-check	2	7	12	2	0	0	23
One player	3	3	2	6	0	0	14
Penalty calls	2	7	3	3	1	2	18
GRAND TOTAL	7	13	18	14	8	3	63

Note. Numbers in each cell indicate individual meaning units for the particular focused code.

All referees discussed attending to the puck carrier or the puck: “So again, just watching the puck. Seeing what develops” (NV – 1); “When they’re pretty much scattered all over the ice, I’m paying a little bit more attention to the puck carrier because he looks like he’s going to try and split the [defensemen]” (INT – 1); “The play was up at the

blueline, I did a quick check in front of the net to see if anybody was there. There was nobody there, so I went back to the puck” (EL – 1). From this, it seemed that there were certain scenarios that required referees to use selective attention on the puck carrier or the puck and that this selective attention was consistent across all participants.

Except in novices, who refereed at a level that prohibited body-checking, an integral aspect of Selective Attention was attending to body-checks. Watching body-checks included the hit itself as well as any possible retaliation from the opposing player: “I’m more focusing on the hit that just happened. Just from experience in [refereeing], if somebody gets hit it could make them angry or something, so they could turn around and punch the guy or hit him back” (INT – 1).

When the guy’s pinning the puck against the boards, it looks like he’s looking for what way is he going to go. And then when both defensemen go at him [to body-check him], I’m watching for hands. In this situation they were all shoulder height.

So it was more of a pin up against the boards. (EL – 2)

These quotes demonstrated that referees are watching body-checks and ensuring that no infractions occur during the body-check (i.e., players keep their hands below the shoulders of their opponent) or after the body-check. It is interesting that novice referees did not mention body-checking. Though body-checking is not permitted at younger age divisions, it seems reasonable to expect that novice referees would watch the play to make sure illegal body-checks did not happen. This would be the same concept as an elite referee watching for hooking or tripping in Junior ice hockey—neither incident is permitted, but both frequently occur. Perhaps this awareness develops with experience.

Selective Attention also referred to attending to one player, but was only discussed by intermediate and elite referees. One referee captured what focusing on one player meant:

He's skating up the ice, he's trying to back check, but he's kind of got his stick waving in the air which makes me think that he's going to do something out of the ordinary to the [home team] player. So with him swinging his—he wasn't necessarily swinging his stick—but he had it over his head and you could kind of tell he was going to do something out of the ordinary...that's what drew my attention to him. (INT – 1)

This was commonly stated amongst elite and intermediate referees and was similar to watching body-checks. That is, the elite and intermediate referees focused on situations where players might break the rules. Specific to this quote, the referee noted that a player was carrying his stick high in the air, which is not illegal, but would be an infraction if he contacted another player while holding his stick above his opponent's shoulders. This potential infraction caught the attention of the referee, who then selectively attended to that player. Quotes of this nature indicated that referees reported using visual cues, similar to advanced cues, to help them focus their visual attention.

The final focused code in Selective Attention was penalty calls, which described what referees visually attended to when ruling on penalty infractions. All referees provided examples of penalty calls:

He was cutting to the slot [and] had the angle on the [visiting team] defenseman. The [visiting team] defenseman put his stick down right on his ankle and he went over the skate—over the stick. So I was looking at the [visiting team] player [who]

definitely took away an obvious scoring opportunity on [the play] whether it was by mistake, or on purpose. (NV – 2)

So at that point I'm watching the two of them just take little hacks at each other.

And at that one point the [visiting team] player actually put his stick between the guy's legs and pulled up...it's at that point when I called the slashing penalty. (INT – 2)

Easy enough call. We had right directly in front of me, looking right at it, was the can-opener hook between the legs from the defending team and then the attacking player who's stick was between the legs grabs it and throws it...15, 20 feet. (EL – 1)

Referees described being drawn to situations where potential infractions occurred.

According to their responses, this enabled them to gain more visual information and make appropriate decisions as to whether or not the infractions should be penalized. Novice referees spoke of penalty calls less than intermediate or elite referees, which could also be a function of the type of games that they officiated. The novice referees' helmet camera videotapes were collected during games played by 7 and 8 year olds. Penalties at this age division are far more infrequent than in older age divisions. Thus, it would be premature to conclude that visual attention to penalty calls is attributed to experience.

For Selective Attention, referees stated that they focused their attention on the puck carrier or the puck, a body-check, one player, or penalty calls. The results showed that all referees were similar when watching the puck carrier or puck, but that intermediate and elite referees offered more examples of time spent focusing on body-checks and specific players, while differences in penalty calls might be a function of the game type. It is possible that the differences in Selective Attention might be attributed to experience.

In summary, Study 1 identified several visual behaviors that referees described were important to visual attention and these visual behaviors were classified as Divided Attention and Selective Attention. Though only a few differences in behaviors were noted, it was important to collect further data to examine these types of attention using alternative methods to self-report data.

Study 2

The purpose of Study 2 was to explore visual attention differences between the helmet camera videotapes using another method: Focus groups. Specifically, we had referees of differing expertise evaluate the visual behaviors of an elite and intermediate referee as captured by a helmet camera videotape in Study 1. According to Morgan (1997), the benefit of focus groups is that participants can report on a variety of topics that might otherwise go unnoticed during single interviews. Additionally, focus groups add a “synergy” (Morgan, p. 13) whereby new information might be discovered based on the interactions between focus group members.

Method

Participants. Two elite ($N = 3$ and 3), two intermediate ($N = 4$ and 4), and two novice ($N = 3$ and 3) focus groups were conducted using the same parameters as in Study 1 (e.g., elite male referees from the CCHL; see Table 4). The transcripts of the two focus groups from each expertise level were combined for interpretation.

Data Collection. Participants watched two of the 12-minute helmet camera videotapes (which were similar in nature regarding goals, face offs, and potential infractions) from Study 1—the game refereed by the second elite participant and that refereed by the first intermediate referee. These two participants were chosen because of

their superior videotape quality compared to other participants. Only two videotapes were selected to limit the length of the focus groups to approximately 90 minutes. The focus group participants were given no information about the referees who were being watched, but they were told about the level and score of the game. The videotapes were projected onto a 45" by 70" screen and participants given three written questions to discuss: (1) What do you think the referee was visually attending to? (2) Do you think that was beneficial to his decision-making? (3) Do you think his attention have been directed elsewhere? The goal of this procedure was to create participant-driven discussion about the possible visual behaviors of the videotaped referees. At any time, participants could ask to stop or rewind the videotape and see a scenario multiple times. The researcher would also stop the videotape and probe the participants during interesting events (e.g., referees looking away from the puck) or to stimulate discussion. The focus groups were audiotaped and transcribed identically to Study 1.

Table 4

Demographic Information for Elite, Intermediate, and Novice Focus Groups

Level	Average Age	Average Total Years Experience	Average Years at Current Level
Elite	28.5	14.1	6.1
Intermediate	22.3	7.0	4.6
Novice	30.6	1.3	1.3

Data Analysis. The purpose of Study 2 was to seek further information about the visual attention behaviors reported in Study 1 that might help better describe how ice hockey referees rely on visual information. To do this, the principal investigator deductively coded the transcripts from Study 2 searching for focused codes that would be labeled as Divided or

Selective Attention. Sometimes, the focus groups discussed what the referee was doing, but disagreed with the action performed by the referee. Thus, it was important to distinguish negative and positive comments. Using the focused code of majority of players, a negative comment example is, “He doesn’t keep all the players in view”, while a positive comment example is, “I like that he’s trying to watch all the players on the ice.” Also, during data collection, it became apparent that the focus group participants tended to compare behaviors between the two videotaped referees; therefore, we also needed to set criteria by which we would determine “differences” between the videotaped elite and intermediate referee. When the difference in meaning units between the elite and intermediate referee was at least 5 (for a positive or negative focused code), we assumed it was different and noteworthy to discuss for our study. All focused codes from Study 1 are shown in the Study 2 tables to demonstrate that the codes identified in Study 1 were replicated with no new emergent focused codes for Divided and Selective Attention. Our emphasis for the results concerned the differences that were identified by the focus group members.

Results and Discussion

Divided Attention. Three focused codes delineated the videotaped referees: (a) Majority of players; (b) Away from the player/puck; and (c) Post-whistle attention (see Table 5).

For the theoretical code of Divided Attention, it was immediately apparent that the way in which the videotaped elite and intermediate referees viewed the majority of players was different from each other. All focus groups noted that the elite referee often intentionally kept the majority of players in his visual field. This is exemplified by the following quotes:

I was thinking that he's looking at the front of the net now, as well...he just did like a generic look in the middle and kept an eye on everything. Even though he's looking here, because that's what he probably did, [he took] a very quick glance over here to see if anything's going on and is like, "Okay, do I need to focus over there or should I kind of stay here?" (EL – FG)

He just turned his body...and now he can see too that all the guys from one team, the [visiting] team, are in view so he doesn't really have to—as long as he's got all five guys from one team in view—there's not much else to worry about, right? (INT–FG)

This type of visual attention was also reported by the focus groups for the intermediate referee, but to a much lesser extent. In fact, it was more frequent that the intermediate referee was criticized by the focus groups for allowing situations to occur in which he could not see the majority of the players on the ice:

Well my favorite (said sarcastically) is the views when he's looking up the boards at the puck. He literally is looking up the boards, like he does not have his head remotely turned. So he's probably seeing five players, if that. He's got nothing. I could literally be standing at my bench throwing a water bottle at the other coach and nobody would have a clue. No seriously. (EL – FG)

Well he's not seeing the ice. He's not seeing the players, so...you can't make any calls. In other words I think he's found himself behind the play and he's trying to catch up. So he's lost sight of the game while he's trying to get back into it where he thinks he should be. (NV – FG)

The videotaped elite referee had 15 more positive comments and 12 fewer negative comments from the focus groups, indicating that the majority of players focused code discriminated the elite and intermediate referee according to the descriptions generated the referee focus groups.

For away from the play/puck, the results indicated to our participants that both videotaped referees had a tendency to look away from the play in order to assess potential infractions. One difference was that the intermediate referee did not look away from the play every time it was required. It seemed as if the intermediate referee was still forming this behavior into a habit: “They’re battling right now in the corner and he just went right up [the ice] without thinking about it. They could be dropping the gloves right now” (INT – FG); “Everything away from the puck and where the puck is going. The Hockey Canada term is scanning the ice, which is not there” (EL – FG). Possibly, all referees know that they must look away from the play or puck, but that elite referees are better able to identify and attend to these situations based on increased experience.

Post-whistle attention also appeared to distinguish the videotaped referees. The elite referee, for example, was commended for dividing his attention after whistles:

I think his initial focus was on the immediate scuffle around the net. He’s not really too worried immediately about the benches, he’s just focusing on the guys who are causing grief for him. Gets them quickly and intervenes there, but then you can see his head start looking out towards the blue line and I’m sure he’s looking a little bit toward the benches just to make sure that’s going well, but his initial 5 seconds or so are certainly focused on the guys involved in the scuffle to sort of stop the fire before it really gets started. If it was a more heated game or there was a more serious

Table 5

Divided Attention Codes for the Focus Groups

Focused Codes	Elite – Elite	Elite – Inter.	Inter. – Elite	Inter. – Inter.	Novice – Elite	Novice – Inter.	Total – Elite	Total – Inter.
Majority of players	5	0	9	4	9	4	23	8
Away from the play/puck	3	1	3	7	0	3	6	11
Post-whistle attention	3	0	2	0	0	1	5	1
Face-offs	1	0	1	4	1	0	3	4
Majority of players (negative)	0	8	1	1	0	4	1	13
Away from the play/puck (negative)	1	4	2	0	0	3	3	7
Post-whistle attention (negative)	0	6	1	5	0	2	1	13
Face-offs (negative)	0	0	0	0	0	0	0	0
GRAND TOTAL	13	19	19	21	10	17	42	57

Note. Numbers in each cell indicate meanings units described while participants watched the videotapes. The first part of the column title indicates which focus group is being identified. The second part of the column title refers to which videotape was being watched. Thus, Novice – Elite refers to the novice focus group when watching the elite referee's videotape.

altercation I think you'd see them start focusing more quickly towards the blue line towards the benches. (EL – FG)

Oppositely, the intermediate referee was criticized for not looking around the ice after whistles:

Because you see [the players] all still looking back there. So it seemed to be something happening, you know. He's looking at the [penalty] box the whole way. Like when I signal a penalty and I usually still watch the play and make the signal. Like he's running to make his call; instead he should just, like, sit there and wait until it calms down. (NV – FG)

Post-whistle attention, therefore, was a distinguishing factor between the referees, that again, might be attributable to the elite referee's increased referee experience.

Selective Attention. The theoretical code of Selective Attention yielded far fewer meaning units than Divided Attention (22 versus 99 meaning units; see Table 6), which replicates the results from Study 1. Yet the reasons for this are unclear. A possible reason is that referees attend to several cues during game play, thus, dividing attention is a more useful visual strategy. For Selective Attention, we centered on the only distinguishing focused code, attending to the puck carrier or puck.

For attending to the puck carrier or puck, no positive comments were provided by the focus groups in regard to either videotape; yet there were several negative comments about the intermediate referee, all from the elite focus groups: “Just looks like a young referee. Very quick to follow the puck...[he needs to] scan, slow down” (EL – FG); “He definitely follows the puck. Like what's going on on the far side? He follows the puck” (EL – FG). These quotes provide support for the idea that more elite referees believe it is

Table 6

Selective Attention Codes for the Focus Groups

Focused Codes	Elite – Elite	Elite – Inter.	Inter. – Elite	Inter. – Inter.	Novice – Elite	Novice – Inter.	Total – Elite	Total – Inter.
Puck carrier/puck	0	0	0	0	0	0	0	0
Body-check	2	1	0	0	0	1	2	2
One player	0	0	1	0	0	0	1	0
Penalty calls	2	0	3	0	1	3	6	3
Puck carrier/puck (negative)	0	5	0	0	0	0	0	5
Body-check (negative)	0	0	0	1	0	1	0	2
One player (negative)	0	0	0	0	0	0	0	0
Penalty calls (negative)	0	0	0	0	0	1	0	1
GRAND TOTAL	4	6	4	1	1	6	9	13

Note. Numbers in each cell indicate meanings units described while participants watched the videotapes. The first part of the column title indicates which focus group is being identified. The second part of the column title refers to which videotape was being watched. Thus, Novice – Elite refers to the novice focus group when watching the elite referee’s videotape.

important to adapt visual attention strategies to disregard the puck in more situations than less elite referees. It appears that elite referees believe it is preferable to focus on the majority of players, as opposed to attending to the puck.

General Discussion

From the results of these two studies, it was evident that referees of all expertise levels used Divided and Selective Attention, but that the way in which they were used might differ. Beginning with the focused codes that composed Divided Attention, differences were noted across the results of Study 1 and Study 2. In Study 1, all referees believed it was important to focus on the majority of players, at times they focused away from the play or the puck, and they all implemented post-whistle attention. The results of Study 2, however, indicated that there were knowledge differences evidenced on the commentaries of the focus groups relating to the attention behaviors between the videotaped elite and intermediate referee. Specifically, the focus groups suggested that the elite referee was superior to the intermediate referee at keeping the majority of players in his sightline, knowing when to focus away from the play or puck, and being more attentive after whistles. Results such as these might be indicative of the elite referee's ability to attend to and process visual information more efficiently than the intermediate referee.

These findings parallel some hypotheses that sport scientists use to describe visual attention advantages in athletes (e.g., Abernethy & Russell, 1987; Helsen & Starkes, 1999). Furthermore, this might be evidence of an advanced heuristic or knowledge base used by the elite referee that enabled him to attend to different types of information than the intermediate referee. Research on athletes has often shown that elite athletes use heuristics and knowledge, typically gained through experience, in order to reduce visual search time

and generate appropriate responses more efficiently than novice athletes (e.g., Bard, Fleury, & Goulet, 1994; McPherson & MacMahon, 2008; McPherson & Thomas, 1989). Heuristics and knowledge bases have also been prevalent in sport officials, for example, handball referees (Souchon, Cabagno, Traclet, Trouilloud, & Maio, 2009). Integrating our findings even further with the literature on heuristics and knowledge bases (Anderson, 1987; French et al., 1996), it is possible that all of our participants knew to use certain types of visual attention based on declarative knowledge, but that elite referees were able to implement specific visual behaviors more consistently due to an enhanced procedural knowledge base.

Though results of the Selective Attention theoretical code yielded fewer meaning units, some insights can still be made. One noteworthy result was that in both studies, Selective Attention was infrequently discussed compared to Divided Attention. One possible explanation for this integrates well with previous research by Williams and colleagues (1994). Those authors noted that inexperienced soccer players tended to focus on the central areas of the game play, while experienced players visually searched the peripheral areas. It is possible that, for our results, the experience of the referees as ice hockey players (all but one participant had at least 7 years of playing experience) might have afforded them the knowledge to scan peripheral areas (Divided Attention), while limiting the time that they stabilized their attention on central areas. Thus, experience as ice hockey players might be important for ice hockey referees, at least as it pertains to increasing one's knowledge of visual attention behaviors.

Clearly there are some differences between the visual attention behaviors of elite, intermediate, and novice ice hockey referees. Many of these differences were identified by the focus group participants, which suggest that the successful execution, or 'how-to'

(procedural knowledge) of visual attention behaviors could be a primary difference for elite ice hockey referees. The key for future research is to utilize methods that get a better understanding of these differences. One excellent method would be to continue to have referees wear helmet cameras during games, but add simultaneous verbal reports (e.g., McPherson, 1999) or think aloud via wireless microphones during games. Possibly, this could be coupled with an immediate think-aloud protocol after the game to maximize participant responses. This would be an excellent method to get a better understanding of the cues to which referees attend.

Another possibility for future research would be to compare novice videotapes to a more expert group such as National Hockey League (NHL) referees. Though we attempted to recruit this participant group for the present study, they were unwilling to participate at this time. However, the inclusion of NHL referees would assist in identifying additional differences that contribute to the expert advantage.

Conclusion

Our first study indicated that referees used Divided and Selective Attention in similar ways, though elite referees reported attention shifting more often on face-offs more than intermediate and novice referees, and elite and intermediate referees stabilized their attention on body-checks and one player scenarios more frequently than novice referees. By implementing focus groups in the second study, we were able to identify differences between a videotaped elite and intermediate referee when observing individual helmet camera videotapes. Mostly, the focus groups believed that the videotaped referees used Divided Attention in order to attend to visual cues in the environment, though sometimes they implemented Selective Attention. Part of the advantage for the videotaped elite referee

was his ability to keep the majority of the players in their sightlines, knowing when to focus away from the puck or the play, and being more attentive after whistles. Future research ought to continue to explore methods by which these advantages can be further explained.

Appendix A

To better understand this paper, it is helpful to know the structure of international and Canadian ice hockey leagues and the role of the referee within these leagues.

Working from a top-down approach, the National Hockey League (NHL) is the highest professional ice hockey league. Below professional leagues are amateur ice hockey leagues, the most elite of which is the Canadian Hockey League (CHL). Players in this league are aged 15-20 years and are developing their skills in order to play professional ice hockey. Most players drafted into the NHL come from the CHL (www.hockeydb.com). In Canada, the level below this elite amateur league is Tier II Junior ice hockey and comprises Junior A, B, and C leagues. One of the 10 Junior A leagues in Canada is the Central Canada Hockey League, from which we drew our elite participants. Junior A players are aged 15-20 years, and younger players may still progress to the CHL, while older players typically progress to university ice hockey. Below Junior ice hockey is a development system known as minor ice hockey. One of 13 minor ice hockey branches in Canada is the Ottawa District Minor Hockey Association, from which we drew our intermediate and novice participants. In minor ice hockey, there are age divisions for players aged 5 to 19 years and within each age division, there are various competitive levels, the most elite being AAA and the least competitive being House League. Our intermediate referees regularly refereed Bantam competitive ice hockey while our novice referees regularly refereed Novice and Atom non-competitive ice hockey.

The role of an ice hockey referee is vast and includes many aspects that go unnoticed by the average spectator. Before the game, referees check the gamesheet to guarantee all players are accurately recorded, check the ice surface to ensure safety, and check the players

to make certain they are wearing proper protective equipment. During game play, referees monitor potential rule infractions and goals. During stoppages in play, referees continue to monitor potential rule infractions and communicate with coaches to indicate when they can complete line changes (switching players that are on the ice with players that are on the bench). After the game is over, referees attend to the players as they leave the ice, ensure the validity of the gamesheet (e.g., that the penalties and goals were accurately recorded), and complete a report if any players were ejected from the game (www.hockeycanada.ca). In sum, the role of an ice hockey referee is extensive and occurs before, during, and after the game.

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Article Two

Using self-reports and focus groups to understand the antecedents of visual attention behaviors of elite, intermediate, and novice ice hockey referees

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Keywords: Decision-making, visual cues, helmet cameras, stimulated recall interviews, sport officials

Abstract

Limited research exists that describes sport officials visual behaviors in-situ and how those perceptual skills might integrate with perception in athletes. Across 2 studies, we explored the antecedents of visual behaviors of ice hockey referees. For Study 1, 2 elite, 2 intermediate, and 2 novice ice hockey referees wore helmet cameras for one ice hockey game and participated in stimulated recall interviews. The resultant theoretical codes were Spatial Location and Influences on Visual Attention. In Study 2, elite, intermediate, and novice ice hockey referees formed separate focus groups and watched one elite and one intermediate helmet camera videotape from Study 1. For the results, we outlined differences that were noted by the focus groups between the two videotapes, such as the elite referee's superior positioning, which assisted visual attention. In the discussion we compare the results of the two studies and provide suggestions for future researchers.

Literature Review

Expert performers have consistent, superior performance over an extended period of time (Janelle & Hillman, 2003) and are studied in many domains including medicine (Ericsson, 2004; Verkoeyjn, Rikers, Schmidt, van de Wiel, & Kooman, 2004), computer science (Barfield, 1997; Rist, 1991), music (Colley, Banton, & Down, 1992; Ericsson, Krampe, & Tesch-Römer; 1993), and the focus of the present study, sport (Starkes & Ericsson, 2003; Williams, 2000). Hodges, Starkes, and MacMahon (2006) noted that studying sport expertise is unique as it often involves perpetual movement, time constraints, and athletes with varying capabilities or roles. Thus, athletic and human performance is constantly challenged, making it easy to apply and adapt expert theories in the sport domain (Ericsson, Charness, Feltovich, & Hoffman, 2006; Williams & Ericsson, 2005).

Sport scientists tend to focus their efforts on three types of sport participants: Athletes, coaches, and sport officials. A shared characteristic amongst these sport participants is that all require excellent decision-making skills in order to succeed. For sport officials, decision-making might be particularly salient, as their decisions can significantly impact the result of a competition, especially considering the number of decisions sport officials make during a competition (Helsen & Bultynck, 2004). Thus, it is vital to understand how sport officials make decisions.

One prominent characteristic of expert athletes is superior visual attention, which is the ability to focus on specific information while ignoring irrelevant information in the environment (Vickers, 2007). Previous researchers have demonstrated that the quality of athletes' decision-making often depends on the visual cues to which one attends (Bard, Fleury, & Goulet, 1994; Helsen & Starkes, 1999; McPherson & Vickers, 2004; Müller et al.,

2009). Logically, this would be applicable for sport officials as well. Research ought to be conducted to understand how sport officials' visual attention might impact decision-making under temporal constraints and to examine how findings integrate with extant athlete literature. For example, athletes' visual attention has been frequently studied with consistent results: Experts are superior to novices at anticipation, recall, recognition, and decision-making (see Williams, 2000 for a review).

To explain experts' superior visual attention and decision-making abilities, sport scientists often rely on theories of declarative and procedural knowledge. Declarative knowledge refers to understand facts or rules, while procedural knowledge refers to the 'how-to' or execution of a skill (Anderson, 1987; French, Nevett, Spurgeon, Graham, Rink, & McPherson, 1996). Importantly, these knowledge bases are hypothesized to grow and expand with experience and deliberate practice (effortful practice of which the primary goal is to improve performance (Ericsson et al., 1993). Thus, it is believed that experts' superior perceptual abilities are a result of increased amounts of deliberate practice.

One limitation of visual attention research, however, is that previous researchers have used paradigms that may not capture true expertise (e.g., watching videos in a laboratory setting; Catteuw, Gilis, Wagemans, & Helsen, 2010). New studies should be more rigorous and include new sports, examine decisions that have multiple potential responses, and increase ecological validity. Abernethy, Thomas, and Thomas (1994), for example, suggested that poor ecological validity (i.e., laboratory settings) would hinder referee research and limit possible results. To rectify this, Ste-Marie (2003) suggested the use of head-mounted cameras in order to study referees. As such, we used helmet cameras to investigate visual behaviors of ice hockey referees during live games, as described

through self-reports and focus groups. Ice hockey referees are a unique sample, as they are decision makers in one of the fastest team sports, they navigate through a dynamic environment, and often contact the puck or the players.

This is the second part of a previous analysis on sport officials' visual attention. In the first paper we outlined specific types of attention (Divided and Selective) implemented by ice hockey referees. For this paper, we focus specifically on the antecedents of ice hockey referees' visual behaviors—an important part of understanding the perceptual-cognitive skills of all sport officials. For Study 1, we used self-report measures to understand the antecedents of visual behaviors, while in Study 2, we conducted focus groups to try and glean more information regarding visual behaviors. Given its past success for such inquiries (Helsen & Starkes, 1999; Shank & Haywood, 1987; Williams, Davids, Burwitz, & Williams, 1994), an expertise framework was used in the following studies of elite, intermediate, and novice ice hockey referees.

Study 1

The purpose of Study 1 was to identify self-reported antecedents of referees' visual attention. There are several ways to examine expert performance including observation, psychometrics, laboratory methods, verbalizations, and simulations (Ericsson et al., 2006). We captured expert performance during live ice hockey games and recorded participants' verbalizations in the laboratory. This essentially combined the latter three methods, which are explained herein.

Method

Researcher's Experience. The lead researcher had experience in ice hockey and in ice hockey refereeing, which helped for studying this unique sample. He played

intermediate ice hockey for 13 years, refereed for 17 years, and is a Level Four Hockey Canada referee. He has officiated Major Junior, Tier II Junior A, and Midget AAA ice hockey levels and has officiated multiple provincial championships in Ontario. This experience was beneficial for two reasons. First, the researcher's experience and background in refereeing provided him with a declarative and procedural knowledge base that assisted in understanding the participants and discerning when to probe responses while also allowing him to develop good rapport with the respondents. Second, through the researcher's experiences as a referee, contacts within the targeted referee populations were in place, which proved to be invaluable during recruiting.

Participants. We strived to ensure our participant groups were distinctly different; to help the reader understand these differences, an appendix explaining the structure of ice hockey is provided (see Appendix A). Beginning with our lowest level referees, there were 2 male novice referees (NV – 1 and NV – 2), recruited from the Ottawa District Minor Hockey Association (ODMHA), who were in their first year of officiating, and typically officiated children at lower competitive levels (i.e., Novice (7-8 years) and Atom (9-10 years)). A distinctly different group of ODMHA referees were those who had regularly refereed Bantam competitive ice hockey (players aged 13 and 14 years). We recruited 2 male participants at this level, termed intermediates (INT – 1 and INT – 2). Moving to a more elite level were 2 male referees (EL – 1 and EL – 2) from the Canadian Central Hockey League (CCHL), a Junior A ice hockey league in Ontario. The elite referees had refereed Junior A, B, and C ice hockey for 8 seasons, where players were 15 to 21 years old. Novice referees are typically 13 and 14 years old, which could have been a possible confounding variable as the other participants were 21 years or older. To minimize this, we

deliberately selected older novice referees. Through the selection of ODMHA and CCHL referees, we believed the participant groups remained distinctly different.

Table 1

Demographic Variables for Elite, Intermediate, and Novice Referees

Level	Age	Total Years Experience	Referee Years at Current Level
EL – 1	34	19	8
EL – 2	31	20	8
INT – 1	21	6	4
INT – 2	25	10	8
NV – 1	38	1	1
NV – 2	27	1	1

Importantly, participants were referees, not linesmen. This is a noteworthy distinction as referees and linesmen have different roles in ice hockey, similar to the differences between head and assistant soccer referees. In ice hockey, referees have a greater amount of responsibility, as their primary role is to make decisions on penalties, goals, and other infractions as well as to communicate with players and coaches. The primary role of the linesmen, however, is to monitor offsides and icings. According to MacMahon and Plessner's (2007) framework, referees are interactors while linesmen might be monitors. Thus, it was decided that referees were more suitable for this study.

Bracketing Interview. Since the lead researcher had experience with the targeted sample, was using a constructivist approach, and would be considered a 'passionate participants' (Guba & Lincoln, 1994), it was imperative to conduct a bracketing interview before data collection to explore potential researcher bias. The bracketing interview was

conducted with the lead researcher and a Human Kinetics professor who is familiar with qualitative methods to address: (a) Reason for the project, (b) benefit of the project, (c) assumptions regarding the main findings, and (d) method to attempt to couch the researcher's biases (Grindstaff & Fisher, 2006; Roper, Fisher, & Wrisberg, 2005). The lead researcher's experience did generate the research questions, as in his experience, he noted that visual behaviors seemed to be more important to referee expertise than other skills such as physical attributes. Relating to the actual interpretation of the findings, the bracketing interview exposed minimal biases and it was determined that the researcher's experience in refereeing would not significantly impact the interpretation of the interviews.

Data Collection. The expert performance approach (Ericsson & Smith, 1991) guided the data collection, in particular: (1) Capturing performance in-situ and (2) determining the mediating mechanisms that account for expert performance. As suggested by sport scientists (e.g., Williams & Ericsson, 2005), we used field-testing to capture performance in-situ, then incorporated verbal reports to supplement the data. Participants wore helmet cameras (Contour HD Camcorder with a 500mm, 135° wide-angled lens) for one game (36 to 60 minutes depending on the level of referee). The cameras were centered on the top of the participants' helmets and captured video in whichever direction the referee turned his head¹ (visual attention). After each game, the researcher used his experience to select a continuous 12-minute segment that incorporated several key decisions that were similar across the 6 helmet camera videotapes. For example, all videotapes had at least three goals scored, five face offs, and five potential penalty situations.

¹ Our assumption was when a participant turned his head, his attention also shifted (Vickers, 2007). In the interviews, we ensured to probe about peripheral vision.

The best verbalization method would be to have referees answer questions during stoppages of play (e.g., McPherson, 1999). Referees' responsibilities, however, do not stop during stoppages, making this method unrealistic. Thus, stimulated recall interviews were conducted within 48 hours of the game and before refereeing another game. In stimulated recall interviews, participants view videotaped segments of their performances and discuss their thought processes (Gilbert & Trudel, 1999). For our study, participants watched their helmet camera videotapes on a laptop (HP Pavillion ze2000) and were provided a piece of paper with three questions on it to discuss during the interviews: (1) What cues were you visually attending to? (2) Why were you attending to those cues? (3) How did that help or hinder your decision-making? As mentioned, the focus of this paper is on why participants visually attended to certain cues. Participants were informed that they could, at any time, ask to stop or rewind the videotape and see a scenario multiple times. At times, the researcher proactively stopped the videotape and probed the participants during interesting events, such as when participants focused on one particular player. The purpose of this procedure was to allow for a participant driven discussion of the antecedents of their visual behaviors. This method was also pilot-tested on one minor hockey referee (intermediate) in order to ensure validity of the procedure.

Data Analysis. The stimulated recall interviews were examined for themes that outlined the antecedents of visual behaviors amongst participants such as their rationale for attending to a particular situation and how visual behaviors affected decision-making. The audiotaped interviews were transcribed (Sony ICD-P320 Digital Voice Recorder) and coded by the principal investigator. Coding involved labeling segments of data with a short name that summarizes and accounts for each piece of data (Charmaz, 2006). We used Charmaz's

(2006) three codes: Initial, focused, and theoretical. For initial codes, transcripts were broken down into segments, or meaning units, that represented singular thoughts. Focused coding involved finding similar initial codes and categorizing them into distinct categories. Finally, theoretical coding was the process of specifying potential interactions between the focused codes and classifying the data into overarching themes. Coding was conducted separately within each referee group so that referees were coded with their peers. After, data were compared across groups to investigate between-group themes.

Credibility. The credibility of qualitative research must be established. Creswell (1998) listed eight verification procedures that establish credible data and suggested that two should be implemented for any study. The two procedures for the current study were clarifying researcher bias and member checks. Clarifying researcher bias was achieved through the bracketing interview. For the member checks, the transcripts were coded and participants were sent their coded transcriptions to allow them to comment on the interpretation of their responses, but no changes were suggested. Other credibility procedures may have been indirectly implemented as well. It could be argued that prolonged engagement was achieved, as the principal investigator has been a referee for 17 years and had a full understanding of the culture of refereeing. Furthermore, while rich description was certainly strived for, it is left to the reader to decide if that criterion was met.

Results and Discussion

Initial coding yielded an overwhelming 165 initial code categories and over 700 meaning units. To condense and disseminate these results in a manageable way, the results herein focus on two theoretical codes (Spatial Location and Influences on Visual Attention)

and the resultant six focused codes, which establish direct and indirect antecedents of referees’ visual behaviors.

Spatial Location. Spatial Location described the interplay between the referee’s position on the ice, game context, and visual attention. The two focused codes that contributed to Spatial Location were: (1) Positioning and visual behaviors and (2) Contextual positioning and visual behaviors (see Table 2).

