

**Decision-Making in Ice Hockey Referees:
Officiating Style and the Accurate Detection of Penalties**

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Abstract

Examining officiating in ice hockey has received limited attention, particularly in the area of decision-making at the grassroots, minor ice hockey level. The primary purpose of this research was to create a video tool from hockey game footage and examine minor hockey officials' decision-making in the context of officiating style and experience. Minor hockey officials possessing three levels of officiating experience: (1) 1 y ($n = 10$), (2) 2 to 4 y ($n = 13$), and (3) 5 to 9 y ($n=10$) completed a Video-Based Infraction Detection Task. Referees were shown video clips of potential penalty scenarios from female AAA Bantam and Midget hockey games, according to four game information conditions: (1) No Information, Randomized (NR); (2) No Information, Sequential (NS); (3) Information, Randomized (IR); and (4) Information, Sequential (IS). Specifically, referees received game information (e.g., score) or no game information prior to clip viewing; and the clips were presented randomly or in the sequential order that they occurred during game play. After viewing each clip, referees were asked to determine whether an infraction occurred. The accuracy of the referee's detection performance was calculated using Signal Detection Theory. A 3 (experience group) x 4 (condition) mixed factorial ANOVA, with repeated measures on the last factor, revealed that all officials performed similarly on the detection task irrespective of experience. A main effect was found for condition, $F(3,90) = 40.0, p < .001$ and post-hoc comparisons showed superior accuracy in the IR condition ($81.8\% \pm 1.4$), followed by the IS condition ($74.3\% \pm 1.5$), NS condition ($68.5\% \pm 1.4$), and NR condition ($60.0\% \pm 2.2$). These findings suggest that game information may assist referees attentional focus to the task, as well as put the referee into the context of the game resulting in superior performance for detecting an infraction. The data is discussed in the context of using video-based protocols for training hockey referees at the grassroots level of officiating. This work also provides future directions and

recommendations for the development of video scenarios for referee training, including the incorporation of common stressors identified by minor hockey officials across experience levels.

Lay Summary

This study measures minor hockey officials' accuracy in identifying a penalty infraction using a video tool. Limited research has been conducted with minor hockey officials examining penalty decision-making. As officiating can be a difficult task, potential stressors minor hockey officials may endure was also reported in this research. Using a video tool from the referees' perspective can capture a more realistic scenario an official may encounter while calling a game. These scenarios can include penalty, positioning, and stressor scenarios. This work shows that providing game information prior to viewing a scenario enhances penalty detection performance with officials at all experience levels. The goal of this study is to develop and examine the feasibility of a video tool for training hockey officials at the grassroots level to better prepare minor hockey referees for the task of officiating.

Preface

This document is the original work by the author Jade Werger. The written document was produced by the author, Jade Werger with assistance from her supervisor, Dr. Shannon Bredin. Edits were provided by both Dr. Darren Warburton and Dr. Carolyn McEwan. Development of the video tool presented in Chapter 2 was led by Jade Werger with assistance from BC minor hockey officials to capture and evaluate the video footage. Creation of the video clips was solely edited by Jade Werger. All methods (participant recruitment, procedure, and data collection) were accomplished by Jade Werger. Data analysis was conducted by Jade Werger, Dr. Shannon Bredin, and Dr. Carolyn McEwan. Co-authors of the resulting publication(s) are: Jade Werger, Dr. Carolyn McEwan, Dr. Darren Warbuton, and Dr. Shannon Bredin. Development of the video tool was conducted under the UBC Human Ethics Board certificate number H15 – 00282 (Hockey Officials Decision Making: Tool Design). The primary investigation of the thesis was conducted under UBC Human Ethics Board certificate number H15-01552 (Officiating Styles in Ice Hockey Referees).

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CHAPTER ONE

Introduction

1.1 Introduction

Referees play an important role in the sporting environment. Referees are the mediators between two competing opponents, are in charge of applying rules and regulations, and play a key role in ensuring fair, enjoyable, and safe play. Even though referees are considered to be neutral spectators, conscious or unconscious bias may influence a referees' decisions during a game. For example, influencing factors on decision-making capabilities can include the effect of crowd size and/or noise at home (Balmer et. al., 2007; Downward & Jones, 2007; Goumas, 2014; Greer, 1983; Nevill, Balmer & Williams, 2002; Nevill, Newell, & Gale, 1996; Nevill, Webb, & Watts, 2013; Page & Page, 2010; Unkelbach & Memmert, 2010). In addition, game factors such as time of game and successive penalties may also influence the decision-making process of referees leading to biased and/or inconsistent calls (Bar-Eli, Levy-Kolker, Pie, & Tenenbaum, 1995; Bar-Eli & Tenenbaum, 1989).

Examining consistency and accuracy in officiating has been the main underlying research focus in the area of referee decision-making. Consistency of a referee in decision-making is highly dependent on the individual's style of officiating. Officiating style reflects whether the referee calls penalties strictly by the description in the rule book or whether (s)he calls penalties at his/her discretion based on the flow of the game. Unkelbach and Memmert (2008) use the term *rule administration* in a context-free manner where referees assess each potential penalty decision independently of the next without taking the current game score or playing time into consideration and then providing a decision in strict accordance with the game rules and regulations. An

alternative approach is a *game management* style, which focuses on the context of the game, the specifics of the situation, or whatever decision is considered best for an “optimal flow of the game”. The difference in these two approaches is whether there is strict practice of the rules and regulations or whether referees focus on what is perceived to be the best call for a fair game.

To date, research has shown the tendency to use a game management officiating style in many sports. For example, Unkelbach and Memmert (2008) found that soccer referees used a game management approach because they awarded less yellow cards in the beginning of a soccer game compared to the rest of the game. When the same soccer referees watched a potential penalty scenario they thought was from the beginning of the game, they were more likely to make a different decision when compared to watching a scenario they thought was occurring nearing the end of the match. Bar-Eli and Tenenbaum (1989) also showed that time in a basketball game (i.e., beginning, middle, or end of each half) influenced when minor and major infractions occurred. Minor infractions occurred more often than major infractions up until the end of the second half when quantity of major violations increased substantially. Subsequently, officials made more calls in the end phases of the game. This finding suggests that players may become more aggressive as the end of the game nears. Further, Bar-Eli et al. (1995) showed that players tended to become more aggressive when referees called a violation against them or missed a violation call in their favour. An away game and unexpected events also increased player aggression.

Event sequencing has also been investigated as it relates to officiating style. Brand, Schmidt, and Schneeloch (2006) presented referees with video contact situations in a random sequence and in the order of the original sequence of events. When presented in random sequence, referees demonstrated more rigorous decisions. When showing video contact situations according to its original sequence, referees performed more closely to the referees in a real game scenario; hence

demonstrating a game management style in which, successive penalty decisions have a sequential effect on the referee's decision making.

In soccer, Plessner and Betsch (2001) showed that referees awarding a penalty in a prior situation, failed to award a penalty in the next potential foul scenario involving the same team. In contrast, the probability of awarding a penalty in the second scenario increased if the referee had not called a penalty in the first scenario. Findings also showed that awarding a penalty to one team increased the probability of awarding a penalty to the opposing team. These results were supported by Schwarz (2011) who demonstrated that referees exhibited an “equality orientated bias” (p. 446). That is, referees based later decisions on decisions made earlier in the match, wherein the timing of penalties creates contingencies for the referee to balance out the game. Similar findings have been shown when examining patterns of foul calls in college basketball. For example, Anderson and Pierce (2009) showed a tendency for the number of fouls presented in a game to even-out throughout the game; however, there was also a prevalence for foul calls to be called against the visiting team or against the team leading on the scoreboard. Taken these findings together, game circumstance is an influential factor in referee decision making and the adoption of a game management style.

In the past decade, accommodations have been made in actual game play towards the introduction of video replay, and the opportunity for officials to discuss calls with one another during the game. These adjustments have been implemented to assist the referees' decision-making capabilities, wherein the official is provided the opportunity to verify or correct a decision made during the game. It is expected that these implementations will improve the accuracy of game decisions made by officials at the professional level (using video replay and discussion) and at amateur levels (using discussion).

In the research setting, video analysis has been used in various sport studies to examine officiating decision making capability. These include such factors as:

- (1) crowd noise (Balmer et al., 2007; Nevill, Balmer, & Williams, 2002),
- (2) game management and sequential effects (Brand, Schmidt & Schneeloch, 2006; Mascarenhas, Collins, & Mortimer, 2002; Plessner & Betsch, 2001; Unkelbach, & Memmert, 2008),
- (3) referee assertiveness (Wilson & Mock, 2013),
- (4) team aggression reputation (Jones, Paull, & Erskine, 2002),
- (5) jersey colour (Krenn, 2014),
- (6) home advantage (Poolton, Siu, & Masters, 2011),
- (7) gender and race bias (Souchon, Livingstone, & Maio, 2013; Wagner-Egger, Gyax, & Ribordy, 2012),
- (8) information processing (Larkin et al. 2011; MacMahon, Starkes, & Deakin, 2009), and
- (9) visual detection (Cañal-Bruland, Mooren, & Savelsbergh, 2011; Catteeuw et al., 2009a; Ghasemi, et al., 2011; Gilis et al., 2009; Hancock & Ste-Marie, 2013; MacMahon & Ste-Marie, 2002; MacMahon et al., 2007a; MacMahon, Starkes, & Deakin, 2007b; Mascarenhas, Collins, & Mortimer, 2005a; Put et al., 2013a; Renden et al., 2014; Schweizer, Plessner, & Brand, 2013).

Moreover, applied video analysis and computer animation has also been used as a tool for referee training in rugby (Mascarenhas et al., 2005b), basketball (MacMahon, Starkes, & Deakin, 2007b; Schweizer, Plessner, & Brand, 2013), and soccer (Catteeuw et al., 2009b; Catteeuw et al., 2010b; Catteeuw et al., 2010c; MacMahon et al., 2007a; Put et al., 2013b; Schweizer, et al., 2011). In ice hockey, collecting footage of a game from the perspective of the referee has been used recently in the National Hockey League (NHL) via the use of a headcam, more commonly known as a GoPro for the use of video review during the game. However, to date research has been limited as it relates to the use of video capture during officiating at the grassroots, minor hockey level of play. Hancock and Ste Marie (2014) implemented the use of a helmet camera for research investigating hockey official decision strategies at various experience levels.

While there is an increasing body of literature in the area of decision making and officiating, the abundance of research is in the sport of soccer, and to a lesser extent sports such as basketball and

handball. In contrast, the decision-making process of ice hockey referees in general, and officiating style specifically, has received little attention despite the popularity of ice hockey in many countries around the world. Further, the research examining ice hockey referees has been focused at the professional levels of play. Investigations that have been conducted include ice hockey officials' decision making in relation to uniform colour and perception of aggression (Frank & Gilovich, 1988), certification level and perceived stressors (Dorsch & Paskevich, 2007), gaze behavior and decision-making accuracy (Hancock & Ste-Marie, 2013), decision strategies and experience level (Hancock and Ste-Marie, 2014), and certification level, assertiveness, and accuracy of penalty decisions (Wilson & Mock, 2013). Lopez and Snyder (2013) also investigated professional ice hockey officials and the effect of successive penalty calls and time of game on decision making. However, officiating style has not been investigated in minor hockey referees.

In the 2016-2017 season, there was a total of 4,333 ice hockey officials registered in the province of British Columbia (Table 1.1). Minor hockey referees can be as young as 12 years of age. Importantly, at the rep levels of play (Atom to Juvenile), bias in officiating can directly influence league standings. For instance, in many minor hockey leagues across Canada, 2 points are awarded for a win, 1 point for a tie, and zero points for a loss. In addition, a point is also awarded (referred to as the Sportsmanship point) when a team, irrespective of a win or a loss, achieves low penalty minutes (e.g., Atom = 6 minutes or less; PeeWee = 8 minutes or less) provided no Major, Misconduct, Game Misconducts, Gross Misconducts, or Match penalties occur within a game. Therefore, game officials and the penalties (s)he calls can have tremendous influence over the standings in a league, which becomes particularly salient if a game management style is adopted. As such, further research is warranted, especially as it relates to establishing fair play in ice hockey, and in the professional development and training of ice hockey referees at the grassroots level and

beyond. Therefore, the primary purpose of this research was to examine whether ice hockey officials at the minor hockey level demonstrate an officiating prevalence towards a game management style or officiate using strict rule application across experience level. More specifically, ice hockey officials of different experience levels were examined for their capability to accurately make penalty decisions when provided game information and under conditions of no information.

Table 1.1: Number of officials in British Columbia by sex and certification level in 2016-2017, compared to 2015-2016 (Created from the British Columbia Officiating Statistics, BC Hockey 2016 – 2017 Annual Report, p. 30).

