2014-05-02

Hazard Perception in Emergency Service Responders

Johnston, Katherine A.

UNIVERSITY OF CALGARY

Hazard Perception in Emergency Service Responders

by

Katherine A. Johnston

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIALL FULFILMENT OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER OF SCIENCE

DEPARTMENT OF PSYCHOLOGY

CALGARY, ALBERTA

April, 2014

Abstract

Collisions may be particularly risky for emergency medical services (EMS) and the patients they transport. Because of experiences with lights-and-sirens operations, EMS may have advantages in their perception of hazards, avoidance of which is critical to driving safety. To examine if differences in hazard perception between EMS and civilians exist, 29 EMS professionals, and 24 civilians were recruited to participate in a study of hazard perception. The dynamic hazard perception test assessed participants' response latency to hazards in a series of 95 driving videos. There were no differences in simple reaction time between the groups. Compared to civilians, EMS demonstrated an advantage in hazard perception reaction time (HPRT). Within the profession, experienced EMS did not reveal faster HPRT compared to their less-experienced counterparts. Overall, these findings suggest that differences in experience due to emergency vehicle operations may have improved EMS hazard perception latency.

Acknowledgements

This research was completed with the support of AUTO 21 funding.

I would like to thank my supervisor(s), Dr. Chip Scialfa, for his continuous patience, guidance, and motivation, and Dr. Jeff Caird, for his support and encouragement, as well as my committee members Dr. Andrea Protzner and Dr. Joan Vickers. Thanks to the help of Don Allan, Jason Laberge and Nancy Claydon in building relations with AHS EMS Calgary and the recruitment of participants. I greatly benefited from the laughs and mutually disgruntled rants shared with lab mates: Aimee Pearson, Jessica Jones, Rachel Jones Ross, Jasmine Mian, David Borkenhagen, Scheila Cordazzo, Julie Stromer, and Heather Seabrooke. Finally, thanks to home front support from my partner Rob O'Neill, parents Keith Johnston and Shonne Gravel, siblings Alex and David Mewett, and sister-in-law Andrea Wishniowsky.

Table of Contents

List of Tables

List of Figures and Illustration

Chapter 1: Literature Review

The nature of Emergency Service Response (ESR) professions, such as emergency medical services (EMS), police, and fire fighters, means increased exposure to high-risk encounters. Because of the increase in high-risk encounters, EMS are at greater risk of injury. For example, between 2003 – 2007, the fatality rate among Emergency Medical Technicians (EMT, a category of EMS) was 6.3 per 100,000 individuals, which is 1.4 times greater than other professions (Reichard, Marsh, & Moore, 2011). The high-risk situations encountered by EMS may be events specific to the service they provide, such as interacting with violent offenders or patients, or entering an enflamed building. In addition to responding to emergency events, a fundamental aspect of these professions is transportation-related. Because EMS often are involved in either speedy pursuit or travel to and from a scene, they are exposed more frequently to traffic conflicts and thus, as with all drivers, the probability of collision increases. To illustrate, after controlling for exposure, drivers who reported more than 80% of their annual travel to be occupation-related had 53% more collisions with injury than those with no work-related travel (Broughton, Baughan, Pearce, Smith, & Buckle, 2003).

In addition to increased collision frequency, the implications specific to emergency vehicle collisions (EVC) are reason for a more in-depth understanding of the characteristics and causes of EVCs. For instance, patients being transported, who already require medical attention, may be more fragile and therefore more susceptible to injury than other vehicle occupants. Moreover, EVCs affect the larger social environment by limiting the available resources for the zone that they serve. To illustrate the impact, during peak hours, the city of Calgary, Alberta mobilizes 45 active ambulances that respond to approximately 330 calls a day (Calgary Herald, 2013).

However, as of November 2012 the city began to experience a 15% increase in call volume. Orange Alerts (less than 5 available ambulances) were declared, and on two occasions a Red Alert (no available ambulances) was called (Calgary Sun, 2013). During these instances of decreased available resources, a collision involving injury may further limit the available ambulances; one ambulance and EMS crew is removed from service and at least one other required to collect and transport those injured.

As emergency vehicles provide a vital service, it is in the best interest of the community to identify factors that contribute to the prevalence of EVCs. The following thesis examines the causes of emergency vehicle collisions, and investigates potential differences in driving behaviours specific to emergency vehicle operators.

1.1 Characteristics of Emergency Vehicle Collisions

The characteristics of EVCs, such as frequency, collision type, location, and injuries sustained, allow the creation of a meaningful framework that indicates the areas where, when and to whom collisions are most likely to occur. As a result, higher-risk areas and collision types can be identified. The frequency of EVCs over a ten-year period (1988-1997, United States) has been categorized by ESR type; the analysis of the dataset indicated that police have the highest number of collisions (184,984), followed by EMS (36,998), and fire services (29,956) (Becker, Zaloshnja, Levick, Li, & Miller, 2003). Among EMS, police car occupants have the highest number of injuries or fatalities followed by ambulance occupants, and fire services (Becker et al., 2003). The occupants of police cars were more likely than other EMS to be injured or killed in a collision. It is speculated this is due to the number of high-speed pursuits (Becker et al., 2003).

There is a limited literature that analyzes collision details associated with emergency vehicles. For Canadian datasets, this may be due to the limited recording of the collision specifics such as time, road conditions, road type, collision type and number of vehicles involved. Alternative data sources, such as news articles (retrieved from www.EMS.org), are available. Although these articles are uploaded voluntarily by users and are not the total of incidents that occurred nationwide, they do provide a limited account of the collisions occurring. An analysis of the U.S. entries (between 2007-2009) from this source revealed the highest number of EVCs occurred during the month of February (Sanddal, Sanddal, Ward, & Stanley, 2010). This is consistent with analyses of larger national datasets (National Highway Traffic Safety Administration, United States, Custalow & Gravitz, 2004). Presumably, the winter weather in February contributes to the frequency of crashes, although the road conditions for specific cases are not necessarily known.

Custalow and Gravitz (2004) reported that a higher number of EMS collisions were recorded during the day, close to 12 p.m. and on Saturdays. In contrast to the time-of-crash results reported by Custalow and Gravitz (2004), reports from the available news archive did not indicate an effect of time of day (Sanddal et al., 2010).

Similar to passenger vehicle statistics, the largest number of collisions between ambulances and other vehicles occurred in intersections; the reported values range from 43% to 46% (Custalow & Gravitz, 2004; Sanddal et al., 2010). Intersection collisions also accounted for 85% of collisions with injury (Custalow 2004). In 32% of the reports, the ambulances were at fault, having struck another object or vehicle (Sanddal et al., 2010). Analysis of all collision types revealed that 28% were sideswipes and 15% were front-end impact (Custalow & Gravitz, 2004). Although T-bone collisions account for only 9% of overall collisions, they were over-represented in collisions with injury (41%), followed by front-end collisions at 33% (Custalow & Gravitz, 2004). From these statistics, it may be concluded that intersections are an area where emergency vehicles are particularly vulnerable to collisions.

There are a number of factors that may contribute to the injury of EMS personnel. For example, 39.9% of ambulance occupants in fatal collisions were in the patient compartment (NHTSA, 1988-1997) (Becker et al., 2003). In the patient compartment seatbelt usage among EMS is reported to be very low; only 7% reported always wearing a seatbelt during routine trips, while 3.2% wore them during emergency calls (Larmon, LeGassick, & Schriger, 1993). Occupants in the rear are also at risk of injury from projectile instruments such as “sharps”, which accounted for 10.8% of injuries reported by EMS (Maguire et al., 2005). Strains, sprains, and tears were reported as the most frequent injury to EMS (55.4%), which were most commonly reported as back-related injuries (27.6%) (Maguire et al., 2005).

Seventy-four percent of ambulance collisions with occupant injuries occurred during lights-and-sirens driving (Custalow & Gavitz, 2004). At higher speeds that often co-occur with lights-and-sirens driving, the increased potential energy translates into collisions with a greater probability of injuries. The use of lights-and-sirens while driving places other EMS at increased risk as well: injuries from collision during their use were at 62% among fire fighters and 52% among police (Becker et al., 2003).

The number of collisions with injuries occurring during lights-and-sirens driving reflects the demands of the task. EMS must successfully navigate through traffic at high speeds, potentially during adverse weather conditions, ignoring in-vehicle distractions (such as radios). Often, EMS are fatigued from long shifts. The trends identified from the reported collision and injury statistics suggest EMS must be particularly vigilant for hazards at intersections. Thus, a factor that is critical in reducing the likelihood of EVCs, especially during lights-and-sirens driving, is the development of hazard perception skill.

1.2 Hazard Perception

Hazards are defined as either an object (e.g. vehicle merging into a lane) or condition (e.g. weather such as fog, or rain) that increases the risk of injury. In the traffic safety literature, *hazard perception* is operationalized as the ability to detect dangerous elements in the roadway environment (Horswill & McKenna, 2004). A response component (e.g., touching the hazard), in addition to perceiving the hazard, is included in some measures (Crundall, Chapman, Phelps, & Underwood, 2003). Efficient hazard perception allows individuals to identify a hazard from situational cues and respond appropriately, and has been identified as a skill that is related to safe driving. Studies of hazard perception have reported correlations between reaction time and the number of missed hazards during hazard perception tests, as well as ratings by driving , where better hazard perception was related to safer driving as rated by an on-road instructor (Mills, Rolls, Hall, & McDonald, 1998).

Hazard perception was introduced by Spicer (1964 as cited in Horswill & McKenna 2004) in a study asking drivers to identify important elements from a series of driving videos. Younger, accident-involved drivers were found to be less accurate in the identification of elements than accident-free drivers. Similarily, Pelz and Krupat (1974) reported a significant difference in response latency; drivers with no collision history revealed faster hazard reaction time than those who reported collisions (by 500 ms) and those with reported convictions (by 1200 ms). Those without a collision history are also better at correctly identifying when it is safe to maneuver a vehicle than those with a collision history (Hull & Christie, 1992). Additionally, correlations between reported collisions and scores on a dynamic hazard perception test have revealed significant differences between drivers who have been involved in a collision in the past three years and those who have not (Deery, 1999; McKenna & Crick, 1991; Quimby & Watts,1981).

Although Horswill and McKenna (2004) report a small correlation and effect size between hazard perception and reported collisions (.11), it is nevertheless believed to be an important one. Because hazard perception has been improved in drivers through training, even those considered expert drivers (Horswill, Taylor, Newman, Wetton, & Hill, 2013), there is a potential to reduce the possibility of collision by appropriate evaluation and training.

There are a number of theoretical models explaining hazard perception. Although these models focus on different processes of hazard perception, they are quite similar. Two prominent approaches generally used in the literature for understanding context assessment are *Situation Awareness* (SA) and, closely related, the *SEEV* model. The final model that will be discussed, introduced by Fitzgerald and Harrison (1999), is specific to the process of hazard perception.

The first model, Situation Awareness, is an established concept in psychology, however there is variability in its definition (Rousseau, Tremblay & Breton, 2004). The operationalizations encompass a variety of cognitive processes such as workload, attention, vigilance and stress (Pew, 2000) and are typically categorized as either state or process-oriented definitions. These definitions distinguish between the underlying cognitive processes of situation awareness, which Endsley (1995) calls *situation assessment*, and the state of *situation awareness knowledge* (Rousseau, Tremblay & Breton, 2004). The categories are further segregated into *operator-focused* and *situation-focused* approaches, where the former describe process-oriented frameworks attributed to the situation awareness state, while the latter rely more on direct perception and understanding the environment. For the purposes of understanding hazard perception and its underlying processes, a process-oriented, operator-focused approach will be taken.

Endsley's (1995) core model encompasses three components for achieving situation awareness. These include: perception, comprehension, and projection of the future. The perception process uses attentional selection based on the task at hand and interacts with long-term memory (LTM) to identify representations. Comprehension relies on the individual's LTM mental models to understand the environment. The first two stages allow the individual to make projections of the future status of the elements in the environment, such as deciding if an element is potentially hazardous. Achieving situation awareness, in the case of hazard perception, allows the individual to identify an element as a hazard and respond (e.g. evasive maneuvering) before the collision occurs.