Table 2

Focused Codes that Constituted the Spatial Location Theoretical Code

Focused Codes	EL – 1	EL – 2	INT – 1	INT – 2	NV – 1	NV – 2	Total
Positioning and visual behaviors	1	6	10	0	5	7	29
Contextual positioning and visual behaviors	5	8	9	2	3	1	28
GRAND TOTAL	6	14	19	2	8	8	57

Note. Numbers in each cell indicate individual meaning units for the particular focused code.

Positioning and visual behaviors referred to when respondents adjusted their position on the ice in order to obtain better visual angles for watching the play. This was a strategy described by 5 participants, and the nature of this strategy can be noted in the following excerpts:

Here obviously is the scrum and I’m skating behind the play to see who’s coming in from behind the players. Linesmen are in there to break up any altercations, but what’s going on behind them? Line change, defensemen coming in, forwards going out? I can see everybody, watching everybody. (EL – 2)

I just try and get the best look possible. So if I’ve got to skate closer to the play then I will. We’re really not supposed to go behind the net, so in this situation here I

usually probably go to the bottom of the circle because that's where I feel I have the best angle. Just basically, again, the best angle to see what's going on, I think, is the most important thing to do here. (INT – 1)

When the play's behind the net I've been moving to the goal line just to kind of get a better view behind the net because it's hard to see the little players behind the net.

But, mainly working on positioning. So I can be in better positions to make, you know, educated calls. (NV – 2)

It may be initially surprising that novice referees spoke of positioning and visual attention more frequently than elite or intermediate referees. When examining the context of the quotes, however, it became evident that elite referees talked about positioning and related it to anticipating what play might happen (e.g., the quote above), whereas novices discussed positioning as a reaction to a play (e.g., if they could not see a play well, they changed position). This was a distinguishing characteristic amongst participants.

Contextual positioning and visual behaviors were codes that described times when referees discussed their location on the ice and visual behaviors in relation to the context of the game. Though all referees discussed this focused code, novice referees were adamant that their position, and therefore visual behaviors, did not change based on contextual changes within the game: “No, absolutely not [changing positioning or vision on power plays]” (NV – 1); “Um, no. Nothing really changes [on power plays]” (NV – 2). Elite and intermediate referees, however, reported that the context of a game often forced them to alter their positioning, visual behaviors, or both. For example, visual attention was affected by a power play or game situation, as explained by one elite referee:

So, where I'm at right now was because the team's on a powerplay. I've circled behind the players so that I can keep everybody in front of me. So the play is definitely going to go up the ice, so there's no need for me to be in a position where I have to watch behind me because the play is definitely going up the ice—they're on a powerplay. So when on a powerplay I'll circle behind everybody so that everybody's in front of me. So that's what I'm looking at—I'll have hopefully nine players in front of me at that time. So I guess to answer the question: How does that help me? It helps me by keeping everybody in front of me in a situation where I know the play's moving up the ice. (EL – 1)

It would also play into the, where is that game at? Is it a chintzy penalty? Do I need a chintzy penalty at that time? Is it a solid penalty? Is the level of the game coming up and something happens in front of the net that I've got to call it? And sometimes you've just got to eat it, right? You just say, "I didn't see—I didn't see it the way I wanted to see it." (EL – 1)

Again we found results that seemed to indicate that elite and intermediate referees more often used information in a different way and for different reasons than novice referees. Specific to this focused code, more elite referees appeared to consider the context of game situations and adapted their visual attention in order to put themselves in positions to make better decisions. This is in line with other previous sport official research that suggests context is an influencing factor for referees (e.g., MacMahon & Starkes, 2008). This sort of higher-order processing or procedural knowledge might be what enables elite referees to attain higher levels of ice hockey.

Influences on Visual Behaviors. In several situations, referees reported that they altered their vision due to certain in-game changes. Such changes in visual behavior comprised the theoretical codes Influences on Visual Behaviors. For example, referees may have anticipated a goal and stated they would direct their attention to the front of the net. Four focused codes constituted Influences on Visual Behaviors: (1) Anticipation, (2) Learning/experience, (3) Assisting focal attention, and (4) Prioritizing visual behaviors (see Table 3).

Table 3

Focused Codes that Constituted the Influences of Visual Behaviors Theoretical Code

Focused Codes	EL – 1	EL – 2	INT – 1	INT – 2	NV – 1	NV – 2	Total
Anticipation	3	12	5	15	2	2	39
Learning/experience	0	0	4	0	6	2	12
Assisting focal attention	2	6	3	8	0	0	19
Prioritizing visual behaviors	4	3	0	0	0	0	7
GRAND TOTAL	9	21	12	23	8	4	77

Note. Numbers in each cell indicate individual meaning units for the particular focused code.

Anticipation referred to situations in which participants described a change in visual behaviors based on an expected scenario. All participants spoke of anticipation and how it assisted them, as demonstrated by the following quotes: “Here I was just anticipating that [the] white team would get the puck out [of the zone] before they did. So I’m just continuing momentum, but I’m not skating. I’m just gliding” (EL – 2); “And then I noticed the [visiting team player] come out with the [home team player]. So I wanted to keep my eye on him, because I knew they were chirping each other earlier on in the game” (INT – 2).

Just the way he was coming at him and I knew this player—the blue player—had to cut to the net. So just the way he was skating I thought, ‘Okay, there could be some contact here and I’m going to watch it.’ (NV – 2)

Though the number of meaning units varied amongst participants, it was apparent that all referees used anticipation at certain points in the game. It is possible that anticipation is learned through refereeing experience as well as playing and watching ice hockey. If that were the case, differences in anticipation for this study would be minimal. This may seem contradictory to work by Williams and Davids (1995) who stated that experience watching and playing sports did not lead to declarative knowledge advantages for athletes. We, however, believe our participants are somewhat different from Williams and Davids’, as all of our athletes gained athletic experience in ice hockey before becoming referees. Furthermore, following studies have suggested that there is some transfer in perceptual skills when the transferred skills are applied across similar sports (Smeeton, Ward, & Williams, 2004). Certainly playing and refereeing ice hockey would be considered ‘similar sports’, whereby transfer of anticipatory skills might occur.

Learning and experience was another focused code that indirectly impacted visual attention, but it was only reported by novice and intermediate referees. This included instances where referees mentioned aspects of on-ice refereeing experience, refereeing other sports, playing experience, or input from other referees or referee supervisors that had bearing on the rationale of their visual behaviors or was an instrument for visual behaviors.

In the beginning it’s, well it’s not really clear exactly what the best way to do it is [positioning yourself on the ice]. You just have to go and see what works, what you

feel comfortable with. I feel a lot more confident now that I get right close to the net. I feel like I'm in the right spot to make the call. (NV – 1)

If he decides to lay a slash...it's right in front of me and I'm in really good position to make a call. Something goes off in my head like, 'Um, okay, you'd better stay here for a second just to make sure everything is all right.' I think it comes from refereeing soccer and also from playing hockey for so many years...I was a defenseman too...you know the [referee's] got his back turned and 'whack', right in the back of the knee...or give the guy a shot when they're not looking. It sounds bad, but I can say, 'I know what you're thinking, I've been that person before.' (NV – 2)

It's really neat to hear what they [supervisors/other referees] have to say and the kind of help that they give me will help me keep improving on my game as a referee or as a linesman. That's basically it. That's—I guess that's why I look where I do sometimes because that's where I've been told to look from guys [supervisors/other referees] that are helping me out. (INT – 1)

The fact that these forms of learning were not discussed by elite referees might be because elite referees have been refereeing for many more years than less elite officials; therefore, their learning experiences are less tangible, perhaps even forgotten. Regardless, it is evident that less experienced referees make mention of prior learning experiences when reflecting on reasons for their visual behaviors, supporting that they learn in several different ways and that learning ultimately assists their reported visual attention.

Assisting focal attention incorporated situations where referees described visual behaviors that helped them maintain a central focus, yet still watch peripheral areas. Not

surprisingly, this focused code was almost entirely centered on how peripheral vision, which was never reported by novice referees, assisted visual attention. The four intermediate and elite referees spoke of peripheral vision, and the following citations provided good examples of how this assisted focal attention:

Using the periphery you kind of see where the...one [visiting team] player's kind of sitting—he's kind of high on the slot and I know the defensemen are on the blueline. So just by watching the corner [of the rink] and taking a look out of the side of my eye there, I can most definitely see who's where and assess any risk. (INT – 2)

Well see right now, my head's going up, but I've got one, two, three, four, five, six players [in view]. So the other four players are literally on my right-hand side. So I'm looking peripherally at them. Everybody's skating forward. There's nothing going on behind me. So there's no need to turn my head to look. I've got them peripherally on the right-hand side. (EL – 2)

Assisting focal attention differentiated elite and intermediate officials from novice officials. Clearly, at higher levels of ice hockey peripheral vision is important for referees. It is possible use of peripheral vision increases with experience or it might be a necessary requirement with higher levels of ice hockey whereby, at least anecdotally, evidence suggests that more infractions occur away from the main play. Regardless, it demonstrates that more experienced officials believe that broader environmental cues away from focal attention are important to be able to make better decisions.

Finally, prioritizing visual behaviors was when referees discussed using probabilities or other methods to rank their attention, which was an aspect of visual attention discussed only by the elite referees. Elite referees mentioned that at times, they would look at certain

situations because there was a higher situational probability of something happening in those areas of the ice: “I’m typically more concerned with the infraction than the turnover because we have linesmen that cover the turnover” (EL – 1).

At this level of hockey you don’t get a lot of undisciplined players who stand in front of the net by themselves and that are going to do anything with the goalie. They’re at this level because they’re disciplined players. So you’ve got to remember that whenever you’re [refereeing] these guys you do get situations—and we’re taught to watch for these things—where there’s one player in front of the net; but it’s a low percentage of something that’s going to happen in this league. So I try to keep my attention to where there are more players in my sight. (EL –1)

From this result, it appears that elite referees process visual cues and are able to extract and prioritize information better than non-elite referees because of knowledge of probabilities. Previous research, in fact, has noted that experts use probabilities to know where to focus (e.g., baseball batters, Paull & Glencross, 1997; gymnastic judges, Ste-Marie, 1999). This seems like an important ability in ice hockey refereeing as there are 12 players on the ice at one time and the fast pace of the game makes it impossible to attend to every environmental cue. It is also similar to the notion that higher-order thinking and more expansive knowledge bases are constituent components of experts (McPherson, 1999). Essentially, it is possible that elite referees have developed a vast knowledge base that allows them to prioritize visual behaviors based on past experiences, focus on specific and relevant cues, and make better decisions.

The results of Study 1 outlined some key differences in the self-reported visual behaviors of ice hockey referees. For example, elite referees used game contexts, peripheral

vision, and probabilities in order to adapt visual behaviors. In Study 2, the antecedents of visual behaviors will be further investigated by conducting focus groups.

Study 2

For Study 2 we investigated potential visual behavior differences with respect to two participants from Study 1 using another method: Focus groups. Specifically, we showed one elite and one intermediate helmet camera videotape to focus groups composed of elite, intermediate, and novice referees to identify any differences antecedents of visual behaviors that were noticed between the videotaped referees. According to Morgan (1997), the benefit of focus groups is that participants can report on a variety of topics that might otherwise go unnoticed during single interviews. Additionally, focus groups add a “synergy” (Morgan, p. 13) whereby new, and more descriptive, information might be discovered based on the interactions between focus group members.

Method

Participants. Two elite ($N = 3$ and 3), two intermediate ($N = 4$ and 4), and two novice ($N = 3$ and 3) focus groups (none of the participants from Study 1 were used in Study 2) were conducted using the same parameters as in Study 1 (e.g., elite male referees from the CCHL; see Table 4). The focus groups of the same expertise level were combined for interpretation.

Data Collection. Participants watched two helmet camera videotapes collected in Study 1: That of the second elite and first intermediate referee, which were similar in nature regarding goals, face offs, and potential penalties. These two participants were chosen because of their superior videotape quality compared to other participants. Only two videotapes were shown to limit the focus group discussion to approximately 90 minutes and

the focus group participants were given no information about the referees who were being watched. The helmet camera videotapes were projected onto a 45" X 70" screen and participants were provided three written questions to allow for a participant-drive discussion: (1) What do you think the referee was visually attending to? (2) Do you think that was beneficial to his decision-making? (3) Do you think his attention have been directed elsewhere? As in Study 1, the participants or researcher could stop the videotapes at any time. The focus groups were audiotaped and transcribed identically to Study 1.

Table 4

Demographic Information for Elite, Intermediate, and Novice Focus Groups

Level	Average Age	Average Total Years Experience	Average Years at Current Level
Elite	28.5	14.1	6.1
Intermediate	22.3	7.0	4.6
Novice	30.6	1.3	1.3

Data Analysis. For Study 2, we wanted to elicit third-party knowledge of referees' vision as it pertained to the antecedents of visual behaviors—specifically Spatial Location and Influences of Visual Behaviors—which would complement the results of Study 1. As such, we deductively coded the transcripts from Study 2 searching for focused codes already discovered in Study 1. At times, the focus groups disagreed with the action performed by the referee and it became necessary to separate negative and positive comments. Using the focused code of post-whistle attention, a negative comment example is, "He's not watching the players going to the benches", while a positive comment example is, "He's got an eye on the players' bench, the coaches, and the players on the ice." Additionally, it became apparent early in the data analysis that the focus group members were making comparative

judgments of the videotaped referees. Therefore, it was important to set criteria by which we would determine “differences” in the quantities of coded units reported with respect to the videotaped referees. We assumed that when the difference in number of meaning units elicited for the elite and intermediate referee was at least 5 (either the positive or negative comments), it was noteworthy of discussion for our study. Though all focused codes from Study 1 are shown in the Study 2 tables, we comment only on the results where differences were determined.

Results and Discussion

Spatial Location. For the theoretical code of Spatial Location, only the positioning and visual behavior focused code met our criteria for differences (see Table 5). Though the elite and intermediate focus groups noted positioning and visual behavior, it was the novices who truly identified how well-positioned the videotaped elite referee was and how that aided his visual attention:

Well, I think it was definitely a better referee than in the first clip that we saw. He's at the net very quickly. I like his positioning. I like how he's opening himself up—like he's almost mimicking, a little bit, like the four-man system by standing in the corner facing the entire zone as opposed to standing at the hashmarks. So he's just opening up his vision, and, like usually we were able to see almost all 10 skaters when they were on the ice. (NV – FG)

See what he does there? He gets further into the corner and he turns around so he sees, like, he just gets in and turns. So now he sees the whole play and he's got a great view for the goal, which is why he's able to see the [home team] player, you know, just pushing up against the goalie. (NV – FG)

Table 5

Spatial Location Codes for the Focus Groups

Focused Codes	Elite – Elite	Elite – Inter.	Inter. – Elite	Inter. – Inter.	Novice – Elite	Novice – Inter.	Total – Elite	Total – Inter.
Positioning and visual behaviors	2	1	1	0	12	0	15	1
Contextual positioning and visual behaviors	4	0	6	4	1	4	11	8
Positioning and visual behaviors (negative)	0	2	5	4	1	5	6	11
Contextual positioning and visual behaviors (negative)	1	0	0	1	0	1	1	2
GRAND TOTAL	7	3	12	9	14	10	33	22

Note. Numbers in each cell indicate meanings units described while participants watched the videotapes. The first part of the column title indicates which focus group is being identified. The second part of the column title refers to which videotape was being watched. Thus, Novice – Elite refers to the novice focus group when watching the elite referee’s videotape.

Though the elite and intermediate focus groups did not often praise the videotaped elite referee's positioning, they were critical of the videotaped intermediate referee's position:

Maybe it's a positioning thing, the penalty looked like—from where he was he was looking through the net. Not the best position to be in. I would go below [the goal line]. You should be going high though. Like I didn't see the penalty because the net was in the way. (EL – FG)

For me, I would definitely want to move a little bit closer to whatever just happened to see it better. If there'd just been two guys over there and a quick pass here and a quick pass there...you [would be able to] see clearly what's going on. But when you have a whole bunch of players—like, look at that. You're pretty far away. You can see his sight line is blocked by two players right there...like, you can't even see.

(INT – FG)

Regardless of the underpinning mechanisms, it was evident that our focus group members thought more often that the elite referee was frequently in a better position than the intermediate referee, which may have also increased his ability to attend to more relevant cues required for decision-making. Context, on the other hand, was not something that the focus group members reported as being different between the videotaped referees.

Influences on Visual Behaviors. The theoretical code of Influences on Visual Behaviors yielded fewer meaning units than that of Spatial Location (24 compared to 55 meaning units; see Table 6). It appears that how a referee positions himself on the ice to best see potential infractions is a prime antecedent for visual behaviors. Though other influences on referees' visual behaviors were identified, the lone focused code that focus groups members thought differentiated the videotaped referees was learning and experience.

Table 6

Influences on Visual Behaviors Codes for the Focus Groups

Focused Codes	Elite – Elite	Elite – Inter.	Inter. – Elite	Inter. – Inter.	Novice – Elite	Novice – Inter.	Total – Elite	Total – Inter.
Anticipation	1	0	2	1	2	2	5	3
Anticipation (negative)	0	0	0	0	0	0	0	0
Learning/experience	3	0	0	0	2	0	5	0
Learning/experience (negative)	0	1	0	1	0	0	0	2
Assisting focal attention	2	0	0	0	2	0	4	0
Assisting focal attention (negative)	0	2	0	0	0	0	0	2
Prioritizing visual behaviors	1	0	0	0	2	0	3	0
Prioritizing visual behaviors (negative)	0	0	0	0	0	0	0	0
GRAND TOTAL	7	3	2	2	8	2	17	7

Note. Numbers in each cell indicate meanings units described while participants watched the videotapes. The first part of the column title indicates which focus group is being identified. The second part of the column title refers to which videotape was being watched. Thus, Novice – Elite refers to the novice focus group when watching the elite referee’s videotape.

For learning and experience, the focus groups offered several quotes indicating that they thought the elite referee had more experience than the intermediate referee, which enabled him to be more relaxed and maintain better positioning: “Obviously experience. More relaxed. He’s kind of knowing where to look as opposed to trying to look everywhere” (EL – FG); “You can already see a big difference of experience or expertise. He has a different angle to the play. I find also his body is wide open to whatever’s happening—like he gives himself the best possible angle” (NV – FG). It would be helpful to know whether experience included playing experience, refereeing experience, learning from supervisors or other referees, or all of the above. Interestingly, one focus group member indicated that experience was mostly accumulated through refereeing experience: “Yeah, learning as you go type thing. People can tell you, but you kind of have to do it yourself to understand it” (EL – FG). It may be that guidance from supervisors and other referees is required, but ultimately, experience as a referee is something that our participants felt helps to determine the quality of referees—a construct quite similar to deliberate practice (Ericsson et al., 1993).

General Discussion

The results of the two conducted studies revealed that there were several antecedents of referees’ visual attention behaviors, the most significant being Spatial Location. In Study 1, it was evident that most participants described a link between on-ice positioning and enhanced visual attention. For Study 2, however, the focus group members repeatedly noted that the videotaped elite referee was often in a better position than the videotaped intermediate referee. Though the result of being in a better position is obvious (it improves sightlines, visual attention, and ultimately, decision-making ability) reasons for why the elite

referee was in a better position are still unclear. One plausible explanation relates to knowledge bases (Anderson, 1987, Thomas, 1994) and deliberate practice (Ericsson et al., 1993). Previous researchers have offered theories that, at least in sport, expert performers increase perceptual skills by developing refined, sophisticated procedural knowledge bases (French et al., 1996; McPherson, 1994, 2000; McPherson & Thomas, 1989) through years of deliberate practice. Thus, the videotaped elite referee may have accumulated more hours of deliberate practice in refereeing than the intermediate, thereby allowing him to read and predict situations on the ice, and enabling him to adjust his position more quickly than the intermediate referee. Examining deliberate practice hours for referees might be beneficial to address this explanation.

Also notable for Spatial Location was the fact that context influenced positioning and visual attention behaviors. Previous researchers have shown that context can, often negatively, impact decision-making for sport officials (Brand, Schmidt, & Schneeloch, 2006; MacMahon & Starkes, 2008; Plessner & Betsch, 2001; Unkelbach & Memmert, 2010). Our results indicated that monitoring the context of the game benefited referee decision-making. For study 1, elite and intermediate referees discussed how context allowed them to adjust their positioning on the ice and prioritize their visual behaviors, while novice referees were adamant that visual attention and positioning should not change based on context of the game. For study 2, the focus group members noted that the elite referee appeared to adjust his position based on context better than the intermediate referee, though this result did not meet our pre-set criteria for differences. Regardless, it is clear that context can have a positive influence on visual attention, which somewhat contradicts previous research. Perhaps this ambivalence between previous literature and the current

research can be explained by the fact that previous researchers have focused on how context negatively impact decisions, while this research demonstrates that referees described context as being important to visual behaviors. Understanding the link between context, visual behaviors, *and* decision-making would, therefore, be worthwhile.

The theoretical code of Influences on Visual Behaviors yielded two noteworthy results. First, learning and experience appeared to impact visual attention. Study 1 showed that novice referees learned from referee supervisors and other referees in order to improve their refereeing skills. In Study 2, the focus group members identified that the elite referee was clearly more experienced than the intermediate referee, but that learning and experience was primarily driven by “doing”, not by being taught how to do something. It seems that there are multiple methods for learning that were described by our participants. This mixed result integrates well with the concept of declarative and procedural knowledge (French & Thomas, 1987; Thomas, 1994). Novice referees were attempting to learn positioning, rules, communication skills, and other aspects important to refereeing. By being taught these skills, it appears that they were building a declarative knowledge base—that is, they were learning rules and facts of ice hockey refereeing. Learning from experience, however, is more indicative of procedural knowledge, or how to perform certain skills. Congruent with this was that the elite referee in Study 2 was identified as being more experienced and that his skill set was likely acquired through repeatedly refereeing ice hockey games. It seems likely that referees, much like athletes (French et al., 1996; French & Thomas, 1987; McPherson, 1994), progress along a continuum from declarative to procedural knowledge.

The second important discussion point for the code Influences on Visual Behaviors were the results of assisting focal attention. In Study 1, elite and intermediate referees

reported the importance of using peripheral vision, while novice did not make any comments regarding peripheral vision. Though the Study 2 results did not meet our outlined criteria for differences, the pattern mimicked that from Study 1. This result might integrate with previous research by Williams and colleagues (1994). The authors noted that inexperienced soccer players tended to focus on the central areas of the game play, while experienced players visually searched the peripheral areas. This could explain why novice referees had yet to incorporate peripheral vision into their refereeing skill set. Furthermore, as the elite referees had the greatest amount of playing and refereeing experience, it seems likely that they had more situations whereby peripheral vision was an asset to them. Thus, experience as ice hockey players and referees might be important for developing and relying on peripheral vision to assist focal attention.

It is evident that visual attention differences exist between elite, intermediate, and novice ice hockey referees. Future researchers ought to identify means by which to isolate and better understand these differences. Simultaneous verbal reports would be of tremendous value for such an endeavor (e.g., McPherson, 1999). It is impossible to have referees retire to the one side of the rink and make verbal reports into an audiotape; therefore, the alternative is to have referees wear wireless microphones during games and implement a think-aloud protocol, perhaps coupled with an immediate think-aloud protocol following the game. This would be an excellent method to get a better understanding of the cues to which referees attend.

Additionally, it would be valuable to compare novice videotapes to a more expert group such as National Hockey League (NHL) referees. We attempted to recruit this participant group for the present study, but they were unwilling to participate at this time.

The inclusion of NHL referees would assist in identifying additional differences that contribute to the expert advantage.

Conclusion

Our first study indicated that elite and intermediate referees Spatial Location somewhat differently than novice referees, which may have been a by-product of experience. For Influences on Visual Behaviors, all referees were similar on anticipation, but novices had more discussion on learning and experience and did not discuss assisting focus attention. Furthermore, elite referees were the only ones to prioritize visual behaviors. We conducted focus groups for our second study to supplement the results of Study 1. Here, we found that the elite referee had better positioning, which helped visual attention, seemed to have learned through on-ice experience, and was described as being better than the intermediate referee at using peripheral vision. Future research should continue to explore methods by which these advantages can be further explained.

Appendix A

To better understand this paper, it is helpful to know the structure of international and Canadian ice hockey leagues and the role of the referee within these leagues.

Working from a top-down approach, the National Hockey League (NHL) is the highest professional ice hockey league. Below professional leagues are amateur ice hockey leagues, the most elite of which is the Canadian Hockey League (CHL). Players in this league are aged 15-20 years and are developing their skills in order to play professional ice hockey. Most players drafted into the NHL come from the CHL (www.hockeydb.com). In Canada, the level below this elite amateur league is Tier II Junior ice hockey and comprises Junior A, B, and C leagues. One of the 10 Junior A leagues in Canada is the Central Canada Hockey League, from which we drew our elite participants. Junior A players are aged 15-20 years, and younger players may still progress to the CHL, while older players typically progress to university ice hockey. Below Junior ice hockey is a development system known as minor ice hockey. One of 13 minor ice hockey branches in Canada is the Ottawa District Minor Hockey Association, from which we drew our intermediate and novice participants. In minor ice hockey, there are age divisions for players aged 5 to 19 years and within each age division, there are various competitive levels, the most elite being AAA and the least competitive being House League. Our intermediate referees regularly refereed Bantam competitive ice hockey while our novice referees regularly refereed Novice and Atom non-competitive ice hockey.

The role of an ice hockey referee is vast and includes many aspects that go unnoticed by the average spectator. Before the game, referees check the gamesheet to guarantee all players are accurately recorded, check the ice surface to ensure safety, and check the players

to make certain they are wearing proper protective equipment. During game play, referees monitor potential rule infractions and goals. During stoppages in play, referees continue to monitor potential rule infractions and communicate with coaches to indicate when they can complete line changes (switching players that are on the ice with players that are on the bench). After the game is over, referees attend to the players as they leave the ice, ensure the validity of the gamesheet (e.g., that the penalties and goals were accurately recorded), and complete a report if any players were ejected from the game (www.hockeycanada.ca). In sum, the role of an ice hockey referee is extensive and occurs before, during, and after the game.

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Article Three

Eye movement recordings and decision-making accuracy of
elite, intermediate, and novice ice hockey referees

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Keywords: Eye tracking, eye movement recording, decision-making, sport officials, visual cues

Abstract

Visual search patterns are part of the expert advantage for athletes (Mann et al., 2007), but are infrequently examined for sport officials. This is an important aspect to consider for sport officials as visual search patterns are related to decision-making. We examined eye movement recordings and decision-making accuracy of elite ($N = 10$), intermediate ($N = 10$), and novice ($N = 10$) ice hockey referees in a laboratory setting. Participants wore a head-mounted eye movement recorder, watched ice hockey video clips on a computer screen, and made decisions regarding potential infractions. Dependent measures included the number of fixations, decision accuracy, and decision sensitivity. Results of the MANOVA indicated that there were no differences in visual search patterns, accuracy, or sensitivity amongst referees. In the discussion we highlight limitations of laboratory testing and offer alternative explanations for the findings.

Literature Review

The study of expert sport performers has revealed that experts typically do not possess superior innate abilities (Ericsson & Lehmann, 1996); rather, experts invest in large amounts of deliberate practice (effortful activities where the primary purpose is to improve performance), which results in domain-specific ‘software’ characteristics (Ericsson, Krampe, & Tesch-Römer, 1993; Ericsson & Lehmann, 1996; Hodges, Kerr, Starkes, Weir, & Nanandiou, 2004; Starkes, 1987). These perceptual-cognitive skills often delineate experts and non-experts in the athletic domain (Mann, Williams, Ward, & Janelle, 2007; McPherson, 2000; McPherson & French, 1991; Starkes, 1987; Ward & Williams, 2003). A number of perceptual-cognitive skills, such as anticipation, recall, and response time, contribute to the expert advantage in athletics (Abernethy & Russell, 1984; Allard, Deakin, Parker, & Rodgers; 1993; Tenenbaum, 2003). While athletes’ perceptual-cognitive skills have been frequently examined, another important sport participant—sport officials—is often overlooked.

Regardless of one’s chosen sport role (e.g., athlete, coach, or official), decision-making is an integral part of success. Athletes (Farrow & Abernethy, 2002; Paull & Glencross, 1997) and coaches (Abraham, Collins, & Martindale, 2006; Côté, Salmela, Trudel, Baria, & Russell, 1995), for example, use decision-making to try to positively and directly impact the outcome of a competition. Sport officials, on the other hand, make decisions with the intent to maintain a safe and fair competitive environment, while avoiding players and maintaining proper positioning. In fact, the quality of sport officials’ decision-making can discriminate expert and non-expert sport officials, as has been demonstrated in the sport of rugby, for example (Mascarenhas, Collins, & Mortimer, 2005). Here the authors

noted that the top 20 rugby officials in England made significantly more accurate decisions on a laboratory test than their peers who were ranked 21 to 65. Adding to this is the fact that sport officials often make multiple decisions each minute of a competition. Helsen and Bultynck (2004) noted that head soccer referees averaged approximately three to four decisions per minute of play. The sheer frequency of decisions and the fact that decision-making can distinguish expert and non-expert sport officials highlights the importance of examining variables that might impact their decision-making processes. In this research, we explore eye movements and decision-making in ice hockey referees.

Research on perceptual-cognitive skills is extensive and it is beyond the purview of this paper to review all aspects (for a review, see Hodges, Starkes, & MacMahon, 2006). Relevant to this study is literature on gaze behaviors (i.e., both head and eyes are involved in the visual search) and eye movements (i.e., only the eyes are involved and head is stationary; Vickers, 2007). Goulet, Bard, and Fleury (1989) investigated the gaze behavior of tennis players returning a serve and discovered that expert players made faster decisions, had more correct responses, and had a greater number of fixations of shorter duration than novice players. Similarly, Williams and colleagues (Williams, Davids, Burwitz, & Williams, 1994) noted that expert soccer players made faster decisions while making a greater number of fixations of shorter duration away from the ball and outside the penalty area than non-experts. Contradicting these results, Mann and colleagues' (2007) meta-analysis indicated that while expert athletes, compared to non-experts, made faster decisions, they also have fewer fixations, but the fixations were of longer duration (though the former factor only approached statistical significance). These equivocal results might be due to the different sport types included in the aforementioned analyses. Goulet and

colleagues and Williams and colleagues focused on interceptive (i.e., racquet sports) and strategic (i.e., team sports) sports, respectively. Mann and colleagues, however, incorporated interceptive, strategic, and *other* sports, which encompassed sports that were self-paced, had closed-skills, or involved aiming tasks. Eye movement patterns might depend on sport type or the specific decision-making task.

Specific to our studied population, the perceptual-cognitive study of sport officials has recently expanded (Catteeuw, Gilis, Jaspers, Wagemans, & Helsen, 2010; Gilis, Helsen, Catteeuw, van Roie, & Wagemans, 2009; MacMahon & Starkes, 2008; Oudejans et al., 2005; Unkelbach & Memmert, 2008), but to our knowledge, only one study has used an eye movement paradigm. In that research, Bard and colleagues (Bard, Fleury, Carrière, & Hallé, 1980) tracked gymnastics judges' visual search patterns and noted that experts had fewer number of fixations of longer duration and detected more errors than novices, though none of the results were statistically significant. It is evident that further research is warranted to understand sport officials' eye movements and visual search patterns, which may, ultimately, impact decision-making. Furthermore, Bard and colleagues studied eye movements in a closed-skill sport; yet it is evident that different sport types might produce different search strategies. Therefore, it would be beneficial to track eye movement recordings of sport officials in an open-skill sport, such as ice hockey. Ice hockey is a strategic sport and ice hockey referees are considered interactors (MacMahon & Plessner, 2007). Ice hockey referees are an interesting population, as they make decisions in one of the fastest team sports, manage a game that has an ever-changing environment with spatial and temporal constraints, and often make physical contact with the puck or the players.

The purpose of the current study was to investigate the visual search patterns and decision-making abilities of elite, intermediate, and novice ice hockey referees using expert-novice and eye movement paradigms. Guided by previous research (e.g., Bard et al., 1980; Mann et al., 2007), we pursued this by studying the number and duration of fixations when referees watched ice hockey game situations on video and were tasked with making a speeded decision about potential infractions. Following the results of Goulet and colleagues (1989) and Williams and colleagues (1994) who examined interceptive and strategic sports, we hypothesized that elite ice hockey referees would make more accurate decisions and have more fixations of a shorter duration than the intermediate and novice referees, but that intermediate and novice referees would not differ from each other on either measure.

Method

An appendix is provided to assist the reader in understanding the participant groups and the experimentation. This appendix describes the general structure of ice hockey and the responsibilities of referees (see Appendix A).

Participants

The participants were 30 male ice hockey referees, comprising 10 elites¹ ($M_{\text{age}} = 30.6$; $M_{\text{experience}} = 15.5$), 10 intermediates ($M_{\text{age}} = 24.6$; $M_{\text{experience}} = 7.0$), and 10 novices ($M_{\text{age}} = 33.8$; $M_{\text{experience}} = 1.3$). To stay consistent with one of the tenets of an expert-novice paradigm, we ensured that the participant groups were distinctly different. The elite participants refereed Junior A ice hockey for at least one season, and had refereed Junior A or B ice hockey (players aged 15-21) for at least four seasons. The intermediates frequently refereed competitive youth ice hockey (players aged 13-17) and had never refereed Junior

¹ Originally we intended to examine expert, elite, and intermediate ice hockey referees. We recruited in the National Hockey League, but were eventually denied access to their officials. Thus, we chose to examine elite, intermediate and novice referees.

ice hockey. The novices were first or second year referees, and only refereed competitive youth ice hockey players younger than 11 years old. These participant groups represent a typical progression for developing referees.