2016 - 2017	Female	Male	Total	2015 - 2016
Level 1	237	2131	2368	2463
Level 2	128	1441	1569	1599
Level 3	23	253	276	274
Level 4	4	73	77	66
Level 5	0	33	33	21
Level 6	0	10	10	10
Total	392	3941	4333	4433

In sport officiating, stress becomes an important issue as it can disrupt a referees' judgment during the game as well as their overall wellbeing. Internal and external influences or potential stressors have been identified and measured for intensity of stress. Generally, officials have shown to report low to moderate stress during competition in basketball (Burke et al., 2000; Kaissidis-Rodafinos, Anshel, & Sideridis, 1998; Rainey & Winterich, 1995; Stewart et al., 2004), soccer (Gencay, 2009; Taylor & Daniel, 1987), football (Goldsmith & Williams, 1992), volleyball (Goldsmith & Williams, 1992; Stewart & Ellery, 1996; 1998); rugby (Rainey & Hardy, 1997), ice

hockey (Dorsch & Paskevich, 2007; Dorsch et al., 2012) and baseball/softball (Rainey, 1994b). Although levels of stress have been reported typically as low to moderate, assessments to date generally utilize self-report. In addition, various sources of stress can affect the official's cognitive and psychophysiological processes during the game, reducing their performance (Anshel, 1990; Jones & Hardy, 1989; as cited in Gencay, 2009). Often, the stressors experienced by officials come from factors in the game that are out of their control such as verbal threats from players, spectators, or coaches, mistakes made from their partner official, and being evaluated. Typically, most of the stressors experienced by an official during a game directly or indirectly relate to his or her performance on the ice (Anshel, 1990; Goldsmith & Williams, 1992; Jones & Hardy, 1989; as cited in Gencay, 2009). In a profession that requires an abundance of responsibility and receives constant analysis from others, many young officials do not continue officiating (Goldsmith & Williams, 1992). Therefore, a secondary purpose of the research was to examine minor hockey officials perceived intensity and occurrence of stressors across experience levels. The goal of this secondary purpose was to generate preliminary data into what stressors are negatively affecting minor hockey officials, especially young referees. The intention of this work is to recommend future research protocols for investigating the relationship between stressors and officiating style. Taken together, the overall humanistic goal of this work is to generate knowledge to improve ice hockey referees' performance, as well as to better establish a supportive and safe environment for officials and players alike.

1.2 Overview of the Research

This thesis document consists of two investigations: a primary investigation that examines accuracy in minor hockey official's decision-making in the context of officiating style and

experience level; and a secondary investigation examining the perception of stress among minor hockey officials of differing experience level. This document also describes the creation and use of a video tool in the primary investigation. In total, 52 minor hockey officials were recruited to participate in this research. Data from 33 minor hockey officials were analyzed for the primary investigation and the data of 52 officials for the secondary investigation.

For the primary investigation, officials ($n = 33$) were recruited and classified according to one of three levels of experience: (1) 1 year of experience ($n = 10$), (2) 2 to 4 years of experience ($n = 13$), and (3) 5 to 9 years of experience ($n = 10$); and ranged in age from 12 to 24 years. Officials viewed 100 short video clips of potential penalty scenarios of AAA Bantam Midget female hockey. These 100 video clips were broken up into four conditions; (1) Information, Randomized (IR); (2) Information, Sequential (IS); (3) No Information, Randomized (NR); and (4) No Information, Sequential (NS). More specifically, the conditions either contained game information (I) (such as time of the game, score of the game, and home and away team identification) or contained no game information (N) and were presented either in sequential (S) order of occurrence or in randomized order (R). For each clip, participants recorded on a response sheet whether they believed an infraction was to be called and if so, what the infraction was. Participants were also asked to record their confidence in each decision. The data were then analyzed for accuracy of penalty decision using the Signal Detection Theory method of analysis. It was hypothesized that:

1. the more experienced referees (5 to 9 y) will perform with the greatest accuracy when compared to the less experienced referees (1 y and 2-4 y), whom will perform similarly.
2. the referees will make more accurate decisions in a random condition, which will result in more correct calls on a video-based infraction detection task compared to

a sequential condition (where the knowledge of one video clip from an earlier time in the game can potentially influence a decision on the next clip).

3. the referees will make more accurate decisions in a no information condition (via stricter application of the rules due to the absence of game factors) compared to an information condition.
4. taking hypothesis 2 and 3 together, the greatest accuracy in performance will be shown in the no information, random (NR) condition and the least accurate performance in the information, sequential (IS) condition across the groups.
5. the more experienced referees will demonstrate greater levels of confidence in detecting an infraction as a function of more officiating experience.

To examine the secondary objective, all participating officials completed The Hockey Official Sources of Stress Inventory (HOSSI – 20) (Dorsch, et al., 2012). This inventory consisted of twenty stressors an official may encounter when officiating. The perceived extent and intensity was recorded for each stressor based on the officials most recent season. It was hypothesized that:

1. the referees will score low to moderate levels of perceived stress
2. less experienced referees will identify higher levels of perceived stress on ‘Fear of Mistakes’ compared to more experienced referees.
3. more experienced referees will report higher levels of perceived stress on “Verbal and Physical Abuse” compared to less experienced referees.

1.3 Overview of the Thesis Document

The present document is organized into five chapters. An introduction to the thesis document is presented in Chapter 1. Chapter 2 describes the development of the video clips of potential penalty calls, which was used as a tool in the primary investigation. The primary investigation is presented in Chapter 3. Chapter 4 presents the secondary investigation, which generated descriptive data on perceived stressors and how it relates to experience as an official. Chapter 5 concludes the thesis with a discussion of the main findings and implications derived from the research. Discussion on the limitations of the research and future recommendations complete the chapter. An extended literature review can be found in the Appendix of this document.

CHAPTER TWO

Using Video Capture to Evaluate and Improve Referee Penalty Decision Making in Ice Hockey

2.1 Introduction

Examining decision making in ice hockey referees has received limited attention; yet ice hockey is a popular sport. While research is needed to examine the factors that influence referee decision making, few research tools exist. One area of increasing feasibility is the use of video for both training and for research purposes. In the research setting, applied video analysis has been used as a tool for referee training in rugby (Mascarenhas et al., 2005b), basketball (MacMahon, Starkes, & Deakin, 2007; Schweizer, Plessner, & Brand, 2013), and soccer (Catteeuw et al., 2010b; Catteeuw, et al., 2009b; MacMahon et al., 2007a; Put et al., 2013b; Schweizer et al., 2011). These studies have shown promising results for enhancing the accuracy of referee decision making in their respective sport. However, applied video analysis from a referee's perspective has only been observed once in hockey officiating research by Hancock and Ste-Marie (2014). The purpose of this chapter is to describe the development of video clips for use in the primary investigation. Although the purpose of this work is methodological in nature, we also present descriptive information that provides some insight into the utility of on-ice video capture for the examination of referee decision making.

2.2 Methods

2.2.1 Participants

Officials from a Bantam and Midget Female AAA spring ice hockey tournament (in the Greater Vancouver Region) were recruited to participate in the capture of video for the development of a tool to be used in the primary investigation of this thesis. Informed written consent and parental consent when necessary was obtained from eleven certified minor hockey officials ($n = 3$ f, $n = 8$ m), who captured head-cam game video while officiating. In addition, a total of four female hockey teams were recruited and provided parental consent to be videotaped during their game play.

2.2.2 Video Clip Development

Game footage was captured via Vivitar sports cameras mounted to the helmets of both the referee and linesmen while officiating. Approximately 6 hr of game footage was captured. From this footage, a total of 194 video clips of potential penalty scenarios (on-ice infractions) were created (each clip lasting approximately 7 s in duration). Information recorded for each clip included: (1) time of game, period, score, assignment of home versus away; (2) whether a penalty was called; and (3) the offending team (in the event of a penalty).

2.2.3 Panel Analysis

All video clips were individually evaluated by a panel of experienced officials ($n = 3$ (1 F; 2 M)) age = 44.3 ± 11.6 y; experience = 15.7 ± 5.1 y) to determine game play penalty decisions. Each panel member was asked to evaluate the scenario in accordance with the Official Rule Book of Hockey, and was only provided with the age, sex, and competition level of the players in the video scenario. Out of the 194 video clips, 14 clips were eliminated because of poor quality or camera

angle, leaving 180 video clips for evaluation by the officiating panel. Out of 180 video clips, the panel identified (with agreement) 44 clips with infractions and 136 clips without infractions. A decision was made on 180 clips (an infraction occurred or an infraction did not occur) with an inter-rater reliability of 84% amongst the panel of experienced officials using the percent agreement method of calculation.

2.2.4 Game Play Decisions Versus Panel Decisions

When compared to actual game play penalties, officials on the ice called 16 of the 44 panel-identified infractions. This finding may reflect different processes in decision-making, wherein we postulate that the consensus panel managed calls based on the strict interpretation of the rule book while the officials on-ice may have used a more game management style to make decisions (e.g., time of infraction, score of the game). In addition, the consensus panel was not time constrained in their decision-making; whereas, the on-ice officials were required to make a decision in the moment. The consensus panel were all highly experienced hockey officials who are well recognized and involved in BC hockey officiating. Referees on the ice were, for the most part, less experienced officials. This could also provide some explanation for calls that were missed.

2.2.5 Final Product

At the completion of this process, a total of 44 infraction clips and 136 non-infraction clips were available for use in the primary investigation.

CHAPTER THREE

Primary Investigation:

Accuracy of Penalty Calls on a Video-Based Infraction Detection Task in Minor Ice Hockey Officials

3.1 Introduction

The purpose of the primary investigation was to examine whether ice hockey officials at the minor hockey level demonstrate a preference towards a game management style or officiate using strict rule application across experience level. To investigate, ice hockey officials of different experience levels (1 y, 2-4 y, 5-9 y) were examined for their capability to accurately make penalty decisions on a video-based infraction detection task when provided game information and under conditions of no information. Previous research has shown the tendency to adopt a game management style in the sports of basketball (Anderson & Pierce, 2009; Bar – Eli & Tenenbaum, 1989; Brand Schmidt & Schneeloch, 2006), soccer (Plessner & Betsch, 2001; Schwartz, 2011; Unkelbach & Memmert, 2008), and ice hockey (Lopez & Snyder, 2013). In addition, officials with more officiating experience have demonstrated higher accuracy in infraction calls in both Australian football (Larkin et al., 2011) and ice hockey (Handcock & Ste Marie, 2013). Therefore, we hypothesized:

1. More experienced referees (5 to 9 y) will perform with the greatest accuracy when compared to the less experienced referees (1 y and 2-4 y), whom will perform similarly.
2. Referees will make more accurate decisions in a random condition, which will result in more correct detection of a video-based infraction compared to a sequential

condition (where the knowledge of one video clip from an earlier time in the game can potentially influence a decision on the next clip, decreasing detection accuracy).

3. Referees will make more accurate decisions in a no information condition (via stricter application of the rules due to the absence of game factors) compared to an information condition.
4. Considering hypothesis 2 and 3 together, the greatest accuracy in performance will be shown in the no information, random (NR) condition and the least accurate performance in the information, sequential (IS) condition across the groups.
5. The more experienced referees will demonstrate greater levels of confidence in detecting an infraction as a function of more officiating experience.

The data was analyzed using the tenets of Signal Detection Theory, which has been used previously to examine infractions and decision-making in sport (e.g., Hancock & Ste-Marie (2013), MacMahon, Starkes, & Deakin, (2007b), and MacMahon & Ste-Marie (2002).

3.2 Methods

3.2.1 Participants

Thirty-three active, certified male and female minor ice hockey officials (12 years or older) were recruited from the Lower Mainland of British Columbia and were classified according to one of three levels of experience: (1) 1 year of experience ($n = 10$), (2) 2 to 4 years of experience ($n = 13$), and (3) 5 to 9 years of experience ($n = 10$). To be certified, an official must have completed a two-part process (except for Level I) involving clinical and practical assessment. Once certified, officials are expected to stay up-to-date with new rule interpretations and officiating techniques. To maintain

one's current level of certification, the individual must attend a full *Hockey Canada* officiating program clinic and write a national examination every year (achieving a set passing score) (Officiating Essentials, 2015).

To recruit participants, referee representatives from local hockey associations were contacted by phone and/or email. Representatives from multiple associations assisted in the recruitment process by using various approaches to provide the study information to potential participants. Tactics included: posting recruitment information to online officiating forums for the overseeing association, emails to officials, personal connections, and the presence of a research team member at officiating camps and recertification clinics. All participants provided informed consent (or assent in the context of mature minors). This research followed the ethical guidelines set forth by the University of British Columbia's Behavioural Research Ethics Board for research involving human participants.