The second model, the SEEV model, shares similarities with Situation Awareness, however it focuses on the allocation of visual attention. Horrey, Wickens and Consalus (2006) suggest that the allocation of visual attention to an area of interest within a scene, such as a hazard, is dependent on four factors: the *salience* of the object or event, the *effort* in scanning, the *expectancy* of the object or event, and the *value* of obtaining information from a source. For instance, there is high cost associated with missing an adjacent vehicle while changing lanes, but relatively low cost in missing billboard information. The SEEV model shares similar components to situation awareness definitions such as Klein's (1997) definition of situation assessment (process-oriented situation awareness), which in addition to goals and identification of actions, includes cue salience and expectations.

The final model proposed by Fitzgerald and Harrison (1999) views hazard perception as a multifaceted skill and identifies three underlying processes: Workload Management, Automaticity, and Attention (see Figure 1). The processes are stipulated to interact with one another and be to be moderated by levels of experience. For instance, novice drivers may be more likely to experience overload during higher workload driving situations. This may result in reduced resources to detect hazards. Additionally, as drivers become more experienced, routine tasks that are less complex may become automatic and require little effort from the driver to produce the behavior. Finally, similar to the SEEV model, Fitzgerald and Harrison (1999) address the importance of the allocation of attention to relevant stimuli. Again with experience, drivers are more aware of areas where hazards may emerge.

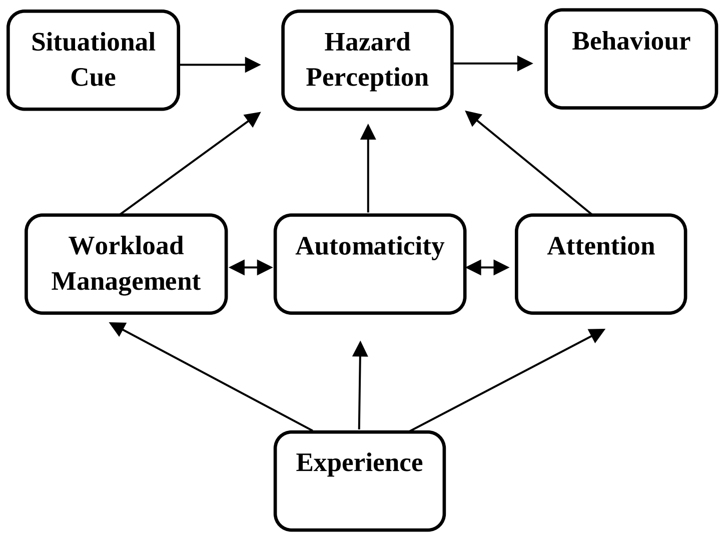

Figure 1. Hazard perception as a multifaceted skill moderated by experience (from Fitzgerald & Harrison, 1999).

The preceding models describe a number of factors that influence a driver’s detection and identification of an on-road element as potentially dangerous. However, the identification of a hazard in an on-road setting is more complex than simple identification; drivers must detect hazardous elements from cluttered scenes that include multiple potentially relevant targets, while ignoring irrelevant information.

A number of factors influence perception by affecting visual search and the recognition of objects. The models of hazard perception, specifically the SEEV model that focuses on the allocation of attention and the process-oriented Situation Awareness models, incorporate components of perception, such as salience, for the detection of hazards. Without accounting for the strategic goals of the individual, visual search must rely solely on the object features, such as salience, sudden onset, or movement of each element in the environment. This bottom-up method of processing has been attributed to novices without mental models for organizing and predicting the appearance of stimuli (Shinoda et al., 2001). Although a more salient object may be easier to detect, stimulus features detected through bottom-up processes may fail to attract attention. These failures, called change or inattention blindness, have been demonstrated in a series of studies (see Crundall, 2005 for a review). There are however top-down influences that affect identification, such as the relevance of the element to a search goal, or the *attentional set* of the individual. An attentional set is a means of prioritizing stimuli, or scene elements, so as to avoid irrelevant information. This effect has been demonstrated in detection studies where salient (but non-relevant) distractors were not found to impair performance (Folk, Leber, & Egeth, 2002; Folk, Remington, & Johnston, 1992; Lamy & Tsal, 1999; Theeuwes, 1990;Yantis & Egeth, 1999). Similar to this, the *contingent capture hypothesis* states that the degree to which salient *distractors* capture attention is a function of their relationship to the attentional set (Folk, 2002). In laboratory settings there may be a clear distinction between salient goal-relevant targets and non-relevant distractors (e.g. the use of letters vs. numbers). However, in the driving environment there are multiple goal-related elements that are continuously changing, which drivers must scan to detect targets (hazards) amidst the distractors. In the driving literature, the moderating effect of top-down processing on attentional capture has been demonstrated by Shinoda et al., (2001); By providing specific instructions to participants to both follow a lead vehicle and obey traffic signs, participants' visual search to the areas of signage increased compared to the follow-only instructions. This emphasizes the importance of the role that top-down processing plays, as well as other components of the models such as experience, expectancy, and value.

The recognition of hazards amidst distractors while driving improves with experience (Crundall & Underwood, 1998; Crundall et al., 2005; Fisher et al., 2003); however the proposed influence of experience depends on the model. Situation awareness models suggest that as experience with a particular task increases (e.g., as with pilots in flight decks), so does knowledge of the task-specific elements. Increased familiarity with task-specific elements subsequently improves the identification of hazards (Pew, 2000). The SEEV model asserts that experience provides individuals with an expectancy of the location of potential targets and their associated value (i.e., the consequences of not performing an evasive maneuver). Finally, Fitzgerald and Harrison (1999) suggest that experience moderates all the underlying components of hazard perception resulting in improved hazard perception. In addition to experience, models (i.e., Fitzgerald and Harrison (1999)) include automaticized responses as a factor that influenced identification of hazards.

In Schneider and Shiffrin's (1997) seminal papers on learning and automaticity they describe experience, or learning, as acquired through mapping trials. During the mapping trials the subject is repeatedly exposed to an event such as target identification, and performs a subsequent response. The trials took one of two forms: *consistent mapping*, where the event and response did not change across trials; and *variable mapping*, during these trials the targets and distractors that required a response were alternated. It is proposed that during early trials individuals must exhaustively search the characteristics of each presented set of elements and compare them to the mental set of targets stored in LTM. After many trials however, Schneider and Shiffrin (1997) suggested that objects presented through consistent mapping would begin to attract attention during search tasks and an automatic attention-response response would develop that no longer requires a serial search. Subsequently, the reaction times to consistently mapped events would decrease eventually becoming independent of set size.

In addition to Schneider and Shiffrin's (1997) work on automaticity, Logan (1988) proposed the instance theory of automaticity, which suggests that initial performance of a task is slow because it relies on a general, attention-demanding algorithm. The theory is based on three assumptions: first, that the encoding of a memory is an unavoidable consequence of attention; second, that the retrieval of a memory associated with an event is an automatic consequence of attention to the event; finally, that each time an event, or instance, is encountered, it is encoded as a separate memory. As an individual has more encounters with an event, more instances are encoded; this results in a race between memory retrieval and the algorithm to generate a solution to the task. With increased exposure to a task, as would occur with experience, the minimum retrieval time of an encoded instance decreases. Performance is thought to be automatic (effortless, unconscious and rapid) when enough instances have been encoded that the response to the event is based on of the direct retrieval of a memory rather than working through the slow, demanding algorithm.

As discussed previously, the driving environment is continuously changing. However this does not necessarily indicate strictly variable mapping trials. Logan (1988) suggested that in addition to whole-stimulus encoding partial, or feature encoding of instances, was also possible. Indeed, Brockmole and Henderson (2006) utilized real-world images in a contextual cueing study. They postulated that although there were variances in the scenes presented, that participants had created a schema of the spatial configuration of some features based on scene regularities. Across displays they found improvement in identifying targets. However, if scenes were inverted and violated the global context there was a reduction in performance. Similarly, studies have demonstrated that after an initial contextual cueing, participants demonstrated a transfer effect to new scenes with a new global arrangement as long as some of the features were preserved (Jiang & Wagner, 2004). Therefore although the driving environment may be variable, global consistencies in the features of a scene across trials may allow for the development of an automatic response.

Beyond an automatic response, there is evidence that the development of automaticity reduces workload management demands (Young & Stanton, 2007). Workload management is explained as the cognitive capacity available after tasks such as vehicle control. The influence of high workload on driving has been assessed through the manipulation of route complexity (Patten, Kircher, Ostlund, Nilsson, & Svensson, 2006). The workload management of four levels of experience (novices with no driving experience; learners; experts with one year driving experience; and advanced drivers) were compared through secondary task performance, which required a judgment on object similarity. Additionally, available cognitive capacity was measured utilizing a peripheral detection task. The number of correct responses was used to measure attention capacity. Scores on the secondary tasks revealed that overall the novice and learner groups had fewer correct responses than their experienced counterparts. The workload manipulation also affected responses. Response times to the peripheral targets were significantly longer in more complex routes (Patten et al., 2006). These results indicate that more cognitively demanding tasks have a negative impact on the available cognitive capacity for the performance of a secondary task.

Additionally, attention is affected by mental workload, or how cognitively demanding a task is. Attention has been specified by models, such as SEEV (Horrey et al., 2006), to incorporate both the effective scanning of the environment and the effort required to do so. The Useful Field of View (UFOV) indicates the area in the environment where information from a stimulus may be extracted. Rantanen and Goldberg (1999) demonstrated that the size and shape of the UFOV were altered when workload was manipulated. During heavy-workload conditions there was a significant decrease in the size of the UFOV compared to a moderate-workload condition (Rantanen & Goldberg, 1999). This is of particular importance when considering lights-and-sirens driving. EMS likely experience heavy workload while navigating traffic at high speeds. Additionally, if they are transporting a critical-care patient, there may be increases in stresses affecting available cognitive resources. Reduction in peripheral vision decreases the area available to detect hazards without head movements; consequently, search techniques, such as scanning, become increasingly important for the identification of hazards.

Negative effects from higher workload and decreases in the UFOV may be amplified for novices because experience is thought to moderate processes linked to hazard perception (Klein, 1997; Horrey et al., 2006; Fitzgerald & Harrison, 1999). The role of experience for the development of automaticity has been addressed previously, however, an influence on both workload management and attention has also been demonstrated in the literature. The effect of workload on reaction time, addressed in the Patten et al., (2006) study, included an additional component that assessed experience; participants were grouped as either low-mileage (representative of less experience) or high-mileage (more experienced) drivers. Low-mileage participants demonstrated slower response times than their high-mileage counterparts. Of greater significance, experience had a moderating effect on reaction time within workload conditions:

low-mileage drivers revealed significantly longer reaction times during the higher workload conditions, while no effect of workload was found for the high-mileage group. These findings suggest that for those who have not automated aspects of task performance, there are fewer attentional resources available to allocate towards the secondary task.

A common method of evaluating drivers' scanning is through the analysis of eye movements. Drivers are required to engage in repeated scanning of the scenario to detect potential hazards. Effective scanning typically involves broader scanning, shoulder checks, and glances to mirrors; these generally develop with experience. For example, Chan, Pradhan, Pollatsek, Knodler, and Fishers (2010) have demonstrated that the eye movements of novice drivers are often directed to the road ahead and compared to more experienced drivers, less often to regions of greater hazard potential. For experienced drivers these scanning techniques may be automaticized. However, novices require more effortful and conscious movements and errors are more likely to occur.

A consistent finding in the analysis of novice drivers' visual search strategies has been their restricted horizontal scanning compared to more experienced drivers (Mourant & Rockwell, 1972; Deery, 1999; Underwood, 2007). Novices also make more redundant fixations (Mourant & Rockwell, 1972) and are less likely to look at areas where hazards may occur, such as areas where road users may intersect (Chan et al., 2010; Underwood, 2007). As a result, novices' identification of hazards is negatively impacted and this deficiency is independent of reaction time (Scialfa et al, 2011)

1.3 Hazard Perception and Emergency Service Responders

The majority of research to date has focused on comparisons of novice and experienced drivers. Crundall and Chapman (2003 & 2005) sought to expand this literature by including a comparison group with a different level of experience: EMS. Novice drivers, experienced police and a civilian group matched on age and time since obtaining licensure, were shown three different video clips (pursuit of a vehicle at high speed, responding with lights-and-sirens to a scene, and a control). Attention was measured by recording participants' eye movements. Novices revealed the longest gaze duration towards road hazards (Crundall et al., 2003). Gaze duration towards the median was similar for the controls and police during the pursuit clip. However, differences were found in the gaze durations between police and matched controls towards the pursuit stimuli (shorter for police); areas where a hazard *may* appear (side road; longer for police); and towards unprotected pedestrians (longer for police). It is likely that increased exposure to the task for police required that fewer attentional resources be allocated to the pursuit stimuli, which allowed more resources to be directed toward areas of potential hazards (Crundall et al., 2005).