Importantly, participants were referees, not linesmen. In ice hockey, referees and linesmen are both on the ice during play. The referee physically covers more of the ice surface, makes more decisions (e.g., penalties and goals), and has a higher level of interaction with the players and coaches than do the linesmen. The primary role of linesmen is to monitor offsides and icings. Referees are considered interactors, but linesmen may very well be considered monitors (MacMahon & Plessner, 2007). Thus, it was decided that examining referees and their penalty decisions, which is their primary responsibility, was the most suitable experimental design for this study.

Materials and Task

To examine referees' eye movements, participants watched video clips while sitting approximately 36 inches away from a computer screen. The video clips were displayed on a 30-inch (diagonally measured) Apple® computer screen. The task for the participants was to make decisions concerning whether there was an infraction during the ice hockey play observed. During the task, participants wore an EyeLink II SR Research® eye movement recorder. This eye movement recorder was a head-mounted, binocular, 500Hz device that tracked pupil movements. During each clip, a potential infraction was shown and the clip continued until the potential infraction was resolved. For example, if a player put his stick in between the skates of another player and tried to trip him, the clip would continue show whether the non-offending player lost or maintained his balance. Once that information was

displayed, the screen would go black for 4 seconds while the referee indicated his response. The researcher recorded these responses on a sheet of paper.

Video Clips. The selection of the video clips for the experiment was undertaken using a three-step process. First, the principal investigator extracted 147 video clips from National Hockey League (NHL) game tapes and helmet camera videotapes, previously collected in our research laboratory². These clips represented plays on the ice where infractions should or should not have been called and were representative of situations referees would normally encounter (e.g., potential infractions for hooking, tripping, roughing, and elbowing). For the second step, the lead author (an elite referee) and a referee supervisor (a former elite referee)³ rated each of the clips and assigned them individual scores out of 30 based on sightlines and vantage points, clarity of the situation, and overall appeal, which referred to how likely it was that the situation would occur at any given competitive level in ice hockey. The categories were weighted equally out of 10. The intent of this process was to keep only the most ecologically valid clips—in other words, those that most closely resembled a true game scenario and from the perspective of a referee on the ice. The lead author and referee supervisor added their two ratings together and only the clips with a combined score of 45 out of 60 or higher moved into the third phase of selection. Here, the lead author, the referee supervisor, and an additional referee supervisor (a former elite referee) reviewed the remaining 41 clips as a group and came to consensus on the penalty decision (i.e., was there an infraction, and if so, what was the infraction?) by

² For the NHL videotapes, we ensured that the clips were from an ice-level camera in order to increase the ecological validity of each clip. The helmet camera videotapes were part of a previous analysis on referees' visual attention. In that task, referees wore helmet cameras during game play. Thus, we selected clips that captured the visual angle of what ice hockey referees typically encounter during a game.

³ A referee supervisor attends ice hockey games and evaluates the performance of the referees. Typically, they provide an assessment of fitness, appearance, rule knowledge, rule application, positioning, and communication. Given these responsibilities, it was assumed that referee supervisors would have a vast knowledge of potential infraction scenarios and could evaluate the video clips for the outlined characteristics.

examining the clips multiple times and in slow-motion when necessary. This reduced the clips to 13 ‘penalty’ clips and 17 ‘no penalty’ clips, which ranged from 3-6 seconds in duration. The four ‘no penalty’ clips which received the lowest original rating out of 60 were then deleted to keep the decision type equal amongst the experimental stimuli. The order of the 26 remaining clips was then randomized for the experimental task.

Procedure. Participants entered the laboratory, the experiment was explained, and informed consent was obtained. The eye movement recorder was fastened and calibrated for each participant. The participants were shown 5 ‘pilot’ clips to acquaint themselves with the procedure. The participants were instructed to make their decisions as quickly as possible once the screen went black. This delayed response feature was added after pilot-testing showed that referees were making responses before the clips ended, which led to premature—and at times, obviously incorrect—responses. Referees were asked to verbalize their decisions by stating either ‘no penalty’ or ‘penalty’. When a penalty decision was made, participants were instructed to indicate the actual infraction observed (e.g., “Tripping”). After these five practice trials, the participants were asked if they had any questions before beginning the experiment. Following this, the experiment instructions were repeated, then the experimental stimuli were presented and the participants watched and reported their decisions for the 26 video clips in succession. The principal investigator recorded the decision verbalizations by hand on a data-recording sheet.

Measures. Four measures were recorded for each video clip: Decision accuracy, decision type, number of fixations, and average fixation duration. Decision accuracy was simply if the participant stated “no penalty” in ‘no penalty’ situations or stated the proper penalty in ‘penalty’ situations. For decision type, we used the signal detection model

(Macmillan & Creelman, 2005) to classify participants' decisions into four categories. 'Hits' occurred when referees accurately assessed penalties during 'penalty' scenarios. 'Misses' were those decisions in which participants did not call penalties during 'penalty' situations. 'Correct rejections' were situations in which participants stated "no penalty" during 'no penalty' situations. 'False alarms' referred to when participants indicated a penalty should be called when in fact no penalty should have been assessed. The number of fixations referred to the number of times a participant moved their eyes and fixated on a point for a minimum of 100ms. The average fixation duration was the average length of time participants focused on an area before fixating elsewhere. Decision speed was not recorded because Hockey Canada places no emphasis on decision-making speed. Referees are instructed to make correct decisions even if it requires 2 to 3 seconds of processing. Therefore, decision speed would not be an ecologically valid measurement for ice hockey referees.

Data Analysis

One-way multiple analysis of variance (MANOVA) tests were conducted in PASW 18.0 to analyze the dependent measures. The first MANOVA compared decision accuracy, number of fixations, and average fixation duration according to expertise (elite, intermediate, or novice). For the second MANOVA, it was important to delineate decision accuracy and decision type, as decision type is a measure of response sensitivity and response bias. Thus, we followed guidelines to perform a signal detection analysis (Macmillan & Creelman, 2005). Signal detection analysis, termed d-prime analysis, isolates the number of hits and false alarms for an experimental task. Mathematically, d-prime is represented as: $d' = z(H) - z(F)$, where H is the percentage of 'hit' responses for each

participant, F is the percentage of ‘false alarm’ responses for each participant, and z is the transformed z -scores of H and F . A d -prime score of 1.0 represents a 69% sensitivity rate, a d -prime score of 0.0 represents an equal number of hits and false alarms, and a negative d -prime score indicates more false alarms than hits. The purpose of the d -prime analysis for this experiment was to determine if the sensitivity of the responses was different amongst referees. As such, we conducted a MANOVA analyzing d -prime and number of fixations according to expertise.

Results

For the first MANOVA, decision accuracy scores out of 26, number of fixations per clips, and average fixation duration per clip were analyzed according to expertise. Our first step was to ensure that the assumptions associated with a MANOVA analysis were met. First, we entered our dependent measures into a correlation analysis to assess multicollinearity. Correlation results indicated that the number of fixations and the average fixation duration violated the assumption of multicollinearity ($r = -.73, p < .001$); therefore, one variable needed to be removed from the analysis. We chose to remove average fixation duration and keep number of fixations, as number of fixations is a more common variable reported in the literature (Mann et al., 2007). Next we assessed multivariate normality. One method to assess multivariate normality is to conduct a regression analysis and inspect the residual statistics—particularly Mahalanobis distance. For two dependent variables, Mahalanobis maximum distance should be less than 13.82. As our value was 7.17, we met the assumption of multivariate normality. The assumption of homogeneity of variance-covariance was also met, Box’s $M > .05$, as was the homogeneity of variance, Levene’s Test $> .05$.

After verifying we met the various assumptions, we conducted a one-way MANOVA with two dependent measures (decision accuracy and number of fixations). Results indicated no significant differences for the combined dependent measures, $F(3, 54) = 1.04, p = .40, \eta^2 = .07$ (see Table 1). Though elite referees ($M = 19.50/26$) were more accurate than intermediates ($M = 17.50/26$) or novices ($M = 18.10/26$), this difference was not significant. For number of fixations, novice referees ($M = 8.84$) had fewer fixations per clip than elites ($M = 9.30$) or intermediates ($M = 9.42$) (see Figure 1), but again, this difference was not significant. Upon further evaluation, we noted that observed power for the MANOVA was .31, indicating that the MANOVA had a low ability to detect possible significant differences.

For the second MANOVA, we analyzed decision sensitivity and number of fixations per clip across expertise levels. Again, we first ensured that the assumptions of this analysis were met. As average fixation duration was highly correlated with the number of fixation on the previous MANOVA, it was not included in the second MANOVA. Correlation analysis of d-prime and number of fixations showed there was no multicollinearity ($r = .25, p = .19$). For multivariate normality, Mahalanobis maximum distance was 7.00, less than the critical value of 13.82. Next, the homogeneity of variance-covariance test was deemed acceptable (Box's $M > .05$). Finally, homogeneity of variance was also met (Levene's Test $> .05$).

Having met the assumptions, we conducted a one-way MANOVA with two dependent measures (decision sensitivity and number of fixations). Results again indicated no significant differences for the combined dependent measures, $F(3, 54) = 1.13, p = .35, \eta^2 = .08$ (see Table 1). For the d-prime analysis, elite referees ($M = 0.70$) demonstrated greater

sensitivity in their responses than intermediates ($M = -.46$) or novices ($M = -.24$)(see Figure 1), but this difference was not significant. The number of fixations remained unchanged from the previous analysis. Once again, results of the MANOVA indicated that the test had low ability to detect possible significant differences ($1 - \beta = .33$).

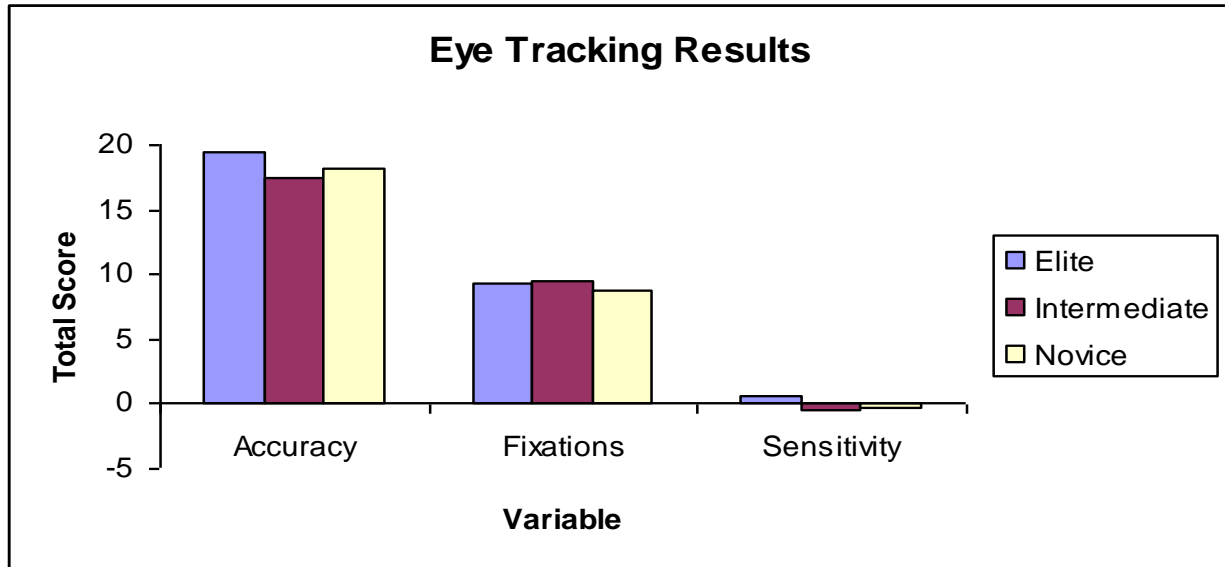


Figure 1. Raw scores for decision accuracy, number of fixations per clip, and decision sensitivity.

When conducting a MANOVA in PASW 18.0, one-way analyses of variance (ANOVA) are automatically calculated for each dependent measure. This enables the researcher to check the difference in results from the MANOVA to the ANOVA. For example, it could be argued that for our researcher, ANOVA might be a better statistical test due to the number of participants we recruited. However, even when examining ANOVA statistics for decision accuracy, decision sensitivity, number of fixations per clip, and average fixation duration, no significant results existed according to referee expertise, though the ANOVA for decision sensitivity showed a trend that elite referees were more sensitive in their decisions.

Table 1

MANOVA and ANOVA statistics for decision accuracy, decision sensitivity, number of fixations, and average fixation duration (AFD)

Variable	Test	F	p	η^2	1 - β
Accuracy + Fixations	MANOVA	1.04	0.40	0.07	0.31
Sensitivity + Fixations	MANOVA	1.13	0.35	0.08	0.33
Accuracy + AFD	MANOVA	1.25	0.30	0.09	0.36
Sensitivity + AFD	MANOVA	1.35	0.26	0.09	0.39
Accuracy	ANOVA	1.93	0.17	0.13	0.37
Sensitivity	ANOVA	2.11	0.14	0.14	0.40
Fixations	ANOVA	0.18	0.84	0.01	0.08
AFD	ANOVA	0.96	0.40	0.07	0.20

Discussion

To our knowledge, the results presented herein are the first eye movement recordings tested on open-skill sport officials. Using elite, intermediate, and novice ice hockey referees, we determined that there were no significant differences for decision accuracy, decision sensitivity, and the number of fixations per clip. This result is similar to that of Bard and colleagues (1980), who noted that in a closed-skill sport, gymnastics, expert and novice judges did not differ on decision accuracy or number of fixations. While it is possible that eye movement recordings and decision-making abilities are not a constituent component for the expert advantage in ice hockey referees, other explanations ought to be

considered, especially since the test power was not particularly high ($1 - \beta = .31$ and $.33$) and previous research has shown decision-making advantages for other sport referees. Mascarenhas and colleagues (2005), for example, noted decision-making differences in rugby referees when presenting them with 10 difficult tackle scenarios. Thus it was important for our research to examine ways in which we could alternatively explain our results. In particular, we focused on the stringent methods we employed to ensure ecological validity of the laboratory task (i.e., structure of the video clips and removing game context).

Structure of the Video Clips

One alternative explanation for the lack of significant results was the structure of the clips. Our experiment followed recommendations from previous researchers (e.g., MacMahon & Ste-Marie, 2002; Plessner & Betsch, 2001) concerning the importance of providing participants with sightlines and perspectives that they would normally encounter during competition. Thus, when originally designing the experiment, we intentionally selected clips that would replicate a game situation for sports officials. That is, we searched for clips that were at ice-level and from a referee's perspective. Video clips taken from the helmet camera proved effective for this design, but video clips taken from NHL games that met these criteria were more elusive. Most often, NHL video cameras capture game play from a central position—not an ice-level camera reflective of what a referee would encounter. We relied, therefore, on replay angles for the NHL video clips, which were typically less than 5 seconds long.

When speaking with participants at the conclusion of the experiment, it appeared that this clip length limited the amount of available perceptual information. Participants had 3-6

seconds to attend to, analyze, and make a decision on a video clip. While this is plenty of time for a closed-skill sport (see experiments by Abernethy & Russell, 1987; Goulet et al., 1989; Jackson & Mogan, 2007) it seems like a limited amount of time for sport officials in an open-skill sport. Specifically, in ice hockey there are 10 skaters and two goaltenders on the ice for one referee to watch. Penalties frequently occur on the puck carrier as well as away from the puck carrier. Thus, ice hockey referees are trained to watch for “problem areas” on the ice. Additionally, ice hockey referees must watch for goals, other infractions (e.g., passing the puck with the hand), and attempt to stay out of the way of the players. These are all components that can affect referees’ visual search patterns, and by limiting our video clips to 3-6 seconds we may have reduced our chance to detect real visual attention differences.

Furthermore, the nature of the clips might have limited prediction and peripheral advantages normally attributed to expert decision-makers (e.g., Abernethy & Russell, 1987; Bard, Fleury, & Goulet, 1994). Participants were shown the entire video clip and asked to make a decision, thereby removing any predictive elements. Though referees are not normally tasked to predict outcomes of potential infraction, it is possible that referees predict *where* infractions might occur and then visually attend to those areas on the ice. For peripheral advantages, the video clips often had the potential infraction in the focal part of the video clip, likely making the visual search field too limited. Previous research in this laboratory and by other researcher (Bard et al., 1994) has shown that peripheral vision is an important component for elite performers, which might help distinguish elite and novice ice hockey referees. To explore prediction and peripheral advantages in ice hockey referees, it would be prudent in a future endeavor to show participants longer video clips with a broader

viewing area to identify if elite and novice referees differ on predicting where an infraction might occur, peripheral scanning patterns, and resultant decision-making abilities. In particular, it may be appropriate to use clips that are 10-15 seconds in duration, capture the majority of the players on the screen at all times, and have infractions on, and away, from the puck carrier. These improvements may then allow researchers to determine if, indeed, there are differences in visual search patterns between elite, intermediate, and novice ice hockey referees.

Screen size is often discussed in relation to visual search experiments with equivocal results. Williams and colleagues (1994), for example, have suggested that in order for visual search experiments to resemble real scenarios, video clips should be projected onto a large screen so that the athletes on the video clips are life-sized. Additionally, Al-Abood and colleagues (Al-Abood, Bennett, Hernandez, Ashford, & Davids, 2002) indicated that screen size could impact results. Those authors noted that when watching a basketball player taking free throws on smaller screens, participants had more fixations of shorter duration as compared to larger screens. Related to decision-making, however, Spittle, Kremer, and Hamilton (2010) discovered that decision accuracy was not affected by screen size, possible because the relational information was not altered. This hypothesis is derived from that of Williams and colleagues (Williams, Hodges, North, & Barton, 2006) who described team sport performers as perceiving and processing visual displays as a function of relational information. Though we were able to capture video clips at a more realistic angle than most previous research, we were unable to project our clips onto large screens. In the pilot-testing phase, however, both participants indicated that they felt that they were “in the game” based on the sightlines and perspectives of our clips. Still, it may be worthwhile in future

investigations to project video clips onto life-sized screens and determine if visual search patterns and decision-making differ amongst sport officials.

Context and Game Management

Though no research has been conducted to determine if context and game management have an impact on visual search patterns, the absence of these factors may have affected the decision-making accuracy of sport officials. MacMahon and Starkes (2008), for example, indicated that participants' decisions in a baseball-umpiring task were based on context. Specifically, umpires tended to call more strikes after 'definite balls' than after 'definite strikes'. They also called more strikes any time there were three balls in the count. This is just one of many examples of how context might affect decision-making (see also Anderson & Pierce, 2009; Findlay & Ste-Marie, 2004; Glamser, 1990; Nevill, Balmer, & Williams, 2002).

Game management, on the other hand, is quite different from context. Recent studies (Mascarenhas, Collins, & Mortimer, 2002; Plessner & Betsch, 2001; 2002; Unkelbach & Memmert, 2008) on sport officials have shown that elite officials use a certain amount of game management, or calibration, to make decisions. Essentially, referees do not always make decisions based on the letter of the law. Instead, they use judgment and communication to inform their decision-making and navigate through the challenge of officiating a competition. As an example, basketball (Brand, Schmidt, & Schneeloch, 2006) and soccer referees (Plessner & Betsch, 2001; Schwarz, 2011) appeared to be influenced by sequential effects—a form of game management. That is, referees' prior decisions have an impact on decisions later in the game. Referees might set a certain standard of play early in a game and then rate, or compare, infractions based on this standard. Additionally, referees

appear to be hesitant to severely punish a team multiple times in one competition (e.g., award two penalty kicks against a team).

The notion of game management or calibration captures the complexities of officiating sports and in testing officials' decision-making skills. Imagine an ice hockey referee who correctly penalized every infraction during each game. The length of the game would exponentially increase and the players' and coaches' perceptions of the referee of quickly depreciate despite the fact that the correct decisions were being made.

Nevertheless, in order to provide a standardized laboratory experiment with video clips from several games and at least an attempt of an objective measure (correct versus incorrect), context and game management were not provided for participants. Thus, our experiment might have tested eye movement recordings from a declarative knowledge paradigm rather than a procedural knowledge paradigm. Declarative knowledge includes facts and rules, while procedural knowledge refers to how to do something (French & Thomas, 1987). Because we removed all context and game management from the video clips, it is possible that we removed the "how to" of refereeing; that is, the procedural knowledge that more elite referees might invoke and rely on to make decisions during game situations. To rectify this, researchers would need to track referees' eye movements during game play. Though there are eye movement recording systems being developed for such experimentation, their lack of immediate availability has precluded their use in such research to date.

Conclusion

This experiment was designed to examine the visual search patterns and decision-making accuracy of ice hockey referees while maintaining a certain standard of ecological

validity. Specifically, in our video clips we tried to maintain similar sightlines and perspectives to what participants would normally encounter during game situations. Though the results indicated no significant differences for any of the measurement variables, recommendations concerning the research design are offered. First, we propose that it is vital to consider the predictive and peripheral information included for any similar experiments. It is possible that the quality of referees might be distinguished by their ability to attend to and process a greater amount of information. Second, the removal of context and game management may also influence the visual search patterns and decision-making of referees. As such, future research on visual search patterns and decision-making should incorporate these factors in their design. In fact, we would argue that the best approach to this research topic is to use in-situ designs that will enable researchers to truly distinguish visual search patterns and decision-making accuracy amongst elite and novice ice hockey referees.

Appendix A

Working from a top-down approach, the National Hockey League (NHL) is the highest professional ice hockey league. Below professional leagues are amateur hockey leagues, the most elite of which is the Canadian Hockey League (CHL), which comprises the Western Hockey League, Ontario Hockey League, and Quebec Major Junior Hockey League. Players at this league are aged 15-20 years and are developing their skills in order to play professional hockey. Most players drafted into the NHL come from the CHL (www.hockeydb.com). In Canada, the level below this elite amateur league is Tier II Junior ice hockey, and comprises Junior A, B, and C leagues. One of the 10 Junior A leagues in Canada is the Central Canada Hockey League, from which we drew our elite participants. Junior A players are aged 15-20 years, and younger players may still progress to the CHL, while older players typically progress to university ice hockey. Below Junior ice hockey is a development system known as minor ice hockey. There are 13 minor ice hockey branches in Canada. One such branch is the Ottawa District Minor Hockey Association, from which we drew our intermediate and novice participants. In minor ice hockey, there are age divisions for players aged 5 to 19 years and within each age division, there are various competitive levels, the most elite being AAA and the least competitive being House League. Our intermediate referees regularly refereed Bantam (aged 13-14) competitive ice hockey while our novice referees regularly refereed Novice (aged 7-8) and Atom (aged 9-10) non-competitive ice hockey.

The role of an ice hockey referee is vast and includes many aspects that go unnoticed by the average spectator. Before the game, referees check the gamesheet to guarantee all players are accurately recorded, check the ice surface to ensure safety, and check the players

to make certain they are wearing proper protective equipment. During game play, referees monitor potential rule infractions and goals. During stoppages in play, referees continue to monitor potential rule infractions and communicate with coaches to indicate when they can complete line changes (switching players that are on the ice with players that are on the bench). After the game is over, referees attend to the players as they leave the ice, ensure the validity of the gamesheet (e.g., that the penalties and goals accurately recorded), and complete a report if any players were ejected from the game (www.hockeycanada.ca). In sum, the role of an ice hockey referee is extensive and occurs before, during, and after the game.

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Part III: Global Discussion and Integration

Global Discussion and Integration

The global discussion serves four main purposes. First, I will discuss results that were not included in the three main papers. Next, I will integrate the results of the three papers. Third, I will outline alternative methods that could have been used to analyze the data. Finally, I will offer suggestions for future research on ice hockey referees.

Excluded Data

A doctoral dissertation often requires a synthesis of the data to be able to present and submit it to quality journals. That was the case for the present study. Though most of the data collected for this project were presented in the three main papers, some data were excluded, which is discussed below.

Stimulated Recall Interviews. I conducted stimulated recall interviews that lasted approximately 60 minutes per participant. For the first two articles, however, I presented only the most relevant data (as it related to visual behaviors of ice hockey referees), which meant some resultant themes were excluded from the main papers. These themes included miscellaneous comments, memory, visual impediments, and communication. The first three themes were mostly general commentary by the participants regarding the game sequence; for example: “Net’s off” (INT – 1); “I think that’s the cross-checking penalty. Can’t remember what penalty it was” (INT – 2); “Can’t see what’s going on because my head’s down” (INT – 1). For communication, however, several participants reported that communication was an important aspect of refereeing, but clearly that theme did not integrate with any of the emergent theoretical codes, nor did it relate to referees’ visual behaviors. Referees of all levels spoke of communication, which included communicating with other officials, coaches, and players:

So when the play goes up the ice it's basically just, it's a force of habit to check when need be. Most linesmen at this level will tell us if we need to or don't need to. And actually [name of linesman] in this game is very good at telling you, "Now", "Not now", "Just keep going." (EL – 1)

Because I waved off a goal, and called the penalty because of the waved off goal, I'm not going over to the bench. Usually the coach wants an explanation for every waved off goal, in this situation with—how much time was left in the period? Two minutes maybe? I am telling him—like when I skate close to the bench, like you can see—like I'm looking at him for the line change procedure anyway, but I'm looking at—he wants me to come over and I'm telling him, "I'll be there at the end of the period." Just save delaying the game. (EL – 2)

In between a whistle, like at the net or something, if there's stuff going on I'm usually yelling, "All right guys, that's it, that's it. I've got no penalties right now, so let's move it. Keep it clean." Or if there's something going on I'm usually yelling, "[Visiting team player] get out of there—you're going to the box already—stop" or, "[Home team player], you're going to the box." Just so they know what's going on and maybe if I'm yelling at the people, or the players, that they already got a penalty, they'll smarten up and won't put their team down any more. (INT – 1)

Despite its exclusion from the main papers, it was evident that referees believed that communication was a vital aspect of refereeing.

Focus Groups. Each focus group was approximately 90 minutes long. Similar to the stimulated recall interviews, it was imperative to focus only on the results relevant to the main thesis papers, which were the visual attention behaviors the focus group members

believed differentiated the videotaped elite and intermediate referee. The transcripts were deductively coded to search for similar visual behaviors reported by the focus group members, but when re-scanning the transcripts, it did not appear that any consistent, new themes emerged from the focus groups. There were, however, two other interesting results derived from the focus group transcripts not described in the two main papers. First, there were cases whereby similarities were noted between the elite and intermediate referee. Second, there were times when the focus group members would disagree with each other or disagree with an action or decision made by the referee that they were watching.

For similarities between the elite and intermediate referee, the focus group members noted that the two referees were comparable in their visual attention behaviors with regard to face-offs, body-checks, penalty calls, contextual positioning and visual behavior, and anticipation. Mostly, this reflects the results discovered with the helmet camera videotapes, with the exception of face-offs. Despite the intermediate referees in the helmet camera phase not discussing face-offs, the focus group members suggested that the intermediate referee was, in fact, visually attending to face-offs. From this, it would appear that while there are distinct skills that the elite referee demonstrated more effectively, his advantages did not pervade across all refereeing skills.

The second interesting aspect of the focus groups that was not included in any of the main papers was how the focus groups members would disagree with each other or with the referee they were watching. The following was an example of disagreement amongst the elite focus group members when discussing the videotaped intermediate referee's positioning after a center-ice face-off:

Focus Group Member 1: He gets jammed up, you can tell on the face off.

Focus Group Member 2: Got a little rattled there off the face off drop.

Focus Group Member 1: Right here he's jammed.

Focus Group Member 2: He should've just gone for it [gotten out of the middle of the ice and to the boards].

Focus Group Member 1: He should just wait. I don't know about that last one....

Focus Group Member 2: I think when the puck, like when the puck was at the red line, he could've just bolted for the boards and gotten out of the way.

Researcher: So you say bolt for it and you said wait. Why do you say bolt for it?

Focus Group Member 2: I don't know. Get to the safe spot as soon as possible.

Researcher: Yeah.

Focus Group Member 2: I don't know. It's more a personal preference I think. If you want to wait, wait; but do so while still watching the play. But if you're going to go for it, go for it; but get there quickly.

Researcher: That sounds pretty good. Why do you say wait?

Focus Group Member 1: Yeah, I mean, he runs the risk of getting more in the way, right, by moving. So if he just waits...

Focus Group Member 3: Just preference.

Focus Group Member 2: That part too, you're thinking of your own safety too...just get out of the way. So if you think you can get to the boards before them, you go for it or you just go around.

Focus Group Member 1: But either way you don't stop in the middle and just end up looking back and forth.

Though all focus group members agreed in this situation that the referee being watched positioned himself incorrectly, the way in which to correct this mistake was not entirely clear. This was one example of disagreement amongst the participants.

Eye Movement Recordings. The only result automatically calculated by the eye movement recording software that was excluded from this study was data on referees' saccades. A saccade is the time between fixations, or the shifting of one's focus from one fixation location to another. To my knowledge, no existing literature has examined saccades; rather, the focus is on the number, location, and length of fixations. Based on this, it was determined that examining saccades was not important for the present study; thus it was not analyzed or presented in any of the main papers.

Integration of the Papers

The three presented papers provide detailed description of the visual attention behaviors of elite, intermediate, and novice ice hockey referees. Using stimulated recall interviews, referees reported watched similar areas on the ice, but the antecedents of their visual behaviors were quite different. Elite referees, as compared to novices, described the importance of changing on-ice positioning, relying on contextual game information, prioritizing visual behaviors, and using peripheral vision in order to make better decisions. Thus, it appeared that elite referees had a more in-depth knowledge base that helped them to describe their visual behaviors. As was presented in the first and second papers, this knowledge based parallels that of declarative (rules and facts) and procedural (how to execute skills) knowledge (Anderson, 1987; French, Nevett, Spurgeon, Graham, Rink, & McPherson, 1996; French & Thomas, 1987; Thomas, 1994). Essentially, elite referees described in-depth rules, or antecedents, relating to their visual behaviors—something that

was absent from the transcripts of the novice referees. Expertise researchers would hypothesize that this increased knowledge base for elite referees was due to increased amounts of deliberate practice or deliberate experience in which the elite referees were engaged. Though hours of deliberate practice were not tracked for this dissertation, it is important to note that the elite referees did have more years of referee experience than their intermediate or novice counterparts. Thus, it is possible that deliberate practice as referees contributed to the elite referees developing more sophisticated procedural knowledge bases to assist their visual behaviors.

Results of the focus groups added to the concept of elite referees having superior knowledge bases compared to non-elite referees. Often, the focus group members described scenarios in which they believed the elite referee, compared to the intermediate, utilized superior Divided and Selective Attention as well as having superior antecedents that led to better visual behaviors. Thus, an emergent theme was that the elite referee not only knew which type of visual attention to use, but he was also reported as being more effective and consistent at the execution (procedural knowledge) of visual attention.

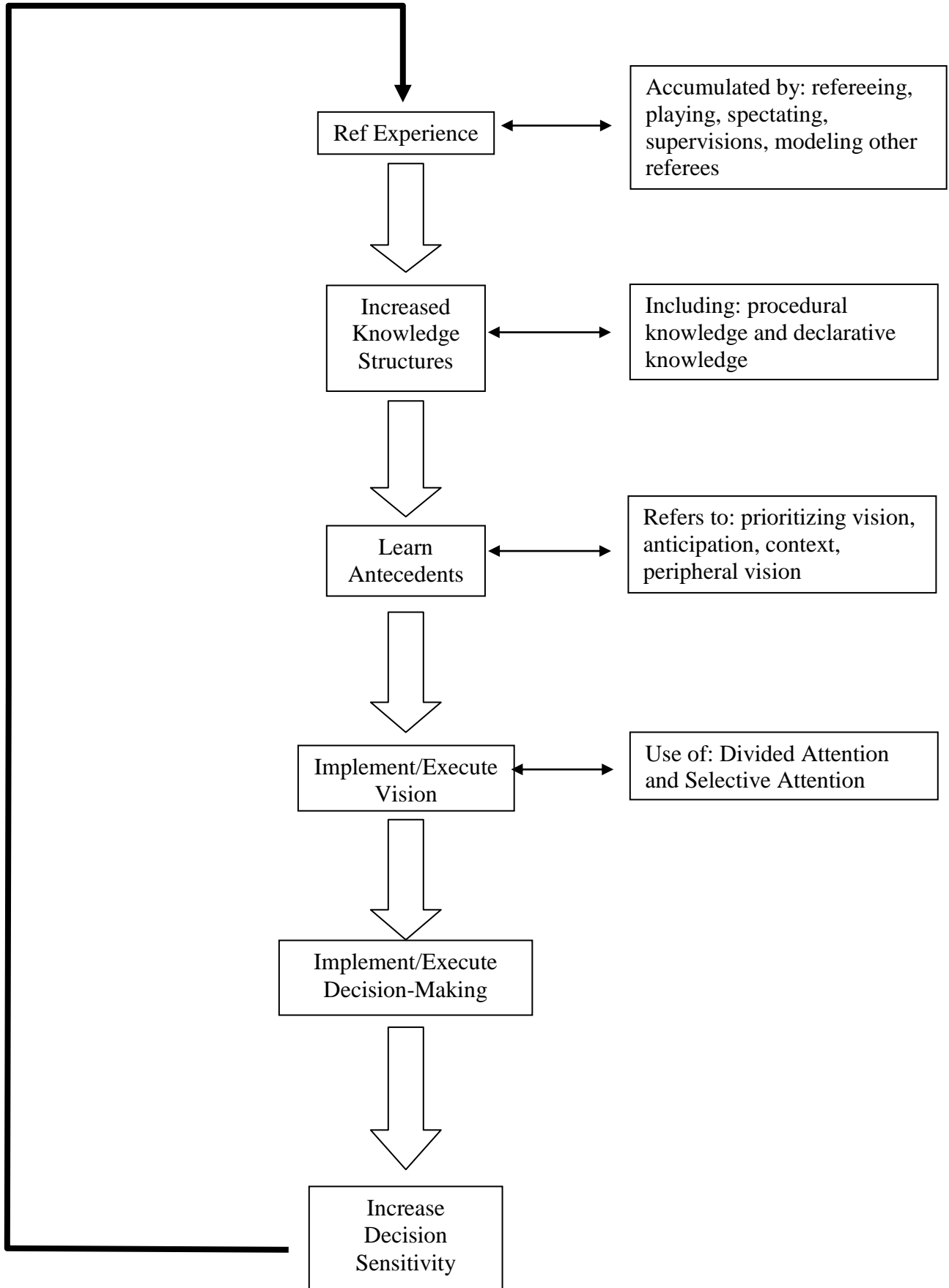
While the first two papers were centered on the visual behaviors of ice hockey referees, the third paper was conducted to test objective measures of referees' visual attention. Specifically, the focus was on visual search patterns and decision-making—a complement to the qualitative papers. The general theme of the eye movement recording paper was a lack of significant differences on all measures amongst the referee groups. Based on the result of the previous papers, this result may not be surprising. Elite referees in the qualitative papers believed that peripheral vision, anticipation, game context, and prioritizing visual behaviors were important aspects of visual behaviors. It is these aspects

that appeared to delineate elite and novice referees. In the eye movement recording experiment, however, none of these characteristics were captured in the video clips (this is described in detail in the discussion of the third paper). Thus, the absence of these perceptual-cognitive characteristics may have negated the expert advantage.