3.2.2 Assessments

3.2.2.1 Questionnaire

Each participant completed a questionnaire that included the collection of general demographic questions (e.g., age, sex), questions related to playing experience (e.g., highest level of ice hockey played), and questions regarding officiating experience (e.g., number of years officiating).

3.2.2.2 Video-Based Infraction Detection Task

The task consisted of viewing a series of 25, 5-10 s clips of potential penalty scenarios recorded from AAA Bantam and Midget female ice hockey games (see Chapter 2) projected onto a large screen using a LCD projector. Immediately following each video clip, participants were asked to

determine whether there was a ‘penalty’ or there was ‘no penalty’ in the scenario. In the case of a ‘penalty call’, participants were asked to indicate the name of the infraction (e.g., tripping). In addition, participants were asked to indicate their level of confidence in making a correct decision (i.e., infraction call) using a percentage to indicate the confidence level from 0% - 100% where 0% represented not at all confident and 100% indicated the participant felt completely confident in his or her decision. Referees received 10s to record their responses, after which the next clip appeared.

3.2.3 Procedure

Participants attended one data collection session in total. In the session, participants were examined across four conditions, which were manipulated according to level of information provided to the referee and organization of the video clips. In a condition, participants were either provided game information (I: time of game, period, score of game, home versus away information, and playing level) or not provided game information prior to a set of scenarios (N). In addition, scenarios were presented in a randomized manner (R: scenarios were presented from various game time points and teams) or sequentially (S: scenarios were presented from the same game, in the chronological order that the action occurred). These four conditions are referred to as: (1) Information, Randomized (IR); (2) Information, Sequential (IS); (3) No Information, Randomized (NR); and (4) No Information, Sequential (NS). A total of 25 unique clips were viewed per condition that included 20 test clips and five practice clips. All conditions contained the same amount of ‘penalty’ clips and ‘non-penalty’ clips (e.g., 6/20 clips were penalty calls while the remaining 14 were non-penalty calls). The order of condition was determined by assignment to one of four presentation groups (Table 3.1).

Table 3.1 Testing Procedures.

Presentation Group	Order of Condition Presented			
	Set 1	Set 2	Set 3	Set 4
Group 1	IR	NS	IS	NR
Group 2	NR	IS	NS	IR
Group 3	NS	NR	IR	IS
Group 4	IS	IR	NR	NS

IR = Information, Randomized; IS = Information, Sequential; NR = No Information, Randomized; NS = No Information, Sequential

A 2-min break was provided to participants following the completion of each condition. As the referees were tested within their assigned groups, the participants were instructed not to communicate with one another about their decisions, which was monitored for the duration of the session. All responses were made individually on his or her respective answer sheet.

3.2.4 Data Treatment

Signal Detection Theory (SDT) was used to assess referee performance on the video-based infraction detection task. In total, the hockey officials were asked to make a penalty decision on 100 potential penalty infractions. In accordance with Signal Detection Theory, each decision was assigned one of the following labels: Hit, False Alarm, Miss, and Correct Rejection (see Table 3.2). Specifically, if a participant signalled there was a penalty and a penalty was present in the clip, the participant's response was recorded as a **Hit**. If a participant signalled there was a penalty, but a penalty was not present in the clip, the participant's response was recorded as a **False Alarm**. If a participant signalled there was no penalty when a penalty should have been called, the participant's response was recorded as a **Miss**. If a participant signalled there was no penalty on the clip and a penalty was not present, the participant's response was recorded as **Correct Rejection** (Macmillan, & Creelman, 2004; MacMahon, Starkes, & Deakin, 2007b).

Table 3.2. Signal Detection Theory.

RESPONSE	Penalty Present	Penalty Absent
YES	HIT	FALSE ALARM
NO	MISS	CORRECT REJECTION

Performance accuracy (number of correct calls) was then calculated by adding the number of Hits with the number of Correct Rejections and dividing by the total number of responses for the condition to obtain an accuracy percentage:

$$\frac{\text{Number of Hits} + \text{Number of Correct Rejections}}{\text{Number of Responses}}$$

3.2.5 Statistical Analysis

A 3 (Experience Level: 1 y, 2-4 y, 5-9 y) x 4 (Condition: IR, IS, NR, NS) ANOVA, with repeated measures on the last factor was conducted for each dependent variable (performance accuracy and confidence ratings). Post hoc comparisons (Tukey HSD) were conducted if an interaction or a main effect was found. The level of significance was set a priori at $p < 0.05$. All tables and figures are reported as the mean \pm *SD*.

3.3 Results

Thirty-three participants were used in the analysis. The participants' age ranged from 12 – 24 y (Mean = 15.7 ± 2.9 y) with 1 – 9 y of experience officiating (Mean = 3.6 ± 2.6 y). There was a significant difference in age, where participants with 5-9 y of experience were older (18.3 ± 0.8 y)

compared to referees with 1-y experience (14.4 ± 0.8 y) and 2-4 y (14.8 ± 0.7 y) experience. Participant characteristics are presented in Table 3.3.

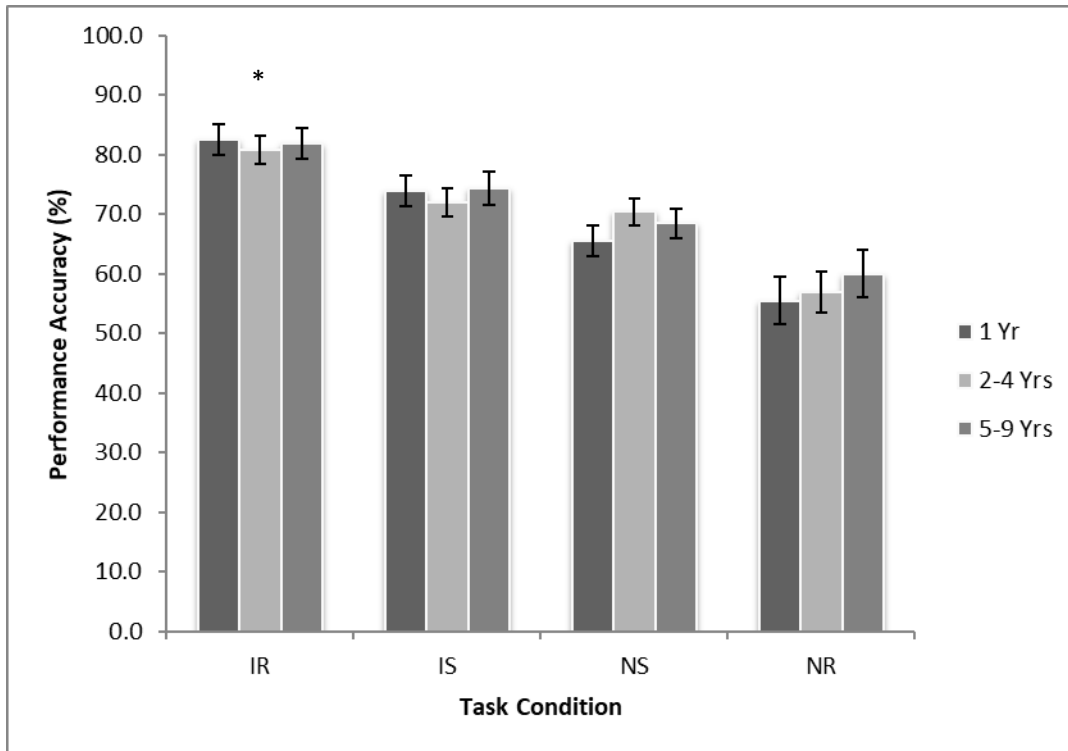
Table 3.3 Referee Characteristics.

Experience Group	N	Experience (y)	Age (y)
		Mean (SD)	Mean (SD)
1 Year	10	1.0 (0.0)	14.4 (3.5)
2 to 4 Years	13	2.9 (1.7)	14.8 (1.9)
5 to 9 Years	10	6.9 (1.5)	18.3 (1.7)*

* = significant main effect for age (5 to 9 y > 1 y and 2-4 y, $p < 0.05$).

3.3.1 Performance Accuracy

The analysis revealed no significant interaction effect for experience group and condition or a main effect for experience group. All the minor ice hockey officials performed similarly on the video-based infraction detection task irrespective of experience level. A significant main effect was found for detection task condition, $F(3,90) = 40.0$, $p = 0.00$. Post-hoc comparisons revealed that all official groups were most accurate in the IR condition (Mean = $81.8\% \pm 1.4$), followed by the IS condition (Mean = $74.3\% \pm 1.5$), then the NS condition (Mean = $68.5\% \pm 1.4$) and NR condition (Mean = $60.0\% \pm 2.2$), respectively. These results are displayed in Figure 3.1.



* = significant main effect for task condition (IR > IS > NS > NR, $p < 0.05$).

Figure 3.1 Accuracy of Performance on a Video-Based Infraction Detection Task as a Function of Task Condition and Experience Level.

3.3.2 Level of Confidence

Level of confidence was calculated by adding participant confidence scores together for each video task condition and dividing by the total number of clips recorded. The analysis showed no significant interaction effect for experience group and condition ($p = 0.146$), as well as no main effects for experience group ($p = 0.709$) or task condition ($p = 0.490$). The minor ice hockey officials reported high levels of confidence for their decisions in all conditions (IR Mean = $88.5\% \pm 2.0$; IS Mean = $87.6\% \pm 2.6$; NS Mean = $89.1\% \pm 2.1$; NR Mean = $89.1\% \pm 2.1$). While there was a trend emerging for increased confidence with years of experience level (1 y Mean = $86.4\% \pm 3.7$; 2-4 y Mean = $88.6\% \pm 3.3$; 5-9 y Mean = $90.8\% \pm 3.8$), this did not reach significance. These results are displayed in Figure 3.2.

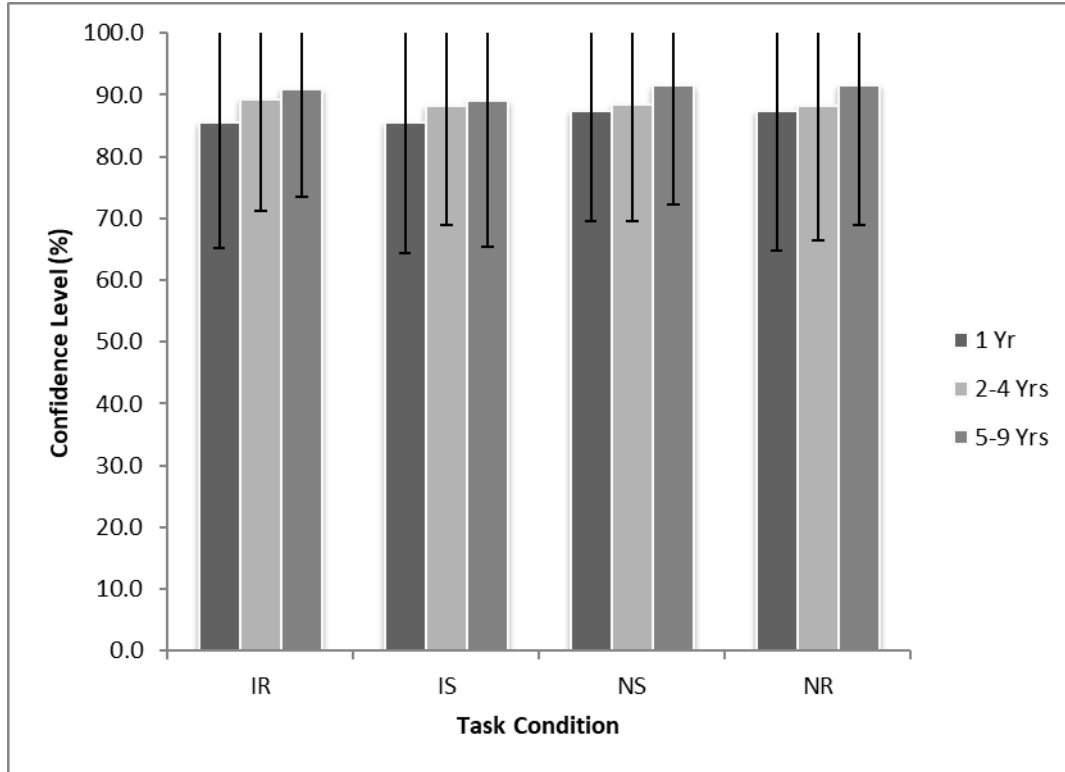


Figure 3.2 Self-reported Confidence Level on a Video-Based Infraction Detection Task as a Function of Task Condition and Experience Level.