Studies of attention and workload management provide an indirect indication of the impact of experience on hazard perception by assessing its underlying skills. More direct assessments are realized using Hazard Perception Test (HPTs). These tests typically involve the presentation of either static or dynamic images of traffic scenarios to participants. The traffic scenarios contain a conflict where action is required to avoid collision or conflict. Participants indicate where the conflict is located (McKenna & Crick, 1991; Scialfa, Deschenes, Ference, Boone, Horswill & Wetton, 2011, Chapman & Underwood, 1998; Crundall, Chapman, Phelps, & Underwood, 2003; McKenna, Horswill, & Alexander, 2006; Underwood, Crundall, & Chapman, 2011).

A number of studies have assessed hazard perception in both novice and experienced drivers as a trainable skill (Crundall, Andrews, van loon & Chapman, 2010; Garay-Vega, &

Fisher, 2005; McKenna, Horswill & Alexander, 2006; Fisher, Pollastek, & Pradhan, 2006). The idea that training may improve hazard perception is partly formed from the belief that the deficit in novice drivers' identification of hazards may be explained on an informational basis. That is, novices lack the experience, and therefore knowledge, necessary to know where to look to anticipate hazards. Training studies seek to increase the informational basis by instructing novice drivers where hazards are more likely to emerge and which road-users may pose additional risk. For example Fisher, Pollatsek and Pradhan (2006) asked novices to drag circles over areas of potential conflicts. A separate novice group was provided with video-based training in hazard awareness. Compared to controls, trained novices' were better able to identify potentially hazardous areas, and during a simulated drive, novices who received training demonstrated more fixations towards areas where hazards were likely to emerge.

Crundall and Chapman (2003 & 2005) also measured EMS' hazard perception compared to civilians. While viewing the video clips, participants continuously rated the perceived threat of hazards. There was no effect of experience in the number of hazards reported but latency was not measured. Further, police experiences from emergency vehicle operations have been found to affect the response latency to hazards. Horswill et al. (2013) assessed the hazard perception of experienced drivers compared to police using a dynamic hazard perception test of civilian driving. On average, police responded 1.27 seconds faster to hazards than their experienced civilian counterparts. Faster response times are particularly important for police when pursuing a vehicle at high speeds. It has yet to be determined if there similar decreases in response latency for other EMS such as EMS.

It is evident that experience plays a role in moderating the skills - workload management, automaticity, and attention - that Fitzgerald and Harrison (1999) indicate as underlying hazard perception. The literature suggests that novices have a distinct disadvantage, specifically by revealing higher levels of cognitive demand and decreased scanning ability. This may be related in part to insufficient exposure to specific instances of stimuli, which would assist in two fashions. The first, according to the Instance Theory (Logan, 1988) and Schneider and Shiffrin, too, would be the development of automaticity. Secondly, the increase in domain-specific knowledge would provide the experience necessary to know where hazards are more likely to emerge, thereby improving visual search (Horrey et al., 2006). This is supported by the results of hazard perception training, which demonstrates a subsequent increase in the expectancy of common hazards and their locations (Fisher et al., 2006).

1.4 The Effect of Experience within Emergency Service Responders

Although more commonly assessed among civilians, the role of experience is also important to understanding skill development in occupations such as EMS. Experience has been identified as a predictive factor accounting for occupational accidents and injuries (Slappendel, Laird, Kawachi, Marshall, & Cryer, 1993). In their analysis of occupational injuries Slappendel et al., (1993) indicated that during the first three years of an occupation, employees were at the greatest risk, with about 70% of injuries occurring in this time. One possibility why employees at this stage have a higher rate of injury is because they are operating with an incomplete mental model of the risks specific to their occupation. Although EMS likely have experience as civilian drivers, they are at greater risk of injury as novice EMS, when they are still developing a mental model of the risks and common hazards associated with emergency vehicle operations.

The experiences gained through emergency vehicle operations differ than those acquired through civilian driving in a number of ways. Firstly, EMS must familiarize themselves with a new set of vehicle operations while using a more complex dashboard interface (e.g. siren controls, computer-aided dispatch) than those found in standard vehicles. In addition, the style of driving required while operating an emergency vehicle differs from that required during civilian driving. The difference in style is primarily related to the emergency response and transportation of patients that occurs during lights-and-sirens driving. It is postulated that because of this increase in exposure specific to emergency driving, over the course of their careers EMS experience a higher number of instances of hazards. The experience garnered from increased exposure to traffic conflicts while travelling at higher speeds creates an extended knowledge base from which more experienced EMS may draw.

Because EMS alter traffic flow in a manner not typically experienced by civilian drivers, the visual search required during lights-and-sirens driving may create a greater demand on processing resources. Novice EMS have less experience to draw upon when faced with a high cognitive-demand scenario, such as an intersection cluttered with distractors. To illustrate, when an emergency vehicle is traveling through a red light; EMS must also attend the traffic perpendicular to them to ensure all vehicles have stopped. While experienced EMS have developed a larger knowledge base of potential hazard locations for this scenario, novices' incomplete mental model of risks results in a reduced expectancy of hazards and of the value of scanning specific locations. Additionally, they may use slower, controlled processing while scanning. The high workload experienced may reduce the available resources for the scanning task and the identification of hazards. While it is clear that a difference exists in the skills of civilians and EMS, the effects of experience among EMS while these skills are developing have yet to be addressed in the literature.

1.5 Current Study and Hypotheses

The current study addresses two gaps identified in the literature. The first is to compare EMS ambulance operators to civilians on a procedure that allows the measure of latency to hazards. The second goal is to measure the influence of experience within the professional group. Additionally, this study will assess if differences exist in the driving behaviours, and knowledge of traffic laws between EMS and civilians, and to what extent these differences may be related to their hazard perception. To meet the goals of this study, a dynamic HPT was presented. The HPT consists of 95 silent driving scenes, 64 of which contain a traffic conflict. The conflicts filmed are representative of those most commonly associated with collisions in adult drivers (McKnight and McKnight, 2003; Preusser, Williams, Ferguson, Ulmer, & Weinstein, 1998). It was hypothesized that because EMS have more experience with hazardous driving situations, there is an increase in their domain-specific knowledge base; therefore they would attend to potential hazards with greater speed and ease. Specifically, it was hypothesized that EMS would demonstrate faster reaction time to hazards. Because experienced EMS have had greater exposure to hazards, and have automatized performance while driving, it was expected that experienced EMS would outperform novices.

Chapter 2: Methods

2.1 Participants

This study was approved by the University of Calgary Conjoint Health Research Ethics Board. A sample of N = 53 participants were recruited and tested, 29 Calgary Zone EMS and a control group of 24 civilian drivers. See Table 1 for descriptive statistics. EMS participants were recruited through notices distributed through collaboration with Alberta Health Services (AHS) Calgary Zone EMS. All study advertisements indicated that the session was a study taking place through the University of Calgary and was not a training session run by AHS. This was to ensure that participants did not feel pressured to complete the study as a job requirement. EMS participants were paid $25 per hour for their time. The control group was recruited using the University of Calgary undergraduate participant pool and through "snowball sampling". Students participating were granted course credit for completing the study. All participants in the control group help a Class 5 license, while EMS held a Class 4. There were no significant differences between the EMS and civilian groups' reported age, years of licensure, collision history, or exposure. Within the EMS group, participants reported an average of M = 6 years (range 1-17) of experience; 67.8% were affiliated with emergency operations (versus Inter-Facility Transportation); 71.4% worked in urban zones.

2.2 Materials and Apparatus

2.2.1 Vision Tests

Photopic acuity was tested using the Landolt C Near Vision chart at a distance of 40 cm. Acuity was measured from 20/400 to 6/120 in .05 logMAR increments. The test uses a series of broken rings printed in rotations of 45^{o}; participants were asked to indicate which side the gap of the optotype faced.

Photopic contrast sensitivity were measured using the Vision Contrast Test System Chart, VISTECH 6000, which measures near sensitivity at 1.5 to 18 cpd from a distance of 40 cm (16 in). The chart uses five rows of sine-wave gratings, which increase in spatial frequency from top to bottom and decrease in contrast from left to right. Participants were asked to indicate the orientation of the grating. The reciprocal of the lowest contrast for the row that is correctly reported is the contrast sensitivity for that spatial frequency.

Colour deficiencies were assessed using the Farnsworth D-15 Dichotomous Colour Blindness Test. Participants were asked to organize coloured discs in increasing wavelength order. The D-15 is considered dichotomous as it distinguishes between severe and mild/normal colour deficiencies. The test was conducted under photopic illumination.

2.2.2 Simple Spatial Reaction Time (SSRT)

Participants completed a simple spatial reaction time test, used to account for any individual differences in general speed of response. In this test, 16 high-contrast black boxes of differing sizes appear at random intervals and locations on a monitor. The size of the boxes range from 2.75 cm x 2.8 cm to 13 cm x 14 cm and were chosen to represent the 25th, 50th, 75th, and 100th percentiles of the height and width of the hazardous objects at onset of the traffic conflicts during the HPT. The task required that they select the center of the black boxes by touching the monitor. A small yellow circle appeared at the selection point to provide visual feedback that participants' responses had been registered. They were informed the test would not give them any information about speed or accuracy of responses

2.2.3 Hazard Perception Test

The Hazard Perception Test (HPT) is a series of 95 silent driving scenes lasting between 10 to 62 seconds filmed in Vancouver, B.C., Canada, and surrounding areas using a Sony Handycam Camcorder, model HDR-SR11 in AVCHD 16M (FH) format at a resolution of 1920 x 1080/60i.

The camera was mounted inside a 2005 Subaru Impreza and secured to the inside door window on the passenger side of the vehicle(Scialfa, Deschenes, Ference, Boone, Horswill & Wetton, 2011). An extendable arm allowed the videotaped scenes to give a “driver’s eye” view. Filming occurred in March and April, 2009, during daylight hours, generally under clear skies and dry roadway conditions in a variety of frequently encountered environments (e.g., residential, limited-access freeway). Each driving scene was edited from original files using Sony Vegas Movie Studio Platinum software (version 9.0a) at a resolution of 1280 x 720 (Scialfa, et al., 2011). Only one traffic device found in the scenarios differed from those found in Alberta, a flashing green signal light. Participants will be instructed to treat the flashing light as a solid. The HPT consists of three 20-min blocks of scenarios that were counterbalanced across participants. Participants completed a short practice trial to familiarize themselves with responding to traffic conflicts similar to those occurring during the experimental trials. Participants were instructed to select the boxes as quickly and accurately as possible. A yellow circle appeared at the point of contact to provide visual feedback that participants’ responses had been registered.

Of the 95 driving scenes, 64 (67%) contain a *traffic conflict*, this is defined as a situation in which the camera car was required to take evasive action such as slowing, stopping, or steering to avoid a collision with a road user or stationary object. Examples of the traffic conflicts include a braking lead vehicle, pedestrian incursion, and construction equipment in the driving lane.

Figure 2. Example of a traffic conflict scene.

At onset of the traffic conflict the object in the scene had a height ranging between 1 and 10 deg (M = 3.0 deg) and a width between 1.6 and 14.8 deg (M = 4.4 deg) at a nominal viewing distance of 50 cm. The eccentricity of the objects relative to screen center ranged between -.9 and 3.4 deg on the vertical axis (M = 1.0 deg) and between -16.2 and 10.9 deg on the horizontal axis (M = -1 deg). Thus, objects in traffic conflicts are quite varied in their size and location but, on average, did not require excellent acuity or peripheral vision. Thirty-one scenes (33%) did not contain a traffic conflict and are included in the series to increase uncertainty about hazard presence, as would be the case in normal driving.