A collective examination of the three papers reveals a common, though tentative explanation of the expert advantage in ice hockey referees: Elite referees use antecedents of visual attention to assist visual behaviors, these antecedents are indicative of enhanced procedural knowledge bases, and this knowledge base is derived from deliberate practice and deliberate experience. This explanation certainly should be examined by future researchers.

Based on the combined findings of the three papers, there might be some initial applications of the results for referee associations and referee training. Referee instructors should be training referees to watch the majority of players on the ice, to use context to help their visual attention, and to try and prioritize where to direct their visual attention. Additionally, they could explore means to increase deliberate practice hours for referees. For example, referees could accumulate experience by watching ice hockey videos. Improvements in decision-making through the use of video simulation have been witnessed with athletes (Abernethy, Wood, & Parks, 1999; Starkes & Lindley, 1994) and it would seem logical that this method could help increase the decision-making abilities of elite, intermediate, and novice ice hockey referees.

Finally, integrating the three papers allows for a proposed model of the visual behaviors of elite referees. This proposed model is preliminary in nature, but might allow future researchers to test models of sport officials' visual behaviors (see Figure below).



Alternative Methods

For a doctoral dissertation, it is always a challenge to determine which methods will produce the most salient and relevant data. As a committee, we determined that the methods described in the above papers were the most effective means to investigate the perceptual differences amongst ice hockey referees. There are, however, other methods that could have been conducted.

Stimulated Recall Interviews. Regarding the data derived from the helmet camera videotapes, I condensed approximately 10 hours of videotape to six individual 12-minute segments that were then reviewed by the respective participants. Immediately, this method excluded the majority of the videotapes, though the 12-minute segments did incorporate several scenarios that ice hockey referee would normally encounter (e.g., goals, penalties, scrums, etc...). It would be interesting, however, to go back to these videotapes and have participants watch entire videotapes to investigate recurring themes, emerging themes, and get a more detailed idea of referees' knowledge bases. This could provide researchers with a better understanding of the dynamic nature of refereeing.

A second alternative method would have been to look for certain events (e.g., focusing on the majority of players or watching one player) on the helmet camera videotapes and calculate the amount of time spent attending to those events. This would help provide a quantitative indication of the visual attention differences between elite, intermediate, and elite ice hockey referees.

Focus Groups. Just as with the helmet camera videotapes, it would have been interesting to have the focus groups review a participant's entire videotape to investigate the recurring and emergent themes throughout the game. The limit with this method, however,

is that the length of time to review the tape would likely exclude the possibility of having focus group members view multiple videotapes from different levels of referees.

Another possible change involves the specific helmet camera videotapes shown to the focus group members. Each focus group watched one elite and intermediate helmet camera videotape in order to identify any differences based on expertise. The elite and intermediate videotapes were chosen because they were the first to be collected (the novice participant group was only added after the National Hockey League and Canadian Hockey League decided not to partake in the study). Consequently, it is possible that I limited the possible differences that could have been found between the referees because they were the two closest groups in terms of skill. Additionally, it might be beneficial to show the focus group members the elite helmet camera videotape and compare it to the novice helmet camera videotape to maximize possible visual attention differences.

Eye Movement Recordings. There were no significant differences between participants on visual search patterns, but it is possible that another type of visual search pattern might have been occurring: That of fixation location. Specifically, while referees did not differ on the number of fixations, it is possible that more elite referees look at different areas of a visual display in order to make more informed decisions. Investigating this would be helpful to ascertain a more complete picture of the visual search patterns of referees. Furthermore, if fixation location differences exist, it is likely that referees could use video simulation to train themselves where to attend. This would be important for referee research.

Future Research

Stimulated Recall Interviews and Focus Groups. As noted in the first two papers, future research into the visual attention behaviors of ice hockey referees ought to include the use of simultaneous verbal reports. By having referees wear wireless microphones, it would be possible to have referees verbally describe their visual attention behaviors throughout an entire game—essentially employing a think-aloud protocol. One difficulty with such a protocol is getting approval from refereeing organizations, as referee governing bodies might be hesitant to allow researchers access to their members on-ice thoughts and insights, especially when the nature of refereeing is such that mistakes often happen. A second challenge with this method would be getting referees to explicitly state the visual attention behaviors when many behaviors might be implicit actions. Coupling this method with an immediate think-aloud protocol after a game would, therefore, seem to be an ideal research method.

Another direction for future researchers would be to use a more structured questionnaire to elucidate responses from referees. This research has outlined major themes and behaviors used by referees, which can now be more precisely investigated to get a better understanding of referees' visual attention. For example, researchers can ask direct questions such as, “Do you focus on the majority of players?”, “Why do you focus on the majority of players?”, and “How do you balance focusing on the majority of players with attending to the puck or away from the play?” These more pointed questions might allow for a deeper understanding of differences between elite, intermediate, and novice referees.

Eye Movement Recordings. The major limit of the eye movement recordings was that we used video simulations in a laboratory setting rather than tracking eye movements

and decisions during live games. Possibly, this explains our limited results for decision accuracy, decision type, and number of fixations amongst the three groups of referees. Though our results showed we had low test power, other eye movement recording methods ought to be considered rather than simply increasing the number of participants.

There is new technology currently on the markets that allows researchers to track eye movements in any setting. These eye trackers are essentially a pair of glasses that participants wear, and as they are wireless, they can be taken anywhere, such as an ice hockey rink. Though this would be ideal, it would be difficult to acquire these glasses without a generous budget for equipment (typically a minimum of \$30,000 USD for the equipment).

Barring the acquisition of such technology, another possibility is to record longer video sequences via helmet camera videotapes, including more variety in the situations—that is, one-on-one plays, multiple player scenarios, and infractions that occur outside the central focal area—and to project these video clips onto a life-sized projection screen. These changes in methodology might assist in delineating eye movements amongst elite, intermediate, and novice ice hockey referees.

Conclusion

In sum, the papers presented herein have offered several new perspectives on the performances and skill sets of ice hockey referees. Though some differences have been noted, it is important that researchers use these results to attempt to gain a more detailed knowledge of the visual attention behaviors of referees. Ultimately, this knowledge would then be able to assist in increasing refereeing performance by providing referee instructors

with resources and information on the best visual attention behaviors to be taught to ice hockey referees.

Part IV: Statement of Contributions

Statement of Contributions

For paper one, Dr. Ste-Marie, Dr. Young, and Dr. Culver assisted me with the formulation of the idea during the proposal phase. Dr. Culver conducted the bracketing interview with me. I recruited all participants, collected all the data, and analyzed all the data. Dr. Ste-Marie helped with interpreting results and setting up the structure of the paper. I was the lead author of the paper, but received valuable editorial assistance from Dr. Ste-Marie.

For paper two, Dr. Ste-Marie, Dr. Young, and Dr. Culver again helped me with the proposal of the project and the formulation of the methods. I recruited all participants, collected all the data, and analyzed all the data. Again, Dr. Ste-Marie assisted with interpreting the results and creating the structure for the paper. I was the lead author of the paper, but received substantial editorial assistance from Dr. Ste-Marie.

For paper three, Dr. Ste-Marie, Dr. Young, and Dr. Culver helped guide the project in the proposal phases. I was responsible for recruiting all participants, collecting and analyzing all the data, and writing the paper. Again, Dr. Ste-Marie provided valuable editorial assistance.

Part V: References

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Appendices

Appendix A: Ethics Approval Letters

File Number: H07-09-10

Date (mm/dd/yyyy): 08/17/2009



Université d'Ottawa **University of Ottawa**
 Service de subventions de recherche et déontologie Research Grants and Ethics Services

Ethics Approval Notice Health Sciences and Science REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

<u>First Name</u>	<u>Last Name</u>	<u>Affiliation</u>	<u>Role</u>
Diane	Ste-Marie	Health Sciences / Human Kinetics	Supervisor
David	Hancock	Health Sciences / Human Kinetics	Student Researcher

File Number: H07-09-10

Type of Project: PhD Thesis

Title: Examining Perceptual Differences Among Expert, Elite, and Intermediate Hockey Referees: Visual Attention and Gaze Behaviours

Approval Date (mm/dd/yyyy)	Expiry Date (mm/dd/yyyy)	Approval Type
08/17/2009	08/16/2010	Ia

(Ia: Approval, Ib: Approval for initial stage only)

Special Conditions / Comments:

Please note that this certificate denotes partial approval and only allows researchers to recruit within the ODMHA. Letters of permission from the NHL and CHL must be submitted to the REB before recruitment may begin within those organizations.

File Number: H07-09-10

Date (mm/dd/yyyy): 08/17/2009



Université d'Ottawa **University of Ottawa**
Service de subventions de recherche et déontologie Research Grants and Ethics Services

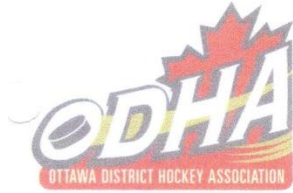
This is to confirm that the University of Ottawa Research Ethics Board identified above, which operates in accordance with the Tri-Council Policy Statement and other applicable laws and regulations in Ontario, has examined and approved the application for ethical approval for the above named research project as of the Ethics Approval Date indicated for the period above and subject to the conditions listed the section above entitled "Special Conditions / Comments".

During the course of the study the protocol may not be modified without prior written approval from the REB except when necessary to remove subjects from immediate endangerment or when the modification(s) pertain to only administrative or logistical components of the study (e.g. change of telephone number). Investigators must also promptly alert the REB of any changes which increase the risk to participant(s), any changes which considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project and safety of the participant(s). Modifications to the project, information/consent documentation, and/or recruitment documentation, should be submitted to this office for approval using the "Modification to research project" form available at:
http://www.rges.uottawa.ca/ethics/application_dwn.asp

Please submit an annual status report to the Protocol Officer 4 weeks before the above-referenced expiry date to either close the file or request a renewal of ethics approval. This document can be found at:
http://www.rges.uottawa.ca/ethics/application_dwn.asp

If you have any questions, please do not hesitate to contact the Ethics Office at extension 5841 or by e-mail at: ethics@uOttawa.ca.

Signature:



OTTAWA DISTRICT HOCKEY ASSOCIATION

1247 Kilborn Place, Suite D300, Ottawa, Ontario, K1H 6K9

Telephone: (613) 224-7686 Fax: (613) 224-6079

www.odha.com

Hockey... for the fun of it!

University of Ottawa
801 King Edward Ave.
Ottawa ON K1N 6N5
Attention: Ethics Board

February 1, 2010

To Whom It May Concern:

The purpose of this letter is to inform you that Mr. Dave Hancock has provided me with the details of his thesis project 'Examining Perceptual Differences among Expert, Elite, and Intermediate Hockey Referees: Visual Attention and Gaze Behaviors'. In addition, I have reviewed Mr. Hancock's PowerPoint proposal and fully comprehend the nature of his project. The data collected from this project may become a useful tool for our Referees and on-ice supervisors.

I fully support this endeavor and grant permission to Mr. Hancock to speak with members of our Senior Body Officials. Please do not hesitate to contact me should you require additional information or clarification.

Member of



To the University of Ottawa Ethics Board:

August 4, 2009.

I am writing to you today on behalf of the Ottawa District Minor Hockey Association (ODMHA) regarding a thesis proposal by doctoral student David Hancock. Recently David made a presentation to one of our executive members, wherein he explained his thesis project including the method, data collection, and all ethic guidelines. He informed us that he would be looking for ODMHA referees to participate in his research. We, at the ODMHA, are fully aware of his project and hope that the results will be beneficial for our officials. To that effect, I am writing this letter to inform the Ethics Board that the ODMHA fully supports David's research and we are giving him permission to utilize ODMHA officials as volunteer participants.

Thank you.

To the University of Ottawa Ethics Board:

I am writing to you on behalf of KMHA Officials. I have spoken with PhD student David Hancock and he has presented a proposal to work with our officials. He included in his proposal the method, data collection procedures, data analysis, as well as ethical guidelines including recruiting, anonymity, confidentiality, the right to withdraw, risks, and full disclosure of results. I believe the project will be beneficial for our officials and I support David in his endeavour. I give him permission to recruit our officials to become participants.

Thanks

Appendix B: Ethics Recruitment Script

My name is David Hancock; I am a doctoral student at the University of Ottawa in Ottawa, Ontario. I would like to thank you all for allowing me to speak to you today regarding my thesis topic. My area of interest for my studies is sport psychology. As a hockey referee for the past 16 years, I have become particularly interested in expertise and referees. To that affect, I would like to outline my thesis project to you, for which I am recruiting volunteer participants.

I am conducting a study entitled, “Examining perceptual differences amongst elite, intermediate, and novice ice hockey referees.” The purpose of this project is to determine how different referees use visual information to assist in decision-making. Specifically, I would like to investigate if elite referees have different visual behaviors than intermediate or novice referees that enable them to make better decisions.

To achieve this purpose, there will be three data collection phases. First, I will recruit volunteers to wear a helmet camera during one of their regularly scheduled games. After the game, we will meet, watch a 10-minute segment of the helmet camera videotape, and you will be free to discuss: a) What you were visually attending to, b) why you focused your attention where you did, and c) how that helped or hindered your decision-making? The total time commitment for this phase is roughly two to three hours (1.5 to 2.5 hours for the game plus a 30-minute debrief). For phase two, I will recruit volunteers to join a focus group. The referees will watch the helmet camera videotapes and collectively discuss: a) What they thought the referee was visually attending to, b) did they think that was or was not beneficial to his/her decision-making, and c) did they think his/her attention should have been directed elsewhere? The focus groups will last approximately one to two hours. For

phase three, I will recruit volunteers to wear an eye-tracking device, basically a camera lens that goes over the eye and specifies the precise location of one's focus, and watch 20-30 hockey clips on videotape. In this stage, you will be asked to determine what, if any, infraction occurred. The time commitment for this phase is roughly 30 to 45 minutes.

It is important to note limitations on who can be involved in the study. First, though consent forms will be made in French and English, you must be proficient in English, as all responses must be made in English. This is because I will be transcribing, analyzing, and interpreting the data and I am not proficient in French. Second, for the intermediate group (Ottawa District Minor Hockey Association) only those of you who regularly referee Bantam competitive hockey can participate in the study. This was decided in my thesis proposal because we wanted to ensure that the elite and intermediate groups were distinctly different from each other. Third, all participants must be 18 years of age or older.

The ethics board at the University of Ottawa has approved this research. In line with their recommendations, your participation in this study will remain anonymous and confidential. The names of the participants will not be shared with anyone. Any names, dates, or locations given in your responses will be removed to protect your identity. In regards to confidentiality, data will be kept in a locked cabinet in my locked office. Furthermore, there are no foreseeable physical, psychological, or social risks from being involved in this study other than those you would normally encounter in your regular referee experiences.

Following data collection and analysis, I will send each participant a condensed version of the results. The condensed version will explain what results I found and how these results can be applied to improve referees' decision-making. I am hopeful that by

providing these results, each participant will benefit by being able to improve their refereeing performance.

If you are interested in being involved in this study, you now have two options. You may email me indicating your interest (dhanc088@uottawa.ca) or you may write down your contact information (name as well as phone number or email address) and hand it to me at the end of this meeting. I will then speak with you individually to discuss the process in more detail, address any questions or concerns you may have, and have you sign the informed consent form. If at any time during this process or during data collection, you decide you would like to withdraw from the study, you may do so with no questions asked.

Thank you for your time and I hope to speak with you shortly.

Appendix C: Ethics Consent Form



Université d'Ottawa · University of Ottawa

Faculté des sciences de la santé
École des sciences de l'activité physique

Faculty of Health Sciences
School of Human Kinetics

Informed Consent Form

The following people are conducting research on the project entitled, “Examining perceptual differences among expert, elite, and intermediate hockey referees: Visual attention and gaze behaviours”. If for any reason you would like to contact us, the following information should provide you with the means to do so:

This letter is to inform you of the activities involved in this study, as well as to seek your consent for your participation in this research project. To be eligible to participate in this study, you must answer yes to the following questions:

- 1) Are you proficient in English? _____(Y/N). This is because I must transcribe and interpret your verbal answers and I am not proficient in French.
- 2) Are you 18 years of age or older? _____(Y/N). This is to ensure that all participants are adults capable of expressing their consent.
- 3) For Ottawa District Minor Hockey Association officials, do you regularly referee Bantam competitive hockey? _____(Y/N). This is to ensure that intermediate and elite participants are distinctly different from each other.

Purpose of the study: In carrying out this research, it is our objective to determine if expert, elite, and intermediate hockey referees utilize different visual information to assist them in their decision-making. If high-quality decision-making can be associated with a particular type of visual strategy, it would then be possible to train hockey referees to use that strategy. This would enhance referee decision-making at all levels of hockey.

Participant requirements: Prior to beginning data collection, participants must fill out a simple demographic questionnaire (10 questions). There are three phases of the research and participants may be involved in one or two of those phases (the level of involvement is decided upon by the participant—not the researcher).

Phase one: In this phase, you will referee one regularly scheduled game (approximately 1.5 to 2.5 hours) while wearing a helmet camera that tracks your visual attention. These sessions will take place at a rink where you would normally referee a game. Following the game, you will debrief with the researcher (approximately 30 minutes) and will be given free reign to discuss: what were you attending to, why you chose to focus on that visual information, and how that helped/hindered your decision-making.

Phase two: In phase two, participants will engage in a focus group session (1.0 to 2.0 hours). These sessions will take place on the University of Ottawa campus, or in a meeting room provided by your referee association. Participants will watch the helmet camera videotapes from phase one and discuss and comment on the referees' visual attention.

Phase three: In phase three, participants will wear an eye-tracking device (a lens that goes in front of the eye and detects precisely where someone has focused their attention), while watching 20-30 hockey clips on videotape, and make decisions as to whether or not an infraction occurred. This will take approximately 30-45 minutes and will occur at the University of Ottawa campus or in a meeting room provided by your referee association.

Potential risk: There are no anticipated risks from this research other than those that you would normally encounter in your regular refereeing experiences.

Potential benefits: In terms of personal benefits, all participants will be sent a condensed version of the results. These results will detail how different levels of referees use their vision to make decisions. This will be beneficial to each participant as it will allow them to learn where they should focus their attention in order to be able to make accurate decisions.

More general benefits are also likely to be derived from this study. Specifically, by understanding how referees' perceptions influence their decision-making, it will be possible to create training programs to increase visual proficiency. This in turn will lead to improved refereeing performance at all levels of hockey.

Anonymity and confidentiality: All data will be coded so that no names, dates, or locations that could identify a referee are revealed. Confidentiality will be ensured, as all data collected will be kept in a locked cabinet in the locked office of MNT205 to which there is limited access for only Dr. Ste-Marie's graduate students. Only David Hancock will have access to the locked cabinet and the data to begin with. Once anonymity is guaranteed, his thesis supervisor, Diane Ste-Marie, and committee members will be allowed to view the data. Five years after the publication of the results, the data will be shredded, destroyed, and disposed. One limitation to anonymity and confidentiality is participants in the focus group phase as they will be in an open discussion with three other referees from their respective leagues. Thus, anonymity and confidentiality within each focus group cannot be protected. However, your identity will not be revealed to any participants who are not in your focus group.

Voluntary participation: Your participation in this study is strictly voluntary. If at any point you wish to withdraw from the study, you may do so with no questions asked.

If you have any questions regarding the project, you may contact either researcher listed above. If you have concerns regarding the ethical issues involved, feel free to contact:

Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, Room 159
550 Cumberland Street, Ottawa, ON, K1N 6N5
613-562-5841, ethics@uottawa.ca

By signing the following you are indicating that you have read and understood the above information and agree to participate in the study, "Examining perceptual differences among expert, elite, and intermediate hockey referees: Visual attention and gaze behaviours". Furthermore, you are acknowledging that you meet all inclusion criteria for the study (proficient in English, 18 years of age or older, Bantam competitive referee (for intermediate officials only)).

Participant's Copy:

Participant's Name: _____ Date: _____

Participant's Signature: _____

Researcher's Signature: _____ Date: _____

Researcher's Copy:

Participant's Name: _____ Date: _____

Participant's Signature: _____

Researcher's Signature: _____ Date: _____



Université d'Ottawa • University of Ottawa

Faculté des sciences de la santé
École des sciences de l'activité physique

Faculty of Health Sciences
School of Human Kinetics

Formulaire du consentement au courant

Les personnes suivantes font la recherche au projet intitulé « Examen des différences perceptuelles entre les arbitres de hockey aux niveaux de l'expert, de l'élite, et de l'intermédiaire: la comportement de l'attention visuelle et du regard ».

Vous pourriez nous contacter au suivant :

Cette lettre serve à vous informer des activités requis pour ce recherche, et à obtenir votre consentement pour la participations dan ce projet. Pour être éligible a participer, il faut r à répondre oui, aux questions suivants.

- 1) Êtes-vous compétent en anglais? _____ (oui/non) Ca c'est important par ce que je ne suis pas bilingue et je doit transcrire et interpreter vos réponses orales.
- 2) Avez-vous 18 ans ou plus? _____ (oui/non) C'est pour assurer que tous les participants sont des adultes capable d'articuler leurs consentement.
- 3) Pour les officiels qui représentent « ottawa dist. Minor hockey asstn », êtes-vous un arbitre régulier pour le hockey compétitif « bantam »? _____ Ca c'est pour assurer un différence distincte entre les participants intermédiaires et élites.

But de l'étude :

Notre objectif est à déterminer si les arbitres de hockey expert, élite et intermédiaire utilisent les informations visuels différents, pour les aider à prendre des décisions. Si nous pouvons trouver un corrélation entre une stratégie visuelle spécifique et l'abilité a prendre des décisions de qualité, il serai possible à entraîner les arbitres à l'utiliser cette stratégie. Ca pourrai améliorer l'abilité des arbitres à prendre des décisions à chaque niveau de hockey.

Conditions requises aux participants :

Avant de la collecte de données, chaque participant doit remplir un questionnaire démographique (10 questions). Il y a trois parties de la recherche. Les participants peuvent être impliquer en 1 ou 2 parties. (Déterminer par le participant).

Partie un : Le participant arbitre un match de hockey (environ 1.5 -2.5 heures) et porter un casque avec un camera, qui peut suivre l'attention visuelle. Les matchs seront jouer au même endroit que les participants arbitre normalement. Après le match, l'arbitre va faire un compte rendu orale avec le chercheur (environ 30 minutes), et peut discuter : de quoi vous avez attendu, pourquoi vous avez décidé à fixer sur un information visuel spécifique, et comment celui à influé vos décisions.

Partie deux : Les participants engagent dans une session de groupe (durant 1 a 2 heures). Les sessions seront a l'université d 'Ottawa où dans une salle de réunion pourvoit par votre association d'arbitre. Les participants vont surveiller le film fait au partie un, avant d'avoir un discussion et commentaire au sujet de l'attention visuel d'arbitre.

Partie trois : Les participants vont porter un appareil qui suivre le mouvement des yeux pour déterminer précisément, où l'arbitre à fixer son regarde, au même temps qu'il surveille 20-30 clips et prendre des décisions concernant l'événement des infractions. Cet exercice doit prendre environ 30 – 40 minutes, et sera a l'université d 'Ottawa où dans une salle de réunion pourvoit par votre association d'arbitre.

Potentiel de risque : Dans ce recherche, nous ne prévoyons pas de risque au-dessus de risque que les arbitres experience normalement.

Potentiel du bien : Chaque participant va recevoir les résultats de l'étude. Les résultats vont détailler comment chaque niveau d'arbitre utilise la vision à prendre des décisions. Ca sera du bien pour les participants pour les entrainer et améliorer la facon qu'ils fixent leur regarde, et donc, prendre des décisions précis.

De plus, les résultats peuvent être utiliser d'établir des programmes d'entraînement pour des arbitres, pour développer leur abilités visuel. Puis, ça pourrai améliorer la performance des arbitres a chaque niveaux de hockey.

L'anonymat et la confidentialité : Toutes les données seront coder pour assurer que les arbitres ne sont pas identifier par les noms, les dates où les endroits. La confidentialité sera assurer, et toutes les données seront garder dans un cabinet sous clef situé au bureau MNT205 qui est toujours fermer à clef et accessible seulement aux étudiants de Dr. Ste-Marie. David Hancock sera la seule personne avec l'accès au cabinet. Quand l'anonymat est garanti, son professeur et des membres du comité seront permettre à voir les données. Cinq ans après la publication des résultats, les données seront détruire. Une des limitations d'anonymat et de la confidentialité est que les arbitres qui participent aux discussions en groupe discuteront avec trois autres arbitres qui sont de leurs niveaux respectifs. Par conséquence, l'anonymat et la confidentialité dans chaque groupe de discussion ne sont pas complètement protégés. Cependant, votre identité ne sera pas indiquée aux participants qui ne sont pas dans votre groupe de discussion.

La participation volontaire : Votre participation dans cette etude est strictement volontaire. Si vous voulez retirer de l'étude, vous le pouvez n'importe quand, sans question.

Si vous avez des questions concernant ce projet la, vous pouvez contacter les chercheurs inscrit en haut. Si vous avez une inquiétude au sujet d'éthiques, vous pouvez contacter le bureau suivant :

Subventions de recherche et déontologie, Université d'Ottawa, Pavillon Tabaret (159)
550 rue Cumberland, Ottawa, ON, K1N 6N5
613-562-5841, ethics@uottawa.ca

Votre signature au-dessous, indique que vous avez lu and compris l'information et que vous êtes d'accord et voulez participer dans l'étude intitulé, « Examen des differences perceptuels entre les arbitres de hockey aux niveaux de l'expert, de l'élite, et de l'intermediare : la comportement de l'attention visuel et du regard». De plus, vous confirmez que vous avez satisfait la critère d'inclusion pour l'étude (vous êtes compétent en anglais, vous avez 18 ans ou plus, et pour les arbitres intérmédiares, vous êtes un arbitre compétitif au niveau de « Bantam »).

La copie du participant:

Nom du participant : _____ date :

Signature du participant : _____

Signature du chercheur : _____ date :

La copie du chercheur:

Nom du participant : _____ date :

Signature du participant : _____

Signature du chercheur : _____ date :

Appendix D: Demographic Questionnaire**I. Contact Information**

- a. Name: _____
- b. Age: _____
- c. Email (phase one participants only): _____

II. Refereeing Information

- a. Total years of experience: _____
- b. Years at current level (Hockey Canada, CJHL, or NHL): _____
- c. Years of experience in other sports: _____
- d. Number of playoff seasons worked at your current level: _____

III. Playing Information

- a. Total years of experience: _____
- b. Highest level achieved: _____
- c. Number of years at highest level: _____

Appendix E: Helmet Camera Picture



Appendix F: Stimulated Recall Interview Debriefing Questions

Participants watched their helmet camera videotapes and were given three written questions to discuss:

- 1) What cues were you visually attending to?
- 2) Why did you attend to those cues?
- 3) How did that help or hinder your decision-making?

Appendix G: Stimulated Recall Interview Focused Code Table

Focused Code	EL –	EL –	INT –	INT –	NV –	NV –	TOTAL
	1 – 1	1 – 2	1 – 1	1 – 2	1 – 1	1 – 2	
Miscellaneous	3 (6.2)	7 (7.0)	6 (7.0)	6 (7.1)	6 (12.8)	0 (0.0)	28
Memory	0 (0.0)	3 (3.0)	2 (2.3)	4 (4.7)	2 (4.3)	0 (0.0)	11
Penalty calls	2 (4.2)	7 (7.0)	3 (3.5)	3 (3.5)	1 (2.1)	2 (6.9)	18
Communication	2 (4.2)	3 (3.0)	6 (7.0)	4 (4.7)	1 (2.1)	0 (0.0)	16
Visual impediments	1 (2.0)	1 (1.0)	6 (7.0)	3 (3.5)	1 (2.1)	0 (0.0)	12
Majority of players	7 (14.6)	16 (16.0)	3 (3.5)	18 (21.2)	2 (4.3)	6 (20.7)	52
Away from play	1 (2.0)	1 (1.0)	3 (3.5)	3 (3.5)	3 (6.4)	1 (3.5)	12
Away from puck	0 (0.0)	1 (1.0)	6 (7.0)	1 (1.1)	1 (2.1)	0 (0.0)	9
Puck carrier/puck	2 (4.2)	3 (3.0)	4 (4.6)	6 (7.1)	8 (17.0)	3 (10.3)	26
Body-check	2 (4.2)	7 (7.0)	12 (14.0)	2 (2.4)	0 (0.0)	0 (0.0)	23
One player	3 (6.2)	3 (3.0)	2 (2.3)	6 (7.1)	0 (0.0)	0 (0.0)	14
Positioning and VB	1 (2.0)	6 (6.0)	10 (11.6)	0 (0.0)	5 (10.6)	7 (24.1)	29
Learning/experience	0 (0.0)	0 (0.0)	4 (4.6)	0 (0.0)	6 (12.8)	2 (6.9)	12
Post-whistle attention	3 (6.2)	7 (7.0)	2 (2.3)	4 (4.7)	2 (4.3)	3 (10.3)	21
Anticipation	3 (6.2)	12 (12.0)	5 (5.8)	15 (17.6)	2 (4.3)	2 (6.9)	39
Assisting focal attention	2 (4.2)	6 (6.0)	3 (3.5)	8 (9.4)	0 (0.0)	0 (0.0)	19
Contextual positioning and VB	5 (10.4)	8 (8.0)	9 (10.5)	2 (2.4)	3 (6.4)	1 (3.5)	28
Prioritizing VB	4 (8.5)	3 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7
Face-offs	7 (14.6)	6 (6.0)	0 (0.0)	0 (0.0)	4 (8.5)	2 (6.9)	19
GRAND TOTAL	48	100	86	85	47	29	395

Note. Column numbers indicate the number of meaning units for each participant. Focused code percentages for each participant are provided in parentheses. ‘VB’ denotes visual behaviors.