3.4 Discussion

The purpose of this investigation was to examine ice hockey officials' capability to accurately make penalty decisions on a video-based infraction detection task when provided game information and under conditions of no information, as well as information provided in a sequential pattern versus randomized scenarios. We hypothesized that referees would make more rigorous decisions under no information conditions compared to information conditions. Providing no information should elicit a tendency to utilise strict rule administration to make a decision versus the provision of game information, which should elicit the tendency to utilise a more game management style under information conditions. In addition, research has shown that more rigorous decision-making

occurs when video scenarios of game play are presented in random sequences versus the presentation of scenarios in the original sequencing of events (Brand, Schmidt & Schneeloch, 2006). When greater rigor for the rules of the game is applied, it was expected that individuals will perform with greater accuracy in their decision-making. Therefore, we hypothesized decision-making performance to be most accurate under the NR condition and the least accurate performance in the IS condition.

Our findings showed the contrary and all participants (irrespective of experience level) demonstrated the most accurate performance in game information conditions, with the information, random condition reaching a success rate greater than 80%. However, the officials demonstrated the greatest difficulty in making correct calls in the no information, randomized condition, successfully making only 60% correct calls across all experience levels.

While these findings were contrary to our original hypothesis, there is a potential explanation. Information conditions may have produced more accurate performance versus no information conditions because of the priming of attentional focus and/or specificity related to the task. We suggest that providing game information ahead of the clip primed the participant for the video clip. That is, a simple act of reading the information provided ahead of the video clip may have served as a cue to focus, bringing the referees attention to the scenario about to viewed. This is supported by anecdotal feedback provided to the research team following completion of their respective sessions, wherein some officials commented that being provided game information helped them “get into the game” or “into the moment” to make a call. When comparing the IR and IS conditions, performance was significantly superior when viewing clips in random order versus viewing clips as a sequence of events (80.8% vs. 74.3%). While it is possible that the random condition elicited more of a rule administration style versus a slight shift in the sequential clips to using a game management style, it

is more likely that the differences exhibited in decision-making capabilities actually reflected changes in attention demands. Greater demands on attention were required in the IR condition. Changing the game information on each clip may have made the participants pay more attention to each randomly-presented video scenario (increasing concentration or attention focus), which elicited better performance on the infraction detection task.

Evidence-based support for the finding of superior performance under information conditions versus no information conditions can be extrapolated from the motor behaviour literature. An area of research focus in motor expertise research has been on examining performer perceptual capabilities and strategies. This area of research was initiated by a classic paper by Chase and Simon (1973) who showed that master chess players were only superior in their capability to recall a perceptual display (i.e., the positions of chess pieces briefly displayed on a chess board) compared to less skilled players when the perceptual display represented an actual game situation. No performance advantage was shown between skill levels when the pieces were placed on the chessboard randomly. The importance of a task-specific display structure for perceptual performance has been replicated in the sport science research (e.g., in basketball (Allard, Graham, & Paarsalu, 1980), in field hockey players, (Starkes & Deakin, 1984), and in rugby (Nakagawa, 1982)). While these investigations focused on performer perceptual and memory capabilities, the findings are also important here as it demonstrates the importance of game context. While all the videos shown to the referees were actual video clips from real games, providing information prior to viewing the clip, may have provided the referee with greater feelings of a game-like context. In our study, the officials only performed with 60% accuracy in the NR condition. There was no information provided to place the official into the context of the game, nor could the official use information from a previous clip (as per the sequential presentation of clips) to make a decision.

Therefore, poor performance was demonstrated in the NR condition where participants had no insight into the game and were less able to analyze the perceptual display under time constraints.

Poor performance in the NR condition may also have been confounded by the quality of the video clips. For example, some officials commented that they had a hard time tracking the play. A frequent comment related to increasing video scenario quality was to have a longer lead into the potential penalty scenario which would allow the officials to have a better grasp of the surroundings and how the play developed making the scenarios more ecologically valid. The provision of clips, with short lead in times, may have made the provision of information critical to successful completion of the task at hand, thereby also contributing to superior performance displayed across participants in the information conditions versus the no information conditions.

We predicted that superior performance would be demonstrated in the most experienced group versus less experienced groups (1 y and 2-4 y). Our results did not support this hypothesis. However, a lack of significant findings can be partially explained in the context of the discussion above. In addition, the sample size of the present investigation was also small. While the 5-9 y group exhibited the highest mean accuracy in all conditions, these results did not reach statistical significance. We suggest that a greater sample size is likely needed for novice-expert differences to emerge.

Finally, we hypothesized that the more experienced referees will demonstrate greater levels of confidence. Our findings showed that regardless of experience level, the referees reported high levels of confidence in the decisions. This high level of confidence was also found for all conditions, even if the officials' actual performance accuracy was poor (as shown in the NR condition). While confidence is important to possess when officiating a game, confidence level

should be comparable to actual performance. Therefore, confidence is an area that needs to be targeted within the training environment.

CHAPTER 4

Stressors Experienced by Minor Hockey Officials

4.1 Introduction

Hockey officials' play a critical role during a game. They are there to ensure players and coaches abide by the rules of the game to regulate a fair and safe environment. While officiating, referees have to be aware of their surroundings, be attentive to each player on the ice, and ready to make quick decisions all while moving swiftly and skilfully on the ice. Considering these responsibilities in a competitive environment, hockey officials can encounter a number of stressful situations, which can be derived from many sources such as spectators, players, coaches, partner officials, and within ones' own self. These stressors can affect an officials' judgment to make a call, as well as their overall wellbeing.

In previous related research, it has been found that an official's age coincides typically with what stressors they react more strongly to. For instance, in Dorsch and Paskevich (2007), young ice hockey officials perceived greater stress levels for Fear of Making a Mistake compared to older ice hockey officials. Fear of Making a Mistake includes such stressors as *Making a Wrong Call* and *Presence of Supervisor*. In addition, Level 1 or less experienced officials reported lower overall feelings of stress compared to more experienced, higher level officials. In contrast, prevalence of physical threat increased as certification level increased (Dorsch et al., 2012), wherein older, more experienced officials perceive *Verbal Abuse by Coaches* and *Threats of Physical Abuse* as particularly salient stressors. This finding can in part be explained by the fact that older, more experienced officials are often certified to officiate at a higher, more competitive level where emotions within the game can run high for all parties involved.

The purpose of this investigation was to examine the prevalence and perception of intensity of potential stressors that minor hockey officials may experience while officiating. It was hypothesized that:

1. The referees will score low to moderate levels of perceived stress
2. Less experienced referees will identify higher levels of perceived stress on ‘Fear of Mistakes’ compared to more experienced referees.
3. More experienced referees will report higher levels of perceived stress on “Verbal and Physical Abuse” compared to less experienced referees.

4.2 Methods

4.2.1 Participants

Ice hockey officials who officiate in minor hockey (Hockey 1 through Juvenile) were recruited from the Lower Mainland of British Columbia. All officials were recruited for participation in our primary investigation examining officiating style (see Chapter 3). Participants were assigned to one of four groups according to years of experience: 1 Year ($n = 13$), 2 – 4 Years ($n = 15$), 5 – 9 Years ($n = 14$), and 10 + Years ($n = 10$). This research was conducted in accordance to the ethical guidelines set forth by the University of British Columbia’s Behavioural Research Ethics Board for research involving human participants.

4.2.2 Assessment: HOSSI-20

To examine stressors in minor ice hockey officials, the HOSSI-20 was administered. The HOSSI- 20 is a modified version of the HOSSI-15 developed by Dorsch and Paskevich (2007) and based on the Basketball Sources of Stress Inventory (BOSSI; Anshel & Weinberg, 1995). The HOSSI–15 consisted of Two Subscales: (1) Fear of Mistakes, and (2) Verbal and Physical Abuse,

with 7 and 8 stressors in each subscale, respectively. The HOSSI-15 was validated using experienced hockey personnel during the regular season who identified appropriate content for the survey. From the HOSSI-15, further stressors were added in two subscales: (3) Difficulty with Partner Official, and (4) Other, with 3 and 2 stressors added, respectively to form the HOSSI – 20 (Dorsch et al., 2012). Reliability values for the three subscales were found to be acceptable for Fear of Mistakes ($\alpha = .84$) and Verbal and Physical Abuse ($\alpha = .84$) but not for Difficulty Working with a Partner Official ($\alpha = .56$). For this reason, the latter scale is recommended for descriptive purposes only (Dorsch et al., 2012).

To complete the HOSSI-20, the officials were asked to indicate the intensity of their stressful feelings on a Likert scale. In the HOSSI-20, the scale ranges from 1 (*Not at all stressful*) to 9 (*Extremely stressful*) for each stressor. We made a slight modification to the scale to provide a range from 1 (*Not at all stressful*) to 10 (*Extremely stressful*). On the scale, the officials were also asked to self-report from recall the extent to which the various stressors occurred during their most recent season using a categorical response selection: (1) *Never*, (2) *Every 10 games*, (3) *Every 3-5 games*, or (4) *Once or more a game*. Participants had the option to provide additional stressors at the end of the questionnaire.

4.2.3 Procedure

Prior to completing the HOSSI - 20, participants engaged in the video-based infraction detection portion of the study (see Chapter 3). After completion of the task and a short break, participants were briefed on the HOSSI – 20 and then completed the assessment. Participants were debriefed once completing the HOSSI – 20.

4.3 Data Treatment and Statistical Analysis

Using similar data treatment procedures as Dorsch et al. (2012), responses to a stressor's prevalence was calculated by percentage for each response category per stressor by experience group. Mean intensity scores were calculated for each subscale, as well as each subscale by experience level. A One -way ANOVA was conducted to determine reliability of the subscales among experience group. Cronbach's Alpha determined a relatively high internal consistency of .893 for 46 cases across the subscales and experience level determining the scales to have a high internal consistency.

4.4 Results

Written informed consent (or assent in the context of mature minors) was received from fifty-two minor hockey officials from the Lower Mainland of British Columbia. Characteristics of the participants are displayed in Table 4.1. Participants ranged in age from 12 to 66 years (Mean = 22.7 ± 15.0 y; $n = 4$ f, 48 m) with years of experience ranging from one to 45 years. Participants also ranged in certification level from level 1 to level 6. Only one participant indicated they had a level 6 certification, one with a level 4 certification, six with a level 3 certification, nineteen with a level 2 certification, 23 with a level 1 certification, and two participants did not report their certification level.

Table 4.1 Participant Characteristics (*n* = 52).

Experience Group	N	Experience (y) Mean (SD)	Age (y) Mean (SD)	Certification Level
1 Year	13	1.0 (0.0)	14.0 (3.1)	Level 1 (<i>n</i> = 13)
2 to 4 Years	15	2.9 (0.9)	16.7 (7.4)	Level 1 (<i>n</i> = 11) Level 2 (<i>n</i> = 3) Not Reported (<i>n</i> = 1)
5 to 9 Years	14	6.7 (1.4)	28.1 (16.9)	Level 2 (<i>n</i> = 10) Level 3 (<i>n</i> = 2) Level 4 (<i>n</i> = 1) Not Reported (<i>n</i> = 1)
10 + Years	10	16.4 (11.0)	35.4 (19.2)	Level 2 (<i>n</i> = 5) Level 3 (<i>n</i> = 4) Level 6 (<i>n</i> = 1)

Participant response for each stressor as measured by perceptions of intensity is displayed in Table 4.2 across groups. The top three ranked stressors for each experience group is also identified in Table 4.2. Out of the top three stressors for each participant group, the stressor of “*Being Evaluated*” was common to all officials. The 1 y group, 2-4 y group, and the 5-9 y group, all identified “*Making a Wrong Call*” also as a top three stressor. Other top three stressors included, “*Making a Mistake in Procedure*” by officials in year one, “*Presence of Supervisor*” by officials with 2-4 y of experience, and “*Making a Mistake in Rule Application*” by officials with 5-9 y of experience. The ten years or more experience group identified “*Confrontations with Coaches*” and “*Verbal Abuse from Coaches*” as a top ranked stressor.

Table 4.2 Self-reported intensity of stressors reported by years of officiating experience (*n* = 52 participants).