The HPT scenes are separated into three, fixed 20-minute segments. Custom software defined the onset, offset, and spatial extent of the traffic conflicts of each scene (see Marrington, Horswill & Wood, 2008). This same software was used to present driving scenes to participants and record the spatial coordinates of their responses and their reaction times. A 17-inch Elo 1729L touch-screen LCD desktop monitor with a resolution of 1280 x 1024 set at a viewing distance of approximately 50 cm was used to present the HPT and collect responses.

The test has been shown to be reliable (Cronbach's alpha = .75) and sensitive to levels of experience: discriminant validity was assessed by predicting group membership (novice, experienced) from hazard perception reaction time, classification accuracy was 84% overall and 14% for novices (Scialfa et al., 2011).

2.2.4 EMS Knowledge Questionnaire

A short questionnaire (see Appendix A) was administered to EMS participants to assess knowledge of traffic laws associated with the operation of ambulances. Although compliance by civilian drivers to the laws associated with lights-and-sirens driving will impact the level of risk for EMS drivers, it is equally important that EMS demonstrate an understanding of the regional laws. Because of factors external to EMS, such as failure by civilian drivers to comply with regulations, (i.e., yielding to emergency vehicles) there is a greater onus on EMS to detect and respond to traffic conflicts before a collision occurs. In addition to hazard perception, knowledge of traffic laws specific to emergency vehicle operations is important in high-risk areas such as intersections where EMS may violate regular traffic flow. For example, although advanced warning (i.e., lights-and-sirens) is used to slow approaching drivers, these signals may be missed. A noise level of approximately 90 dB (the combined noise of moderate-level radio and air conditioning) in a vehicle with the windows closed is enough to diminish the distance a siren can be heard, reducing it to 8-10 meters in urban intersections (De Lorenzo, & Eilers, 1991). If travelling at a speed of 50 km/h, there is less than one second from the time the warnings can be heard to the time of collision. For this reason regional traffic laws that regulate emergency vehicle operations are developed to reduce potential collisions. In recognition of the potential that civilians may miss advanced warnings, Alberta Traffic Laws indicate that while running lights-and-sirens, EMS must come to a complete stop at an intersection before passing through. The EMT knowledge questionnaire used was modeled after the short questionnaire by Whiting, Dunn, March, and Brown (1997), which assess basic knowledge of appropriate behaviours such as speeding and approaching intersections. The questions were altered in accordance with Alberta Traffic Laws.

2.2.5 Driver Behaviour Questionnaire

The Driver Behaviour Questionnaire (DBQ; Appendix B) assed details such as participants driving history, average kilometers driven per year, years driving, number of citations and collisions, and current driving behaviours. The DBQ was introduced by Reason, Manstead, Stradling, Baxter and Campbell (1990) and consisted of 50 Likert-scale items that measured errors (limits related to processing, perception or attention), violations (driving style and habits) during driving and lapses. The DBQ has been used as a predictor of collision involvement in numerous studies. A meta-analysis of the predictive accuracy of the DBQ revealed both errors and violations to be significant predictors of self reported accidents (de Winter, & Dodou, 2010). However, a more recent assessment of the predictive capabilities of the DBQ suggests better predictive accuracy for self-reported instances of collisions rather than objective collision data (Wahlberg, Dorn & Kline, 2011). The appended version of the DBQ is a variation that assesses current driving behaviours in a series of 125 questions using a 6-point (1-6) Likert scale which measure the participants tendencies towards risk taking (i.e. Take a chance and run a red light), distraction (i.e. miss a sign because you were talking to a passenger) and road rage (i.e. told to calm down by a passenger because you are angry at other drivers). The questionnaire also assesses driving changes that may be caused by visual impairments (i.e. have difficulty seeing a traffic light at dawn or dusk).

2.3 Procedure

Participants were tested in a session lasting approximately 2 hours. The control group was tested at the Perceptual and Cognitive Aging Lab. at the University of Calgary. EMS were predominantly tested at their emergency operations headquarters, however they were also given the option to complete the session the University of Calgary. Upon arrival at the facility participants were asked to read and sign the consent form (Appendix C). A researcher also verbally described the details of the study and what would be expected of them. After obtaining consent participants completed a series of visual tasks.

Vision tests were administered first. Only those participants who demonstrated better than 20/40 vision with corrective lenses, and no severe colour deficiencies were permitted to continue.

For the SSRT and HPT tasks participants were seated at a viewing distance of 50 cm from the pupil to the screen, additionally; the monitor was adjusted to a viewing angle of -10 deg. If participants required corrective lenses they were asked to wear them. Before commencing the experiment a brief practice trial was administered so that participants became familiar with the pressure required to select objects using a touch-screen monitor.

Participants then completed the computer-based tasks: a reaction time test (SSRT) and the HPT. Upon completion they were asked to complete the DBQ and a short demographic questionnaire (Appendix D). At the end of the experimental trials participants were debriefed on the purpose of the experiment and compensated for their time.

Chapter 3: Analysis and Results

3.1 Outliers

Analysis of the simple spatial reaction time (SSRT), hazard perception reaction time (HPRT), false alarm, and miss rate data revealed five participants (1 EMS, 4 civilian) whose scores were more than 2.5 standard deviations from the mean for their group. In addition to this, two of the civilian participants had difficulty understanding what the hazard perception test task required.

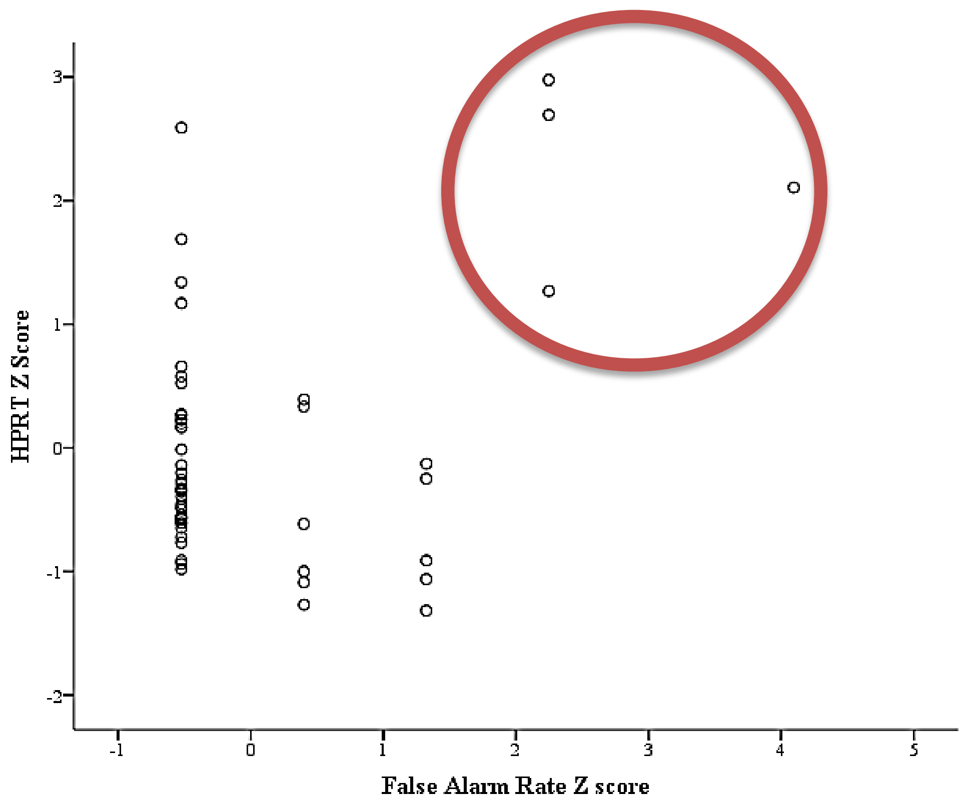

Figure 3. HPRT Z-scores as a function of false alarm rate Z-scores. Outliers are identified within the circles.

Analyses were completed once including the outliers and again excluding them. Although there was no effect on significance levels, the outliers were found to influence the magnitude and direction of the correlations between HPRT, false alarms and miss rates. Initial analyses, including the outliers, revealed significant positive correlations suggesting that as participants' responses slowed the number of false alarms and misses increased. In contrast, examination of the correlations excluding the outliers' revealed negative, though non-significant, relationships between HPRT and miss rate and a significant correlation with false alarm rate (see Table 2). The data suggests a speed-accuracy trade-off: As reaction time decreased participants had more misses and false alarms. Analysis of the groups separately revealed that the speed-accuracy trade-off was true only for EMS (see Table 3 and 4). Including the EMS outlier resulted in a positive, though non-significant relationship between HPRT and false alarms. However, excluding the outlier revealed the speed-accuracy trade-off. Conversely, the inclusion of the four civilian outliers resulted in a significant positive relationship between HPRT and false alarms. The removal revealed a negative, though non-significant relationship.

After reviewing figures of the relationship between HPRT and both false alarms and miss rates, it was apparent that the outliers were influencing the data disproportionately. The effect of the outliers can be seen in Figures 3 and 4. The outliers are consistently located in the upper right corner of each graph. Because the sign and magnitude of the correlations changed when they were included, they were removed for subsequent analyses, including correlation matrices, and significance tests.

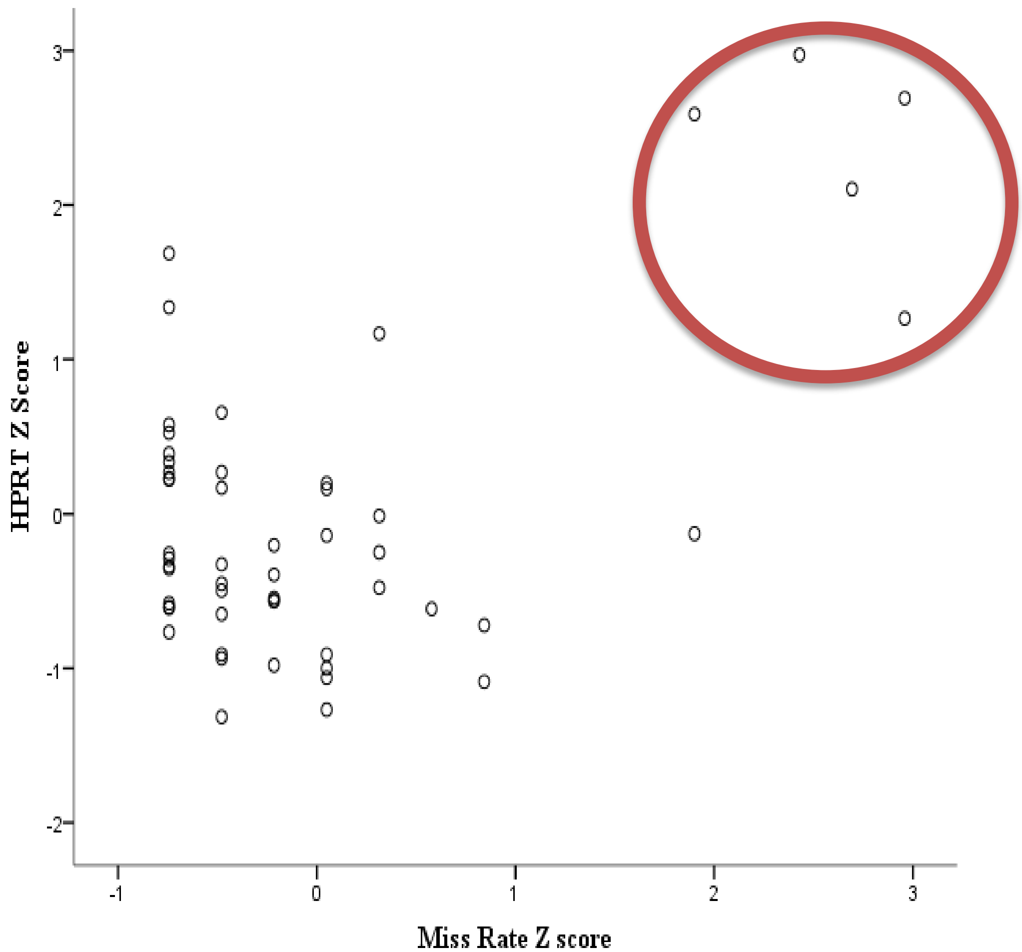

Figure 4. HPRT Z-scores as a function of miss rate Z-scores. Outliers are identified within the circles.