Appendix H: Raw Stimulated Recall Interview Quotes

1. Miscellaneous

- a. Okay. Can we pause it for a second? I just have to remember that I'm actually the one that was taping this. Like this is what I was looking at rather than just watching it like I would watch on TV. It's like, okay, I have to keep that in mind. This is what I'm looking at, why am I looking at it? (NV – 1 – 1: Miscellaneous)
- b. There you go [a goal is scored]. (NV – 1 – 1: Miscellaneous)
- c. If you think I'm missing something clearly you can prompt me. Any tips for what you're looking for because I don't want to ah... (NV – 1 – 1: Miscellaneous)
- d. Just trying to get out of the way I suppose. (NV – 1 – 1: Miscellaneous)
- e. But I did have a collision yesterday in one of my games. Coming out of the face-off, I looked one way and backed up and I collided with a child and we both fell. (NV – 1 – 1: Miscellaneous)
- f. Yeah, you could say that, like I don't want to impede the play and I certainly don't want to hit anyone or collide. And the look on the face, he was pretty upset with me. (NV – 1 – 1: Miscellaneous)
- g. Having some rough play there. (INT – 1 – 1: Miscellaneous)
- h. Net's off. (INT – 1 – 1: Miscellaneous)
- i. Back away from the play. (INT – 1 – 1: Miscellaneous)
- j. Another penalty. (INT – 1 – 1: Miscellaneous)
- k. Yep [he has a delayed penalty]. (INT – 1 – 1: Miscellaneous)
- l. And a false start. (INT – 1 – 1: Miscellaneous)
- m. In front of the net. (INT – 1 – 2: Miscellaneous)
- n. The more the focus on there as opposed to the rest of the ice? (INT – 1 – 2: Miscellaneous)
- o. No, that was the one later on. I think it was the last one where I called the two [Home Team] players. (INT – 1 – 2: Miscellaneous)
- p. Net came off—(INT – 1 – 2: Miscellaneous)
- q. No I didn't. It was the other one where the defenseman came in. (INT – 1 – 2: Miscellaneous)
- r. The kid [injured player] got up right away too. (INT – 1 – 2: Miscellaneous)
- s. It's kind of dark, eh? (EL – 1 – 1: Miscellaneous)
- t. Awareness—team awareness—zero. (EL – 1 – 1: Miscellaneous)
- u. How was my positioning for the goal? [Humorously] (EL – 1 – 1: Miscellaneous)
- v. Right there he's asking what I have on my head. (EL – 1 – 2: Miscellaneous)
- w. Play's dumped into the corner, (EL – 1 – 2: Miscellaneous)
- x. Nothing. (EL – 1 – 2: Miscellaneous)
- y. Must be different with a shorter guy, eh? Like the angles? Like they're looking right in his eyes where right now it looks like, "Who are you talking to?" (EL – 1 – 2: Miscellaneous)
- z. So in this case, there was the pass up. (EL – 1 – 2: Miscellaneous)
- aa. Puck right in the chops. (EL – 1 – 2: Miscellaneous)
- bb. Here, just back it up again. (EL – 1 – 2: Miscellaneous)

2. Memory

- a. Wow, that's a good question. I'm anxious to see what I do. (NV – 1 – 1: Memory)
- b. I like to think I at least look over and make sure that they're standing and part of the play and not distracted by something else. (NV – 1 – 1: Memory)
- c. Do I call penalties here? Offsetting [penalties]? (INT – 1 – 1: Memory)
- d. That's the unsportmanlike [penalties]? (INT – 1 – 1: Memory)
- e. Uh, no. (INT – 1 – 2: Memory)
- f. I think that was a different one. (INT – 1 – 2: Memory)
- g. This might've been the one where we did take it outside—no because it came across the ice. (INT – 1 – 2: Memory)
- h. I think that's the cross-checking penalty. Can't remember what penalty it was. (INT – 1 – 2: Memory)
- i. I didn't see what happened there, just stoppage of play, right? (EL – 1 – 2: Memory)
- j. In this situation where the puck comes along the boards, if you just back it [the video] up...why did play stop? Puck comes towards me, #10, that's just a shove, but do we have the chip or the can-opener there? Now I can't see it, I think I was looking at the puck. (EL – 1 – 2: Memory)
- k. Scroll back, is this the one where he shoves him from the side or trips him? (EL – 1 – 2: Memory)

3. Penalty calls

- a. Like you want the kids to have fun and that's what the focus is really, for me. I don't want to be too hardcore with the rules. (NV – 1 – 1: Penalty calls)
- b. I think with the lower calibre hockey that I've been doing, it's making the determination whether did the player just, you know, skate and can't stop because he's such a little—young players in hockey can't stop and just run into each other or is there intent behind it when I'm making a call because there are so many times where players just kind of run into each other and if I took the stance that, you know, body contact is body contact, we'd probably never get off the ice. It'd be so long, so just trying to make determinations whether it's intent. Was there a real goal-scoring opportunity or was it just players so young, have a hard time stopping, and just kind of run into each other to stop. (NV – 1 – 2: Penalty calls)
- c. I was the back official on it, and I believe it was the white player cutting to the net, and I don't know if was by mistake or anything but because he was cutting to the slot he had the angle on the blue defenseman. The blue defenseman put his stick down right on his ankle and he went over the skate—over the stick. So I was looking at the blue player definitely took away an obvious scoring opportunity on it whether it was by mistake, or on purpose... I was watching it from the back so I had everything in front of me and I was watching him cut to the net. So I had everybody in front of me. And my focus was on that white player, watching him. And, again, seeing right in front of me, probably 30 feet from me, the blue player putting his stick on the ankle. (NV – 1 – 2: Penalty calls)
- d. Tell them [the teams] I'm not going to take any of that—after the whistle the rough stuff's got to stop. (INT – 1 – 1: Penalty calls)

- e. A little bit of rough play. Put two guys in the box. (INT – 1 – 1: Penalty calls)
- f. So on that play there, I gave a penalty to the blue guy. (INT – 1 – 1: Penalty calls)
- g. So at that point I'm watching the two of them just take little hacks at each other. And at that one point the [Visiting Team] player actually put his stick between the guy's legs and pulled up. And I think it's at that point when I called the slashing penalty. (INT – 1 – 2: Penalty calls)
- h. I called a tripping here—That one I was watching the puck and where the [Visiting Team] player's stick was. Obviously he just took the guy's feet out, he didn't even touch the puck at all. (INT – 1 – 2: Penalty calls)
- i. Yes, and I gave both players roughing penalties there. (INT – 1 – 2: Penalty calls)
- j. Should be a penalty against, probably a slashing penalty on white. 10 white. So the penalty was for slashing and it was because of the guy coming through the slot, in control of the puck, and there was a slash on the stick, above the bottom third of the stick. So that's what the penalty was for. (EL – 1 – 1: Penalty calls)
- k. Easy enough call. We had right directly in front of me, looking right at it, was the can-opener hook between the legs from the defending team and then the attacking player who's stick was between the legs grabs it and throws it approximately 15, 20 feet. (EL – 1 – 1: Penalty calls)
- l. And here I'm looking for what happens when that defenseman catches the puck. Like I remember the team asking—they come up and ask, "What happened there? I thought you couldn't move?" And I'm like, "Well he didn't move his hand, he just moved his shoulders side to side." But I don't think—he didn't move the puck. So when he catches it, see how his hand doesn't move, it's just his shoulders, because he thinks he's getting checked. So I think it was just a matter of he was protecting himself more than he was trying to avoid the player and keep the puck in the zone. Because obviously he's outside the zone and that's not a penalty. Had he done that in order to deke out the player trying to gain possession or get the puck, completely different story. (EL – 1 – 2: Penalty calls)
- m. And there when there's a scrum at the net, it looks like he tripped the guy, but he didn't, he had his stick on the ice trying to play the puck and the defenseman backs into him, right. Yep. And then he said, "Check the tape." (EL – 1 – 2: Penalty calls)
- n. So here's an example, too of, that guy got checked into the boards from behind, but he was intentionally trying to block the player [who checked him] from playing the puck. But because he still has, somewhat, control of what the puck's doing, there's no penalty. You know what I mean? So I'm watching for that too. Like yeah, the guy bumped him, but the red player intentionally got bumped in order to gain control of the puck. #14 makes contact from behind, but nothing. (EL – 1 – 2: Penalty calls)
- o. Uh-huh. For basically shoving the guy for no—I didn't see anything that the white guy did that initiated it. (EL – 1 – 2: Penalty calls)
- p. Well it's a penalty to #20, but, I think I called the boarding on that play, right. (EL – 1 – 2: Penalty calls)

- q. Yep, because he's moving. Boarding because he's shoving him from the side, but not necessarily from behind, like the top shoulder. His intention wasn't to crank him from behind, but—I didn't think he was intending to hit him from behind—but because the puck was there and he had lost 2 steps or whatever, in order to beat the attacking player to the puck he shoves him. Just a dangerous play against the boards: boarding. (EL – 1 – 2: Penalty calls)
- r. And he [offending player] wasn't really moving either. (EL – 1 – 2: Penalty calls)

4. Communication

- a. Especially when it's close because with the angle it's hard to tell. I think back, and I can't really see and I look to him to see what the call is. Well often times I'll check to see what my other linesman will call. What he's making at the line [offside or not offside]. Like, I watch him rather than watch the play sometimes. (NV – 1 – 1: Communication)
- b. I'm not sure what he's [linesman] telling me there. Oh yeah, he's telling me to take the face-off outside. (INT – 1 – 1: Communication)
- c. In between a whistle, like at the net or something, if there's stuff going on I'm usually yelling, "All right guys, that's it, that's it. I've got no penalties right now, so let's move it. Keep it clean." Or if there's something going on I'm usually yelling, "Green [blue] get out of there—you're going to the box already—stop" or, "White, you're going to the box." Just so they know what's going on and maybe if I'm yelling at the people, or the players, that they already got a penalty, they'll smarten up and won't put their team down any more. (INT – 1 – 1: Communication)
- d. The white coach is yelling at me that he [the injured player] got speared. (INT – 1 – 1: Communication)
- e. I ended up talking to both my linesmen. If I remember correctly, one of them [the linesman] said he [the injured player] just got hit hard into the boards and the other linesman said he didn't see it also. (INT – 1 – 1: Communication)
- f. I can talk to them where they can hear me now and say, "Guys that's enough, that's enough. I've got you and you going to the box." (INT – 1 – 1: Communication)
- g. I feel moving closer to the play helps break it up faster because I know the players know—if they can hear me—they know then I've got so—and—so going to the box or I've got nobody going to the box. (INT – 1 – 1: Communication)
- h. At this point I'm talking to the players, just to move the puck out. (INT – 1 – 2: Communication)
- i. At this point I'm watching the players on the ice and the [Visiting Team] team has a late change. I send both kids back. Except for the one kid who's not listening. I think I said at this point, "I don't speak [Visiting Team's language]" so I didn't understand what the kid was saying to me. (INT – 1 – 2: Communication)
- j. They [Home Team] asked a couple of times for penalty shots. Even [Linesman] wanted a penalty shot for anything. (INT – 1 – 2: Communication)
- k. Make sure I'm checking with the coaches, try to communicate with them just to make sure they know when to make the appropriate change there. Watching the

players coming on and off the ice too. With the exception of the one time where I didn't count the players after the goal. (INT – 1 – 2: Communication)

- l. So when the play goes up the ice it's basically just, it's a force of habit to check when need be. Most linesmen at this level will tell us if we need to or don't need to. And actually [name of linesman] in this game is very good at telling you, "Now", "Not now", "Just keep going." (EL – 1 – 1: Communication)
- m. I turn my attention to the home bench who's yelling at me, "What's he supposed to do?" [Referring to attacking player who threw the stick]. (EL – 1 – 1: Communication)
- n. Well, they always ask, "Wasn't that a stick?" But no. In that situation, when they ask right away, I'm like, "No, puck right in his face." That's why I stopped play before he even—I knew he was hurt and obviously spitting blood, he was. (EL – 1 – 2: Communication)
- o. And here I'm looking for what happens when that defenseman catches the puck. Like I remember the team asking—they come up and ask, "What happened there? I thought you couldn't move?" And I'm like, "Well he didn't move his hand, he just moved his shoulders side to side." (EL – 1 – 2: Communication)
- p. Because I waved off a goal, and called the penalty because of the waved off goal, I'm not going over to the bench. Usually the coach wants an explanation for every waved off goal, in this situation with—how much time was left in the period? Two minutes maybe? I am telling him—like when I skate close to the bench, like you can see—like I'm looking at him for the line change procedure anyway, but I'm looking at—he wants me to come over and I'm telling him, "I'll be there at the end of the period." Just save delaying the game. (EL – 1 – 2: Communication)

5. Visual impediments

- a. Basically there's less obstructions. I can get in there and look around players more easily I find. Where you're standing farther back—especially with the kids when the bunch together, its, uh, it can be challenging for sure to see what they're up to. (NV – 1 – 1: Visual impediments)
- b. Can't see what's going on because my head is down. (INT – 1 – 1: Visual impediments)
- c. Absolutely [Agreeing that sometimes you simply cannot see all the plays on the ice]. (INT – 1 – 1: Visual impediments)
- d. Well there you go, I took a little peek back and missed the hit at centre ice. (INT – 1 – 1: Visual impediments)
- e. On this injury here, I didn't have the best sight of what happened. (INT – 1 – 1: Visual impediments)
- f. I really didn't personally see a spear. (INT – 1 – 1: Visual impediments)
- g. So if you don't see anything, you can't call it. (INT – 1 – 1: Visual impediments)
- h. Yeah, and I know the camera didn't scan that way but I was also, I was trying to scan back and forth between the guys at the blueline for the hit (INT – 1 – 2: Visual impediments)
- i. I dropped my head! (laughing) (INT – 1 – 2: Visual impediments)
- j. I dropped my head? [Laughing.] (INT – 1 – 2: Visual impediments)

- k. Looks like I was getting a little bit tired there as I put my head down while I was skating. (EL – 1 – 1: Visual impediments)
 - l. There was another play, it was the same thing, but he can—opened the guy. But on the camera angle here, you couldn't see where his stick was, right? (EL – 1 – 2: Visual impediments)
6. Majority of players
- a. Usually it's the kids are standing around and they're hitting the puck, or trying to hit the puck. Of course if I see it, if I see something out of the ordinary I'll try to—I would do something. But generally I find the same thing happens each time. So I guess that's maybe part three of the question, like how having a preconceived notion of what's going to happen. Then if something does happen out of the ordinary I'm maybe not prepared. It's quite possible. (NV – 1 – 1: Majority of players)
 - b. Well, in the big scrums, not really. (NV – 1 – 1: Majority of players)
 - c. I'm just looking to see where everybody is on the ice. I come from a soccer refereeing background where you're the only person on the field so you're constantly just trying to take in everything. (NV – 1 – 2: Majority of players)
 - d. So here I was looking at two things. I was looking back and forth to make sure the player wasn't injured [and] trying to keep my eye on the play. (NV – 1 – 2: Majority of players)
 - e. When I'm the back official I want to keep everything in front of me. So, like that's my call. I turn my back to them and something happens and I miss it, you know, that's bad because I'm out of position. You know, I missed that call. (NV – 1 – 2: Majority of players)
 - f. I want to keep everybody in front of me and for the little guys too, I just want to make sure nobody's injured. Yeah, I wanted to keep them all in front of me. (NV – 1 – 2: Majority of players)
 - g. I noticed myself a couple of times in that game, as a back official, you know, I'm watching the puck all the time—and I'm well, "One second, I've got to watch the rest also." You know, I've got to have some faith in the other official that he's going to pick something up 10-feet from him on the puck and I can watch, you know, anything that might go on in the high slot. So a couple times I kind of realized, "Okay, I need to take just to quick look around." (NV – 1 – 2: Majority of players)
 - h. I want to work on, as the back referee, watching more of the—watching the whole area as opposed to just focusing on the puck carrier. Because something—if I position myself so everybody's in front of me, so I should be—instead of just focusing on that puck carrier as the back referee, just looking around and seeing everything on the ice. (NV – 1 – 2: Majority of players)
 - i. Uh, I'm just really trying to focus on where the majority of the players are. (INT – 1 – 1: Majority of players)
 - j. So if you have your head watching the white guy at the point, you don't know what's happening at the front of the net where the majority of the players are. (INT – 1 – 1: Majority of players)
 - k. Because the play's moving up the ice, there's only two blue guys that have the puck, all the players are behind the play. So I know there's nothing really

happening where the puck is, so I just want to make sure there's nothing happening behind the play where the majority of the players are. (INT – 1 – 1: Majority of players)

- l. The more checks you do, most definitely, it helps you because you have a more, like a better sense of what's going on around you. So your awareness is heightened. Yeah, the more you check the more you can see. Kind of have a feeling where it is, you can react to potential issues on the ice. (INT – 1 – 2: Majority of players)
- m. And I wanted to see if there were [Visiting Team] players back there as well just to see if there was—you know a fast break or any sort of possible infraction going on before the hit [in the corner] happens. You want to get it in, make it done quick, and that way you can focus again on the potential infraction. (INT – 1 – 2: Majority of players)
- n. At this point the guys are just standing around. The guys weren't moving. You notice the way they're spaced out. Less chance of something going on. Basically, the way the guys are spaced out there's less risk because they're not within a close proximity to each other. So it requires less attention to scan the ice because you know that they're not moving so it's going to take them a while to catch up to one of the other players. That gives me a little bit more time to focus on the puck and the play moving up [the ice]. (INT – 1 – 2: Majority of players)
- o. And basically assessing any risk possible behind me before I move up the ice because that way if there's something going on I can turn around and I can focus on that. (INT – 1 – 2: Majority of players)
- p. Looking to know where the players are on the ice. I need to know where the defending players are compared to where the [Home Team] players were. (INT – 1 – 2: Majority of players)
- q. Just scanning the ice, kind of getting a feel of where everybody is. (INT – 1 – 2: Majority of players)
- r. I'm more focused on the puck because that's where the potential hit is. But, you know, I'm still trying to focus on the two guys that are coming off the boards as well. Take a little flick of the eye back and forth and just keep an eye on it. (INT – 1 – 2: Majority of players)
- s. So most definitely make sure I know what's behind me too. Always when I'm skating up the ice [referring to check backs]. (INT – 1 – 2: Majority of players)
- t. Do the check back to see what's going on back there. Yeah, make sure you know who's there. (INT – 1 – 2: Majority of players)
- u. Trying to locate where all the [Home Team] players are. (INT – 1 – 2: Majority of players)
- v. Got to scan the ice. (INT – 1 – 2: Majority of players)
- w. Yes [Response to scanning away from play and back to puck carrier]. (INT – 1 – 2: Majority of players)
- x. scanning the ice to make sure I know where all the [Home Team] players are as they're moving up the ice and that way I know where the [Visiting Team] players are too. (INT – 1 – 2: Majority of players)
- y. Yeah. Because I would spend more time watching him chase the puck carrier while scanning back in front of the net. (INT – 1 – 2: Majority of players)

- z. At this point I'm scanning, watching the puck go to the point, also watching the guy in front of the net to make sure he doesn't interfere with the goalie. And make sure that the [Visiting Team] players aren't doing the same thing—like interfering with the players in front of the net. (INT – 1 – 2: Majority of players)
- aa. So a little scan, maybe not so much with the head movement, but my eyes can focus on them or—(INT – 1 – 2: Majority of players)
- bb. That way you know, like you're more aware of where they are and what kind of potential problems they pose on the ice. (INT – 1 – 2: Majority of players)
- cc. No because you're still, like, I'm more focused because the majority of the players on the ice are in that one spot. But I still have to do checks just to see where they are (INT – 1 – 2: Majority of players)
- dd. So when the play goes up the ice it's basically just, it's a force of habit to check when need be. Most linesmen at this level will tell us if we need to or don't need to. And actually [name of linesman] in this game is very good at telling you, "Now", "Not now", "Just keep going." So for myself with the check back when moving up the ice, it's a habit, but it's not always a habit—it's only when needed. (EL – 1 – 1: Majority of players)
- ee. Okay, so in that situation the puck had gone back to the point, but there was no attacking player going back to the point, so I knew [to put] my attention to the net—where there's 1, 2, 3, 4, 5, 6, 7 players at the net with no puck—so if something's going to happen in that situation, it's more likely going to be with the 7 players in front of the net rather than the one guy at the blueline shooting the puck all by himself. So the attention moves from the puck to the players. (EL – 1 – 1: Majority of players)
- ff. So I guess that was just a quick check back, right? Play turned over at the blueline, went up the ice, and I just did a standard, very routine, "Okay everybody's going this way, there's two guys back here, what are they doing?" Quick check, and then up the ice I go. (EL – 1 – 1: Majority of players)
- gg. So there's a situation I probably won't need to check back because I have 1, 2, 3, 4, 5, 6, 7, 8 players in front of me, so not a situation where I need to look back. Yeah, so not a situation where I have to look back. (EL – 1 – 1: Majority of players)
- hh. Yeah, that's where my attention is [on puck and 5 players]. (EL – 1 – 1: Majority of players)
- ii. I mean, for myself, what I try to do as a referee is keep as many people as I can in my sightlines. So, I'll always try to have my head looking at where the majority of the people are—not necessarily where the puck is. (EL – 1 – 1: Majority of players)
- jj. My feel for the game and the way I want [to call] the game is bodies—infractions usually happen on bodies. So I watch bodies and I try to have as many of them in front of me as I can at all times. (EL – 1 – 1: Majority of players)
- kk. watching in front of the net, (EL – 1 – 2: Majority of players)
- ll. Exactly [he focuses on where majority of players are]. Depending on where the puck's going to go though, right. Possibility for icing so watching the attacker and looking back. (EL – 1 – 2: Majority of players)

- mm. But I'm watching everybody. So my eyes are just scanning everywhere. Where are they going, yeah. (EL – 1 – 2: Majority of players)
- nn. Battle for the puck, nothing. Watch 'em play, goalie catches it. (EL – 1 – 2: Majority of players)
- oo. Well see right now, my head's going up, but I've got 1, 2, 3, 4, 5, 6 players. So the other 4 players are literally on my right-hand side. So I'm looking peripherally at them. Everybody's skating forward. There's nothing going on behind me. So there's no need to turn my head to look. I've got them peripheral on the right-hand side. (EL – 1 – 2: Majority of players)
- pp. Then here I've got 3 attackers low, all 4 guys are obviously in straight view, but I'm still checking back to make sure what's going on behind me...peripherally. In this situation with 3 guys low, 2 guys trying to pin 2 guys, I'm focusing right there and at the net. (EL – 1 – 2: Majority of players)
- qq. Here just keeping all the players in front of me again. With that close play at the net, I'm just turning. (EL – 1 – 2: Majority of players)
- rr. Depends on how many guys they have low. Like it doesn't matter that there's a powerplay or not, if you've only got 1 guy low, like a majority of the players are up high, so I'm not going to be at the net. Because the odds are they're going to be shooting the puck and I'd be in the way or get hit by the puck. By being here I can still see all the players and there's no activity at the net, so I'm within 2 strides of being there. (EL – 1 – 2: Majority of players)
- ss. So now I can see everything from the player shooting the puck right to the front of the net by being where I am. And I'm not necessarily watching in front of the net until the point comes up where I can see a player actually in the crease. (EL – 1 – 2: Majority of players)
- tt. But here, I'm concentrating now because the player's actually in the crease. Now I'm looking at, what are the defensemen going to do to the guy that's coming in [the crease] because odds are that's going to happen before a puck's shot on net. (EL – 1 – 2: Majority of players)
- uu. So here I'm waving off the goal because of the guy in front of the net in crease. The defenseman had held up from hitting the guy, I think because I was right there and waved off the goal right away. There's always the potential for the other guy still cracking him, but... (EL – 1 – 2: Majority of players)
- vv. And no goal here, it's waved off because if you look, as I was watching the guy in front of the net, the goalie's pads were in his [attacking player] feet. When the goalie goes down into the butterfly position, like I'm watching can he move because that guy's in front of him? Especially when he's [the attacking player] in the crease. So see how his stick is on his pad as he's saving that shot, the other player's skate is stopping him [the goalie] from turning to the right in about .2 seconds, whenever you un-hit pause. He's coming across, the puck's loose, the player was in the crease before the puck was, and the goalie can't move over. (EL – 1 – 2: Majority of players)
- ww. Now I'm also watching what's that—I'm still watching the red defenseman to see what's going to happen there, right? So it's kind of tough because I've got to watch for the interference, and for that, and loose puck, and the defenseman

possibly going to be cross-checking, shoving, punching, whatever. (EL – 1 – 2: Majority of players)

- xx. Same thing here, I'm looking back. Just monitoring all the players on the ice. (EL – 1 – 2: Majority of players)
- yy. Both. Just a scan just to see what's going on. (EL – 1 – 2: Majority of players)
- zz. Here I'm looking, because I can tell just by the camera, how like it's kind of titled, I'm looking back but my head's looking forward. So that if a player happens to look back, they know that I'm looking at them, but I might not even be. Just for that split—whatever it was—2 seconds. (EL – 1 – 2: Majority of players)

7. Away from play

- a. Yeah, I guess it is [my habit that I consciously look at things away from play]. (NV – 1 – 1: Away from play)
- b. Sometimes I like to just check—well I didn't do it there—but I'll check back to make sure, look for kids that are behind and see what they're doing. Just any players basically just to see what they're doing basically. (NV – 1 – 1: Away from play)
- c. Yeah, for sure. I found yesterday too with the early morning, the kids are more prone to falling down and not getting up. (NV – 1 – 1: Away from the play)
- d. Uh, I wouldn't—different side of the ice, probably not; because this was in such close quarters and both of them went down I just want to make sure that first of all there was no injuries (NV – 1 – 2: Away from the play)
- e. In this scenario I don't remember if I looked back, but I would usually pay more attention to the play behind instead of the play going up the ice. (INT – 1 – 1: Away from the play)
- f. Well there you go, I took a little peek back and missed the hit at centre ice. (INT – 1 – 1: Away from the play)
- g. I'd probably say I would more so ignore them in this situation because the puck carrier—he's skating pretty fast—if he's got his head down or something, he's going to get clocked. So I would probably say I would more so ignore the other players. (INT – 1 – 1: Away from the play)
- h. Yeah, I knew there was a [Home Team] player and a [Visiting Team] player up around the blueline. I wanted to make sure that nothing was going on behind the play. (INT – 1 – 2: Away from the play)
- i. At that point I wasn't too concerned with the [Visiting Team] player at [going toward] the blueline—or the [Home Team] defenseman—because I knew where all four [Visiting Team] players were so I didn't really need to pay attention to the guy at the blueline. (INT – 1 – 2: Away from the play)
- j. Well I still—because I knew he's kind of hanging out in front of the net—wasn't sure if there was a [Home Team] player there and I just wanted to make sure I was aware of who was where on the ice at the time. (INT – 1 – 2: Away from the play)
- k. Well you can see, just as play moved back, I took a quick look out into the slot to see who was there. So you'll see the 3 guys, 3 or 4 players here. And then there's a quick look out to the slot. Right there. See how I was just seeing if—if there was anybody there. (EL – 1 – 1: Away from the play)

1. Here I'm looking at the 2 guys that are right in front of me, but also the 2 guys that were up at the blueline. Like they're obviously gone to create contact, but what are they going to do? Is it going to be a little shove? (EL – 1 – 2: Away from the play)

8. Away from puck

- a. So, you know, I always check back to see if they were actually hurt. Because yesterday we had to blow the whistle twice because kids were just staying down. (NV – 1 – 1: Away from the puck)
- b. Well I know they're—[the Home Team's] got—they've got pretty good puck possession. (INT – 1 – 1: Away from the puck)
- c. So once again, the puck was really on the outside of the zone there. So I know where the puck is, I know where the players are on the ice; (INT – 1 – 1: Away from the puck)
- d. once again I'm paying more attention to the front of the net. That's mostly where the stuff will happen—whether a defenseman cross-checks a forward in the back or you get a trip behind [the net]. (INT – 1 – 1: Away from the puck)
- e. So that's why I'm trying to pay a little bit more attention to that because I know [the Home Team's] got possession of the puck and I know they're not going to be hitting any blue guys or anything like that. (INT – 1 – 1: Away from the puck)
- f. Oh absolutely, yeah [players being spaced out always from visual attention away from the puck] (INT – 1 – 1: Away from the puck)
- g. I'm just making sure there's nothing going on behind the play. Making sure there's no cross-checks or trips or no rough play or anything like that. (INT – 1 – 1: Away from the puck)
- h. Okay, I'm not too focused on the puck because I know there's—I can see the [Visiting Team] players in front of the net here. (INT – 1 – 2: Away from the puck)
- i. Now here when the puck's dumped in on the goalie, it's off the boards into the goalie, goalie catches it. I'm looking not at the goalie, but at what's happening on the side of the net. And obviously in this situation, red guy's going after the white guy, for whatever reason. (EL – 1 – 2: Away from the puck)

9. Puck carrier/puck

- a. Yes. (NV – 1 – 1: Puck carrier/puck)
- b. So again, just watching the puck. Seeing what develops. (NV – 1 – 1: Puck carrier/puck)
- c. Yeah, it's just like the kids—they all bunch around the puck. (NV – 1 – 1: Puck carrier/puck)
- d. I'm not sure what to say about it all. Just watching the puck still. (NV – 1 – 1: Puck carrier/puck)
- e. Just basically watching the play, and generally keeping a closer eye on the puck because that's where the action generally happens. (NV – 1 – 1: Puck carrier/puck)
- f. And like you were saying the other day, building the fundamentals first and generally the action happens around the puck. (NV – 1 – 1: Puck carrier/puck)
- g. I find in this league so far the biggest penalties are tripping, or—basically tripping. I've only called—well I've called two penalties actually and they were

- both for tripping. I found that's what happens the most—stick gets in there and the kid falls. (NV – 1 – 1: Puck carrier/puck)
- h. No [I don't consciously look away from the puck]. Like I don't have—there's no method to it. (NV – 1 – 1: Puck carrier/puck)
- i. and right when the puck drops, following the puck, to give the other referee a chance to get into position. I'll follow the puck right off the bat to, you know, if something goes right towards the blueline I can be there to make the call. Or if the other referee's trying to get back to position. (NV – 1 – 2: Puck carrier/puck)
- j. I think I might be just a force of habit. I've always watched where the puck goes—Force of habit as a player, on the ice. Force of habit also watching on TV. You're always watching where the puck goes. (NV – 1 – 2: Puck carrier/puck)
- k. Watch the puck carrier, yeah. (NV – 1 – 2: Puck carrier/puck)
- l. You know the puck carrier—there's going to be players around him—so you want to try and focus on maybe, I guess, on him because you know he's either going to get hit or there's going to be some stick work involved, because they've got to get the puck off him. (INT – 1 – 1: Puck carrier/puck)
- m. And he did split the 'd' [defensemen], see? (INT – 1 – 1: Puck carrier/puck)
- n. Yes [he focuses attention on a play where one player has an obvious advantage over another]. (INT – 1 – 1: Puck carrier/puck)
- o. So in this situation, where they're pretty much scattered all over the ice, I guess I'm paying a little bit more attention to the puck carrier because he looks like he's going to try and split the 'd' [defensemen] or dump it in or something. (INT – 1 – 1: Puck carrier/puck)
- p. I'm obviously watching the puck here to see if there's any sort of contact coming from the [Visiting Team] player, (INT – 1 – 2: Puck carrier/puck)
- q. And I think, with this, I was looking at something in front of the net, out of my peripherals while also following the puck just to know where the puck is. (INT – 1 – 2: Puck carrier/puck)
- r. And if the [Home Team] defensemen are just staying back at the point and there's no [Home Team] player floating around the front of the net, then I can spend most of my focus on the guys and the puck in the corner. (INT – 1 – 2: Puck carrier/puck)
- s. So I'm kind of watching to see—still have to keep an eye on the puck a little bit. (INT – 1 – 2: Puck carrier/puck)
- t. I called a tripping here—That one I was watching the puck and where the [Visiting Team] player's stick was. Obviously he just took the guy's feet out, he didn't even touch the puck at all. (INT – 1 – 2: Puck carrier/puck)
- u. At that point, yeah [he is focused only on this situation]. Because that's where the play is moving. It's a potential goal, so obviously I have to be a little more focused on the goal than the play behind me at that point. And also because that's the highest risk there because that's where the puck is. (INT – 1 – 2: Puck carrier/puck)
- v. So the play was up at the blueline, I did a quick check in front of the net to see who was—see if anybody was there. There was nobody there so I went back to the puck. (EL – 1 – 1: Puck carrier/puck)

- w. So basically my attention was there watching that play in the corner—there were 4 players with the puck, right? As soon as the puck moves away around the boards, my attention now goes away from these guys because I don't need to be there anymore. The attacking players are going to clear out and the play's moving away, so my attention goes now, away from those guys. (EL – 1 – 1: Puck carrier/puck)
 - x. No because I'm—yeah, I'll just stop if I have to, but I'm still, technically, looking at those 2 guys that were up at the blueline. Like where they're going. So I can kind of see them out of the corner of my eye. So I know I can just pivot and get back behind these guys and then get back into position. But I can't take my eyes off where the puck is and the puck carrier, right. (EL – 1 – 2: Puck carrier/puck)
 - y. What's happening is these 2 other guys come in. Now I'm clearly looking at the puck because it's in their feet. Are they trying to play the puck or are they trying to stop play? And who's trying to move the puck. Puck comes out, I just head check both ways because I know if the puck comes back I got 4 guys skating right at me. (EL – 1 – 2: Puck carrier/puck)
 - z. watching the puck carrier for possession there as well as is he tripping over his feet of the defenseman's feet or is the defenseman tripping the forward. (EL – 1 – 2: Puck carrier/puck)
10. Body-check
- a. I'm more focusing on the hit that just happened; just from experience in reffing, if somebody gets hit it could make them angry or something so they could turn around and punch the guy or hit him back. (INT – 1 – 1: Body-check)
 - b. So I'm paying more attention to that hit right now because he got hit pretty hard so you never know if he could do something behind the play. So you've got to pay attention to that. (INT – 1 – 1: Body-check)
 - c. I'm more focusing on the hit that just happened (INT – 1 – 1: Body-check)
 - d. I probably wouldn't change anything. Like I said before, you get hit—the other guy can get angry or something, punch you in the back of the head or something like that, so paying a little bit more attention to the play behind me. (INT – 1 – 1: Body-check)
 - e. It could be a negative thing, but in this situation I think it was a positive thing. That hit right there didn't seem too bad or anything like that. Puck was there. (INT – 1 – 1: Body-check)
 - f. In this situation there, I would probably say I'm more focused on the blue guy because he laid the hit. While the white guy's on the ice, you never know, maybe that blue guy can do something stupid to him while he's on the ice. (INT – 1 – 1: Body-check)
 - g. Yes [he focuses attention on a play where one player has an obvious advantage over another]. (INT – 1 – 1: Body-check)
 - h. In that situation there, the blue guy took a decent hit in the corner there, so if I remember correctly, I'm looking back to make sure he's getting up and not injured. (INT – 1 – 1: Body-check)