Stressor	Experience Level				
	1 y (<i>n</i> =13) M (SD)	2-4 y (<i>n</i> =15) M (SD)	5-9 y (<i>n</i> = 14) M (SD)	10+ y (<i>n</i> = 10) M (SD)	All Groups (<i>n</i> = 52) M (SD)
Verbal and Physical Abuse Subscale	2.9(2.1)	3.1(2.6)	3.9(2.6)	5.1(2.6)	3.7 (2.7)
Verbal abuse from coaches	3.8(3.0)	4.4(2.8)	5.6(2.3)	6.2(2.8)	4.9(2.8)
Verbal abuse from players	2.5(1.7)	2.1(1.9)	2.9(1.4)	4.7(1.9)	2.9(1.9)
Verbal abuse from spectators	2.6(1.9)	2.9(2.5)	2.7(2.2)	4.7(2.8)	3.1(2.4)
Confrontations with coaches	3.2(2.2)	4.2(2.7)	5.0(2.4)	6.4(2.7)	4.6(2.7)
Confrontations with players	2.8(1.4)	2.3(1.9)	3.1(1.7)	4.4(2.5)	3.1(2.0)
Confrontations with spectators	2.6(1.9)	2.9(2.7)	3.3(2.7)	3.5(2.5)	3.0(2.4)
Threats of physical abuse	2.6(2.6)	3.1(3.1)	5.0(2.6)	5.5(4.2)	3.9(3.5)
Fear of Mistake Subscale	3.7(2.8)	4.3(2.5)	5.4(2.6)	5.0(2.7)	4.7(2.7)
Making a wrong call	5.0(3.2)	5.1(2.6)	6.1(2.2)	5.5(2.5)	5.4(2.6)
Being in the wrong location to make a call	3.2(2.8)	4.1(1.8)	5.4(2.6)	5.3(1.9)	4.4(2.5)
Making a mistake in rule application	3.5(2.7)	4.5(2.0)	6.3(2.8)	5.9(2.8)	5.0(2.7)
Making a controversial call	3.2(2.0)	4.3(2.3)	6.2(2.4)	5.1(2.6)	4.7(2.5)
Calling a major penalty or misconduct	3.4(3.1)	3.3(2.8)	4.2(2.8)	4.8(3.2)	3.8(2.9)
Making a mistake in procedure	4.0(2.9)	3.1(2.2)	4.0(2.7)	4.4(2.7)	3.8(2.6)
Being evaluated	4.0(3.1)	5.5(2.7)	6.3(2.6)	6.3(3.0)	5.5(2.9)
Presence of supervisor	3.4(2.9)	4.9(2.9)	4.9(2.4)	5.4(2.6)	4.6(2.7)
Difficulty with Partner Official Subscale	2.5(2.3)	3.4(2.5)	4.3(2.6)	5.0(2.5)	3.7(2.6)
Miscommunication with partner official	2.6(2.1)	3.5(2.0)	4.9(2.7)	5.3(2.7)	4.0(2.5)
Difficulty with partner official	2.2(2.3)	3.5(2.8)	4.9(2.9)	5.5(2.6)	4.0(2.9)
Supporting partner officials after they have made a mistake	2.5(2.5)	3.1(2.7)	3.2(2.1)	4.1(2.0)	3.2(2.4)
Other Subscale	2.3(2.2)	3.4(2.6)	4.1(3.0)	4.0(2.7)	3.4(2.7)
Experiencing an injury	2.5(1.8)	3.2(3.3)	5.1(3.0)	5.0(2.7)	3.8(2.6)
Presence of the media	2.2(2.6)	3.6(2.9)	3.1(2.7)	3.5(2.6)	3.1(2.7)

* The top 3 stressors in each group are shaded with white text.

4.5 Discussion

The purpose of this investigation was to examine the perceived intensity of stressors hockey officials self-report experiencing in a season. Using the HOSSI -20 (Dorsch et al., 2012) this research provides insight into the different variables hockey officials encounter while officiating in minor hockey across experience level. Similar to previous studies, feelings of stress were reported to be low to moderate across all officiating groups and tended to increase as officiating experience increased. For instance, all items in the Abuse Subscale increased with feelings of intensity as officiating experience increased. As officials gain more experience and complete higher certification levels, they are afforded opportunities to officiate higher, more competitive level hockey where emotions for all of those involved (i.e., players, coaches, fans) are elevated and invested into the game. Backlash towards the referee is often seen during these high intensity games. This is reflected in the responses of the experienced officials.

The *Fear of Mistakes* subscale demonstrated the greatest intensity across all experience levels of officials. More specifically, all groups of officials reported the item *Making a Wrong Call* to be a top intensity stressor. However, the stressor of *Being Evaluated was reported by* all groups of officials as a highly intense stressor (despite only being evaluated on an infrequent schedule). Other stressors such as *Experiencing an Injury* and *Presence of Media* received low intensity ratings, especially for the least experienced officials, as these are stressors that are highly dependent on the level of hockey that is being refereed. The rating of intensity increased with years of experience.

Translating these study results to official training can bring awareness to the barriers officials face during a game. As the item *Making a Wrong Call* was a top stressor for all experience groups, including effective coping strategies into official training should help officials retain focus on the game and reduce stress (see Appendix I *Extended Review of Literature*). Awareness of officiating

stress research should be shared with other positions in hockey such as coaches, players, and parents. Support from these groups would help reduce the intensity of stressful scenarios for officials. As mentioned in Chapter 2, incorporating videos from a referee's perspective into Respect in Sport initiative could provide coaches, players, and parents with perspective on what officials experience on the ice. This would hopefully reduce the number of sources officials generate feelings of stress from while on the job.

CHAPTER 5

Limitations and Recommendations

5.1 Introduction

The purpose of this thesis was to examine the accuracy in minor hockey official's decision-making in the context of officiating style and experience level, as well as examine individual's perception of stress from our sample. In addition, this thesis also describes the creation and use of a video tool that was used in the research. From this research, a number of recommendations have been developed, which address the limitations of the work contained in this document, as well as provide direction for future work.

5.2 Video Tool Use

Using a video tool from the referee or linesmen's perspective can provide a more realistic point of view when using penalty or positioning scenarios for referee training. As such, it has the potential to benefit greatly in the development of referees. Through the creation and implementation of a tool for use in the video-based infraction detection task (see Chapter 2 and 3), various feedback was collected to incorporate into further work in the area.

The development and use of this video tool received positive feedback from the consensus panel. In providing feedback to the research team for future development of video tools for referee training, the consensus panel recommended expanding the clip directory to the use of clips from a variety of age and skill levels, using clips with both female and male hockey players, and allowing more time to lead into the clips so that the referees can better gage their surroundings, including the play prior to the scenario of interest. Similarly, some officials who participated in the data collection

suggested that being provided game information helped them “get into the game” or “into the moment” to make a call (previously discussed in Chapter 4), which may have influenced referee performance across skill levels. In this manner, a longer lead in time may negate the need for information provisions prior to viewing a clip, as well as improved the clips where participants had difficulty tracking the play given the limitations of real-life, video footage from a head cam.

This tool, as well as the research derived from it, could be enhanced by also having the consensus panel rate the difficulty of each clip. This would allow for examining the role of scenario difficulty in the decision-making process and performance accuracy on the detection task. Difficulty of decision could then be accounted for in the research design, wherein each condition would receive an even distribution of ‘tough’, ‘medium’, and ‘easy’ calls. Given that a difficulty rating was not established for each clip, we cannot eliminate the possibility that the NS and NR conditions contained clips that were more difficult than the clips presented in the IR and IS conditions.

A limitation of the information conditions was that the infraction clips obtained were not evenly distributed among periods. The clips that were created depended on actual games played and the footage from these games that was collected during filming. Overall, there was a lack of footage to create clips with from the third period. For the research, 4 out of the 6 infraction calls were obtained from the first period, and the remaining two infractions from the second period in the IR condition. In the IS condition, infraction clips were from the first period ($n = 2$), second period ($n = 3$), and third period ($n = 1$). Some factors that contributed to a lack of footage from the third period were: (1) helmet cameras shutting off before the game was over, and (2) poor quality (i.e., the camera fogged up or was shaky and the play could not be seen).

With adjustments, we suggest that a video-based infraction detection tool can become a valuable source for training methods in hockey officials. Increased practice and experience in a task of this

nature could lead to more consistent and accurate officiating, especially in the early years of referee development (Hancock & Ste-Marie, 2013; Larkin et al., 2011). This tool could be developed into an online practice module that is available to minor ice hockey officials. The next step is to also incorporate the most salient stressors experienced by officials into the video tool (e.g., the data derived from Chapter 4) to enhance official preparation and coping. This would allow referees to discuss appropriate responses to best handle a stressful situation and to develop effective coping responses to maintain focus during the game and care for overall wellbeing.

Through discussion with officials and personnel involved in this study, the idea to include video scenarios from an official's point of view into the Respect in Sport initiative has also been strongly recommended. This would provide spectators, coaches, and players the opportunity to experience what an official sees and some of the factors they may deal with during the game, specifically when identifying an infraction and making a penalty decision. The goal of this would be to enhance the level of respect afforded to ice hockey officials (some as young as 12 years of age) and to better acknowledge the difficulties that come with officiating youth sport.

5.3 Stressors

The differences in extent officials feel for each stressor may have a strong relationship with the amount of exposure they have had officiating and the level to which they have officiated. For instance, as officials gain more experience and complete higher certification levels, they are offered opportunities to officiate higher, more competitive levels of hockey where emotions for all of those involved (i.e., players, coaches, fans) are elevated and invested into the game. Backlash towards the referee is often seen during high intensity games. Some of these experiences were reflected in the officials' responses in the HOSSI-20.

Translating the study results into certification workshops for ice hockey officials can bring awareness to the barriers officials face during a game. The item, '*Making a Wrong Call*' was a top stressor for all experience groups and is a stressor that can occur quite frequently. Including effective coping strategies that directly address top stressors into an official's training is important for both referee performance and stress reduction (see Appendix I *Extended Review of Literature*, page 65). Awareness of officiating stress research should be shared with ice hockey coaches, players, and parents. Greater understanding and support from these important stakeholders would assist in reducing the intensity of stressful scenarios for ice hockey officials, especially given the young age of a large portion of minor ice hockey officials. As a number of officials identify difficulty with a partner official items as a stressor, effective communication skills and teamwork exercises should always be incorporated into referee training. It is suggested that bringing in a professional to run these sessions or having the facilitators of the clinic educated by a professional in this field would assist in the effective training of these skills.

5.4 Participant Recruitment

From this research experience, it is recommended to establish a partnership and recruit participants through a hockey official camp or recertification clinic. However, a hockey school will typically have officials with similar experience whereas a recertification workshop will have a more diverse group of officials. Collaborating with the Provincial hockey organization to incorporate this research into the recertification clinics would allow for data collection from a group of officials with varying experience levels. Clinics are held in multiple locations across the Province prior to the hockey season. Future research initiatives could also partner with hockey official camps to examine new officials. Another approach to ensure randomization of experience level in groups is to establish a date for data collection set months prior so officials can commit to participating in the

study while allowing the researcher enough time to recruit and distribute participants evenly among groups.

5.5 Knowledge Translation

Findings of this research have practical application as it relates to improvements in referee training programs at the grassroots level. Using video footage of minor ice hockey games should continue to be used as a tool for ice hockey referee training. It is the goal of this research to contribute to the development of training methods to increase the performance of ice hockey referees (e.g., accuracy), as well as in improving the safety and fair play of the game for minor hockey players. The results of this investigation will be shared via infographic and video vignette to BC Hockey. The completed investigation will also be submitted for publication consideration in a peer-reviewed journal in the field, and for presentation within the academic community.

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Appendix A

Extended Review of Literature

The following is an extended review of literature providing an overview of the varied research in the area of decision-making in sport officials.

A.1 Introduction

Officiating a sporting event requires a repertoire of skills including (but not limited to): knowledge of the game rules, the capability to maintain attention and awareness while staying with the play, and the capability to make quick, accurate decisions. Obtaining these skills requires experience with precision of calls as there are many factors that can interfere with maintaining the attention necessary to make a decision (e.g., spectator harassment, making a mistake in a call, and/or player confrontation). Officials that have experience with stressful situations can develop effective coping strategies to minimise the influence of the stressors on their performance during a game. Using memory recall can improve the consistency and aid in quick decision-making in the performance of a referee.

A.2 Information Processing

In the field of motor behaviour, decision-making is often examined using an information processing approach. Information processing can be broken down into three events or stages: (1) Input stage (i.e., environmental stimulus); (2) Processing stage (i.e., the cognitive decision-making process); and (3) the Output stage (i.e., the motor response to the stimulus) (Schmidt and Lee, 1999). Speed of processing through these stages is often determined using a chronometric approach (e.g., an individual's reaction time).

More specifically, the Input stage, also referred to as the stimulus identification stage, occurs when the individual detects a stimulus in the environment (sensation) and then places meaning onto the stimulus (perception). For example, in baseball, an umpire must first detect the stimulus (the ball) in the air using the visual system and track that ball as it moves towards the plate. This process is sensation. Following this, the umpire must place meaning to the stimuli by finding a corresponding event stored in memory. This involves a process referred to as perception. The umpire then uses the information derived from the sensory and perceptual processing of the pitched ball, to decide on a response to the stimuli. Is the pitched ball a 'ball' or a 'strike' as determined by the rules of the game (the response selection stage). Once a decision has been made, the motor system is programmed to carry out the decision by translating the requested cognitive action into muscular movements (the response programming stage). The selected response is then carried out through an observable physical action (the output stage). The action chosen is communicated to the environment through a verbal motor response with accompanying body movements to indicate a "ball!" or "strike!".