3.2 Group Characteristics

Characteristics of the EMS and civilian groups are given in Table 1. The groups differed, non-significantly, on the gender ratio assessed using a Chi-squared test. Both groups were within the normal range for acuity and contrast sensitivity and exceeded the minimum standard of acuity for driving. The average age of participants in each group did not differ significantly, however the EMS did have a broader age range. Additionally they did not differ significantly on years since obtaining licensure, or number of collisions. The civilian group reported they drove significantly fewer kilometers per year than the EMS.

As false alarms go up, miss rate goes up. General indication of poor performance, this runs counter to the idea of a speed accuracy trade-off.

Table 1. *Descriptive statistics (M, SD) of group characteristics for EMS and civilians. Analyses exclude outliers.*

	EMS ***n*** **= 28**	**Control** ***n*** **= 20**	**p-value**
Age	30.50 (*6.79*)	29.50 (*4.24*)	.541
Age Range	21-49	24-37	
Gender ratio (M:F)	18:10	9:11	.184
Years of Licensure	13.96 (*6.79)*	12.70 (*4.65)*	.475
Avg. driven distance (km/yr)	23,400 (*11,050*)	15,067(*17,548*)	.049
Collisions within last 2yrs.	.07 (*.26*)	.16(*.37*)	.356
Years of Experience	6 (1-17)	-	
Less than 5 yrs. Exp. (%)	28	-	
Urban (%)	71.4	-	
Emergency Operations (%)	67.8	-	
Avg. Km/yr. in Ambulance	39,825 (*38,437*)	-	
Avg. total km/yr.	63,225 (*40,535*)	-	
Collisions in Ambulance	.36 (*.678*)	-	

Table 2. *Correlation matrix of outcome variables and demographic information for EMS and civilians, excluding outliers.*

	Age	**Gender**	**Years of Licensure**	**Total Km/yr.**	**Collisions**	**SSRT**	**False alarm**	**Miss rate**	**HPRT**
Age	1	-	-	-	-	-	-	-	-
Gender	-.121	1	-	-	-	-	-	-	-
Years of Licensure	.947**	-.087	1	-	-	-	-	-	-
Total Km/yr.	-.025	-.262	-.002	1	-	-	-	-	-
Collisions	-.339*	.106	-.299*	.077	1	-	-	-	-
SSRT	-.074	.163	-.146	-.068	-.044	1	-	-	-
False alarm	.225	-.192	.194	.058	-.073	-.140	1	-	-
Miss rate	.2143	-.379**	.156	.074	-.072	-.146	.467**	1	-
HPRT	-.126	.118	-.148	-.148	-.139	.148	-.327*	-.237	1

* indicates significant relationship ($p < 0.05$).
** indicates significant relationship ($p < 0.01$).

Table 3. *Correlation matrix of demographic information and outcome variables for EMS excluding outliers.*

	Age	**Years of Licensure**	**Years of Experience**	**Personal distance driven (km/yr)**	**Ambulance distance driven (km/yr)**	**Collisions in Ambulance**	**Urban/ Rural**	**IFT/ Emergency**	**SSRT**	**False alarm**	**Miss rate**	**HPRT**
Age	1	-	-	-	-	-	-	-	-	-	-	-
Years of Licensure	.953**	1	-	-	-	-	-	-	-	-	-	-
Years of Experience	.638**	.644**	1	-	-	-	-	-	-	-	-	-
Personal distance driven (km/yr)	-.081	-.066	-.074	1	-	-	-	-	-	-	-	-
Ambulance distance driven (km/yr)	-.202	-.194	-.213	.051	1	-	-	-	-	-	-	-
Collisions in Ambulance	.233	.293	.147	-.183	-.164	1	-	-	-	-	-	-
Urban/ Rural	-.075	-.058	-.290	-.045	-.016	-.38	1	-	-	-	-	-
IFT/ Emergency	-.085	-.076	-.304	-.392*	.153	-.260	.580**	1	-	-	-	-
SSRT	-.079	-.103	-.318	-.062	.056	-.124	.102	.189	1	-	-	-
False alarm	.311	.244	.147	-.007	-.007	.115	-.050	-.260	-.218	1	-	-
Miss rate	.155	.119	.214	.036	-.125	.013	.014	-.341	-.263	.381*	1	-
HPRT	-.165	-.134	-.101	-.024	.200	-.042	.191	.098	.076	-.625**	-.349	1

* indicates significant relationship ($p < 0.05$).
** indicates significant relationship ($p < 0.01$).

Table 4. *Correlation matrix of demographic information and outcome variables for civilians excluding outliers.*

	Age	**Gender**	**Years of Licensure**	**Total Km/yr.**	**Collisions**	**SSRT**	**False alarm**	**Miss rate**	**HPRT**
Age	1	-	-	-	-	-	-	-	-
Gender	-.450*	1	-	-	-	-	-	-	-
Years of Licensure	.928**	-.326	1	-	-	-	-	-	-
Total Km/yr.	.464*	-.396	.496*	1	-	-	-	-	-
Collisions	-.345	-.369	-.298	-.022	1	-	-	-	-
SSRT	-.021	-.137	-.237	-.209	-.175	1	-	-	-
False alarm	.038	-.204	.083	.215	.209	.034	1	-	-
Miss rate	.329	-.442	.228	.500*	-.080	.015	.572*	1	-
HPRT	-.015	-.143	-.111	-.072	-.172	.200	-.032	-.159	1

* indicates significant relationship ($p < 0.05$).
** indicates significant relationship ($p < 0.01$).

3.3 Driver Behaviour Questionnaire

A number of participants did not complete the Driver Behavior Questionnaire. To shorten testing sessions and increase the likelihood of participation in the study, EMS personnel were given the option to complete the driver behavior questionnaire using an online survey tool after the testing session at their earliest convenience. Reminders to complete the questionnaire were sent to participants who had not finished within a week. Of the 29 EMS personnel who participated in the study, 21 completed the questionnaire.

Analysis of the Driver Behavior Questionnaire was completed using the Parker et al. (1995) items and three factors: Errors, Violations, and Lapses. Errors are limits related to processing, perception or attention. Violations relate to driving style and habits. Finally, lapses include memory and attention problems. For a list of the items used see Table 5. There was no significant difference between the EMS and civilians on any of the factors (see Table 6)

Table 5. *Results (M, SD) of the Parker et al. (1995) subset of the DBQ.*

Item	**Factor**	**EMS** $N = 21$	**Control** $n = 19$
When turning right nearly hit a cyclist	E	5.76 (.47)	5.74 (.56)
Underestimate the speed of an oncoming vehicle	E	5.23 (.63)	5.21 (.79)
Fail to check your mirrors before pull	E	5.48 (.60)	5.47 (.61)
Brake too hard on a slippery road	E	5.38 (.67)	5.11 (1.1)
Ignore a yield sign and almost collide	E	5.67 (.48)	5.32 (1.20)
Attempt to pass a vehicle that you hadn't noticed was signaling	E	5.67 (.48)	5.32 (1.06)
In a line of cars nearly hit the car in front of you	E	5.57 (.59)	5.47 (.77)
Fail to notice pedestrians crossing	E	5.43 (.51)	5.47 (.77)
Get into the wrong lane when approaching	L	5.19 (.75)	4.68 (1.49)
Hit something when backing up	L	5.76 (.44)	5.53 (1.02)
Intending to drive to destination A, realize you are in route to B	L	5.09 (.63)	4.95 (.78)
Realize you have no clear recollection of the road	L	4.47 (1.12)	4.53 (1.54)
Switch on one thing instead of another	L	5.24 (1.04)	5.47 (.84)
Forget where you parked your car	L	5.19 (.93)	4.84 (1.42)
Attempt to leave a parking space in the wrong gear	L	5.67 (.58)	5.74 (.45)

Deliberately disregard the speed limit	V	3.9 (1.14)	3.89 (1.63)
Drive over the legal blood-alcohol limit	V	5.75 (.55)	5.47 (1.22)
Get involved in unofficial races	V	5.71 (.72)	5.63 (.68)
Feel angered by another driver's behaviour	V	5.81 (.68)	5.89 (.32)
Drive especially close to or flash the car in front of you	V	5.05 (1.02)	5.21 (1.13)

Table 6. *Results (M, SD) of the DBQ analysis using the Parker et al. (1995) items and a three factor solution.*

Type	**EMS** ***n*****= 21**	**Control** ***n*** **= 19**	**p-value**
Errors	5.52 (.33)	5.35 (.57)	.239
Lapses	5.23 (.44)	5.11 (.67)	.483
Violations	5.24 (.52)	5.22 (.54)	.892

3.4 Traffic Knowledge Questionnaire

EMS answered significantly more questions correctly (of a total of 5) than civilians on the traffic knowledge questionnaire (*M* = 3.86, *SD* = 1.11 and *M* = 1.9, *SD* =.85, respectively), *t* (46) = 6.59, *p* <.001. For both groups, the most frequently missed questions were those related to following distance and the appropriate response to an ambulance in oncoming traffic.

Table 7. *Percentage of correct responses to traffic law questions.*

	Yielding to an ambulance. Same Direction	**Yielding to an ambulance. Opposite direction**	**Minimum following distance behind an ambulance**	**Ambulance yielding requirements at a red light**	**Ambulance Speed Limits**
EMS	85.7	60.7	50	96.4**	92.9**
Control	75	35	40	25**	15**

** Indicates significance (*p* <.01).

3.5 Simple Spatial Reaction Time (SSRT)

SSRT was calculated as the mean reaction time for SSRT trials in which participants responded to the target (see Table 5). Missing data were excluded from analysis. A total of 3 trials were missed. EMS (*M* = 684 ms) had a shorter SSRT than civilians (*M* = 708 ms), however the difference was non-significant.

3.6 Hazard Perception

Two analyses of the HPT test were completed. The first test compares performance between EMS and civilians, using both an analysis of variance and an analysis of covariance. The second examines performance as a function of experience level among EMS using linear regression. The analyses were applied to reaction time (HPRT), false alarms, and misses.

3.6.1 Scene Selection

Although the 64 traffic conflict scenes were previously identified to contain a hazard, they were not identified consistently by those participating. The interpretation of hazard perception data is difficult if observers are not consistently identifying the hazards. Therefore the exclusion criteria used in previous studies (Scialfa et al., 2011) was used to eliminate scenes that were not consistently identified as containing a hazard by participants. Traffic conflict (TC) scenes were excluded from analyses if the hit rate, the identification of a hazard in the defined spatial-temporal window, was less than 85%. Of the 64 traffic conflict scenes, 42 were included in the analysis. See Table 8 for a description of the excluded and included scenes. Cronbach's alpha for the resulting 42-item hazard perception test was .862. Missing data for each scene was replaced by the group (EMS, control) mean for the specific scene. Hazard perception reaction time was calculated from the remaining scenes. Similarly, if 15% or more of the participants identified a hazard in a non-traffic conflict scene, the scene was excluded from analyses. Of the 31 scenes that did not contain a traffic conflict, 9 were included; false alarm rate was calculated from these scenes.

Table 8. *Classification of traffic conflict type and scenes included in analyses.*

Type	All TC scenes 64 n (%)	TC Subset scenes 42 Included n (%)	22 Excluded n (%)
Moving vehicle in same direction as the camera car			
Signal/ turn right	7 (10.9)	5 (7.8)	2 (3.1)
Signal/ turn left	5 (7.8)	2 (3.2)	3 (4.7)
Parking	3 (4.7)	3 (4.7)	0 (0)
Slowing	12 (18.8)	6 (9.4)	6 (9.4)
Turning/ merging into CC* lane	9 (14.1)	9 (14.1)	0 (0)
Stopped in CC lane	6 (9.4)	5 (7.8)	1 (1.6)
Moving vehicle in different direction of the camera car			
Crossing CC path from the left	2 (3.1)	2 (3.1)	0 (0)
Crossing CC path from the right	1 (1.6)	1 (1.6)	0 (0)
Head-on	2 (3.1)	1 (1.6)	1 (1.6)
Miscellaneous			
Pedestrians	5 (7.8)	3 (4.7)	2 (3.2)
Cyclists	8 (12.5)	5 (7.8)	3 (4.7)
Road Work	3 (4.7)	1 (1.6)	2 (3.2)
Object on the road	1 (1.6)	0 (0)	1 (1.6)

3.6.2 Comparison of (and change in TOC) EMS and Civilians

Total Touches. The total number of touches was recorded for participants. This included the total number of both hits and false alarms, as well as additional touches made to traffic conflict scenes outside the predefined parameters of the hazard. The touches were included for only traffic conflict and non-traffic conflict scenes that met the inclusion criteria. Analysis revealed a significant, negative correlation between total touches and HPRT for both EMS and civilians, r = -387, p = .007, suggesting that those who made more touches responded faster. However, there was no significant difference in the number of touches made by each group (EMS M = 115.29, SD = 23.18; civilians M = 108.2, SD = 18.26), t (46) = 1.11, p = .271.