- i. But like you said, I took a quick look back and the puck got dumped into the play so that sort of helped because that drew my attention to where the puck was again. (INT – 1 – 1: Body-check)
- j. Absolutely [watches players after a big hit]. On a big hit you want make sure it's all clean, there's no elbows up, no head-shots— (INT – 1 – 1: Body-check)
- k. head-shots in hockey these days that's all that they talk about in the NHL, (INT – 1 – 1: Body-check)
- l. so you just want to make sure that it's a clean hit. (INT – 1 – 1: Body-check)
- m. Yeah, and I know the camera didn't scan that way but I was also, I was trying to scan back and forth between the guys at the blueline for the hit (INT – 1 – 2: Body-check)
- n. I'm more focused on the puck because that's where the potential hit is. (INT – 1 – 2: Body-check)
- o. I was looking—there was a player over here finishing a check. I watched the guy finish the check. So as a referee, whenever you have a rule that allows a player to finish a check after the puck's been moved you need to watch that guy finish the check for high hits, elbows, so you need to scan across away from the puck usually, to watch that guy finish the check. (EL – 1 – 1: Body-check)
- p. So again, you watch that because the guy, the defenseman stepped up to finish the check along the bench, so you've got to key in on that. (EL – 1 – 1: Body-check)
- q. There, obviously, it's just a weird check, more of a push. Nothing. (EL – 1 – 2: Body-check)
- r. There his arm's on the player making the hit, #6 white. Like I'm not watching where he's necessarily making contact but how he's holding his arm before the hit. (EL – 1 – 2: Body-check)
- s. Yeah, so like, right here, he's still within the stick length of hitting him, so he's okay. And then as soon as the contact—I don't see arms up or anything else, right— (EL – 1 – 2: Body-check)
- t. I still check back in case that guy's—the winger that's clearing the zone—in case his arms come up, so I'm just looking for what happened on that hit. (EL – 1 – 2: Body-check)
- u. So the break there, same thing. Winger attacking to make the hit. Defenseman moves back out of the way. Nothing. Still just watching for that stick, because if you noticed, he had 2 hands loose—he didn't have 2 hands on the stick—so I'm looking for where that stick's going too because the player's supposed to still have control of his stick. (EL – 1 – 2: Body-check)
- v. It's the white winger, his left hand's free of the stick and it looks like his elbow's going to pop. But what happens? He hugs it back it in. Makes contact with boards because the player moves, right? (EL – 1 – 2: Body-check)
- w. When the guy's pinning the puck against the boards, it looks like he's looking for what way is he going to go. And then when both defensemen go at him, I'm watching for hands. In this situation they were all shoulder height. So it was more of a pin up against the boards. (EL – 1 – 2: Body-check)

11. One player

- a. Guy—he was going up the ice—I could've gave him a couple different penalties. Slashing, hooking, I think I let a slash go and then he finally gives the blue guy—or gives the white guy—two tugs with the stick. So that's enough. He's got to go to the box there for hooking. (INT – 1 – 1: One player)
- b. Uh, he's skating up the ice, he's trying to back check, but he's kind of got his stick waving in the air which makes me think that he's going to do something out of the ordinary to the white player. So with him swinging his—he wasn't necessarily swinging his stick—but he had it over his and you could kind of tell he was going to do something out of the ordinary so that's why I paid a little bit more—that's what drew my attention to him. (INT – 1 – 1: One player)
- c. And here I'm watching the [Visiting Team] player because he's kind of tangled up with the [Home Team] player in front of the net. (INT – 1 – 2: One player)
- d. Yeah, it's to make sure—I always check back to see if the goalie's doing something too. Maybe the goalie's hurt. (INT – 1 – 2: One player)
- e. Yeah [he saw player coming the entire way before the hit]. (INT – 1 – 2: One player)
- f. Where the [Home Team] player started. The fact that the [Visiting Team] player was defenceless at some point, had his head down, and he's trying to unload the puck. And then he [Visiting Team player] gets absolutely flattened. (INT – 1 – 2: One player)
- g. I kind of had a feel of where everybody else was. I take a look back [at the injured player]. Obviously the kid that hit him was a little bit bigger than him. (INT – 1 – 2: One player)
- h. And I also want to know what's going on with the goalie and make sure that, you know, he's not hurt. (INT – 1 – 2: One player)
- i. Well, this—I'm watching this guy in front of the net because I know he's going to try and block or run interference on this guy because he's beat. He's flat-footed, the attacking player's moving—I know he's going to try and run some interference because he's beat. (EL – 1 – 1: One player)
- j. So he's going to try and slow that guy down any way he can without taking a penalty. Unfortunately for him, he put the stick between the guy's legs. So clearly an obstruction call, right? Because he's flat-footed. (EL – 1 – 1: One player)
- k. And there's no need for me to look at the puck behind me because there's nobody there. So my attention has to be on that guy who's flat-footed. (EL – 1 – 1: One player)
- l. And there you see play along the boards, you've got the defenseman trying to kick the puck, but he's got 2 hands against the boards so you know that...do you know what I mean? There's no obstruction [on] the winger on that play. He's guarding the puck. See? (EL – 1 – 2: One player)
- m. Again, definitely watching the player that's right in front of the goalie. (EL – 1 – 2: One player)
- n. Now here I can really notice that, like as their cycling towards the centre of the ice, I'm still watching mainly the guy that's in front of the goalie. (EL – 1 – 2: One player)

12. Positioning and visual behaviors

- a. Well I, I guess I'd say it was a learning experience the other day where I was—actually it was in this game here where the puck, I was quite sure it had gone in, but I didn't actually see the puck in the net. So, you know, I guess that's a bad example because that's something I was doing yesterday in my games is I was getting right in there just so I could be sure because I have to be the decider. (NV – 1 – 1: Positioning and visual behaviors)
- b. You know when you get caught there, up close with the kids, you want to get out of the way, but I know I few times yesterday I was really in the way. (NV – 1 – 1: Positioning and visual behaviors)
- c. Uh, it's more just to get to the boards. (NV – 1 – 1: Positioning and visual behaviors)
- d. Yeah, because I'm generally moving faster than they are anyway. So, if I can go to the open spot I'll take it. (NV – 1 – 1: Positioning and visual behaviors)
- e. I may be looking for a way out of the situation because the puck was pretty close to where I was. So I was maybe making sure I had room to move if I had to. (NV – 1 – 1: Positioning and visual behaviors)
- f. I don't know. I wouldn't really make an adjustment for this [when play is on far side of ice]. I really didn't have a tough time seeing what the little kids and that. (NV – 1 – 2: Positioning and visual behaviors)
- g. There's a couple of times, where I'm the down-low official and play comes behind the net and I'm in my half-piston position and I have a hard time so I kind of go down to the goal-line to get a better view of what's behind the net. (NV – 1 – 2: Positioning and visual behaviors)
- h. There does [come a time when play is too close to referee]. There is. At that point I'm trying to keep the play in front of me. (NV – 1 – 2: Positioning and visual behaviors)
- i. So I'm trying to get backwards as fast as I can to at least make it to the blueline to be in position to make the call at the blueline and not having to get tangled up and turned around looking different ways. (NV – 1 – 2: Positioning and visual behaviors)
- j. Yes. Yeah I do get into that scenario in the endzone, but I'm on the boards—not the half-piston—but on the boards where the puck is kind of coming around and they're all bunching towards you and you don't want to turn your back to the middle of the ice to see what's going on the boards and you don't want to get caught out of position. (NV – 1 – 2: Positioning and visual behaviors)
- k. Looking for a little lane where I can only—where I can move maybe four or five feet only. Keep everything in front of me and just kind of slide into that lane. (NV – 1 – 2: Positioning and visual behaviors)
- l. I think I have some things to work on like my positioning and that. Just to—like I said earlier, when the play's behind the net I've been moving to the goal-line just to kind of get a better view behind the net because it's hard to see the little player's behind the net. But, um, mainly working on positioning. So I can be in better positions to make, you know, educated calls. (NV – 1 – 2: Positioning and visual behaviors)
- m. I just try and get the best look possible. So if I've got to skate closer to the play then I will. We're really not supposed to go behind the net, so in this situation

- here I usually probably go to the bottom of the circle because that's where I feel I have the best angle. (INT – 1 – 1: Positioning and visual behaviors)
- n. Just basically, again, the best angle to see what's going on, I think, is the most important thing to do here. (INT – 1 – 1: Positioning and visual behaviors)
 - o. Between a goal I try and pay as much attention to the players behind me. I'm also trying to get the number of the guy who scored and the guy who got the assist. So I try and keep my back towards the play [he means back away from the play] as much as possible. (INT – 1 – 1: Positioning and visual behaviors)
 - p. I would probably say trying to get into a better position. Really there's nothing going on, the puck's kind of bouncing off the boards here, so I'm just trying to make a safe exit from the face-off that just happened and looking for players around me. (INT – 1 – 1: Positioning and visual behaviors)
 - q. Not necessarily, I probably could have been in a way better position to see what happened. (INT – 1 – 1: Positioning and visual behaviors)
 - r. I had a delayed penalty on. I don't really recall but I could've just been more sitting back and not skating as hard because I had a delayed penalty on, but I could've been in a lot better position there. (INT – 1 – 1: Positioning and visual behaviors)
 - s. Well being on the other side of the ice you kind of got to move into the right position to get a better view of everything. (INT – 1 – 1: Positioning and visual behaviors)
 - t. So in this play here I was against the boards where the hashmarks are and then I kind of skated across the ice so I've got a view of, pretty much, all 10 players on the ice now. (INT – 1 – 1: Positioning and visual behaviors)
 - u. I think moving closer to the play will help you see a little bit more of what's going on compared to what it is if I was still standing against the boards. (INT – 1 – 1: Positioning and visual behaviors)
 - v. Yeah, that's a good way to put it [adjusts positioning, but not visual strategies]. (INT – 1 – 1: Positioning and visual behaviors)
 - w. But if I can position myself where my head is looking at more people, then that's what I'll do rather than always constantly moving my head back and forth. (EL – 1 – 1: Positioning and visual behaviors)
 - x. No because I'm—yeah, I'll just stop if I have to, but I'm still, technically, looking at those 2 guys that were up at the blueline. Like where they're going. So I can kind of see them out of the corner of my eye. So I know I can just pivot and get back behind these guys and then get back into position. But I can't take my eyes off where the puck is and the puck carrier, right. (EL – 1 – 2: Positioning and visual behaviors)
 - y. So here I'm back into position and the guys were all in front of me. (EL – 1 – 2: Positioning and visual behaviors)
 - z. Here obviously the scrum and I'm skating behind the play to see who's coming in from behind the players. Linesmen are in there to break up any altercations, but what's going on behind them? Line change, defensemen coming in, forwards going out? I can see everybody, watching everybody. (EL – 1 – 2: Positioning and visual behaviors)
 - aa. Back into position. (EL – 1 – 2: Positioning and visual behaviors)

- bb. so what are you watching for? Everything. That's why I'm at the top—the bottom of the circle, do you know what I mean? Like out higher, so I can still see everything. More of the focus is at the net, but peripherally looking at the top of the crease to the hashmarks and then all the way back against the boards. (EL – 1 – 2: Positioning and visual behaviors)
- cc. Yep, because I knew there was 4 guys within 10–15 feet. So if the puck comes back, they've either turned off the boards or they're right behind me. And then in this situation I'm just against the boards and they bring it out in front of me, so I'm fine. (EL – 1 – 2: Positioning and visual behaviors)

13. Learning/experience

- a. In the beginning it's, well it's not really clear exactly what the best way to do it is. You just have to go and see what works, what you feel comfortable with. I feel a lot more confident that I get right close to the net. I feel like I'm in the right spot to make the call. (NV – 1 – 1: Learning/experience)
- b. For me so far it's been [learning from] instinct and also experience. Like I was mentioning about being too far from the net. So I've adjusted and I've tried to make sure I'm always in a better position now that I know what the better position is. (NV – 1 – 1: Learning/experience)
- c. But I found I wasn't getting in there before yesterday, for example. Like I probably hadn't been within 15 feet of the net while the play was on, like I was too far back. So, you know, I've made that adjustment. (NV – 1 – 1: Learning/experience)
- d. Game experience, yes. (NV – 1 – 1: Learning/experience)
- e. But it's not like it's something new. Like this is how we were instructed to do it. You know, using the half-piston etc...etc... (NV – 1 – 1: Learning/experience)
- f. I've really found that it's really almost a brand new sport, brand new game now that I'm a referee. Basically I have to just approach it from a completely different angle because, well, because you do. You're not part of the play, you're watching right, you're supervising. (NV – 1 – 1: Learning/experience)
- g. I'm just looking to see where everybody is on the ice. I come from a soccer refereeing background where you're the only person on the field so you're constantly just trying to take in everything. (NV – 1 – 2: Learning/experience)
- h. and second of all, you know, if he decides to lay a slash, they're getting knocked down, it's right in front of me and I'm in really good position to make a call. Kind of something goes off in my head like, "Um, okay, you'd better stay here for a second just to make sure everything is all right." I think it comes from refereeing soccer [being aware of potential infractions] and also from playing hockey for so many years, you know [being aware of potential infractions]. I was a defenseman too that always look—you know the linesmen—you know the ref's got his back turned and 'whack'. Right in the back of the knee, you know, or give the guy a shot when they're not looking, so...sounds bad, but I can say, "I know what you're thinking, I've been that person before." (NV – 1 – 2: Learning/experience)
- i. It's really neat to hear what they have to say and the kind of help that they give me will help me keep improving on my game as a referee or as a linesman. That's basically it. That's—I guess that's why I look where I do sometimes

because that's where I've been told to look from guys [supervisors/other refs] that are helping me out. (INT – 1 – 1: Learning/experience)

- j. I think just over the years of experience of refereeing and getting supervisions, it's really neat to learn from guys that have more experience than I do and guys that have reffed higher hockey than I do. So they've been in the position where I've been before. (INT – 1 – 1: Learning/experience)
- k. You know where the puck is, you know that there's nobody around the white guy [who is at the blueline] and you know that there's a bunch of people in front of the net. So if you have your head watching the white guy at the point, you don't know what's happening at the front of the net where the majority of the players are. So that's why I'm taking a peek—just from years of experience from being told in supervisions to look not always where the puck is—did I say that right? Look not always where the puck is but where the play is. (INT – 1 – 1: Learning/experience)
- l. Just years of experience and being told from supervis[ors]. (INT – 1 – 1: Learning/experience)

14. Post-whistle attention

- a. So I'm checking his number [the player who scored]. (NV – 1 – 1: Post-whistle attention)
- b. Well I don't know if I did in that case, but I just try to make sure that there's no collisions basically. Just make sure they're doing what they're supposed to be doing. (NV – 1 – 1: Post-whistle attention)
- c. Right there I'm looking back to make sure the penalty time gets put on the clock and uh, taking note of the time in case it didn't. Right. So there's another whistle and I skate over to the penalty box to say, "Okay, are we just doing clock and the time then [rather than put the penalty time on the clock]" (NV – 1 – 2: Post-whistle attention)
- d. Right now I'm just looking at benches and making sure they got their right players on the ice—I'm not going to run over any kids skating to the spot. (NV – 1 – 2: Post-whistle attention)
- e. Looking at the amount of players on the ice (NV – 1 – 2: Post-whistle attention)
- f. Yep. [Indicating after a whistle, he generally keeps an eye on everything] (INT – 1 – 1: Post-whistle attention)
- g. Between a goal I try and pay as much attention to the players behind me. I'm also trying to get the number of the guy who scored and the guy who got the assist. So I try and keep my back towards the play [he means back away from the play] as much as possible. (INT – 1 – 1: Post-whistle attention)
- h. At this point I'm watching the players on the ice and the [Visiting Team] team has a late change. I send both kids back. Except for the one kid who's not listening. I think I said at this point, "I don't speak [Visiting Team's language]" so I didn't understand what the kid was saying to me. (INT – 1 – 2: Post-whistle attention)
- i. Well obviously scanning the ice to see who's where. Make sure I'm checking with the coaches, try to communicate with them just to make sure they know when to make the appropriate change there. Watching the players coming on and

- off the ice too. With the exception of the one time where I didn't count the players after the goal. (INT – 1 – 2: Post-whistle attention)
- j. This is where the face-off should've gone outside if it didn't already. Yeah, the 'd' [defensemen] came in. (INT – 1 – 2: Post-whistle attention)
- k. Obviously when I'm skating to the box I'm taking a quick peek over at the players to make sure nothing's going on. (INT – 1 – 2: Post-whistle attention)
- l. It was a game where it was very quiet, nothing happening after the whistles, so I was able to blow my whistle, turn my attention to the benches, get the line change going, get the game going. (EL – 1 – 1: Post-whistle attention)
- m. And in this game there wasn't a lot of stuff after the whistle that I needed to key in on. So in this type of game it wasn't necessary for me to be in a position where—after every whistle—where I had to be there to use the vocals. I can pretty much just do my job with the line changes after every whistle because the game did not need me to be in there talking to the players, you know, sorting things out. (EL – 1 – 1: Post-whistle attention)
- n. So once again, as a referee, there's clearly nothing happening after the goal so I don't need to hang around. The team that just got scored on basically is clearing out while the attacking team is celebrating. So I don't need to be there, so I'm clearing out. (EL – 1 – 1: Post-whistle attention)
- o. Now I'm looking at the team coming off the ice and the players coming [on] the ice, but also the players that are going off the ice, where they're skating. So I'll turn my attention to them more than the players coming off the ice on the line change if the players going off the ice are going towards the other team. (EL – 1 – 2: Post-whistle attention)
- p. At this level always concerned about it because they're always talking. (EL – 1 – 2: Post-whistle attention)
- q. So we're good to go, get the guys out for the line change. Let the [home team] guys take a little bit more time than they're supposed to just because [of the injury]. (EL – 1 – 2: Post-whistle attention)
- r. Oh yeah. Again, just double-check, make sure. Also check where the 'd' [defensemen] are, if the 'd' [defensemen] came in on the scrum, etcetera. (EL – 1 – 2: Post-whistle attention)
- s. Scrum ensues. Now here I'm shoulder checking to see if anybody's coming in to aggravate this assault—like aggravate the situation. Nothing. Back on to what's going on. Nothing's really going on. I'm not looking at these guys [around the net] anymore. I'm back, stopping the guys coming in. (EL – 1 – 2: Post-whistle attention)
- t. Now at this point I'm making sure that they're not delaying—like white's not delaying in starting the game because now red's down 2 men, do you know I mean? Yeah, I'm looking at the bench making—like for the line change procedure—I'm making sure that red's got their 3 guys out as soon as possible. In this situation they had them out and everything's fine. But I'm looking at the white bench to make sure that they're not delaying by getting the players that they want on this 2-man attack [the 5 on 3 powerplay]. (EL – 1 – 2: Post-whistle attention)

- u. Line change, everybody's on, get into position. (EL – 1 – 2: Post-whistle attention)

15. Anticipation

- a. Well, something you wouldn't expect them to do. Maybe like a slash or hitting with their hand. (NV – 1 – 1: Anticipation)
- b. Well I'm basically watching the defenseman to see if he does something illegal, right—that would constitute a penalty. Because in this kind of situation that's, you know, he would be more apt to cause an infraction of some sort. (NV – 1 – 1: Anticipation)
- c. And not really at the Novice level, but you can almost anticipate when the players get better, where they're going to be and what can happen. (NV – 1 – 2: Anticipation)
- d. Just the way he was coming at him and I knew this player—the blue player—had to cut to the net. So just the way he was skating, I thought, "Okay, there could be some contact here and I'm going to watch it." And when I saw him—the blue guy gets a bit of the angle—he lowers his shoulder and extends out to knock him off the puck. So even though it is Novice, I felt that you gotta teach the kid he can't do that. You know, he can hurt another kid if that's on the boards or that. (NV – 1 – 2: Anticipation)
- e. I'm more focusing on the hit that just happened; just from experience in reffing, if somebody gets hit it could make them angry or something so they could turn around and punch the guy or hit him back. (INT – 1 – 1: Anticipation)
- f. So I'm paying more attention to that hit right now because he got hit pretty hard so you never know if he could do something behind the play. So you've got to pay attention to that. (INT – 1 – 1: Anticipation)
- g. I probably wouldn't change anything. Like I said before, you get hit—the other guy can get angry or something, punch you in the back of the head or something like that, so paying a little bit more attention to the play behind me. (INT – 1 – 1: Anticipation)
- h. In this situation there, I would probably say I'm more focused on the blue guy because he laid the hit. While the white guy's on the ice, you never know, maybe that blue guy can do something stupid to him while he's on the ice. (INT – 1 – 1: Anticipation)
- i. once again I'm paying more attention to the front of the net. That's mostly where the stuff will happen—whether a defenseman cross-checks a forward in the back or you get a trip behind [the net]. (INT – 1 – 1: Anticipation)
- j. and then I noticed the [Visiting Team] guy come out with the [Home Team] player. So I wanted to keep my eye on him, because I knew they were chirping each other earlier on in the game. (INT – 1 – 2: Anticipation)
- k. So at that point I'm watching the two of them just take little hacks at each other. And at that one point the [Visiting Team] player actually put his stick between the guy's legs and pulled up. And I think it's at that point when I called the slashing penalty. (INT – 1 – 2: Anticipation)
- l. At this point I'm scanning, watching the puck go to the point, also watching the guy in front of the net to make sure he doesn't interfere with the goalie. And

- make sure that the [Visiting Team] players aren't doing the same thing—like interfering with the players in front of the net. (INT – 1 – 2: Anticipation)
- m. I think there's less of a risk at this point, because there's less [Visiting Team] players on the ice [because it is 5 on 3]. (INT – 1 – 2: Anticipation)
- n. Looking for any sort of rush possibility or even just to see if there's any sort of issue that may occur. (INT – 1 – 2: Anticipation)
- o. Bringing—carrying the puck up the ice, looking for a long pass or—where I put myself in a position where I have to play catch up and tend to focus less on what's going on behind and more on what's actually happening around the puck. (INT – 1 – 2: Anticipation)
- p. Because the greater risk on the ice is with the hit being—it's coming. And that way I can watch that to see if there's anything there—maybe like a high hit—I think the greatest risk is posed on that hit—the potential hit that's coming—whereas the two guys coming off the boards, you know, they're skating towards the play as opposed to, you know, kind of turning towards each other. (INT – 1 – 2: Anticipation)
- q. Yes [indicating that he focuses on high hit/body-check/elbow rather than hook/hold/trip]. (INT – 1 – 2: Anticipation)
- r. Watching the puck to see any sort of potential shifts in the movement of the play and just keep scanning the ice. (INT – 1 – 2: Anticipation)
- s. Maybe not more head shifting, but most definitely scanning will be a little bit easier. Looking from spot to spot. That way I can react to any possible change in the flow or change in the movement of the play. (INT – 1 – 2: Anticipation)
- t. No I was watching it because he had just got rid of the puck and I knew that the [Home Team] kid was going in on him. (INT – 1 – 2: Anticipation)
- u. Because the [Visiting Team] team is short-handed there, I'm looking to see where the [Home Team] players are positioning themselves knowing that the puck's going to get dumped down the ice, I've got to know if I have to focus more on the guys that are moving up with the play or the guys that are actually moving the puck up. (INT – 1 – 2: Anticipation)
- v. At this point the guys are just standing around. The guys weren't moving. You notice the way they're spaced out. Less chance of something going on. Basically, the way the guys are spaced out there's less risk because they're not within a close proximity to each other. So it requires less attention to scan the ice because you know that they're not moving so it's going to take them a while to catch up to one of the other players. That gives me a little bit more time to focus on the puck and the play moving up [the ice]. (INT – 1 – 2: Anticipation)
- w. Just wanted to see if there were any players coming in behind me for my own safety. That way I know if the guy's coming from the point he's not going to take me out. (INT – 1 – 2: Anticipation)
- x. And I wanted to see if there were [Visiting Team] players back there as well just to see if there was—you know a fast break or any sort of possible infraction going on before the hit [in the corner] happens. (INT – 1 – 2: Anticipation)
- y. Yeah, I was looking to see where I'm going to have to go. If there was nobody up there then I can hang back, but if there was somebody going, then I've got to get going to. (EL – 1 – 1: Anticipation)

- z. Once again, just a quick scan up the ice before the play was moved up the ice to see who was going. (EL – 1 – 1: Anticipation)
- aa. When I check back when I'm backing up to the boards, it's just to make sure there is nobody behind me. (EL – 1 – 1: Anticipation)
- bb. Yeah, I'm watching for what's the guy that has possession of the puck doing because if he—if you see how the red stick is in between the legs and the boards, he's trying to play the puck because he knows that the defenseman is trying to kick the puck. So say for—in that example, like nothing happens so there's no penalty. But there's no holding, there's no nothing because how can you? Do you know what I mean? (EL – 1 – 2: Anticipation)
- cc. On those close plays along the blueline you're watching just for obstruction on the wingers. Yep. Not necessarily watching for the offside, but more for the obstructions. (EL – 1 – 2: Anticipation)
- dd. so I'm looking to where that puck's going in case there's a fast transition where I have to turn around and move. (EL – 1 – 2: Anticipation)
- ee. Exactly. Just watching, again, for where that stick—see how the stick's going to be cranked backwards—where's that going? (EL – 1 – 2: Anticipation)
- ff. And as soon as the attacking player gains possession of the puck I'm making sure that the other guys that are holding the other guy [the first attacking player] against the boards are not holding him, but literally just checking for a penalty. Nothing there yet. (EL – 1 – 2: Anticipation)
- gg. Yep, watching feet for a trip, watching—because the odds are the puck—the guy's going to try for a wrap-around. There's going to either be a rebound and then the defensemen don't want to lose their man, and they want to also get back to the front of the net, (EL – 1 – 2: Anticipation)
- hh. But still, on those situations you have to watch because whenever you have 2 other players coming in, if that player is knowingly going to get bumped from behind, but somebody else gets in front of him, he's going head-first into the boards. So you just have to make sure of that. That's what I'm looking for anyway. (EL – 1 – 2: Anticipation)
- ii. I think here I was just anticipating that white would get the puck out before they did. So I'm just continuing momentum, but I'm not skating, I'm just gliding. (EL – 1 – 2: Anticipation)
- jj. So puck's out and I stay in [the endzone] obviously because everybody else is coming backwards. (EL – 1 – 2: Anticipation)
- kk. Looking for a long pass. (EL – 1 – 2: Anticipation)
- ll. Shot on net, nothing really, just transition. (EL – 1 – 2: Anticipation)
- mm. There's a change so I can tell that, like on the—just go back. When the puck transitions—that's the other thing with the attacking team—they're going to have an advantage if they can make a change right here on the high guy. Because the red bench is at the attacking blueline and they're in their defending zone. So if they can make a pass to a guy coming off the bench, I've got to make sure that they're within that 5-feet as well as make sure there's not too many men. (EL – 1 – 2: Anticipation)

16. Assisting focal attention

- a. Yeah, I would say so. Yeah. [uses peripheral vision]. (INT – 1 – 1: Assisting focal attention)
- b. But like you said, I took a quick look back and the puck got dumped into the play so that sort of helped because that drew my attention to where the puck was again. (INT – 1 – 1: Assisting focal attention)
- c. So I know there's nothing really happening where the puck is, so I just want to make sure there's nothing happening behind the play where the majority of the players are. (INT – 1 – 1: Assisting focal attention)
- d. And I think, with this, I was looking at something in front of the net, out of my peripherals while also following the puck just to know where the puck is. (INT – 1 – 2: Assisting focal attention)
- e. So a little scan, maybe not so much with the head movement, but my eyes can focus on them or—(INT – 1 – 2: Assisting focal attention)
- f. they're trying to play a guy on the puck [carrier] and another guy towards the defenseman, so there's more room out there. It gives me a better look of what's going on at the blueline. (INT – 1 – 2: Assisting focal attention)
- g. Yeah, because the way I angled my head I still can see what's going on in front of the net. (INT – 1 – 2: Assisting focal attention)
- h. and using the periphery you kind of see where the other two [Visiting Team] players—well the one [Visiting Team] player—kind of sitting—he's kind of high on the slot and I know the defensemen are on the blueline. So just by watching the corner and kind of taking a look out of the side of my eye there I can most definitely see who's where and assess any risk. (INT – 1 – 2: Assisting focal attention)
- i. Maybe not more head shifting, but most definitely scanning will be a little bit easier. Looking from spot to spot. (INT – 1 – 2: Assisting focal attention)
- j. At this point the guys are just standing around. The guys weren't moving. You notice the way they're spaced out. Less chance of something going on. Basically, the way the guys are spaced out there's less risk because they're not within a close proximity to each other. So it requires less attention to scan the ice because you know that they're not moving so it's going to take them a while to catch up to one of the other players. That gives me a little bit more time to focus on the puck and the play moving up [the ice]. (INT – 1 – 2: Assisting focal attention)
- k. Well I think like, mainly, using your peripheral you can see the majority of what's going on the ice. Maybe your eyes aren't focused on it, but you can see everything that's going on the ice. (INT – 1 – 2: Assisting focal attention)
- l. Absolutely [uses peripheral vision to scan ice]. Because of our positioning—because the positioning that we're taught, from where I am, yes my head's looking this way, but you can see in front of the net. And that's designed from our positioning system that we have. (EL – 1 – 1: Assisting focal attention)
- m. You could make a call from that, but it would be a tough sell—to sell the call—because, you're right, my attention wouldn't be there. So it would be a situation where, you know, it wouldn't be solid call to make because 100% of my attention was not on that scenario. (EL – 1 – 1: Assisting focal attention)
- n. Yeah even if my eyes are straight ahead, I can still see 1, 2, 3, 4, 5, 6, 7 of the 8 players. I'm not worried about the defenseman on the right side because

obviously he's probably not going to be shooting the puck right away. (EL – 1 – 2: Assisting focal attention)

- o. It helps in this rink because there's the ringette line. So peripherally I'm looking at skates down there, I'm not looking at the goalie, I'm not looking at anything else. (EL – 1 – 2: Assisting focal attention)
- p. So I'm looking straight at that, but peripherally, where's the puck going to go. (EL – 1 – 2: Assisting focal attention)
- q. Well see right now, my head's going up, but I've got 1, 2, 3, 4, 5, 6 players. So the other 4 players are literally on my right-hand side. So I'm looking peripherally at them. Everybody's skating forward. There's nothing going on behind me. So there's no need to turn my head to look. I've got them peripheral on the right-hand side. (EL – 1 – 2: Assisting focal attention)
- r. I could probably still see out the corner of my eye what had happened, but not necessarily see what's going on in the full realm of the video. Absolutely. But then, more of my peripheral vision's looking at the puck than necessarily where the camera's actually looking right now. (EL – 1 – 2: Assisting focal attention)
- s. But I think still, because I was looking at the play behind the puck carrier, right, I'm looking—I see that that's a puck, not a stick because I'm still watching the other guy that was against the boards as he's coming off. Just lucked out I guess. (EL – 1 – 2: Assisting focal attention)

17. Contextual position and visual behaviors

- a. Yeah, it's true. (NV – 1 – 1: Contextual position and visual behaviors)
- b. Yeah, like, I don't know. I don't know how common this is but often times I'm not even really aware of how much time is on the clock, or what the score is. I'm just, you know intent on what's happening right now and I don't try to be influenced by any other—by anything else. (NV – 1 – 1: Contextual position and visual behaviors)
- c. No, absolutely not [changing vision on a power play]. (NV – 1 – 1: Contextual position and visual behaviors)
- d. Um, no. Nothing really changes [on power plays]. Just keep my positioning good. Keep everything in front of me. (NV – 1 – 2: Contextual position and visual behaviors)
- e. Then I'm skating back [after assessing the penalty] and I see two guys, I guess you could say chirping each other, so at this point in the game I don't really want anything bad to happen, or any stupid play to happen. (INT – 1 – 1: Contextual position and visual behaviors)
- f. So if I sit them in the box both teams will get the point and hopefully that stuff after the play gets stopped—the roughing play after the play gets stopped. (INT – 1 – 1: Contextual position and visual behaviors)
- g. I believe this is in the 3rd period, I believe [the Home Team] was up [in the score]. It's a playoff game. They're going to be playing each other again. (INT – 1 – 1: Contextual position and visual behaviors)
- h. So the blue team knows that, they know that if they start playing a little bit dirty, a little bit chippy, they can get under [the Home Team's] skin and throw them off their game. (INT – 1 – 1: Contextual position and visual behaviors)

- i. So that's what I mean by "at this point in the game". I don't want anything to go downhill. I don't want nothing overly stupid to happen. (INT – 1 – 1: Contextual position and visual behaviors)
- j. Um, maybe in this game a little bit. The green or blue guys, whatever you want to say, they're losing the game, they're getting a little bit more chippy. (INT – 1 – 1: Contextual position and visual behaviors)
- k. So you could probably say that I'm watching the blue guys a little bit more than I'm watching the white guys because I know that they're getting a little bit more chippy. (INT – 1 – 1: Contextual position and visual behaviors)
- l. They're losing; they want to get under the white team's skin. So I'm probably paying a little bit more attention to the blue guys and what they're doing on the ice compared to what the white guys are doing. (INT – 1 – 1: Contextual position and visual behaviors)
- m. Yeah, the situation [dictates visual attention]. (INT – 1 – 1: Contextual position and visual behaviors)
- n. Because I knew there was a [Home Team] guy playing higher on their blueline, given that they were still on the powerplay. And he would've been relatively close to the [Visiting Team] defenseman. (INT – 1 – 2: Contextual position and visual behaviors)
- o. Because the [Visiting Team] team is short-handed there, I'm looking to see where the [Home Team] players are positioning themselves knowing that the puck's going to get dumped down the ice, I've got to know if I have to focus more on the guys that are moving up with the play or the guys that are actually moving the puck up. (INT – 1 – 2: Contextual position and visual behaviors)
- p. So, where I'm at right now was because the team's on a powerplay. I've circled behind the players so that I can keep everybody in front of me. So the play is definitely going to go up the ice, so there's no need for me to be in a position where I have to watch behind me because the play is definitely going up the ice—they're on a powerplay. So when on a powerplay I'll circle behind everybody so that everybody's in front of me. So that's what I'm looking at—I'll have hopefully 9 players in front of me at that time. So I guess to answer question three: how does that help me? It helps me by keeping everybody in front of me in a situation where I know the play's moving up the ice. (EL – 1 – 1: Contextual position and visual behaviors)
- q. It would also play into the, where is that game at? Is it a chintzy penalty? Do I need a chintzy penalty at that time? Is it a solid penalty? Is the level of the game coming up and something happens in front of the net that I've got to call it? And sometimes you've just got to eat it, right? You just say, "I didn't see—I didn't see it the way I wanted to see it, but I needed it." (EL – 1 – 1: Contextual position and visual behaviors)
- r. See so once again, everybody's in front of me. No need for anyone to be behind me. I typically do that just in powerplay situations. So basically looking at the puck on powerplays at all times because most infractions on a powerplay are going to happen on the puck carrier. So if there's a second infraction, very likely going to be on the puck carrier. So when a team's on a powerplay, more