A.3 Heuristics

Referees' decision making needs to be done in a swift manner as there is limited time to analyze the immense amount of information that needs to be processed in a dynamic game environment. One method of making quick decisions is the implementation of a simple decision strategy called heuristics. Gigerenzer and Gaissmaier (2011) define a heuristic as: *"a strategy that ignores part of the information with the goal of making decisions more quickly, frugally and/or accurately than more complex methods"* (p. 453). According to Gigerenzer et al. (1999), heuristics involves three processes: (1) the use of search rules, which specify the direction the search extends in the search

space; (2) the use of stopping rules to specify when the search is stopped; and (3) the use of decision rules to specify how the final decision is reached (as cited in Gigerenzer & Gaissmaier, 2011).

These three building blocks utilize core mental capacities such as: recognition memory, frequency monitoring, and object tracking to construct heuristics referred to as the adaptive toolbox (Gigerenzer et al., 1999, as cited in Gigerenzer & Gaissmaier, 2011).

Raab (2011) describes a simple heuristic as a ‘less can be more’ concept when a simple decision strategy outweighs a more complex strategy (i.e., when one uses logic or statistics to come to a consensus). As a result, using heuristics as a decision strategy incurs an accuracy-effort trade-off where accuracy is jeopardized for the benefit of a faster decision that does not demand exhaustive cognitive effort (Gigerenzer & Gaissmaier, 2011). For a referee, using heuristics is believed to be a suitable decision-making strategy given the environment and structure of sports. For example, an ice hockey referee may see a player’s hockey stick come up above the shoulders and an opposing player’s head snap back. Even though the referee did not see the stick contact the opposing player (e.g., the referee’s viewing angle may not have been clear or the action happened too quickly), (s)he may still call a high-sticking penalty. The referee uses the available information to make a quick penalty-decision based on knowledge of the rules, and previous experience with this type of infraction call.

For a sport official, the role to be a mediator between two teams requires a fair and equal perception of each team. Using the heuristic strategy in officiating decision making can help eliminate bias the official may possess towards a team, compelling the official to make a decision based on previous similar experiences and learned knowledge stored in memory. For instance, the ice hockey official who made the high-sticking call avoided a possible bias s(he) could have by making a quick decision based on the act and consequence seen in front of them and whether they

made the call in a similar situation before. However, there are influential factors that can interfere with a referee's intuition on a game decision (e.g., perceptual-cognitive skills, stress and coping strategies, home bias, and crowd influence) despite the use of the heuristics.

A.4 Decision Accuracy

To date, investigations examining referee decision making has focused largely on the accuracy of the referees' decision (e.g., correct detection of an offside or infraction). Research has shown that decision making accuracy is influenced by factors such as viewing angle and the time of the game. For example, Mallo et al. (2012) showed that viewing angles of 46 and 60 degree from the play result in more correct decisions by assistant soccer referees. Further, incorrect offside decisions occurred twice as much in the second half of the game compared to the first half of the game for both assistant referees and referees.

Another factor that has been examined in decision accuracy is the influence of officiating experience level. Larkin et al. (2011) found that National League Australian Football umpires made significantly more accurate infraction decisions compared to lower level state league umpires and national league players in a perceptual and decision-making infraction detection video task. Similarly, Hancock and Ste-Marie (2013) showed that higher-level ice hockey officials detected infractions with greater accuracy compared to lower level ice hockey officials when watching NHL playing scenarios. These findings were shown despite no difference in the gaze behaviours between the two levels of referees. This suggests that the higher-level, more experienced referees were able to more readily identify relevant information from the environmental scene compared to the lower-level, less experienced referees to make decisions.

The influence of experience and certification level has shown mixed results in the literature when examining accuracy and assertiveness in ice hockey officials. Wilson and Mock (2013) found that neither assertiveness nor certification level were directly correlated with referee accuracy. However, the more assertive, higher level officials tended to make more correct penalty calls; wherein, highly certified officials with low assertiveness demonstrated the lowest probability of making correct calls. It was suggested that the emotional processes associated with assertiveness (e.g., previous experiences, gut feelings) contributed to quicker, accurate decision making. It was also shown that referees with low certification and low assertiveness were also fairly accurate in their calls. The authors postulated that low certification/low assertiveness officials may be stabilizing their inexperience and lack of assertiveness by paying closer attention to situational factors occurring during the game, allowing them to make accurate calls (Wilson & Mock, 2013).

A.5 The Use of Visual Cues

Visual cues are most often the first source of information used in the executive functioning of referee's. The referee interprets the visual information in front of him using core capabilities in his adaptive toolbox to come to a quick decision. For example, suppose an official does not view fully the offensive player's entire movement in an offside situation in soccer. To make an offside decision, the official depends on the availability heuristic wherein, the referees' adaptive tool box is opened to readily recall a similar situation regarding the same level of speed from the onside position. The official will then factor in the odds of this player beginning the run from an onside position to determine quickly whether the player was onside or not (MacMahon & Mildenhall, 2012). To date, much research has been directed towards examining the use of visual information to accurately make offside decisions in soccer (Barte and Oudejans, 2012; Catteeuw et al., 2009a;

Catteeuw et al., 2009b; Catteeuw et al., 2010a; Catteeuw et al., 2010b; Catteeuw et al., 2010c; Catteeuw et al., 2010d; Gilis et al., 2009; Helson, Gilis, & Weston, 2006; Mallo et al., 2012; Oudejans et al., 2005; Oudejans et al., 2000; Put et al., 2013a; Put et al., 2013b).

Accuracy in decision making increases when utilizing functional memory. For example, Ghasemi et al. (2011) have shown that referees will use their visual memory to retrieve information from previous situations while combining the results of this search with the visual scenes currently being played out in front of them. They also showed that those soccer referees who detected the most correct errors and penalty calls when watching video clips of an Iranian soccer premier league performed significantly better on visual tests (e.g., ocular accommodation, saccadic eye movements, and peripheral vision) and on memory assessments (e.g., recognition, visual memory). These findings suggest that both visual capabilities and memory play an important role in successful officiating.

A.6 Playing Experience

Experience level does not only include years of officiating a sport but also experience as a player in the sport. When investigating the sport of basketball, MacMahon, Starkes and Deakin (2009) revealed no significant differences in identifying infractions for basketball players, referees, or coaches. It was suggested that those basketball referees who have playing experience are able to utilize information processing skills cultivated from their years playing when officiating. Research has also shown benefits from playing experience for officiating in ice hockey and handball (Pizzera & Raab, 2012). Moreover, in ice hockey it is postulated that years' as an athlete is associated with increased officiating performance (Pizzera & Raab, 2012).

In other research, Renden et al. (2014) have demonstrated that soccer players and officials with playing experience were more accurate in both foul and dive calls in soccer versus novice participants with little to no playing experience (Renden et al., 2014). Larkin and colleagues (2011) have also shown that Australian football players out performed both National and State level umpires in a pattern recall task (recalling player position on the field). Finally, anticipation of an outcome in volleyball has been correlated to both perceptual-motor experience and observatory experience. For example, international players and coaches with significantly more playing experience outperformed officials (Cañal-Bruland, Mooren & Savelsbergh, 2011). Taken together, this research provides support for the role of playing experience in decision making capabilities.

A.7 Psychophysiological Influences and Coping

Psychophysiological factors will not only influence an officials' performance in the game, but can also influence an officials' psychological and emotional wellbeing. The term psychophysiological refers to the psychological factors a referee may experience and perceive as stressful during a game (e.g., aggression from the spectators, confrontation from the coaches, making a mistake) and the referees physiological response to this stressor (e.g., an increase in blood pressure) that can be dependent on the magnitude of the stress perceived. Stressors can negatively affect referees cognitive and psychophysiological processes such as concentration, attentional focus, effort, and arousal (Anshel, 1990; Jones & Hardy, 1989; as cited in Gencay, 2009). These distractions can become noticeable via the officials' decisions during the sporting event. Because of the stressors experienced while officiating, it is common among young referees to drop out of officiating as performance and satisfaction for the job is decreased (Goldsmith & Williams, 1992).

The type of stress experienced by officials in a game situation is referred to as acute (short term) stress. According to Anshel and Weinberg (1999), acute stress occurs as a response when a person experiences a sudden exposure to stimuli or events that are perceived as unpleasant or challenging. This can include making a wrong call, crowd behaviour, and player conflict. Research shows that sports officials generally experience low to moderate stress during games in such activities as basketball; (Burke et al., 2000; Kaissidis-Rodafinos, Anshel, & Sideridis, 1998; Rainey & Winterich, 1995; Stewart et al., 2004), soccer (Gencay, 2009; Taylor & Daniel, 1987), football (Goldsmith & Williams, 1992), volleyball (Goldsmith & Williams, 1992; Stewart & Ellery, 1996; 1998), rugby (Rainey & Hardy, 1997), ice hockey (Dorsch & Paskevich, 2007; Dorsch et al., 2012) and baseball/softball (Rainey, 1994b).

A.7.1 Sources of Stress in Sport Officials

Several investigations have focused on examining sources of stress in sports officials as measured by survey research (e.g., the Basketball Officials' Sources of Stress Survey, the Hockey Officials Sources of Stress Inventory, and the Soccer Officials Stress Survey). In general, source of stress has varied across sport, country, and certification and/or experience level. For example, Taylor and Daniel (1987) identified six categories of stress: Interpersonal Conflict, Fear of Physical Harm, Time Pressure, Peer Conflicts, Role-Culture Conflict, and Fear of Failure (Rainey, 1999). In baseball and softball umpires: Fear of Failure, Fear of Physical Harm, Time Pressure, and Interpersonal Conflict, were the common responses to sources of stress (Rainey 1995a; 1995b); while Time pressure and Interpersonal Conflict were found to be a common source of stress in Scottish, English, and Welsh union rugby officials (Rainey & Hardy, 1999).

Using the Basketball Officials' Sources of Stress Survey (BOSSS), sources of stress in basketball officials included: Making a "Wrong" Call, Verbal Abuse by Coaches, Verbal Abuse by Players, Threats of Physical Abuse, Being in the Wrong Location when Making a Call, Working with my Partner, Presence of Supervisor, and Experiencing Injury (Anshel, 1995; Kaissidis-Rodafinos & Anshel, 1993; Kaissidis-Rodafinos, Anshel, & Sideridis, 1998). In ice hockey officials, sources of stress were shown to differ across certification level wherein more certified officials showed that Making the "Wrong" Call was a significant source of stress compared to Verbal Abuse by Coaches. The highest level of referees also identified Confrontation with Players versus Threats of Physical Abuse to be highly stressful. The least certified officials and the most certified officials also perceived a greater stress from Fear of Mistakes than from Verbal and Physical Abuse. Further, it was found that prevalence of physical threat increased as certification level increased (Level 1, 15.9%; Level 2, 18.7%; Level 3, 27.9%; and Level 4, 44.4%). Referees reported experiencing threats at least once per season. On the contrary, 82.6% of Level 1 officials reported verbal abuse by coaches and 79.4% reported confrontation with coaches occurring at least once in a season (Dorsch et al., 2012).

Goldsmith and Williams (1992) used a modified version (The Officials Stress Test) of the Soccer Officials Stress Survey (SOSS) to examine factors eliciting stress in football and volleyball officials. Results indicated that football officials reported greater stress from Fear of Physical Harm compared to volleyball officials. Results indicated that football officials reported greater stress from Fear of Physical Harm compared to volleyball officials even though this was perceived as the least stressful source among these officials. Compared to non-certified and intramural officials, certified officials ranked Fear of Failure significantly higher. While there were common reoccurring themes of sources of stress identified across many sports, differences have also been identified. Regardless of

the presence of verbal abuse and threats of physical abuse in ice hockey across all certification levels, Making the “Wrong” Call and Fear of Mistakes is reported as the highest source of stress.

A.7.2 Threats and Aggression towards Sports Officials

Fear of physical harm and verbal abuse were common sources of stress across many sports officials. Folkesson et al. (2002) found that 73% of soccer referees reported experiencing a threat or aggression on at least one occasion. The majority of the violence was verbal aggression (63%), while the remaining 15% reported exposure to direct physical aggression. Age was a factor to experiencing threatening and aggressive acts. Despite some of the younger participants having more experience than some of the older participants, younger soccer officials as a whole were subjected to the greatest number of threats and acts of aggression. As such, it was shown that the younger officials experienced greater pre-match anxiety and struggle with concentration because of the aggressive acts compared with older referees. Moreover, the referees reported greater difficulty coping with aggressive players, coaches, or trainers compared with spectator aggression.