Miss Rate. A miss was recorded when a participant failed to touch the hazard within the spatio- temporal window defined pre-experimentally. Miss rates were calculated for scenes that met the inclusion criteria (see Table 8). There were no significant differences in miss rate between EMS and civilians (see Table 9).

False Alarms. A false alarm was recorded when a participant responded to a non-signal during a non-traffic conflict scene. False alarm rate was calculated for scenes that met the inclusion criteria. There were no significant differences in false alarm rate between EMS and civilians (see Table 5). However, because of the significant correlations between false alarm rates and hazard perception reaction time, the variable was incorporated as a covariate in analyses of HPRT data.

Table 9. *Descriptive statistics (M, SD) of outcome variables*

	EMS Mean (SD)	**Control Mean (SD)**	**p-value**
SSRT (ms)	684.3 (130.26)	708.9 (87.55)	.467
False alarm rate	.357(.678)	.3 (.657)	.772
Miss rate	1.86 (1.78)	1.7 (2.49)	.800
HPRT (s)	1.8 (36)	2.14 (.49)	.01*
Adjust mean HPRT based on covariance analysis	1.8 (.36)	2.14 (.49)	.034*

* indicates significant difference between experimental and control group on that measure (p < 0.05).

HPRT. Prior to completing the analysis, participants' misses (failure to respond to the hazard in the traffic conflict scene) were replaced with the group mean (EMS or civilian) for that scene. After excluding the outliers, a total of 3.57% of the hazards in the traffic conflict scenes were missed. EMS were significantly faster than civilians on average HPRT $F(1, 46) = 7.32$, $p = .01$, $\eta^2 = .754$. Because the civilian group reported significantly less yearly distance driven than EMS, it is possible that group differences in HPRT are due to individual differences in experience as measured by distance driven. Although mean SSRT was not significantly different, because the direction of differences favoured EMS, it is possible that group differences in HPRT may be related to differences in SSRT. To examine this possibility, an analysis of covariance (ANCOVA) was completed assessing the average HPRT for EMS and civilians while controlling for total touches, exposure, SSRT, false alarms and miss rate. The ANCOVA revealed a significant effect of total touches $F(1,41) = 4.54$, $p = .039$, non-significant effects for false alarms $F(1,41) = .007$, $p = .932$, for miss rate $F(1,41) = 2.76$, $p = .104$, SSRT $F(1,41) = .199$, $p = .658$ and for distance driven yearly $F(1,41) = .436$, $p = .513$, suggesting these variables were not correlated with average response time to hazards. The group effect was still significant $F(1,41) = 4.79$, $p = .034$, $\eta^2 =.105$, with EMS revealing faster reaction times to hazards than civilians.

Although the ANCOVA suggests no relationship between HPRT and false alarms, as revealed in Table 2, there is a significant relationship between these variables. One possible explanation for this discrepancy is that the values in Tables 2, 3 and 4 reflect zero-order correlations, while the ANCOVA controls for the overlapping effect of multiple variables. It is possible that after total touches and distance driven are controlled, the part correlation between false alarms and HPRT is non-significant. This possibility was analyzed using a multiple regression examining false alarm rate, miss rate, total touches, SSRT, and total exposure as predictors of HPRT. The analysis revealed a significant model, $F\ (5,42) = 2.84$, $p =.027$; collectively the predictors accounted for 25.2% of the variance in HPRT. Total touches alone accounted for a significant amount of variance (11.3%), $\beta = -.454$, $t(47) = -2.52$, $p = .016$. Although miss rate approached significance (5.6%), $\beta = -.310$, $t(47) = -1.78$, $p = .084$, the remaining predictors did not account for a significant amount of variance: SSRT (.6%), $\beta = .081$, $t(47) = .6$, $p = .552$, total exposure (1%), $\beta = -.101$, $t(47) = -.749$, $p = .458$, and false alarms (.2%), $\beta = .07$, $t(47) = .356$, $p = .724$. Therefore, after controlling for additional variables it was revealed that the amount of unique variance false alarm rate accounted for in HPRT was non-significant.

3.6.3 Predicting driver group

To further assess the discriminant validity of the hazard perception test, individual differences in HPRT, misses and false alarms were used to predict group (EMS, civilian) membership. A forward selection dichotomous logistic regression was used. HPRT alone was a significant predictor in the omnibus $X^2 = 6.95$, $p = .008$. The overall classification accuracy was 64.6%. The classification accuracy for the EMS group was 78.6% and 45% for the control group. The Nagelkerke R^2 was only .181. False alarm ($p = .569$) and miss rate ($p = .704$) did not contribute significantly to the model.

3.6.4 Experienced and Novice EMS

Three separate linear regressions were completed to assess the relationship between EMS experience on miss rate, false alarms, and HPRT. Contrary to the hypothesis there was no significant relationship between experience and miss rate $F(1,26) = 124$, $p = .275$, $f^2 = .048$; false alarms $F(1,26) = 578$, $p = .454$, $f^2 = .022$; or HPRT $F(1,26) = 268$, $p = .609$, $f^2 = .01$. Correlations of EMS variables indicate a speed-accuracy trade off, where faster responses to hazards were significantly related to a higher number of false alarms. Because of this, the relationship between HPRT and experience was reexamined using false alarm and miss rate was as covariates. The relationship remained non-significant ($p = .940$, $f^2 = .012$).

Chapter 4: Discussion and Conclusion

Driving is a complex task that requires a number of perceptual and cognitive skills. Included among these skills is hazard perception, the ability to identify and respond to a hazard before a collision occurs (Horswill & McKenna, 2004). Hazard perception deficiencies in novice compared to their experienced counterparts are widely researched (Crundall & Chapman 2003; Crundall & Chapman 2005; Crundall et al., 2010; Garay-Vega, & Fisher, 2005; McKenna et al., 2006; Fisher et al., 2006; Patten et al., 2006; Horswill et al., 2013). However, there is a growing body of evidence suggesting that differences also exist between experienced civilian drivers and emergency service responders (ESR; Horswill et al., 2013, Crundall & Chapman 2003; Crundall & Chapman 2005). This research suggests that because of the differences in emergency vehicle operations compared to civilian driving (e.g., speed, traffic norm violations), EMS have acquired greater experiences that affect their driving, specifically their hazard perception. To assess the effect of experience from emergency vehicle operations, a dynamic hazard perception test was used to assess the differences in hazard perception between EMS and civilians. First, it was predicted that the EMS would respond faster in reacting to hazards than experienced, civilian drivers. Second, it was predicted that within the EMS group, experienced EMS would respond faster to hazards than novices. As hypothesized, EMS revealed a shorter latency to hazards than civilians, however there was no difference in response latency detected within the profession.

Hazard Perception

The results of the hazard perception test indicate that EMS were significantly faster at responding to hazards than the experienced control group. EMS demonstrated a 340-millisecond advantage over civilians in response time to hazards. At speeds of 60 km/hr this roughly translates to a braking distance advantage of 5.6 meters. This study is the first to assess hazard perception in emergency medical services (EMS) personnel. These findings are consistent with previous work assessing the hazard perception skills of police (Crundall & Chapman 2005; Horswill et al, 2013). Previous studies have demonstrated that police spend more time observing areas where a hazard may potentially emerge (Crundall & Chapman 2005) and have an advantage in response latency to hazards (Horswill et al., 2013).

An explanation of the faster response times to hazards may be that the EMS were on average, faster than the civilian group. However, this is unlikely. Although the results of the reaction time test suggest a trend that EMS were in general faster than the civilians, the difference was non-significant. It is unknown if other EMS have demonstrated faster simple reaction times than civilians (Horswill et al., 2013). Although used as a covariate, the literature examining the hazard perception of police compared to civilians does not report the simple reaction time differences between the groups (Horswill et al., 2013).

Although the groups were not significantly different on most demographic variables, the EMS reported approximately 8000 more kilometers driven yearly in their personal vehicles than the civilian group. This difference is likely in part due to the use of students in the civilian group. Both years of licensure and distance driven yearly are used as indicators of experience (Michon, 1993). It is possible that EMS advantages in hazard perception may be a result of their increased total exposure as measured by distance driven rather than from experiences specific to emergency vehicle operations. Therefore total distance driven yearly (personal and emergency vehicle) was included in the analyses as a covariate. The difference in response latency between EMS and civilians after controlling for distance driven remained significant. Therefore it is unlikely that the advantage in hazard perception demonstrated by EMS is due to greater exposure.

While the shorter response latency to hazards in EMS is not unexpected and may be explained through a number of models, it is somewhat surprising that the differences were detected in a test using civilian scenarios. Because civilians have similar exposure to these scenes as EMS, it was possible that no differences in skills would be detected. However, some theoretical models would suggest that EMS's additional exposure to all scenes increases the ease with which they respond. For instance, the SEEV model suggests that EMS's more developed mental model is beneficial (Horrey et al., 2006). A more diverse set of experiences with hazards increases both the expectancy and value of attending to locations in the visual field. Identification of a hazard relies on a match between the environment and an individual's long-term memory mental models. A match allows the individual to anticipate the hazard and to respond evasively. Because of the differences in emergency vehicle operations, EMS may have aggregated a more diverse array of experiences with hazards. These experiences constitute a richer mental model to draw upon for detecting potential hazards. If a hazard had emerged from a specific location prior, there is now value in attending to that location in the future; therefore the likelihood that an individual will glance to a specific location in anticipation of a hazard is increased.

EMS shorter latency in hazard detection may additionally be explained by advantages gained through automaticity in responses. Despite variability in the driving environment, there may be global consistencies in the features of traffic scenes (i.e., intersection designs are fairly consistent) that may allow for the development of an automatic response (Jiang & Wagner, 2004). As suggested by Schneider and Schifrin (1997), after repeated exposure to a number of hazards, features of the hazards may begin to attract attention automatically and response times are reduced.

The advantages that EMS demonstrate in their response latency to hazards may be attributed to the experiences gained through emergency vehicle operations. These experiences assist in developing a more diverse mental model to detect and predict hazards; and to develop automaticity for detecting hazard features.

Contrary to the hypothesis, there was no significant effect of experience within EMS on their hazard perception reaction time scores, false alarm, or miss rates. An explanation for this may be the clustered experience in the sample obtained. Although participants had a broad range of experience, the majority of the EMS personnel recruited fell within the mid-range (5 years). A larger sample size with participants representing novice (less than 1 year) and more experienced individuals (over 10 years) may be required in future research.

To ensure that the interpretation of the hazard perception data was based on scenes that were consistently identified by participants as either containing (or not containing) a traffic conflict, the overall responses to each scene were examined. The current study removed 22 traffic conflict scenes because of low response rates (< 85%) across participants. This is comparable to the number of scenes removed in previous studies using the same hazard perception test (Scialfa et al., 2011). A breakdown of the scenes excluded is provided in Table 8. Although the scenes excluded are distributed fairly evenly across hazard type, 27% of the excluded scenes were classified as containing a lead vehicle slowing down. The reliability of the final 5- item hazard perception test was .86 suggesting good internal consistency. However, Cronbach's alpha should be interpreted with caution as a higher reliability is associated with a larger number of test items.

A greater number of non-traffic conflict scenes were removed in the current study than previous studies. Twenty-two scenes were excluded from the analyses because of participants' (> 15%) perception and identification of a hazard in the scene; previously in Scialfa et al. (2011) only 11 of these scenes were excluded.