- important to watch infractions on the puck carrier than anywhere else. (EL – 1 – 1: Contextual position and visual behaviors)
- s. So another area you've got to watch is whenever a goalie leaves the net, definitely have to watch the puck at that instance because, for whatever reason, goalies leaving the net is considered a danger area. So you've got to watch the start and finish of a goalie leaving the crease to play the puck. (EL – 1 – 1: Contextual position and visual behaviors)
 - t. In that scenario there I had to circle below the goal line because if I stopped at my regular position I was going to be in the middle of play. So in that situation I thought it was more important to get—to move behind the goal line and out of the players' path. So it brings me to a position now where I can see more people [by being] behind the goal line because I would've been stuck in the middle of them. (EL – 1 – 1: Contextual position and visual behaviors)
 - u. For me it is because I'm taller. For a shorter guy they say that they want them at half-piston there. Well if I'm at half-piston I can't see everything because I'm above it. But I think—see as the play develops towards the front of the net, then I move in order to get to the net to see if anything crosses the goal line. (EL – 1 – 2: Contextual position and visual behaviors)
 - v. With my size I don't have to move because I'm not worried about getting in the way. They'll either bounce off me or they'll be in front of me. (EL – 1 – 2: Contextual position and visual behaviors)
 - w. With white possession, circling the puck [powerplay team in their own end, setting up the breakout], no need to move, just head check. There's only one—white's obviously on the powerplay, red's shorthanded. Odds are they're going to pass the puck more than you're going to get a second attacker for red in there. No need to look back because obviously white's going to look for a long pass or everybody's at the blueline. (EL – 1 – 2: Contextual position and visual behaviors)
 - x. Well I'm within 10 feet of the closest attacking player. Even if he intercepts the pass I can get to the net in order to see a goal. Like I'm just above top of the circle. [I position myself] based on where the closest attacking player is. Odds of the defending team putting the puck in their net are pretty slim. (EL – 1 – 2: Contextual position and visual behaviors)
 - y. Absolutely, because the odds are—depends. If they have 2 guys high then obviously I can't look, always, at the front of the net. But if they have 2 guys high, the odds are the third guy's going to be up at the hashmarks, not in the crease. (EL – 1 – 2: Contextual position and visual behaviors)
 - z. Here's just a simple cycle; they're still on the powerplay. So there's no need to basically worry about who's going to have control. I'm more worried about what's going on in front of the net again and what the 2 guys are doing up top. (EL – 1 – 2: Contextual position and visual behaviors)
 - aa. There, same thing: where's the puck going, who's going after it, and who's open? (EL – 1 – 2: Contextual position and visual behaviors)
 - bb. So here, I've got 4 defenders going back behind the net, no attackers. I'm moving up the boards just to be in position. (EL – 1 – 2: Contextual position and visual behaviors)

18. Prioritizing visual behaviors

- a. I'm typically more concerned with the infraction than the turnover because we have the linesmen that can cover the turnover. I don't typically concern myself with the turnover. (EL – 1 – 1: Prioritizing visual behaviors)
- b. Two reasons really. The linesman is there to go the other on the breakaway and potential goal. And two, I feel like I'm a strong skater and I can catch that—if need be I can go the other way quickly. So I'm more concerned with infractions than turnovers. (EL – 1 – 1: Prioritizing visual behaviors)
- c. Well right now I'm looking where I am because I have more players in sight there than I would in front of the net. Looks like in front of the net there's only one attacking player, whereas at the puck I can see 4 players. So my attention's going to be to where there are more players and a quick check to the net to check that guy in front of the net. (EL – 1 – 1: Prioritizing visual behaviors)
- d. At this level of hockey you don't get a lot of undisciplined players who stand in front of the net by themselves and that are going to do anything with the goalie. They're at this level because they're disciplined players. So you've got to remember that whenever you're reffing these guys you do get situations, and we're taught to watch for these things where there's one player in front of the net; but it's a low percentage of something that's going to happen in this league. So I try to keep my attention to where there are more players in my sight. (EL – 1 – 1: Prioritizing visual behaviors)
- e. So it's just, where's the puck going and then look for who's going where. (EL – 1 – 2: Prioritizing visual behaviors)
- f. And potential goal mouth scrum. So not only do I have to worry about the puck coming in, I have to worry about the defensemen coming in hitting the attacking players, as well as the other 3 defensive players coming back. Like where are they? Plus the defensemen that are coming in, if they're not in on the play, the face-off's going outside. It's a lot to look at. (EL – 1 – 2: Prioritizing visual behaviors)
- g. In this situation because I've been watching the guy in front of the net, I'm watching the goaltender interference. So regardless of whether the puck goes in the net or not, what happened here. (EL – 1 – 2: Prioritizing visual behaviors)

19. Face-offs

- a. Here I'm just watching the white guy in the wrong spot. (NV – 1 – 1: Face-offs)
- b. Now I'm just checking the kids I guess—make sure they're in the right spot. (NV – 1 – 1: Face-offs)
- c. Ah, well just generally make sure that they're in the right position on the right side of the ice. That's basically it. (NV – 1 – 1: Face-offs)
- d. Oh yes, for the kids, yeah. Definitely. (NV – 1 – 1: Face-offs)
- e. Uh, line change procedure, pointing out to the little kids where they're going because if you stand there with your arm in the air they tend to migrate towards you—I've noticed in my first couple games. So I got into the habit of pointing them to the right face-off dot. (NV – 1 – 2: Face-offs)
- f. I want to look at things [at the face-off] the whole time I'm doing it. Like I want to get to my spot but I don't want to compromise not seeing what's in front of me, and, you know, risk missing something over trying to hurry to the spot, you

- know. So I'll focus on where the puck goes, I'll look at the second referee, see which way he goes, and then I'll find my lane and get out. (NV – 1 – 2: Face-offs)
- g. The one thing I was going to mention there [researcher's name], off the face-off, what is not going to get picked up is, yeah I can see all the players—that's a very difficult position as a referee because there is so much going on that you just can't look at everything. (EL – 1 – 1: Face-offs)
 - h. So yeah, everything is there but I've got to watch sticks off a face-off, got to watch interference on the back attacking player, and I've got to watch interference on the front attacking player. So yeah, I've got all 3 [opposing] players in my sightlines, but there's probably 3 or 4 things that I've got to try and pick in that scenario where a lot of times things are missed off that face-off because your attention is just not on the right situation. (EL – 1 – 1: Face-offs)
 - i. Yeah I'm looking at all of them, but I can't see the sticks off the face-off, I'm watching the winger trying to get out to the point or I'm watching the back winger. It's a situation where a lot of things get missed on endzone face-offs because there's just so much to watch. And everybody's in your sightlines, but not everybody gets your attention. (EL – 1 – 1: Face-offs)
 - j. It'll be different situations in the game. If it's late in the game, probably more important to watch the front side winger, right, because that defenseman—he's trying to get out the defenseman to block the shot. So late in the game, in a close game, it's probably more important to watch that guy, whereas every other face-off, it's probably more important to watch sticks off the face-off. High-stick coming up off the face-off. (EL – 1 – 1: Face-offs)
 - k. It's a different situation where, you know—same as if the defending is killing a penalty, it's 5 on 4—if their team wins the face-off clean into the corner, usually an interference is going to happen from the defending winger on the boards because he's trying to block the attacking team from going to get the puck in the corner. So, in a shorthanded situation, my attention would be more on the backside winger with the interference. (EL – 1 – 1: Face-offs)
 - l. There's different exceptions where you should watch the players for interference, but rule of thumb, you know, higher percentage of watching the sticks off the face-off because it is a dangerous situation where the sticks are flying. It's centremen sticks. (EL – 1 – 1: Face-offs)
 - m. So here again is a face-off where it is very difficult—yeah all players are in front of me, but the attention has to be on so many places at the same time. (EL – 1 – 1: Face-offs)
 - n. So I'm looking at centremen and the far wingers, just for obstruction. (EL – 1 – 2: Face-offs)
 - o. So on the face-off, same thing, looking at the far defenseman, and the centremen. Both [focus is on centremen and wingers during face-off]. (EL – 1 – 2: Face-offs)
 - p. Same thing. Nope. A face-off's a face-off. The only difference is encroachment and that's for linesmen to discuss anyway. (EL – 1 – 2: Face-offs)
 - q. Again when the wingers in the back move in [on the face-off], I'm obviously watching for what the sticks are doing. Especially when it's 2 wingers that cause

an altercation for the face-off to be nullified. When there's encroachment, when there's anything else if the back wingers are skating in or if they're slashing each other or if they're shoving each other I'm paying more attention to them on the second face-off than I would on the first. I'm not worried about the centres at this point. I want to make sure that those 2 idiots don't do something else in order to cause an infraction. (EL – 1 – 2: Face-offs)

- r. Same thing, centremen and the far wingers. (EL – 1 – 2: Face-offs)
- s. Again there, nothing on the centremen, nothing on the wingers. (EL – 1 – 2: Face-offs)

Appendix I: Focus Group Questions

Focus group participants watched helmet camera videotapes from phase one and were given three written questions to discuss:

- 1) What do you think the referee was visually attending to?
- 2) Do you think that was or was not beneficial to his/her decision-making?
- 3) Do you think his/her attention should have been directed elsewhere?

Appendix J: Focus Group Focused Code Table

Focused Codes	Elite – Elite	Elite – Inter.	Inter. – Elite	Inter. – Inter.	Novice – Elite	Novice – Inter.	Total – Elite	Total – Inter.
Majority of players	5	0	9	4	9	4	23	8
Majority of players (negative)	0	8	1	1	0	4	1	13
Away from the play/puck	3	1	3	7	0	3	6	11
Away from the play/puck (negative)	1	4	2	0	0	3	3	7
Post-whistle attention	3	0	2	0	0	1	5	1
Post-whistle attention (negative)	0	6	1	5	0	2	1	13
Face-offs	1	0	1	4	1	0	3	4
Face-offs (negative)	0	0	0	0	0	0	0	0
Puck carrier/puck	0	0	0	0	0	0	0	0
Puck carrier/puck (negative)	0	5	0	0	0	0	0	5
Body-check	2	0	0	0	0	1	2	1
Body-check (negative)	0	1	0	1	0	1	0	3
One player	0	0	1	0	0	0	1	0
One player (negative)	0	0	0	0	0	0	0	0
Penalty calls	2	0	3	0	1	3	6	3
Penalty calls (negative)	0	0	0	0	0	1	0	1
Positioning and VB	2	1	1	0	12	0	15	1
Positioning and VB (negative)	0	2	5	4	1	5	6	11
Contextual positioning and VB	4	0	6	4	1	4	11	8
Contextual positioning and VB (negative)	1	0	0	1	0	1	1	2
Anticipation	1	0	2	1	2	2	5	3
Anticipation (negative)	0	0	0	0	0	0	0	0
Learning/experience	3	0	0	0	2	0	5	0
Learning/experience (negative)	0	1	0	1	0	0	0	2
Assisting focal attention	2	0	0	0	2	0	4	0
Assisting focal attention (negative)	0	2	0	0	0	0	0	2
Prioritizing VB	1	0	0	0	2	0	3	0
Prioritizing VB(negative)	0	0	0	0	0	0	0	0
GRAND TOTAL	31	31	37	33	33	35	100	100

Note 1. Numbers in each cell indicate meanings units described while participants watched the videotapes. The first part of the column title indicates which focus group is being identified. The second part of the column title refers to which videotape was being watched. Thus, Novice – Elite refers to the novice focus group when watching the elite referee’s videotape.

Note 2. ‘VB’ denotes visual behaviors.

Appendix K: Raw Focus Group Quotes

1. Majority of players

- a. EL – EL: All players in view, benches in view.
- b. EL – EL: See right there, way better than the last one too. Got everything in view. He's just waiting to kind of go between the players and separate them before he goes to where he needs to go. Now he's going to use the benches.
- c. EL – EL: I would think he's looking at, I was thinking that he's looking at the front of the net now, as well. He did in the first clip too that you showed. In the other end of the rink. He just did like a generic, like, look in the middle and keep an eye on everything. Even though he's looking here, because that's what—he probably did take a very quick...glance over here to see, just to see if anything's going on and is like, "Okay, do I need to focus over there or should I kind of stay here?"
- d. EL – EL: I'm more concerned with the players though. You can judge at where they're looking where the puck is going. You don't have to see the puck and in looking at the players you benefit—you're not going to get run over hopefully and you can sort of keep an eye on what's going on as best as possible that stuff when there is a really close because you're moving fast and things around you are moving fast, you're trying to get out of the way, but I think I try to be more player focused.
- e. EL – EL: Yeah, I tend to look for players in isolation where, you know, for instance—coming up here, that hit there. That's something that would draw my attention; because they're in isolation, it would be a matter of establishing whether or not—what's going on there. Are they sticking around to cause trouble or are they're gone off to resume playing hockey? You know, in that case, it's a simple shifting of your sightline to see that, and not moving the whole head or turning your whole body to adjust...but you're only just looking at that by shifting your eyes.
- f. INT – EL: Right where he did the head check? Check back, make sure nothing's wrong. Check back to see what the wingers or defensemen are doing. Just see what's going on.
- g. INT – EL: ...Because if he, if you're—and he just turned his body. He's looking at the—basically if you draw a straight line to the other circle, like it seems as though he's standing at the bottom of the circle...which is where I would want to stay, where before you were saying more towards the face-off dot, you know, than where he was. Yeah, because he's definitely got more, and now he can see too that all the guys from one team, the [visiting] team, are in view so he doesn't really have to—as long as he's got all five guys from one team in view, there's not much else to worry about, right?
- h. INT – EL: He's in a tough situation because he's got to focus on what's close to him because he's got like six guys, three from each team in there and he's just...so he's got the attention of this, but at the same time this would be the perfect opportunity for like somebody at the point to do something—to get hacked.

- i. INT – EL: He didn't turn his head to the puck when it went back to the point, so he seems to be watching, you mean, he's aware of what's going on in front of the net. Because you'd think if he wasn't really watching it and the puck went back to the point he would at least take a glance. He seems to be just ignoring the puck because he knows it's just going to a point shot. And like we were saying, he can see all the red guys, but he knows what he's going to do with the guy on the point. So he doesn't have to look back there, he just looks to the front of the net and knows the shot's...
- j. INT – EL: He's doing a good job scanning.
- k. INT – EL: He's looking over towards other players on the ice. He spent most of his attention on, like, the scrum that was going on. Like he was glancing over... I don't know, depending on the situation, I might have spent more time looking at what else was going on, but I mean, he was there at the game and what the feeling was. I mean, he's pretty sure that stuff isn't going to happen away from the play otherwise he would have just been more splitting his time more 50/50, because the linesmen were there and if anything did happen, I'm assuming he would have enough trust in them to report anything that happened. So, I mean, depending on the feel of the game at that point, I would have spent more time 50/50 looking at the other guys on the ice.
- l. INT – EL: Not really. Circling around, back and forth. He's scanning the ice.
- m. INT – EL: I think the referee was visually attending to the overall aspect of the game. I think his overall scanning of the ice surface was adequate for this type of level. He did a good job and I think it does make for good decision-making because he didn't miss anything. For that goal he was right there. Right on the spot to make that obvious call. I think his attention was definitely in the right spot the whole game.
- n. INT – EL: I would agree with that aside from this little detail here by not keeping everyone in view when going to the timekeeper, but I thought he did a really good job at focusing what needed to be looked at and again, with the camera, I'm not really sure, sometimes he could have been doing a quick check where it didn't seem as obvious as it did here, but from the looks of it it seemed as though he was paying attention to everything that he needed to and doing good scans of the ice.
- o. INT – INT: Yeah, I do. I think he was checking around a lot and, to me, like, he seems to be, he's in a tough game where you have a lot to watch. Theoretically, something could be happening everywhere on the ice and in a rough game like this, he seems, to me, to be doing a pretty good job. And, like, just from what we saw the only times I thought he was too far away was when that kid got injured to be able to really tell what was going on. The other guy seemed much more willing to kind of get close to the players, it goes with what you'd expect from a junior ref. Because you would go, like, you know like in that scrum when we said that he was too close, like he got right in. He'd be close to whatever was going on. Almost maybe he had more of a rapport with the players, too. Like, he was yapping, "Hey, Thompson, stop it."

- p. INT – INT: Here you've got two guys that the linesmen get in there right away. As soon as linesmen were in, he looked at everyone else to see what was going on.
- q. INT – INT: Right now you're looking at two players who are doing nothing. Because he knows that there's just a defenseman back there, the puck carrier, everybody else is kind of in front of him. And so he's looking at the scrum that could happen. And right now he's probably going to call a penalty after.
- r. INT – INT: I was thinking that everyone's lining up for a shot to be coming in. So it's safe to assume that the defenseman has the puck, right? I'm thinking just looking at the net just to make sure no one gets interfered with or cross-checked in the head. Like as the puck was being shot in.
- s. NV – EL: Yeah and I find like he's got a good view of everything and he had his head on a swivel. That was a call though, eh? Did he make a call there against the boards? Yeah seems like he was right there, so I guess... And here he has to go hard. Good turn and look back.
- t. NV – EL: Yeah like I don't need to be on the ice to see, you know, what's to be seen. He seems to have it all. You see, this is great; you can still see the 'd' [defensemen] up there, but you have complete control over what happens in the corner.
- u. NV – EL: I'm amazed at how you can see everything, like most of the time he can see all five players. Which is why he doesn't seem to miss anything.
- v. NV – EL: You see that's what I meant by left-right, you know, he doesn't see anything so he has to put his head on a swivel kind of thing. He got stuck there; I don't know if he could've gone anywhere, you know. He had to do the best he could. Yeah and he takes the quick look around; just keeps looking to his right making sure nothing's happening further that he needs to see and he's right at the net.
- w. NV – EL: So far his eyes are where they need to be—just on everybody.
- x. NV – EL: I think so too. He's got 6 out of the 10 players on the ice in his sight. You know, you can't see everything so I think he's taking the odds—he's playing the odds on this one.
- y. NV – EL: So it seems to me when he's coming up the ice, he's taking the position behind the play, but just behind the puck carrier so he's kind letting the defensemen be, and focusing on, you know, the 2-on-2 or the 3-on-2 and being very close to that.
- z. NV – EL: I think again it's one of those things where, excuse the term, but he's playing the odds. Like, chances are more things are going to happen in that scrum than out at the point. So he's kind of playing the odds on that one.
- aa. NV – EL: There's such a difference in the quality of this one versus the other one. It's like, the camera's focused on the play all the time.
- bb. NV – INT: You want to see as many players as you can. Keep everybody in view.
- cc. NV – INT: Everybody that's involved in the play he's got right in his visuals. You know, the defensemen are further back and the linesmen have those guys taken care of.

- dd. NV – INT: Well yeah, because he has a clearer view of everything now. Where before, when you're constantly having to do shoulder checks you're probably going to miss something at some point.
- ee. NV – INT: I like his view because he's got the view of the scrum plus he's got the view of the rest of the players. So he can actually see if anything breaks out away from the scrum, but yet he still—

2. Majority of players (negative)

- a. EL – INT: Yes, it's hard to say. Maybe he was looking at the players a bit, but you kind of want to keep the players still in view.
- b. EL – INT: You can tell from the camera angle with his head down when he skates fast. As a referee, it's definitely not the best practice to have.
- c. EL – INT: That is pretty hard to see anything—like he buries his head for the first few strides until he gets going then he looks up. You're losing a lot of time. Where there are some risks where things can happen in those first couple of strides when you accelerate.
- d. EL – INT: His whole head moves all whole lot more. Like his whole head moves all whole lot. Was he reffing because he thought—I mean this is the third period I guess he's used to this. I was wondered at first if he's trying to show the camera everything because he almost looks like he's just frantic trying to see what's going on.
- e. EL – INT: Well you don't even move that much. If he stood with his head somewhere halfway he could see the whole play. All he has to do is establish that the blue defenseman has the puck. It's like, "Okay I don't really need to look at him anymore because I'm looking now for who's coming to get him and not so much where the puck." And that's where somebody was coming to get him. He looked over to look back to see the hit and then I don't even think he saw the hit.
- f. EL – INT: So he should be skating down into the zone to turn around. He should've moved up and turned. To get the best view of the ice and keep the most players in view that way. Well you need to see as many players as possible. And he's got time, it's not like there's this play isn't moving quickly here, it didn't enter the zone. It's going to be dead here in the second because it's four on one as blue gets the puck. He could've skated in relatively quickly and then turned himself around to look up the ice, rather than try to look at it across ice.
- g. EL – INT: Well my favourite is the views when he's looking up the boards at the puck. He literally is looking up the boards, like he does not have his head remotely turned. So he's probably seeing five players, if that. He's got nothing. I could literally be staying at my bench throwing a water bottle at the other coach and nobody would have a clue. No seriously.
- h. EL – INT: Well I think, we've all agreed that his head moves all whole lot more than the other guy, so he's tracking the play by turning his head as opposed to changing and shifting his eyes to where he's gonna look at. And by moving his head so much he's—he loses things. I don't think either he processes and loses it or just doesn't see it out right, because he can't focus on anything long enough to actually see it. Um, so that's the first big difference. The other one is the fact that when he's looking he's very tracking of where the puck is immediately and not angling and turning his head to see, to catch more of the play. [Focus group

member] made the point and you saw it right down the boards, he's looking straight down the boards at the five guys, like you know, two on one team and three on the other who were in the direct vicinity of the play or the puck and there's five more on the remaining entire surface plus the benches. The last point I have is the fact that when he skates his head drops, and if he's looking at his toes—and I'm sure his lovely skater—but if he's looking at his toes he's not seeing things on the ice.

- i. INT – EL: Well, it's hard to say because you don't know what his eyes are actually pointing directly at this. It seems to me that he's focusing too much on the corner because you see there's only two [home team] guys in there, right now, so that means there's three other [home team] guys somewhere on the ice with the two other [home team] guys out of the picture. Yeah. You don't know, he doesn't really know what's going on on the other side of the picture. Even then he uses his peripherals, like, you wouldn't be able to see too much if this is where his head's pointed, so...
- j. INT – INT: Or could it be the natural, "I'm going to put my head down while I skate"? That used to be my problem. I'd put my head down when I tried to skate really fast.
- k. NV – INT: I think he needs to keep his head up more just as he skates, but you know... I wonder where his eyes would've been at that moment. Like his head is tilted, like was he actually looking at the ice or was he looking at the play?
- l. NV – INT: Just he has a tendency to stop looking once he starts skating and that's an issue at this level because you're skating all the time. So you start losing a lot out of it. But I can't say I blame him, because it's a fast-paced hockey game. You know you've really got to start implementing—using your linesman or using a fourth ref.
- m. NV – INT: Well he's not seeing the ice. He's not seeing the players, so you don't see you can't make any calls. In other words I think he's got found himself behind the play and he's trying to catch up. So he's lost sight of the game while he's trying to get back into it where he thinks he should be.
- n. NV – INT: Oh, head down again for a second, I think it's a matter of trying to catch up to the play sometimes.

3. Away from play/puck

- a. EL – EL: He's watching the player not the puck. Yeah. You don't need to watch the puck, nothing's going to happen on the puck. Watch the players go to the puck.
- b. EL – EL: See, again, he didn't follow the puck right there. The ref is definitely watching the play not the puck. [Visiting team]'s got lucky on this shift twice. See, I think right there too he watched the hit behind the net...instead of the puck.
- c. EL – EL: Your options are either track the puck almost exclusively, not look at the puck track the players, or try and find a balance. And I know personally I end up trying to find the balance because my big concern is having the puck end up at my feet and end up having a player take me out or get—interfere with the play. So I'm trying to track where that is, but still being aware of where everyone else is on the ice because if you've got your head down buried at your feet and you're

not looking up your gonna miss something guaranteed. That always seems to be where the big hit goes down, everyone screams. So trying to find that balance there—

- d. EL – INT: He's only needs to check, right? Like there's no one applying direct pressure. See now he's forgotten about the puck and watches the front of the net. That's good. That's good position there. Yeah, the last like 15 seconds were pretty good.
- e. INT – EL: I think he's looking there first because there's the shot came and then they starting jostling for it, so I think he was recognizing that there's a guy there. He wanted to make sure that, one, he wasn't in the crease, and, two, they're being civil to each other.
- f. INT – EL: Yeah, it would be like there was a hit down in the corner and you don't know if he saw it or not because it was in the field of vision, but I definitely would have looked back at those guys at this point, like, as he's skating up. Because if he did see that, then like, he's going to know what they're doing and because that guy that was a bit of a late hit. He could totally see the guy retaliating as soon as they go up ice.
- g. INT – EL: I'm okay with it given that there's two and three players in the vicinity battling for a puck. I'm okay with that. I'm not as worried about what's behind me while the puck's right there, but as soon as one team gains control then I have to.
- h. INT – INT: Yeah, see, that's exactly the thing in the last game we were just talking about, the exact same play where the guy's getting lazy and didn't check back, whereas there he did. And as soon as you see that those two guys are up and skating. Especially the [home team] guy—plus the after the back check and then that [visiting team] guy kind of looked like he was looking, but maybe for a change or something, but at least... You have to check back and make sure that, like, they're not lingering at all. They don't hesitate, they just get up and go away and you know they probably going.
- i. INT – INT: Like you said, as a referee you can only look in so many places at once. Looking back and identifying those two guys, I think, is the normal smart thing to do because that's where you're going to see things develop, especially behind the play. So, looking out, looking back a quick second, like, you're going to take a chance. You may, may, may, may miss something but—
- j. INT – INT: There's something, like, I know this from following, like, the right time that you should look back is when the play breaks out. The guy just hit you that's the perfect time for something and, so, to look back and just see—you don't have to stare at them the whole time. Like, back in that case and point you can see perfectly because they both get up and skate away. So you just have to see that and then pay attention to what's going on up the ice. I think if you miss something it's worth it because more the likelihood is that you're going to miss something behind you than in front of you and if it is in front of you, like, if it's that bad, you know, major and a game or whatever, then somebody's going to have seen it...

- k. INT – INT: You have to look back. There happened to be a hit there and he saw it in the corner of his eye—at least he saw it. Took a quick look back—like he didn't look too long.
- l. INT – INT: To prevent the game from going completely down the [toilet] I think that you have to be able to catch a retaliation call. But I mean if you miss that one behind the net, or behind the play, everyone's going to be all over you. Well you miss—or if the hit was maybe a little bit high at centre ice, then, like yeah, it might have been a high hit but people are more likely to let that one go than the slash or the hook or the punch way behind the play. Because everyone's going to jump all over you for that.
- m. INT – INT: It's probably a good thing you were looking directly at that because I feel coming out of the zone like that you probably would've done a quick head check to the centre of the ice to make sure nothing's happening behind the play, but in doing that, given the way he's holding his stick that may have led me to miss something had I been following proper procedure doing a head check as I was leaving the zone. As it gets to—yeah, as soon as [home team] sort of moves the puck up ice is probably where I'd be thinking, 'All right, take a quick look—take a look back' and then resume that.
- n. INT – INT: Definitely take a quick glance because in my mind I'm going, "Okay, that player's not going to take the defenseman head off." He's giving a bit of puck pressure, but ultimately, he's probably either trying to get in the passing lane or blocking him from having a clear shot rather than taking a run at the guy.
- o. NV – INT: He's checking back to make sure there's nothing going on behind his back because he didn't have all the players in front of him. So a quick shoulder check just to make sure behind the play nothing was going on.
- p. NV – INT: Keep an eye in front of the net, right? Because there's nobody around the puck carrier right now, so I think his focus is more on, you know, on the [home team] player in front and what's going to happen to him standing in front of the net?
- q. NV – INT: I'm doing the same thing. Now looking at the play I'm trying to find my out. There's no scoring opportunity here though so I don't really think we have to focus on the puck so much as the players and what's going and make sure there's no slashing or no roughs—roughing going on behind the play. There's nothing at the net, there's no scoring chance right here. So I wouldn't be too concerned about following the puck.
4. Away from play/puck (negative)
- a. EL – EL: Just that the shoulder checks that we talked about before too. Like we're not really sure if he's checking behind the play. I thought his focus was kind of more on the puck, but we don't know if he's looking back or not.
- b. EL – INT: He's not clearing his zone. He's looking at the pass.
- c. EL – INT: Wonder what's going on on the blue line? Should check back there.
- d. EL – INT: Everything away from the puck and where the puck is going. The Hockey Canada term is scanning the ice, which is not there. I think you want to put yourself in a position where you don't have to be looking around as much. If

they put everything more so in their line of vision already we wouldn't have to look around so much.

- e. EL – INT: I think maybe he should have done a quick check of the blue line while all the stuff that's going on along the boards.
- f. INT – EL: So, like, check those guys behind. See what they're doing, but I know I would be looking at this scrum because I want to see—because you're not going to say, if penalties are going to happen you want to know what. Because you're not going to say to your linesman, "Who started it?" You can't have a conference after a scrum and see whether you can take two guys for roughing.
- g. INT – EL: Yeah. Pretty much. They're battling right now in the corner and he's just went right up without thinking about it. They could be dropping the gloves right now.
- h. NV – INT: He never looked back. He was too far behind the play and he had to keep his eyes forward and couldn't look back. Like—although technically he could have had a quick glance he was just trying to keep up with the play.
- i. NV – INT: Whatever is happening back there because you don't know where the play left from. Maybe it left from a scrum off the boards, you know. There could be an extra shove or something like that. At least take a quick glance, you know see if there's anything worth looking at.
- j. NV – INT: If you see the players are fanned out then you know usually there won't be any issues. But if there is two guys sticking to each other, just kind of like pushing, and you know as they're skating up the ice, then you want to keep an eye on them. Like you still need to keep your eyes on the play, but he was just really far behind. That was a tough one at that level.

5. Post-whistle attention

- a. EL – EL: Trying to get closer. Getting closer. There was icing. And right away he stops and looks down the ice.
- b. EL – EL: He looked like he was looking at the benches there, too.
- c. EL – EL: I think his initial focus was on the immediate scuffle around the net. He's not really too worried immediately about the benches, he's just focusing on the guys who are causing grief for him. Gets them quickly and intervenes there, but then you can see his head start looking out towards the blue line and I'm sure he's looking a little bit toward the benches just to make sure that's going well, but his initial 5 seconds or so are certainly focused on the guys involved in the scuffle to sort of stop the fire before it really gets started. And then if there was— if it was a more heated game or there was a more serious altercation I think you'd see them start focusing more quickly towards the blue line towards the benches, but it wasn't really indicated in this game.
- d. INT – EL: It's good. He's watching the benches. Watching their change to make sure...It's everyone in view. Like everyone. Probably trying to figure out who changed first because [Home Team] is coming out.
- e. INT – EL: I would say at this point he has everyone in view. He tried to distance himself from the [home team] bench, too. Now I just wouldn't have skated over there as soon as there was an injury. He's injured, the trainer's there.
- f. NV – INT: Well he's skating backwards keeping the players in his sight before he goes over to award the goal.

6. Post-whistle attention (negative)

- a. EL – INT: See he went way too fast [to the penalty box] I think. He could have stayed there. Couple extra seconds. Let them clear the zone a little more and take off.
- b. EL – INT: He could have had the opportunity to get the players—or to the benches but he didn't. He came to the crease and zeroed on the players. He does a better job of keeping players in view though than the last guy did on his penalty call.
- c. EL – INT: I'd maybe wait the extra few seconds before going to the player penalty box to make sure the players are separated. If you go back, I don't know if they were doing anything before he went to the box or not, but...I think I'd be more likely in this case also to go over and say something before I call the penalties because if you skate away he openly skates away from the kids who are hanging out together. So he's decided—he was looking, we know he was looking, we just said that. So he skates away from them and decides this isn't a big deal. So if he said it's not a big deal, then I mean back and have words with them rather give the penalties, but he certainly could've waited like [participant] said it would've helped.
- d. EL – INT: Yeah just the extra few seconds, but he only turns back and now the guys are jawing and they weren't as you know just in the camera view they weren't doing anything until he made a signal at the box.
- e. EL – INT: Well he's going get burned on his line change because the guy sent out—the guy opened the door, threw two players out and he hadn't even let the second guy get out the door and his arm comes down to turns around. So now like really, if they're letting out defense you never know the forward door pops open and he sends two guys out there and then he's going to look back and go, "What the heck?" So I think he's not—he still has to look at those guys coming out. At least make sure the door closes after the last two guys go out and that's it.
- f. EL – INT: I don't know, but I just think that he's keep focusing on where the puck is and when the whistle is gone he's got to start looking at where the players are going to be. Yeah. There's going to be a line change he's gotta know that. So he should be looking at where that's going to happen. There's going to be 10 guys potentially...
- g. INT – EL: I wouldn't like that. Be back a little further. Because he can't, like he's looking down right there, he can't even have anybody in his vision. Needs to be back and watching the players.
- h. INT – INT: I think, every time he's called a penalty so far it seems like he's gone over pretty quick to the thing—to the penalty area—and so he was having to look back the whole time. Like, you got to admit he's going over pretty quick. Because, I know when you're reffing sometimes and you call a penalty you should probably, like, "You guys go" and you just go over and report it and not like stand there yelling at them knowing you're going to have the opportunity, but you could maybe linger in the area a bit more so you can see what's going on...