Taking a different approach, Friman, Nyberg, and Norlander (2004) interviewed seven Swedish soccer referees about their experiences with threat and aggression, as well as their strategies for officiating despite this abuse. From these interviews, four main themes emerged: Perceived Sources of Threats and Aggression, Reactions to Threat, Managing Stressful Situations, and Motives to Referee. Threats and aggression occurred when there was a difference in opinion between the officials’ decision and what the players, coaches/trainers, and/or spectators thought the call should be. Such a reaction may occur from home bias among the spectators and/or by lack of knowledge of the game rules from players, coaches, and spectators. Lack of attention to the game by officials also increased players’ and fans aggression towards the official. In addition, a female official

reported sexist verbal aggression. Similar findings for aggression have also been shown by Folkesson et al. (2002).

In basketball officials, 15% reported having been physically assaulted at least once in their careers (Rainey & Duggan, 1998). These physical assaults were as likely to happen to a female referee as a male referee. Of the assaults reported, 45% were categorized as minor incidents (i.e., pushing, grabbing or spitting); while 51% of the assaults reported were categorized as major incidents such as hitting or punching (28%), throwing objects (e.g., chairs, ball) (19%), or choking (4%). These assaults were distributed across levels of play but most often occurred during higher stake games. Twenty-six per cent of the assaults took place during rivalry games between two teams and 19% of the assaults happened during tournament or championship games. Players were most often the perpetrators (41%), followed by parents (20%), coaches (19%), and fans (15%). The majority of the assaults happened during high school (52%) games with 82% of the aggressors being adults.

Experienced rugby officials (6%) have also reported they have been physically assaulted while officiating at least once (Rainey & Hardy, 1999). Similar to basketball officials, 42% of the assaults were minor (pushing, grabbing, shoving) while 47% of the assaults were major (punching, kicking, head-butting, choking). Again, players were the most common perpetrators (71%) with 84% of the players being adults, followed by fans (24%). Special rival matches accounted for 11% of the assaults and 19% took place during championship matches.

The number of assaults in baseball and softball umpires were also found to be consistent with previous work. For example, Rainey (1994a) showed that 10% of experienced baseball and softball umpires had been assaulted at least once when they were on the job. Minor incidents accounted for 44% of assaults, while 43% were major incidents of assault. In contrast with other findings, baseball

coaches were more often the perpetrators to assault. Although there have been individual incident reports of assaults on ice hockey officials, there has been no identified research reporting the number of assaults on and experiences of ice hockey officials.

A.7.3 Magnitude of Perceived Stress

To date, a major research focus has been on examining the magnitude of the perceived stressor. Kaissidis and Anshel (1993) found age of the official to be an indicator of perceived stressor intensity. For example, adolescent basketball officials were shown to perceive greater stress compared to older officials for Making a Wrong Call or Giving a Technical Foul. In ice hockey, Dorsch and Paskevich (2007) showed that young ice hockey officials perceived higher stress for Fear of Making a Mistake (versus Fear of Verbal and Physical Abuse). In addition, they showed an effect for certification level; wherein Level 1 officials experienced lower overall feelings of stress versus higher level officials.

Other research with soccer officials has demonstrated differences in anxiety level as a function of playing division. Premier division soccer officials recorded higher anxiety scores compared to second division officials. However, regardless of the division, referees who perceived their competence as weaker or average scored significantly higher on anxiety measures compared to referees who felt confident in their officiating competence (Johansen & Haugen, 2013).

A.7.4 Coping Strategies and Styles

Research has shown a variety of stressors when officiating. As such, the way in which an official copes with a stressor also warrants attention. According to Anshel and Weinberg (1999), a coping strategy refers to one's reaction to an immediate stressor; while a coping style reflects a consistent

manner of dealing with a stressor across time and situation. An official may demonstrate an **avoidance style of coping**, which involves ignoring threat-related cues (stressor) by seeking support from others or focusing on the task at hand (Anshel & Weinberg, 1999). This type of coping is suggested to work best when emotional resources such as self-confidence or optimism are low, when the source of stress is unclear, if the situation is uncontrollable, or when the outcome measures are immediate or short-term (Roth & Cohen, 1986). In contrast, an official may demonstrate an **approach coping style**, which involves facing the source of stress head on in attempt to reduce its intensity and/or to better understand it (Anshel & Weinberg, 1999). An approach coping style may be useful when the situation is controllable, when the source of stress is known to the person, when an immediate action is required, or when the outcome measures are considered to be more long-term (Roth & Cohen, 1986).

Avoidance coping responses have been demonstrated by Anshel and Weinberg (1999) when investigating American and Australian basketball officials for dealing with such stressors as Player Abuse and Arguing with Coaches. Alternatively, approach coping responses were most often demonstrated when dealing with Abuse by the Coach. Findings also indicated that the more skilled basketball referees selected a coping style depending on the situational characteristics of the stressor (Anshel & Weinberg, 1999). Therefore, identifying an official's coping style to a particular stressor can help the official reappraise the situation or adjust their coping style to reduce the intensity of the stressor.

Research has shown that basketball officials who use an approach coping style more frequently display greater perceived stress intensity (Kaissidis-Rodafinos, Anshel, & Porter, 1997; Kaissidis-Rodafinos & Anshel, 2000). More specifically, a referee who ignores or distances himself (avoidance coping) from a perceived stressor during a game can improve coping effectiveness

compared to a referee who immediately attends to (approach coping) the stressor. Reacting to a stressor can cause the referee to lose focus of the game and increase the level of anxiety (Kaissidis-Rodafinos, Anshel, & Porter, 1997). Other research examining Greek basketball officials has shown that referees who demonstrate less approach coping display higher scores of optimism and self-esteem (Kaissidis-Rodafinos & Anshel, 2000).

Lazarus (1993) describes coping as shaping emotion and psychological stress by influencing how the person-environment relationship is appraised. Neil et al. (2013) examined the influence of stress and emotion on decision making in soccer referees at different competition levels in the UK. The way in which the referees appraised the source of stress (e.g., crowd, previous mistakes, confrontation), the emotions felt, and the coping mechanisms they chose influenced the decisions they made in a game. Differences were found between professional and amateur referees in their experiences of stress, the emotions felt, and their capability to cope during situations of perceived stress. The authors suggested that when officials appraise a situation as a threat, negative emotions accumulate (e.g., anxiety or anger), which distracts the referee from the game, negatively affecting performance. For example, amateur officials displayed counter-attacking behaviours or incorrect decisions due to the inability to cope with stress and negative emotions that caused increased anxiety during the match. In contrast, the professional referees (with at least eleven years or more of experience) displayed problem-focused and emotion-focused coping strategies, which resulted in more accurate perceptions in decision-making (Neil et al., 2013). Problem-focused coping strategies refers to attempts to change the person-environment realities behind negative emotions; while, emotion-focused coping strategies refers to attempts to change either what is attended to or how it is appraised (Lazarus, 1993). Therefore, it was suggested that problem-focused coping strategies were used by the professional soccer officials to manage stressors that were appraised as threatening or

harmful and used emotion-focused coping strategies to lessen the perceived threat of the situation and the magnitude of any negative emotions (Neil et al., 2013).

Folkesson et al. (2002) have suggested that experience is also age-related. For example, younger soccer officials experience more instances of threats and aggression compared to older officials, as well as pre-match worry and difficulties with concentration when faced with violent behaviour. It was further suggested that older officials utilize greater 'life experience' to better cope with the aggressive acts and do not display as much pre-game worry. However, irrespective of age and experience, officials demonstrated greater difficulty coping with aggressive behaviours from soccer players and coaches/trainers versus the aggressive behaviour experienced from spectators. Moreover, officials who are pessimistic demonstrate greater issues with performance and motivation compared to more optimistic officials when handling aggressive behaviours (Folkesson et al., 2002).

Firman et al. (2004) have also provided evidence that loss of concentration, loss of motivation, and decreased performance are common reactions to threat and violence in provincial soccer officials. Other common reactions included feelings of insecurity, depression, and a desire to quit. Referees who were unaffected by threats and violence were able to manage the situation by not attending to the threat, by "staying cool", and did not identify a threat as personal. Additionally, the soccer officials expressed the importance of communicating decisions with players and coaches to lower aggressive behaviour. These findings display the use of both avoidance and problem-focused coping strategies (e.g., not giving the situation attention, not taking a threat personally) and approach or emotion-focused coping strategies (e.g., communication with the coach) to control the game and personal stressors (Firman et al., 2004).

A.8. Referee Bias Under Home Advantage

Referee's across sports are often accused of officiating with a bias, particularly in favour of the home team. This bias is typically associated with the home advantage phenomenon in sport. More specifically, the home advantage is a term used to describe the observation that home teams win over 50% of games played under a balanced home and away schedule (Courneya & Carron, 1992; as cited in Carron, Loughhead, & Bray, 2005, p. 395). Carron, Loughhead, and Bray (2005) suggested a conceptual framework that includes five major components associated with a home advantage, which includes: game location, game location factors, critical psychological states, critical behavioural states, and performance outcomes (see Figure A1).

Game location refers to the site of the match and defines which team is home or away; wherein, game location factors include crowd, learning/familiarity, travel factors, and/or rule factors. Specifically, the crowd is associated with a home advantage because the home team generally receives greater crowd support compared to their visiting competitor. Learning or familiarity refers to the home team's familiarity with the venue compared to the away team's (i.e., the way the puck bounces off the boards or playing on artificial turf vs. real grass) and/or the home team's opportunity to modify temporarily the venue to play on their perceived strengths for a performance advantage (e.g., soften the pitch through excessive watering). Travel factors refer to the influence of the various accommodations a visiting team must endure before a competition such as a mode of transportation, meals on the road, and even time change. Finally, rule factors recognize that in some sports the rules may grant the home team with an advantage (e.g., having the last line change in ice hockey).

Game location factors influence critical psychological states, critical behavioural states, and critical physiological states (e.g., players demonstrate higher confidence levels playing at home and

more aggression on the road, coach's familiarity with the venue, state anxiety in an away venue) as it relates to the competitors and the coaches. Finally, performance outcomes can be viewed as primary, secondary, and tertiary. Primary performance outcomes refer to the fundamental level of performance such as shots on goal percentage or penalty minutes accumulated in a game. The intermediate or scoring aspect of performance is the secondary level, measured by goals or points scored in a contest. The tertiary level of performance outcomes is the most commonly used outcome measure in home advantage studies, identified through win-loss ratio (Carron, Loughhead, & Bray, 2005). A main revision from the previous model by Courneya and Carron (1992) was eliminating officials' role in the home advantage phenomenon. This revision was made because a referee's role in home advantage is subjective to many of the factors used to measure home advantage. Specifically, referees do not hold a home or away status; thus, their performance is not influenced by the home teams 'feel' for the venue, the away teams travel accommodations, or the set rules of the game that favours the home team. However, research has shown mixed results of crowd effects on referees' decisions.

A.9 Referee Bias and Crowd Influence

Spectators in a sporting event can become a stressor for an official. For example, spectators can be verbally and physically abusive towards officials. To avoid these confrontations or to seek acceptance, referees may unconsciously tailor a game towards the home team. This social pressure is often expressed by the home crowd through auditory cues in the form of spectators booing or cheering, which ultimately influences a bias towards the home team.