Compared to Scialfa et al. (2011), participants in this study failed to identify only slightly more traffic conflicts, and perceived double the number of hazards where none were present. Examination of the EMS and civilian scene responses separately revealed differences between the groups. If "false alarms" on non-traffic conflict scenes were based on civilian responses the number of excluded scenes was reduced to 16, closer to the number in previous studies (Scialfa et al., 2011). The number of excluded scenes for the EMS only group remained high at 21. Therefore the number of excluded scenes for the analysis was driven by EMS participants' tendency to perceive more hazards.

Despite this difference in the number of hazards perceived, after excluding scenes, there were no significant differences between EMS and civilians on either false alarm or miss rate. However, examining the correlations between hazard perception reaction time and false alarm rate revealed that group differences exist in the response patterns between EMS and civilians. The civilian group showed no relationship between hazard perception reaction time and false alarm rate. However, for the EMS group, there was a significant relationship between false alarm rate and hazard perception reaction time. For EMS as the speed in responding decreased the number of false alarms increased. The findings reveal a speed-accuracy trade-off. However, it should be noted that because of the exclusion of a number of non-traffic conflict scenes, the false alarm rate data, and subsequent correlations to hazard perception reaction time, are based on only nine scenes.

It is unknown if a speed-accuracy trade-off is consistent with the literature on EMS. Studies examining hazard perception response latency in EMS did not report if such a relationship was observed. Regardless, Wallis et al. (2007) similarly found that while more experienced drivers tended to respond faster to hazards, they also responded more liberally. They suggested that less experienced drivers may be less likely to respond to scenes that are ‘less hazardous’ and that more experienced drivers have a different perception of risk (Deery, 1999; Mayhew & Simpson, 1995). Consistently, novices reported scenes in a static hazard perception test as systematically lower than experienced drivers (Scialfa et al., 2012).

Risk perception, as suggested by Brown and Groeger (1988), is the subjective experience of danger in a traffic hazard. This is determined by two factors: information about the potential hazards in traffic and the ability of the driver. Because of the nature of the EMS profession and their greater exposure to treating individuals involved in collisions, they may perceive more incidents as potentially risky. Therefore, it is feasible that while EMS are faster at responding to hazards, they are also more likely to perceive objects in the traffic environment as potentially risky. In a hazard perception test they would appear to respond in a ‘trigger happy’ manner.

EMS Knowledge Questionnaire.

The groups revealed a significant difference in their knowledge of the traffic laws associated with operating a vehicle when an ambulance in emergency use is present. Overall EMS demonstrated a greater knowledge of the traffic laws. The greatest discrepancy in responses was for questions regarding red light yielding and speed limits for the ambulance. Because the content of these questions do not directly affect civilian drivers it is not surprising that the responses were more frequently incorrect. More surprising for civilians was the low awareness of appropriate responses to an ambulance in traffic (pulling to the right and stopping) and minimum following distance. Considering the prevalence of wake-effect collisions (e.g. civilian collisions that occur as a result of emergency vehicle operations) while emergency vehicles are operating with lights-and-sirens (Clawson, 1997), it may be beneficial to consider public engagement programs. Although there are a number of other factors involved with wake effect collisions (e.g. visibility, noise reduction), increasing public knowledge of appropriate responses may, to some extent, decrease the number of non-ambulance involved collisions.

Comparing EMS percentage of correct responses to those found by Whiting et al. (1998) reveals a greater awareness of the provincial traffic laws for the current sample. Awareness of the traffic laws is important for public safety; this is especially true as ambulances violate norms while operating with lights-and-sirens. Knowledge of the traffic laws and operating in a consistent manner likely assists civilian drivers in anticipating ESR behavior. Predictable behavior may reduce the number of unexpected outcomes that may be attributed to collisions. The sample demonstrated excellent knowledge of the traffic laws, especially for the questions that may be considered most closely related to collisions: red light behavior and ambulance speed limits.

Finally, there was no relationship between the scores on the EMS knowledge questionnaire and the hazard perception test. This may reflect a lack of EMS specific scenes in the test.

Driver Behaviour Questionnaire.

The Driver Behaviour Questionnaire assesses details such as participants driving experiences, collision history, and current driving behaviours. Analysis revealed no significant differences between EMS and civilians on any of the items. The Driver Behaviour Questionnaire has been used as a predictor of collision involvement in numerous studies. Factors such as errors and violations were found to be significant predictors of self-reported collisions (Winter, & Dodou, 2010). The current analysis assessed the responses to the DBQ using the Parker et al. (1995) factors; errors, lapses and violations. There was little variance in mean responses for each factor between EMS and civilian groups. The participants responded to the majority of the items with ‘very rarely’. Participants were assured that the data was confidential and that no identifying information would be attached to their responses. Although a number of assessments of the effect of social desirability on DBQ outcomes have concluded only a small correlation with social desirability scales (Wahlberg, Dorn & Kline, 2011), it is still possible that they were responding to the questions in a socially desirable manner. This may be particularly true for EMS who were recruited with the assistance of organizational management. Because of the low number of self-reported collisions, analyses of the questionnaire responses and self-reported collisions was not completed.

There was no relationship between any of the DBQ factors, errors, lapses, or violations, and HPRT. This may relate to the use of both the DBQ and HPT as prediction tools for collision involvement. The majority of the sample was collision-free, with very few (10%) reporting any collisions. With little variance in collision history it may be difficult to detect any relationship between HPRT and DBQ.

Limitations.

There are a number of limitations in this study that may be addressed in future research. Initial efforts were made to select urban or metropolitan EMS personnel between 24-35 years of age. However, difficulties recruiting and time constraints required that the inclusion criteria be broadened. The hazard perception test used scenes from urban driving environments. Although the majority of the sample (71%) worked in the urban area, a small portion worked in rural zones. It is unknown what the differences in experiences gained from the urban or rural driving environments may have on hazard perception and to what extent differences in experiences from rural driving may be captured in the current test. These differences may emerge, for instance, in rural EMS's overall number of hazards detected compared to urban personnel. This may be attributed to a lack of familiarity with urban driving, and perceiving more scenarios as risky or hazardous. Higher overall perception of hazards would result in higher false alarm rates for EMS. Additionally, it is possible that if rural EMS are less experienced with urban settings they may not demonstrate the same reaction time advantages as their urban counterparts. Therefore it is possible that the use of a mixed (i.e. rural, urban) sample may have diluted the HPRT differences observed.

Experience within the EMS sample had a broad range, however the majority of participants fell within the mid-experience range. Again, problems recruiting participants made it difficult to acquire a sample with a broad, more evenly distributed range of experience. Although this study did not find a significant relationship between experience and hazard perception it is possible that a larger sample would be more sensitive to differences. For instance, Green (1991) suggests a sample of 390 participants to detect a small effect size using one predictor, and a sample of 53 to detect a medium effect size.

Future Research.

This research has laid groundwork for a number of future studies. Hazard perception differences resulting from experiences garnered through emergency vehicle operations have been demonstrated in a test of civilian driving. In addition to a civilian driving hazard perception test, studies examining police have produced job-specific tests using videos filmed during police driving (Crundall & Chapman, 2005; Horswill et al., 2013). The next logical step for this study is the development and validation of an EMS-specific hazard perception test.

Although no effect of experience within EMS was detected in this study, assessing hazard perception using an EMS-specific test may reveal differences that a civilian test is not able to detect. A job-specific test may reveal on average, how much experience (defined as either distance driven, or years of experience) is required before changes in hazard perception occur as a result of emergency vehicle operations.

There may be benefits in developing training modules for novice EMS and training maintenance for experienced EMS. The benefits of hazard perception training are well documented for novice drivers (Crundall et al., 2010; Garay-Vega, & Fisher, 2005; McKenna et al., 2006; Fisher et al., 2006). Within the context of emergency vehicle operations novice EMS may also be considered novice drivers. They may therefore display similar benefits to EMS-based hazard perception training. As well, assessments of the effect of training on hazard perception found that even experienced police demonstrated improvement (Horswill et al., 2013). This suggests that even experienced EMS may benefit from additional training throughout their careers.

As previously stated, higher workload reduces the available cognitive resources and may have a negative affect on tasks such as hazard perception (Rantanen & Goldberg, 1999). It may be beneficial to assess the affect of higher workload by incorporating a dual task. This could be completed with a way-finding task, or by playing an audio recording of the rear compartment during a critical patient call. A series of EMS focus groups revealed a number of distraction-related problems with the CAD. Most notably, participants indicated that novice EMS, who were less familiar with driving routes than their experienced peers, demonstrated an overreliance on the CAD for navigation. Participants indicated that as a result novices spent more time looking down in the cockpit at the CAD, and would frequently miss turns. Simulations that use the CAD in a way-finding task assess resource limitations, which may impact the identification of hazards.

Finally, the hazard perception of fire fighters has not yet been examined. There are a number of similarities in vehicle operations between fire, police and EMS that suggest there may also be advantages in their hazard perception. This includes similar violations of traffic norms and higher speeds. However, a major difference in fire operations is the size of the vehicle and the elevation of the driver from the road compared to either police vehicles or ambulances. As suggested by models such as SEEV, or situation awareness, these experiences may impact a number of perceptual factors related to hazard perception (Horrey et al., 2006; Endlsey, 1995)

Conclusion.

The results of this study indicate that the experiences gained through emergency vehicle operations affect driving beyond ambulance operations by also impacting general driving. As hazard perception is an important part of driving, and more importantly, related to safe driving (Deery, 1999; McKenna & Crick, 1991; Quimby & Watts,1981), EMS' faster hazard perception suggests that they may be safer drivers. However it is difficult to determine if this is true. Although a number of studies provide collisions statistics for emergency vehicles (Becker et al., 2003; Custalow & Gravitz, 2004; Maguire et al., 2005; Sandaal et al., 2010); as these statistics have not been adjusted for population size, it is unknown if the number of collisions is comparable to the civilian population.

Regardless, emergency vehicle collisions are costly for both organizations and for the larger communities that they serve. Although the results of the study suggest that EMS are better able to detect and respond to hazards before a collision occurs, the study examined only civilian driving. It is still unknown what differences exist in hazard perception during emergency vehicle operations. The assumption of overall higher ESR collisions, despite hazard perception advantages, may be explained by the violation of traffic norms and overall greater exposure to driving. For instance, there are a number of hazards occurring at intersections that may be unique to emergency vehicle operations.

Additionally, it is unknown how many emergency vehicle collisions within Canada are considered at fault for EMS. Despite this, organizations implement training strategies in an effort to increase safety and reduce collision numbers. These strategies involve maneuvering training for novices and regular re-training for experienced personnel.

References

Becker, L.R., Zaloshnja, E., Levick, N., Li, G., & Miller, T. R. (2003). Relative risk of injury and death in ambulances and other emergency vehicles. *Accident; analysis and prevention, 35*(6), 941–8. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12971929

Boufous, S., Ivers, R., Senserrick, T. & Stevenson, M. (2011). Attempts at the practical on road driving test and the hazard perception test and the risk of crashes in young drivers. *Traffic Injury and Prevention, 12,* 475-482.

Brockmole, J.R., & Henderson, J.M. (2006). Using real-world scenes as contextual cues for search. *Visual Cognition, 13*(1), 99-108.

Broughton, J., Baughan, C., Pearce, L., Smith, L., & Buckle, G. (2003). Work-related road accidents. TRL Report TRL582.

Chan, E., Pradhan, A., Pollatsek, A., Knodler, M., & Fishers, D. (2010). Are driving simulators effective tools for evaluating novice drivers' hazard anticipation, speed management, and attention maintenance skills? *Transportation Research Part F, 13*(5), 343-353.

Chapman, P.R., & Underwood, G. (1998). Visual search of driving situations: danger and experience. *Perception, 27*(8), 951–64. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10209634

Clarke, D.D., Ward, P., Bartle, C., & Truman, W. (2009). Work-related road traffic collisions in the UK. *Accident; analysis and prevention, 41*(2), 345–51. doi:10.1016/j.aap.2008.12.013

Crundall, D., (2005). The integration of top-down and bottom-up factors in visual search during driving. In Underwood, G. (eds.). *Cognitive Processes in Eye Guidance.* Oxford University Press, New York, US, 283-302.