- i. INT – INT: The entire skate to the ice—or to the penalty box—he didn't even look at the 10 [home players] on the ice. In the other team's corner. There could've been a huge brawl there, 2 against 1.
- j. INT – INT: Maybe not letting all those players on the ice and yes, he should've probably skated back and looked at the play if you've got 10 [home players] on the ice.
- k. INT – INT: I don't know, I might just be personal preference, but when the whistle goes, it's just like I almost put my back towards the end boards so I can watch everybody instead of going out almost between the players where they're changing. That might've been because he's doing a line change too. That's where he's standing. Now he's missing everything because he's looking at the ice.
- l. INT – INT: Um, like when I'm going to the penalty bench—like even once I get there you just take a quick look around the ice to make sure nothing happens. They're like, "Oh, he's at the penalty bench I could do something stupid." Or, "He's not paying attention." So even that half-second quick look right before you give the goal—or the numbers.
- m. NV – INT: Because you see them all still looking back there. So seemed to be something happening, you know. He's looking at the box the whole way. Like when I signal a penalty and I usually still watch the play and make the signal. Like he's running to make his call instead he should just, like, sit there and wait until it calms down.
- n. NV – INT: That's why they make us have a riot pad now. You pull out your riot pad, write your penalties, write your numbers, so you don't have to like necessarily remember them all. You can just sit there, watch, wait until it's done, and then go on and make your calls.

7. Face-offs

- a. EL – EL: And I mentioned the fact that usually at a face-off what I tend to cue on is the back pair of guys because that tends to be the part that's obscured first. That face-off was a really good point where the [Home team] guy took the [Visiting team] guy hard right off the draw trying to go to the blue line and be cognizant and aware of what's going on behind your linesman is pretty important because if there's something bad that's goes on back there and you don't call or see it, it can go south pretty quick right off the hop. But I definitely not looking for things like encroachment—
- b. INT – EL: I would say he's probably looking at the face-off. Because there's no way he can see neither wingers are really jostling or anything, but there's nothing to draw his attention to any kind of confrontation, so...
- c. INT – INT: I always think when I'm reffing [refereeing] the time when I'm most going to miss something is right after you drop [the puck]. Anything can happen because your number one thing you're thinking about is getting out of the middle of the ice. It's a horrible place to be. And if the draw is, like, scrambled at all, everything's right around you and you can have guys maybe behind you.... Like, that's the one time when you're like, "Fuck it, I'm not looking at anything" and...excuse my language.
- d. INT – INT: Yeah. I think he's probably just making sure, like, you never know if the winger, like a lot of times when the play goes over there, you can still have,

and it's breaking out, you can have the winger coming down the far side, and so if you just kind of skate and keep your eye, like, view on the play, like, you can't see what I'm doing, but you can easily get caught from behind when you're out in the middle of the ice.

- e. INT – INT: It's a nice idea that, to think you should be looking at the play and stuff like that, but when you drop the puck at centre you really have to focus on getting to the boards and you can't do it without looking where you're going. And looking over your shoulder isn't necessarily good enough. You might have to actually, like, take a good look and make sure no one's in your way.
- f. INT – INT: But, yeah, the only thing, like, right now on the face-off you just look at, like, just the face-off you can see everything that could happen, but I would say in particular when the puck leaves, because we've just had this these penalties and all this crap, you want to make sure you keep your focus on because you've got.... You'd think you'd keep your focus on where there's players from opposite teams close to each other. And right now you've got three [home team] guys against three [visiting team guys]. That's three potentials for....
- g. NV – EL: Well the two guys back there. Red [visiting team] is probably—its offside in the sense that he's cheating. Now the other guy has a stick up so that could lead to something. I have the tendency to look at the drop and then veer off to where you see players starting to, like, where you see commotion start happening. Yeah you take a center point of view and then you look around it and then once you see something that tells you should look away or you should look somewhere else then you start focusing on another point.

8. Face-offs (negative)

- a. No codes

9. Puck carrier/puck

- a. No codes

10. Puck carrier/puck (negative)

- a. EL – INT: I would already say this guy was following the puck. Since the puck was shot on net and there were no white players near and he stared at the goalie for a couple seconds.
- b. EL – INT: He's definitely looking at the puck.
- c. EL – INT: He definitely follows the puck. Yes. Like what's going on on the far side? He follows the puck.
- d. EL – INT: Like the puck was shot and he followed it right away.
- e. EL – INT: Just looks like a young referee. Very quick to follow the puck, move his head. Scan, slow down. Watch. Too fast on penalties and too fast when he needs to get away from the play after the whistle. It's just that, in games I see, it's just that they just need to relaxed and then everything else will come slower.

11. Body-check

- a. EL – EL: Yeah, like here I would say he's identified the two [Home team] guys are going for, rough or whatever, going to be a hit...there's going to be a hit. Might as well watch that. Watch that. I'm not so concerned that the puck is on the boards.

- b. EL – EL: Right before that too there was a hit on the boards and the puck was gone and it looked like he stayed watching the hit and not the puck. Got tripped up. When he comes back in. Right near the blue line. See here, like the [Visiting team] bench, it's gone. He's still watching the hit. That's where the penalty's going to be.
- c. NV – INT: Okay right here there was a hit that looks like it can lead to something more. And he keeps looking right there even though the players are separating apart because he's keeping in his general view everything, but he wants to keep focus on that incident.

12. Body-check (negative)

- a. EL – INT: Like for him, if we just watch, presumably the defenseman passing the puck is going to get hit. And he didn't look at it. Or didn't watch the hit at all. Like right here. The puck's coming at him and he doesn't watch the hit.
- b. INT – INT: Well, I mean, you've got there's the hit, top left there in the bottom of the circle in the [home team's] zone. And the guy's not hurt, but he got knocked down so he needs to look at that. He never peeked back to the hit. And I was wondering if he had, right along the benches, there. He might have seen that, I don't know, but could have easily given more of a little look.
- c. NV – INT: You've got to watch out for those hits after you give away the puck and he turned with the puck right away instead of just watching for the hit that was going to be given after. He turned right away. Might have seen it with peripheral vision but you know that's... Yeah. Like he just followed the puck and you know, there might have been a hit on the 'd' afterwards.

13. One player

- a. INT – EL: So he was watching the guy right in front of the net, too. Number 7 [for the visiting team].

14. One player (negative)

- a. No codes

15. Penalty calls

- a. EL – EL: No matter which way you can see it, if you can see it you can use it. Use a reflection off the glass. I'm sure you can make the penalty call, it was a huge stretch of my peripheral vision.
- b. EL – EL: I think I said earlier as soon as a guy goes to catch the puck I get instantly cautious about who's coming around him. I don't really care about really the puck itself or the guy catching it. I'm just more worried about who's going to run this guy over as he's looking up for this puck, but that tends to be where I focus my energy on.
- c. INT – EL: Like, I agree with [focus group member] on that. I think for sure what he did he kind of tripped the guy who didn't have the puck so it was a penalty for sure, but the way he's looking he saw it but he chose not to call it. Maybe he's like yelling at the guy or something, but I agree, yeah. I that's that same guy again. Maybe he would get it by now.
- d. INT – EL: He's also looking right at it, so when you say there wasn't much, fall back on him, it wasn't a no call. He purposely saw what happened decided it wasn't worthy of a penalty—

- e. INT – EL: He’s in a position looking like he’d be able to give his judgment as to whether or not an infraction was required or not.
- f. NV – EL: The puck was right there, there wasn’t a scoring opportunity, but there was potential for a, you know, an elbow or a punch or something to be thrown—I think I would’ve had my eyes there. That’s where the action was.
- g. NV – INT: Well, there is a scrum, there’s three of four players on that puck. I think he’s going to be watching for, um, you know, a cross-check, something dirty going on. Whether he’s going to blow the play down because the puck is frozen against the boards.
- h. NV – INT: You know it’s—right now it’s rather simple until things get a little hotter in front of the net. Once that white [home team] player right there moves closer to the crease then you’re going to have to watch out for that ‘d’ [defenseman] or the goalie pushing in and, you know, the interference in front of the net.
- i. NV – INT: You try and make a decision too by looking at it, whether—like how long to let the play before there are going to start being cross-checks and punches start going. So maybe getting a little bit closer just to make that decision.

16. Penalty calls (negative)

- a. NV – INT: Which kind of tells me he missed something original when his back was turned, and that, you know, one shove turns into punches and you’re calling coincidentals to get them both off the ice.

17. Positioning and visual behaviors

- a. EL – EL: Even there when the puck came into the boards you’d think, like, it’s close to his feet, like he’s not...looking down at it. He’s more like, “Okay, where do I got to go to get out of you guy’s way”, right?
- b. EL – EL: Trying to get closer. Getting closer. There was icing. And right away he stops and looks down the ice.
- c. EL – INT: If you zoom in on the last one, it’s because he’s gotten away with the d-man [defensman], trying to gain the zone. He’s trying to see where he is. It’s positionally better. Lots of kids over there. That would also work.
- d. INT – EL: He’s in a position looking like he’d be able to give his judgment as to whether or not an infraction was required or not.
- e. NV – EL: Yeah see how close he’s he is now to the corner? Like as opposed to the other referee there? Like he—plays down the corner, he’s moving around there. He’s moving close to the play there and when it’s in the other corner he moving out closer without interfering with anything. He seems to be way more on top of the action. Yeah I get a feeling like you’re right there.
- f. NV – EL: Yeah. Like that was smart right there; he stopped—he didn’t go inside the zone. He stopped there and he can see everything coming up. If he would’ve tried going inside the zone he would’ve had to turn around to come back and he would’ve missed everything behind him.
- g. NV – EL: Yeah and when the play came towards him he skated off to the side so he could see everything. He didn’t just stay there and then start going left-right, left-right, left-right. Like its strategic the way he positions himself.

- h. NV – EL: See what he does there? He gets further into the corner and he turns around so he sees, like, he just gets in and turns. So now he sees the whole play and he's got a great view for the goal, which is why he's able to see the white player, you know, just pushing up against the goalie.
 - i. NV – EL: But, I like his positioning. I think he does a good job of keeping an eye on things, altercations, or two players coming together.
 - j. NV – EL: Well, when—in most cases—when he can he'll go further in deep to turn around and look at the play out in front of him instead of being in the play. Because you one of the outside looking in and not inside looking around. And he seems to do that. The only time he gets in trouble is when the play started getting around him because you have no choice but to start scanning around, but that's when you open yourself to missing more calls. Other than that, he's got it down.
 - k. NV – EL: Well, I think it was definitely a better referee than in the first clip that we saw. He's at the net very quickly. I like his positioning. I like how he's opening himself up—like he's almost mimicking, a little bit, like the four-man system by standing in the corner facing the entire zone as opposed to standing at the hashmarks. So he's just opening up his vision, and, like usually we were able to see almost all 10 skaters when they were on the ice.
 - l. NV – EL: Another thing he does well too, positioning. Yeah, positioning's perfect.
 - m. NV – EL: Looks to me, too, like he's far enough away that he can see everything, but he's still close enough. Like he's not getting out of position by standing 60 feet away. Yeah. He's able to bring himself away when he can and bring himself in—and when he brings himself in still he's in good position he can see most of the players on the ice.
 - n. NV – EL: So it seems to me when he's coming up the ice, he's taking the position behind the play, but just behind the puck carrier so he's kind letting the defensemen be, and focusing on, you know, the 2-on-2 or the 3-on-2 and being very close to that.
 - o. NV – EL: Um, you know, I think you've always got to try and get out of the way, but sometimes I guess you're saying, "Hey I can't go anywhere." But—you'll just get in the way more. You can't sacrifice good positioning to get out of the way of the puck. If the puck hits you, so be it.
 - p. NV – EL: From playing Junior A, I know a lot of fights start right in front of the net from scrums. So I think that's in the back of his head too that he's in a position to see if there is, first of all, if there is a fight he's right there and what started it. So who the extra two minutes is going to go to, he's right there to see it.
18. Positioning and visual behaviors (negative)
- a. EL – INT: Maybe it's a positioning thing, the penalty looked like—from where he was he was looking through the net. Not the best position to be in. I would go below. You should be going high though. Like I didn't see the penalty because the net was in the way.
 - b. EL – INT: Probably positioning for his dealing with scuffles. He needs to adjust his positioning to make sure he's got the best view to see both players in the scuffle and elsewhere on the ice and benches in view. He seems to be a bit

focused on the scuffle and he doesn't maximize his angles to see—to see more of the ice.

- c. INT – EL: If feel like the way he's kind of positioned his body, too, is he's kind of facing that way exclusively, so he should kind of push more of an angle so you can get the better grasp of the whole zone. But that being said, like even if he could have his head turned right now.
- d. INT – EL: One of the things, too, is the problem I think also, is if you look at, like he's kind of in position, but if you think of where we're supposed to be positioned it doesn't set you up very well to be able to see the, like he's at half-piston—which I don't think I need to explain to all of you—he's got his body facing the corner. He turns kind of more open towards the middle of the ice as you were saying, but then he's going to have, kind of whatever's going on at the net almost over his shoulder, right? So what would almost, looking at this you almost say you want to back down lower into, towards the goal line and try and keep the whole thing in view. Because this kind of makes him have a focus whatever's going on in that corner of the ice as opposed to you don't know what's going on at the points right now. INT – EL: I think it's more just how he positions his body than anywhere he's actually is. If he spreads his body, turns his shoulder more right, he can see more of the ice.
- e. INT – EL: I wouldn't like that. Be back a little further. Because he can't, like he's looking down right there, he can't even have anybody in his vision. Needs to be back and watching the players. INT – EL: Well, I think part of the thing is maybe, like, from where he's positioning himself, you can see how visually, like, what he has to focus on what he was focusing on. I would argue that he's not putting himself in a proper position to be able to focus on what he really should be. You know what I mean? At this point he should be bumping out and going behind these guys coming up, or he should be already getting closer to the blue line because he's stuck in, right at the hash marks as a breakout is happening.
- f. INT – EL: Like right now, a) I wouldn't be in that close to the scrum to begin with. When you're in that close, like you're limiting your sight, right? Once you get in close you can't see out as far as the blue line. So you back up. So even at like half-piston or at the net right now you can still see the defencemen at the point and see if he's coming in, so visually you see the fights and the defensemen at the same time.
- g. INT – EL: Like I agree with [Focus group member] that I'd be looking at this, but I think where he is is not a good position to be. He should be back more and I'd still keep in, I'd be obviously watching because one of my linesmen is in there too so I don't want—make sure they're there, but also that I can see if there's guys coming off the bench going to rough up some guy at the corner or this guy coming off, maybe he comes after that guy, right? INT – INT: If you're the official, though, and you're skating down the ice and the play's on the far side of the rink, you curl in kind of closer to the middle and curl back around the top, if that makes sense, and I'll draw here—why doesn't he have a better view of the ice? Yeah, because the play is on the far side. You can't see a check from behind. You can't see a cross-check, slash or punch to the head. You can't see

that or not as well as you're supposed to. And same way as on your side, you cut out with the play, you can see that play against the boards.

- h. INT – INT: For me, I would definitely want to move a little bit closer to whatever just happened to see it better. It's one thing, too, like, if there'd just been two guys over there and a quick pass here and a quick pass there, but it's just two guys and it's far away, you can see clearly what's going on, though, but when you have a whole bunch of players, like, look at that. You're pretty far away, you can see his sight line blocked by two players right there, like, you can't even see what's....
- i. INT – INT: Yeah, but I'm not going in there to break it up, I'm going in to make sure because I would want to be close enough that—I wouldn't want to be, because if you go by the book, he should be at half-piston right now. And in a scrum like that, I wouldn't want to be that far away, especially in a game with—the type of game it's been.
- j. INT – INT: I think if you were to just simply say one thing, it would be from the first guy. He's close to the, like, as compared to this guy, he was closer to whatever was going on, where this other one was cheating on his positioning a bit more, or like, whatever. Whereas this guy seemed to be a bit more, and the one time he did move in. On that whistle.
- k. INT – INT: I don't know, I feel like I'd want to be closer, but the rate that the puck was moving up and then there were still guys behind the play, like maybe, three or four feet closer into the blueline. But I mean, he was pretty—for puck movement, I guess he was in pretty good position up until the whistle anyways.
- l. NV – EL: I thought he'd gotten a little too close to the scrum, should've stayed back a bit and kept your eye on it. But then you can quickly see the rest of the ice. And definitely hard for him to take numbers [for assessing penalties] from that close.
- m. NV – INT: Well if he doesn't skate very hard okay he's more focused on what's going on, but at the same time he's got a shitty angle. I mean if he has to make a call from the blue line on something that happens down the corner it's a tough one. Like I hate when referees coast into the defensive zone—like especially when the play is right down in the far end corner in three-man system because you miss a lot of the action.
- n. NV – INT: He's too far away from the net. When you look at the back post and the post itself block the entire vision to the other player, so and then the goalie too, so as soon as 19 [#19 for the visiting team] there—19 blue [#19 for the visiting team]—goes in he doesn't really have a clue of what's happening behind the net. So... plus I mean the traffic is in front of the net so I would either go lower, like half-piston, or even actually kind of cheat and go higher.
- o. NV – INT: And positioning—positioning could be better. I find down low at times the angle was not very good. Like the play was happening and he was kind of either too far away or he had something blocking his sight. I mean he missed the jab there on that kid—I assume it was a jab or a punch whatever—but he was so far away there was no way he could see it.
- p. NV – INT: One game last night I had to keep going in and covering for the ref that I thought he was way too back on the play and lollygagging if you will, and

like, he was hanging way back watching everything and he was way out of position because I was going in very close to the net and I was shoulder checking back to “Hey where are you?” And I had to be in position because if there was a goal scored he was nowhere in the area. Nowhere near to the right place to make the call. There’s a fine line between hanging back and watching everybody and being in or out of position.

- q. NV – INT: You try and make a decision too by looking at it, whether—like how long to let the play before there are going to start being cross-checks and punches start going. So maybe getting a little bit closer just to make that decision.

19. Contextual positioning and visual behaviors

- a. EL – EL: Yep. Especially on a five-on-three here, I suspect there will be no [Visiting team] play remotely close to the blue line. So he really shouldn’t be looking past the dots.
- b. EL – EL: We can assume that [Home team]’s going to park guys right there. Yeah, and not move so... Might as well just watch there. And I’m sure the goalie’s going to take a few hacks at that. I’m sure whoever’s reffing knows that [Visiting team player] is a rougher player as you’ve seen in the last 10 seconds. Yeah. There’ll probably be a few whacks on the goalie or something near the goalie.
- c. EL – EL: Well you’ve got to zero in on what’s contested most hotly on a power-play, which usually is the front of the net because typically one team sets up you know on the periphery and another team sets up in the box and the spot that is contested is the front of the net.
- d. EL – EL: But yeah, you’re watching the most contested areas, which is the front of the net and particularly wary of watching the goalmouth and the paint of the crease. I’m trying to see if that’s where ultimately the players going to come eventually, and hopefully if someone’s got their power-play operating right. I think it all depends. I mean if they’re battling for the puck you obviously have to focus on the battle, but like [participant] was saying most the time if they do end up getting set up with pressure you can probably you know just keep the puck movement in the periphery and keep a decent focus in front of the net. This is a good example of that. He watches it when there’s a battle, but you see the puck moves away and now he starts focusing on the front of the net.
- e. INT – EL: Like when you have, like, the two red guys down in the corner like that you can say, well, I’m pretty sure that those two other red guys aren’t going to be doing anything stupid because they’re the only two guys in front of the net, now. You know, you can focus a bit more on where the puck is on the power play, which is what he seems to be doing. He’s kind of watching the play as it moves around.
- f. INT – EL: If they weren’t already down 5–3 with a lengthy two-man advantage now, you guys’d be throwing another guy in the box and saying, like, you’re going to be playing two men down for, what, three minutes almost.
- g. INT – EL: I don’t know, I was just going to say, like, on a 5-on-3 he can afford to cheat a little bit because he can see all three white guys and that’s all that

matters right there. He's got white guys on the outside you can't see. As long as you've got all three guys from one team...

- h. INT – EL: He was definitely looking at the right spots. There's no problem with his position. He knew where the puck was going and he was anticipating the play. Like, when there's the 5-on-3, like he kept the defending three players in view when the puck was in their zone because they're the only three guys who were going to start anything. He didn't really need to worry about too much else other than the white guy who parked himself in front of the net, and when he was there, he was paying attention to him. Like, as soon as there was a shot he'd be going up.
- i. INT – EL: I would agree because that's where all the play is going on and unless it's been a particularly chippy game, I wouldn't feel the need to be checking back to the points as much to see if anything is going on. Like, I'd be more concerned with what's happening with the play going given that three guys from each side are down below the hash marks, I suppose.
- j. INT – EL: And at this point, I get the feeling that the game isn't chippy, so, if anything's going to start, it would be at the puck or right near the puck or where the puck's going to rather than stuff starting at the point with two defencemen, or a defenceman and a winger.
- k. INT – INT: In front of the net, where the [visiting team player's] going towards and forcing a play on the [home team] player where there could be the potential for a body-check or confrontation. So he was kind of making sure he knew where most certain situations happen, other than that, on the PK [penalty kill] or the PP [power play], in general, you're, especially this one, they're generally keeping to the outside, so there really wasn't force on the play, or...so the play was going on pretty smoothly so he was just going to watch where there is going to be, confrontation, body-checks, in front of the net, points
- l. INT – INT: Now I know it's a power play, so...you're not going to get of the biggest hits, biggest stuff behind the play on the power play, but, you never know.
- m. INT – INT: Yeah, watch the front of the net more than anything else. It's just that there are less guys running around trying to beat the crap out of each other. And uh, so like the big action is going to be right at in front of the net rather than the defensive player trying to chase them around the zone. I'm going to assume that [home team's] going to score. The puck will probably stay in the zone. So I'm staying back by the goal line.
- n. INT – INT: I noticed he's standing a lot lower in the zone. Probably because he's assuming that [home team's] going to keep the puck in, at least do something useful with it.
- o. NV – EL: I think near the end of that clip he had it a little bit easier because of the five on three so the play was in that zone so he could position himself in a really good spot so he could see the net and everything like that without going anywhere.
- p. NV – INT: Well you said it's a playoff game right? Yeah so, give him credit he actually ends up with penalties, so he's managing that well.

- q. NV – INT: You want to take a glance and see how close together are they playing. Like usually a situation like this the blue team [visiting team], the defenseman are going to—or the forwards are really going to fan in a little closer in putting separation between the ‘d’ [defensemen], right? So then you know there's not a problem they're so far apart they can't do anything to each other. If there's sticking really close then yeah, you're going to want to keep them in the corner you know of your eye. They're down one man, so 1, 2, 3, 4—all blue [visiting team] players are in the zone. All three forwards of white [home team] are in that area. And then the two defenseman on the blue line I assume. So, like literally, everything that could be happening right now is in that area and where he's standing right now is more than there will be without me trying to set up a power-play.
- r. NV – INT: I find that's he in a better position here than he was 5-on-5. Took a corner position so he had everything in front of him. You could see the goal line. Where a couple of times he's been caught on the boards on the blue line, he's doing one of these—you know head going both ways—I just find his positioning was better.
- s. NV – INT: Well I think you've got a case, and as we eventually figured out the score was one-sided. So the question becomes is it getting too chippy? And you tend to, after you watch it, you're watching a bit closer the team that's a bit down, and that was the tendency, the play was getting out of hand on the other side. So you're watching a bit closer.
20. Contextual positioning and visual behaviors (negative)
- a. EL – EL: That situation I think he's probably thinking too much. Like they're down, five on three, maybe he wasn't happy with the penalty call he made and then that situation you're probably thinking too much. But other situations even though you're looking at it, you might not have the best angle and so you may have.... Maybe not made the right call. Maybe he thought the goalie had it and he should have blown his whistle and then he saw somebody make a move on the puck, so I've got to disallow this goal. So obviously on this goal he's going to rationalize the reason we just saw the goal. Yeah, the penalty makes no sense to me. You can just say he was in the crease and wouldn't get out. My thought process would leave me to believe that, because the guy was in the crease, and he knows it's wrong, he's kind of like, “Something's going to happen. Something's going to happen.” So he's thinking there's going to be a penalty and just overreacts to it. It kind of seems different to me. Had he taken a second maybe he would've too.
- b. INT – INT: I don't know. I'd say, like, I'd be more inclined to say the opposite, you know, because with the scrums we've see, like, there were three scrums just in the little bit we've been watching and if the score is getting out of hand a little bit, I wouldn't be too worried about missing a close goal when you've got your linesmen and everyone looking. I'd be more worried about missing a dirty play behind the play or something like that because all it could take is one dirty thing behind the play and then the guy gets up and punches him in the face and then suddenly...it can get out of hand. So, I'd be more inclined to just like, say, if the play picked up and behind the play there a close, if it goes out and there is a close

play at the net and you're, like, behind the play I would, you know, wouldn't be too worried about it as much. Hopefully, my linesman sees it and if not you just go to the coach and be like, yeah, "What, are you worried about getting your fifth goal as opposed to your fourth—four-goal lead or vice versa, they're going to start the come back (sarcasm)?"

- c. NV – INT: I think the other thing is the blue team [visiting team] was going up and they were shorthanded so he might of been less inclined to try and keep up with the play thinking that "Oh, it's getting it stopped". That's a misconception and you shouldn't do that, but—

21. Anticipation

- a. EL – EL: I don't know if you're into anticipation, but they definitely just anticipated the puck is going to come back to him, so instead of chasing it all the way down, he stayed there.
- b. INT – EL: Anticipating is the thing, because the thing with me, too, is I saw him move. On first view, I thought he kind of dropped it to himself and then deked the guy, but in terms of the reaction, the deke could be just deking with his hands. So, like I think it was, if anything, more the delay than the fact that it was so quick. And it's not like, this is something that in your mind, you're really like worried about, is calling it. Because you can imagine if he did call that, like handling the puck, like, it probably a pretty iffy play, probably...
- c. INT – EL: I think he's anticipating the shot coming in and that [home team] guy is going to be the guy who will interfere with the goalie. In some way, he's probably going to interfere with him. So I would definitely be watching the guy in front of the net rather than the defencemen skating around.
- d. INT – INT: I was thinking that everyone's lining up for a shot to be coming in. So it's safe to assume that the defenseman has the puck, right? I'm thinking just looking at the net just to make sure no one gets interfered with or cross-checked in the head. Like as the puck was being shot in.
- e. NV – EL: I think in this one he's more focused on—he's anticipating something coming up that he doesn't want to be taking his eye off the play.
- f. NV – EL: You're anticipating a lot more action around the net. It's going to be a lot harder to clear the zone.
- g. NV – INT: I don't know, you've got to anticipate too. It's part of our jobs, anticipating on the play, so it could be some bad luck on it, but he saw the puck go back to the [home team] defenseman, so you've got to assume that the play's going to come out towards the neutral zone, so you might want to take a position, like going backwards toward [home team's endzone] so everything can be in front of you. But I could be off...if you guys have anything to...
- h. NV – INT: No, it makes sense. Anticipation is the key. Yeah, I remember sometimes you've anticipated and it hasn't gone the way you expected so now you're caught. And you're getting back.

22. Anticipation (negative)

- a. No codes

23. Learning/experience

- a. EL – EL: Good. Position was good. Yep. Where he's looking is good. Like definitely you can tell a difference between he and the other guys (referee from first video). You can see the experience compared to the other guy.
- b. EL – EL: Obviously experience. More relaxed. He's kind of knowing where to look as opposed to trying to look everywhere.
- c. EL – EL: Yeah, learning as you go type thing. People can tell you, but you kind of have to do it yourself to understand it.
- d. NV – EL: See you can already see a big difference of experience or expertise. He has a different angle to the play. I find also his body is wide open to whatever's happening—like he gives himself the best possible angle.
- e. NV – EL: I think that's experience because he was—the player was coming towards him up against the boards. Technically he could've gone off inside the zone because that's where the play is going to happen, but instead he moved the other way so he could see the rest of the play—not be in the play, but see what everything he needed to see and then he compensated after that by rushing to the net. He was at the net real quick after that.

24. Learning/experience (negative)

- a. EL – INT: Just looks like a young referee. Very quick to follow the puck, move his head. Scan, slow down. Watch. Too fast on penalties and too fast when he needs to get away from the play after the whistle. It's just that, in games I see, it's just that they just need to relaxed and then everything else will come slower.
- b. INT – INT: In terms of the crew, like the referees, these guys had a lot less experience by the looks of it than the first game. It also looks like, whether, we haven't seen the whole game so you can't necessarily say, but it seems to me these guys had a more difficult game. Could be partially because of what they've done in the previous two periods, but in the junior game there really wasn't much going on after the whistle. We had one scrum and in this game it's been like every whistle, and I can imagine, their not very long, but I can imagine they're saying stuff, "These guys are getting kind of squirrely." So...

25. Assisting focal attention

- a. EL – EL: Well we had sort of said that, you know, he probably doesn't need to keep his eyes directly focused on them. He's probably got an idea in his periphery what they're up to and he'd see anything that looked kind of abnormal out of the corner of his eye, because his major focus there is where there's two pairs of guys fighting for puck position. I think he's probably more just aware peripherally of what's going on at the blue line.
- b. EL – EL: Well, I sort of said earlier that my peripheral vision seems to be attracted towards stuff that's moving like a fast movement. You know, I certainly tend to notice more guys going hard to the net in the side of my view or going hard into the corner away from the puck, especially if there is another if there's a second player with them. I tend to get drawn to those situations. I don't know that I really seem to notice guys moving slowly away from the puck as much. I don't tend to be drawn to that. I think there's chance of stupidity, but yeah.
- c. NV – EL: Yeah, he's not necessarily turning his head to where the play is; he's turning his body to where the play is. Right, just because of that he's perceiving a lot more, you know, he's just at the right spot. Like he can tell it's not his head

moving, that's him moving on skates. Yeah he took a nice glance back there, but he used more of his peripheral vision.

- d. NV – EL: He's always looking, at least in his peripherals, of what's going on with those guys along with the puck. Yeah, he's good.

26. Assisting focal attention (negative)

- a. EL – INT: But what scares me about this to is that because he's moving his head so much I'm not sure if he's actually looking and using his peripherals at all. So then if you're thinking, okay he's not using his peripherals, he's staring center screen. Like he can't even see the hit. So he's focused—this guy is the guy who's just like, not just play focused, he's puck focused now. Like really true puck focus. He's track exactly where that black disc is going. He missed a whole—that guy could've just cross-checked him in the face and he wouldn't have known.
- b. EL – INT: Because he hasn't learned yet [to use peripheral vision]. I mean I think some of it, I don't know how long this guy's been an official, but I think some of that reflects the fact that he hasn't learned to rely on it yet. So he doesn't trust it yet. So he can only trust what you can see dead-center in his vision.

27. Prioritizing visual behaviors

- a. EL – EL: I think [focusing on hand passes] it's quite a ways down. I mean it would be something that you pick up in this game more than—You're aware of it a little bit but in other games you're not focusing on who catches the puck it would be something where you end up getting it to attuned to it in a game like this and being able to make a judgment call on that particular play because the relative calm nature of this game, but in other ones, you may not have had a real good look at it because you're looking at a player elsewhere on the ice.
- b. NV – EL: I think it's in the back of your mind if you, you know, focus yourself 100% on the glove pass then you're going to get yourself in trouble. Because, especially the speed of this game, if you're focusing on one major thing, you're missing a lot. So I think he's trying to take—yeah, the glove pass is in the back of his mind—did he close his hand on the puck, did he put down—it's in the back of the mind but he's also seeing the play come towards him going, “Okay, I've got to get out of the way”
- c. NV – EL: I think again it's one of those things where, excuse the term, but he's playing the odds. Like, chances are more things are going to happen in that scrum than out at the point. So he's kind of playing the odds on that one.

28. Prioritizing visual behaviors (negative)

- a. No codes

Appendix L: Eye Movement Recording Sheet

Clip Number	Clip Description	Correct Response	Participant Response
1	INT – 1 – 1 – 1	No penalty	
2	NHL – 5 – 1	No penalty	
3	NHL – 2 – 1	Interference	
4	INT – 1 – 1 – 2	No penalty	
5	NHL – 6 – 4	Roughing	
6	EL – 1 – 2 – 3	No penalty	
7	NHL – 5 – 3	Interference	
8	EL – 1 – 1 – 1	Holding	
9	INT – 1 – 2 – 1	No penalty	
10	NHL – 4 – 1	No penalty	
11	NHL – 6 – 3	Tripping	
12	EL – 1 – 2 – 4	No penalty	
13	NHL – 1 – 1	Holding the stick	
14	INT – 1 – 1 – 4	No penalty	
15	NHL – 6 – 5	No penalty	
16	EL – 1 – 2 – 2	Tripping	
17	NHL – 1 – 2	Tripping	
18	INT – 1 – 1 – 3	Tripping	
19	NHL – 5 – 2	Holding	
20	EL – 1 – 1 – 2	Hooking	
21	NHL – 6 – 2	High sticking	
22	NHL – 1 – 3	No penalty	
23	EL – 1 – 2 – 1	No penalty	
24	NHL – 6 – 1	No penalty	
25	NHL – 3 – 1	Tripping	
26	NHL – 4 – 2	No penalty	