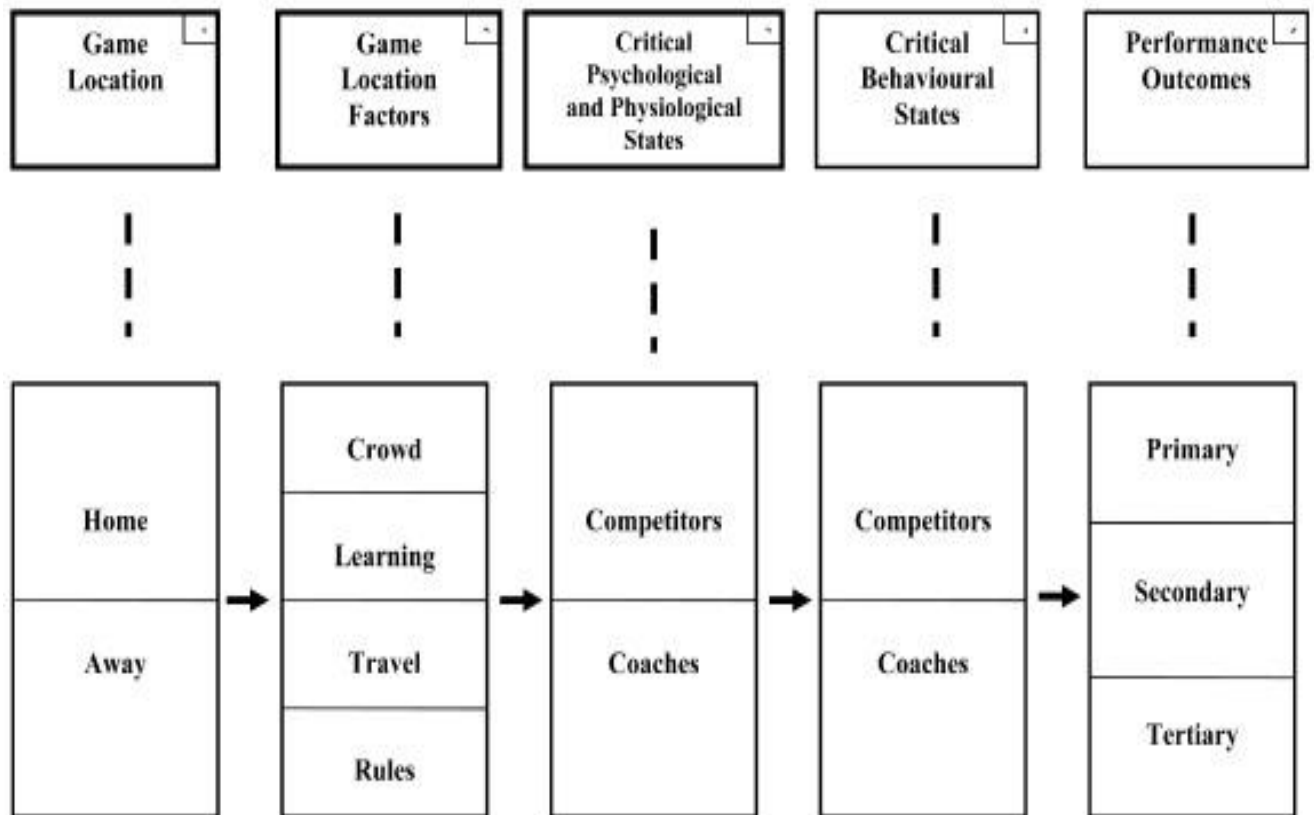


Figure A1. A Conceptual Framework for Home Advantage in Sport Competition
(Carron et al., 2005)

A.9.1. Crowd Noise

Research has shown that crowd noise contributes to cognitive anxiety and increased mental effort in soccer officials, wherein leniency towards the home side occurs when making a foul decision (Balmer et al., 2007). Cognitive anxiety intensity is shown to be higher in a noise condition in comparison to a silent condition. A relationship between mental effort and cognitive anxiety has also been found suggesting cognitive mechanisms of anxiety and effort allocation are interrelated. It had also been shown that professional soccer officials were less certain in their foul decisions when exposed to crowd noise versus silence (Nevill, Balmer, & Williams, 2002). Further, significantly less fouls (15.5%) were also awarded against the home team in a noise group compared

to a silent group, a difference that closely represents the difference/advantage in home wins in soccer. To explain this tendency an avoidance coping style amongst the soccer officials has been proposed (Nevill, Balmer, & Williams, 2002).

Crowd protest has also been shown to influence officiating decisions. When observing men's college basketball spectators, Greer (1983) showed slight reductions in home team violations following crowd protest while a dramatic increase was observed in violations called against the visiting team. It was also shown that the visiting team's performance deteriorated post protest periods. In this study, the most common type of crowd protest was booing directed at the game officials for making an incorrect violation call, particularly when the call was against the home team (Greer, 1983).

The influence of crowd noise on referee decision making has also been investigated in relation to noise volume. For example, soccer officials were more likely to award a yellow card under high volume conditions compared to low volume conditions. The authors suggested that this behaviour was because the soccer officials associated volume of crowd noise with foul severity (Unkelbach & Memmert, 2010).

A.9.2 Crowd Density

Unkelbach and Memmert (2010) utilized a crowd density index to examine the influence of the crowd, which is defined as the percentage used of a stadium's absolute visitor capacity. Also under consideration was the stadium's architecture, which focused on whether the venue was an all-purpose venue with a track and field line separating the pitch from the spectators or if the venue was a "pure" stadium where there was no separation between the crowd and the pitch. Findings showed that crowd density predicted the amount of yellow cards awarded against the away team, also

correlating with game outcome. Implications to this outcome suggest the away team possibly playing more aggressive or the opposite and because away teams lose so frequently, they receive more yellow cards. Another implication suggested by the authors is that better teams could have larger or better attended venues, contributing to the crowd density and its influence on referees' decisions. This correlation was even stronger when the crowd was in close proximity to the pitch.

Goumas (2014) also examines match data from the 2009-2010 and 2010-2011 season of the Union of European Football Associations (UEFA) Champions League and the Europa League. Median crowd density in the Champions League (over three-quarters capacity) greatly exceeded the Europa League's density (about half-capacity). While both leagues showed a bias towards the home team in goals scored, shots on goal, and corner kicks taken, 25% more yellow cards were awarded against the away team in the Champions League versus 10% in the Europa League. These findings suggest that crowd density influences home team bias. As crowd density increased, a home team bias emerged as evidenced by the increase in yellow cards awarded against the away team (Goumas, 2014). In amateur ice hockey, crowd density has been shown to influence game outcome through home advantage when the density of the crowd increases (Agnew & Carron, 1994).

A.9.3 Crowd Size

When analyzing English Premier League (EPL) soccer matches, results showed that more experienced referees exhibited significantly less home bias (Boyko, Boyko, & Boyko, 2007). This finding supports Nevill et al. (2002) in that officials with at least 16 years of experience tend to have less of an influence in home advantage. Differences in individual referees were found amongst EPL soccer officials in the amount of yellow cards and penalties awarded. These results suggest that referees hold some accountability for observed home advantage in the EPL soccer league. The

authors advocate home advantage is dependent on the subject decisions made by each individual official (Boyko, Boyko, & Boyko, 2007).

Page and Page (2010) suggest that differences in referee home bias are related to referees' capability to cope with the crowd pressure. While some officials are able to demonstrate a consistency level of home bias independent of crowd size; most officials increase their bias towards a home advantage as crowd size increases (Page & Page, 2010). Crowd density and crowd distance from the pitch are other possible factors contributing to this social pressure as discussed earlier.

When examining end-of-season results of eight major divisions of the English and Scottish professional soccer leagues, Nevill, Newell, and Gale (1996) found a home advantage in games won, sending-off, and penalties recorded. Crowd size predicted the extent of home advantage; wherein, in venues where crowd sizes were large, away teams were penalised more often than the home side. The authors suggested: 1) the larger crowd sizes provoke away players to engage in more aggressive behaviours on the pitch; and/ or 2) larger crowds influence the referees' decisions against the away team through crowd noise (Nevill, Newell, & Gale, 1996). Further examining home advantage differences in English and Scottish soccer leagues post World War II into the 2000's, Nevill, Webb, and Watts (2013) revealed consistent results with previous studies. That is, leagues with smaller crowd sizes displayed less home advantage scenarios when compared to leagues with larger crowd sizes. Crowd size was also related to the level of competition. Division 2 soccer leagues showed the steadiest decline of home advantage followed by Division 1, the Championship League, the Scottish Premier League, and the EPL League. This decline lessened as league competition level (accompanied by crowd size) increased (Nevill, Webb, & Watts, 2013).

Downward and Jones (2007) also showed that crowd size influenced referee bias on yellow card distribution in the Football Association (FA) Cup over six seasons (1996-2002). Results showed that

the first yellow cards awarded in a game were most often against the away team (versus the home team) and the away team received more yellow card sanctions overall. In general, as crowd size increased, home bias also increased. An exception to this related to the quality of the team. When the away team was higher in the standings, the home team actually demonstrated a higher probability of receiving a yellow card when crowd size increased (Downward & Jones, 2007). Officials in this study may take into consideration which team is the home team and unconsciously avoid making a penalty called based on real life consequences (i.e., not feeling socially accepted by the crowd) when calling an infraction against the home team. Crowd influence is just one of the associating factors that can inhibit stress in sports officials and subsequently determine their coping style.

A.10 General Discussion

Several key points can be synthesized from the research literature to date. In sport officiating, the use of heuristics is a probable decision-making strategy. Visual experience of the sport, motor experience in the sport, and years of experience as a sports official also influences the accuracy of infraction decisions (Cañal-Bruland, Mooren, & Savelsbergh, 2011; Catteeuw et al., 2009a; Catteeuw et al., 2009b; Catteeuw et al., 2010b; Catteeuw et al., 2010c; Catteeuw et al., 2010d; Ghasemi et al., 2011; Hancock & Ste-Marie, 2013; Larkin et al., 2011; MacMahon, Starkes, & Deakin, 2009; Pizzera & Raab, 2012; Put et al., 2013a; Put et al., 2013b; Renden et al., 2014; Wilson & Mock, 2013). Perceived stressors of sports officials vary between individual referees and across sports, cultures, and certification levels (Anshel, 1995; Dorsch et al., 2012; Goldsmith & Williams, 1992; Kaissidis & Anshel, 1993; Kaissidis-Rodafinos, Anshel, & Sideridis, 1998; Rainey, 1995a; 1995b; 1999b; Rainey & Hardy, 1999a; Taylor & Daniel, 1987). However, the magnitude of

stress felt among sports officials in different sports is mutual and is typically experienced at a moderate level as assessed through self-reported survey research (Anshel & Weinberg, 1999; Burke et al., 2000; Dorsch & Paskevich, 2007; Gencay, 2009; Goldsmith & Williams, 1992; Kassidis & Anshel, 1993; Kaissidis-Rodafinos, Anshel, & Sideridis, 1998; Rainey, 1994; Rainey & Winterrich, 1995; Rainey & Hardy, 1997; Stewart & Ellery, 1996; 1998; 2004; Taylor & Daniel, 1987). The most concerning and often mentioned sources of stress in sport officiating included physical and verbal threats or abuse by those involved in the game. Consistency in the number of reported instances existed across sports that studied physical abuse involving a sport official (Firman, Nyberg, & Norlander, 2004; Folkesson et al., 2002; Rainey, 1994; Rainey & Duggan, 1998; Rainey & Hardy, 1999a).

Although coping styles for stressors are suggested to be flexible to the situation, an avoidance coping style appears to be an officials' preferred tendency under stress (Anshel & Winberg, 1999; Kaissidis-Rodafinos, Anshel, & Porter, 1997; Kaissidis-Rodafinos, & Anshel, 2000; Roth & Cohen, 1986). Avoiding confrontation with players, coaches, or spectators allows the referee to maintain his/her focus on the game, which results in better performance and motivation to do the job (Firman, Nyberg, & Norlander, 2004; Folkesson et al., 2002; Lazerus, 1993; Neil et al., 2013; Nevill, Balmer, & Williams, 2002). However, crowd noise from spectator cheering or booing is a factor that can influence a referee's performance. Sport officials in soccer and basketball have been studied in this area and appear to show a bias towards the home teams with violation calls (Balmer et al., 2007; Greer, 1983; Nevill, Balmer, & Williams, 2002; Unkelbach & Memmert, 2010). The crowd density and proximity to the playing surface is another influencing factor on referee decision making (Agnew & Carron, 1994; Goumas, 2014; Unkelbach & Memmert, 2010). As crowd size and proximity increases, the more home bias is shown (Boyko, Boyko, & Boyko, 2007; Downward &

Jones, 2007; Page & Page, 2010; Nevill, Bamer, & Williams, 2002; Nevill, Newell, & Gale, 1996; Nevill, Webb, & Watts, 2013). Although the magnitude of home bias from crowd factors is individualistic and is influenced by experience level (e.g., more experienced soccer officials show less home bias) (Boyko, Boyko, & Boyko, 2007; Nevill, Bamer, & Williams, 2002). As with stress and coping, sport officials with a higher experience level are able to keep their stress levels down by coping with stressors more effectively than those with less officiating experience; crowd factors being one of those stressors (Anshel & Weinberg, 1999; Folkesson et al., 2002; Neil et al., 2013).

In summary, many studies examining sport officiating focus on uncontrollable external sources of stress that can inhibit a referee's decision. What has not received much attention to date is how minor hockey referees manage the game. Whether sport officials are calling a game with consistency is a factor that can either elicit or deflect a stressor, as well as decisions made from a positional standpoint (e.g., being in the optimal position to make a correct call). Taking into consideration the game factors of time in the game, score of the game, home and away team affiliation, level of the teams, and sequential penalty scenarios, the proposed thesis investigation examined game management and the influence of these game factors on accuracy of minor ice hockey referee's penalty decisions using video clips of potential penalty scenarios. Due to the strong influence of stressors in sport officials' performance, preliminary data will also be generated on sources of stress in minor ice hockey officials using a modified version of the HOSSI-20 (Dorsch et al., 2012) to better inform the development of approaches to more effectively train young referees.