Crundall, D., Chapman, P., Phelps, N., & Underwood, G. (2003). Eye movements and hazard perception in police pursuit and emergency response driving. *Journal of experimental psychology. Applied, 9*(3), 163–74. doi:10.1037/1076-898X.9.3.163

Crundall, D., Chapman, P., Phelps, N., & Underwood, G. (2005). What attracts attention during police pursuit driving? *Applied Cognitive Psychology, 19*(4), 409-420.

Crundall, D. & Underwood, G. (1998). The effects of experience and processing demands on visual information acquisition in drivers. *Ergonomics*, 41,4, 448–458.

Custalow, C., & Gravitz, C. (2004). Emergency medical vehicle collisions and potential for preventive intervention. *Prehospital Emergency Care, 8*(2), 175–184. doi:10.1016/S1090-3127(03)00279-X

Deery, H. (1999). Hazard and risk perception among young novice drivers. *Journal of Safety Research, 30*(4), 225-236.

De Lorenzo, R, & Eilers, M. (1991). Lights and sirens: a review of emergency vehicle warning systems. *Annals of Emergency Medicine, 20*(12), 1331-1335.

de Winter, J, & Dodou, D. (2010). The driver behaviour questionnaire as a predictor of accidents: a meta-analysis. *Journal of Safety Research, 6,* 463-470.

Dreyfus, S. (2004). The five-stage model of adult skill acquisition. *Bulletin of Science, Technology & Society, 24*(3), 177-181.

Egeth, H.E., & Yantis, S. (1997). Visual attention: control, representation, and time course. *Annual Review of Psychology*, 48, 269–297.

Endsley, M.R. (1995). Toward a theory of situation awareness un dynamic systems. *Human Factors, 37*(1), 32-64.

Ferreira, J., & Hignett, S. (2005). Reviewing ambulance design for clinical efficiency and paramedic safety. *Applied ergonomics, 36*(1), 97–105. doi:10.1016/j.apergo.2004.07.003

Folk, C.L., Leber, A.B., & Egeth, H.E.(2002). Made you blink! Contingent attentional capture produces a spatial blink. *Perception & Psychophysics*, *64*(5), 741-753.

Folk, C.L., Remington, R. W., & Johnston, J. C. (1992). Involuntary covert orienting is contingent on attentional control settings. *Journal of Experimental Psychology: Human Perception & Performance,18*,1030-1044.

Fisher, D. L., Pradhan, A. K., Hammel, K. R., DeRamus, R., Noyce, D. A., & Pollatsek, A. (2003). Are younger drivers less able than older drivers to recognize risks on the road? *Injury Insights*, 1, 2–7.

Fisher, D., Pollatsek, A., & Pradhan, A. (2006). Can novice drivers be trained to scan for information that will reduce their likelihood of a crash? *Injury Prevention, 12,* 25-29.

Fitzgerald, E.S., & Harrison, W. A. (1999). *Hazard perception and learner drivers: A theoretical discussion and an in-depth survey of driving instructors*.

Garay-Vega, L., & Fisher, D. (2005). Can novice drivers recognice foreshadowing risks as easily as experienced drivers? *Proceedins of the Third International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design.*

Horrey, W., Wickens, C.D., & Consalus, K. (2006). Modeling Drivers' Visual Attention Allocation While Interacting With In-Vehicle Technologies. *Journal of Experimental Psychology: Applied, 12*(2), 67-78.

Horswill, M.S., & McKenna, F. (2004). Drivers Hazard perception ability: situation awareness on the road. In: Banbury, S., & Tremblay, S. (eds.), *A Cognitive Approach to Situation Awareness.* Ashgate, Aldershot, UK, 155-175.

Horswill, M.S., & Taylor, K., Newmam, S., Wettin, M., & Hill, A. (2013). Even highly experienced drivers benefit from a brief hazard perception training intervention. *Accident Analysis and Prevention, 52*, 100-110.

Hull, M. & Christie, R. (1992). Hazard perception test: The geelong trial and future development. *Proceedings of the National Road Safety Seminar.* Wellington, New Zealand.

Jiang, Y., & Wagner, Y. (2004). What is learned in spatial contextual cuing - configuration or individual locations?*Perception & Psychophysicsm 66*(3), 454-463.

Klein, G. (1997). The recognition-primed decisions (RPD) model: looking back, looking forward, In C.E. Zssambock and G. Klein (eds), *Naturalistic Decision Making,* Lawrence Erlbaum Associates, Mahwah, 285-292.

Lamy, D. & Tsal, Y. (1999). A salient distractor does not disrupt conjunction search. *Psychonomic Bulletin & Review, 6*(1), 93-98.

Larmon, B., LeGassick, T. F., & Schriger, D. L. (1993). Differential front and back seat safety belt use by prehospital care providers. *The American journal of emergency medicine*, *11*(6), 595–9. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8240560

Logan, G.D. (1988). Toward an instance theory of automatization. *Psychological Review, 95*(4), 492-527.

Maguire, B. J., Hunting, K. L., Smith, G. S., & Levick, N. R. (2002). Occupational fatalities in emergency medical services: A hidden crisis. *Annals of Emergency Medicine*, *40*(6), 625–632. doi:10.1067/mem.2002.128681

Marrington, S., Horswill, M., & Wood, J. (2008). The effect of simulated cataract on drivers' hazard perception ability. *Optometry Vision Science, 85*, 1121-1127.

Mayhew D.R, & Simpson, H.M. (1995). *The role of driving experience: Implications for the training and licensing of new drivers*. Toronto: Insurance Bureau of Canada.

McKenna, F.P., & Crick, J.L. (1991). Hazard perception in drivers: a methodology for testing and training. *Final Report, Beavioural Studies Unit, Transport and Road Research Laboratory,* Crowthorne, UK.

McKenna, F.P., Horswill, M. S., & Alexander, J. L. (2006). Does anticipation training affect drivers' risk taking? *Journal of Experimental Psychology, 12*(1), 1–10. doi:10.1037/1076-898X.12.1.1

McKnight, J.A., & McKnight, S.A. (2003). Young novice drivers: careless or clueless? *Accident Analysis and Prevention, 35,* 921-925.

Mills, K.L., Rolls, G.W.P., Hall, R.D., & McDonald, M. (1998). The effects of hazard perception training on the development of novice driver skills. *Road Safety Research Report No. 4. Department of the Environment, Transport & the Regions*, London, UK.

Mourant, R., & Rockwell, T. (1972). Strategies of visual search by novice and experienced drivers. *Human Factors, 14,*325-335.

Patten, C., Kircher, A., Ostlund, J., Nilsson, L., &Svenson, O. (2006). Driver experience and cognitive workload in different traffic environments. *Accident Analysis and Prevention, 38*, 887-894.

Pelz, D.C., & Krupat, E. (1974). Caution profile and driving record of undergraduate males. Accident Analysis andPrevention, 6,45–58.

Pew, R.W. (2000). The state of situation awareness measurement: Heading toward the next century, In M.R. Endsley and D.J. Garland (eds), *Situation Awareness Analysis and Measurement*, Lawrence Erlbaum Associates Inc., Mahwah, 33-47.

Preusser, D., Williams, A., Ferguson, S., Ulmer, R., & Weinstein, H. (1998). Fatal crash risk for older drivers at intersections. *Accident Analysis and Prevention, 30,* 151-159.

Quimby, A.R., & Watts, G.R. (1981). *Human factors and driving performance.* Transport and Road Research Laboratory, Crowthorne, UK.

Rantanen, E. M., & Goldberg, J. H. (1999). The effect of mental workload on the visual field size and shape. *Ergonomics, 42*(6), 816–34. doi:10.1080/001401399185315

Reason, J., Manstead, A., Stradling, S., Baxter, J., & Campbell, K., (1990). Errors and violations on the roads: a real distinction? *Ergonomics, 33*(10-11), 1315-1332.

Rasmussen, J. (1983). Skills, rules, and knowledge; signals, signs, and symbols, and other distinctions in human performance models. *IEEE Transactions On Systems Man And Cybernetics*, (3), 257–266.

Reichard, A. a, Marsh, S. M., & Moore, P. H. (2011). Fatal and nonfatal injuries among emergency medical technicians and paramedics. *Prehospital Emergency Care : Official Journal of the National Association of EMS Physicians and the National Association of State EMS Directors, 15*(4), 511–7. doi:10.3109/10903127.2011.598610

Rousseau, R., Tremblay, S., & Breton, R. (2004). Defining and modeling situation awareness: a critical review. In Banbury, S., and Tremplay, S., *A Cognitive approach to situation awareness: Theory and Application* (3-18). UK, Ashgate.

Sanddal, T.L., Sanddal, N. D., Ward, N., & Stanley, L. (2010). Ambulance Crash Characteristics in the US Defined by the Popular Press: A Retrospective Analysis. *Emergency medicine international*, *2010*, 525979. doi:10.1155/2010/525979

Scialfa, C.T., Deschenes, M.C., Ference, J., Boone, J., Horswill, M., & Wetton, M. (2011). A hazard perception test for novice drivers. *Accident Analysis and Prevention, 43*, 204-208.

Schneider, K. (2013, Jan 19). Paramedic Says Long Wat Times continue to plague EMS Systems. *Calgary Sun.* Retrieved from: http://www.calgarysun.com/2013/01/19/paramedic-says-long-wait-times-continue-to-plague-ems-system

Schneider, W., & Shiffrin, R.M. (1977). Controlled and automatic human information processing: I. detection, search and attention. *Psychological Review, 84*(1), 1-66.

Shinoda, H., Hayhoe, M.M., & Shrivastava, A. (2001). What controls attention in natural environments? *Vision Research*, 41, 3535–3545.

Slattery, D.E., & Silver, A. (2009). The hazards of providing care in emergency vehicles: an opportunity for reform. *Prehospital emergency care : official journal of the National Association of EMS Physicians and the National Association of State EMS Directors*, *13*(3), 388–97. doi:10.1080/10903120802706104

Slappendel, C., Laird, I., Kawachi, I., Marshall, S., & Cryer. C., (1993). Factors affecting work related injury among forestry workers: A review. *Journal of Safety Research*, *24*,19-32.

Theeuwes, J. (1990). Perceptual selectivity in task dependent: Evidence from selective search. *Acta Psychologica, 74*, 81-99.

Theeuwes, J. (1991). Cross-dimensional perceptual selectivity. *Perception and Psychophysics*, 50, 184–193.

Underwood, G., Crundall, D., & Chapman, P. (2011). Driving simulator validation with hazard perception. *Transportation Research Part F: Traffic Psychology and Behaviour*, *14*(6), 435–446. doi:10.1016/j.trf.2011.04.008

Underwood, G., Ngai, A., & underwood, J. (2013). Driving experience and situation awareness in hazard detection. *Safety Science, 56,* 29-35.

Underwood, G. (2007). Visual attention and the transition from novice to advanced driver. *Ergonomics, 50*(8), 1235-1249.

Wahlberg, Dorn, L., & Kline, T. (2011). The manchester driver behaviour questionnaire as a predictor of road traffic accidents. *Theoretical Issues in Ergonomics Science, 12*(1), 66-86.

Whiting, J. D., Dunn, K., March, J. A, & Brown, L. H. (1997). EMT knowledge of ambulance traffic laws. *Prehospital Emergency Care : Official Journal of the National Association of EMS Physicians and the National Association of State EMS Directors*, *2*(2), 136–40. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9709334

Wood, J. (2013, Jan 30). Calgary Ambulance Crunch Eases, but Issues Remain. *Calgary Herald*. Retrieved from: http://www.calgaryherald.com/health/Calgary+ambulance+crunch+eases+issues+remain/7890684/story.html

Yantis, S., & Egeth, H.E., (1999). On the distinction between visual salience and stimulus-driven attentional capture. *Journal of Experimental Psychology: Human Perceptions and Performance,* 25*(3), 661-676.*

Young, M.S., & Stanton, N.A. (2007). What's skill got to do with it? Vehicle automaticity and driver mental workload. *Ergonomics, 50*(8), 1324-1339.

Appendix A

EMS Traffic Knowledge Questionnaire

1. When approached from behind by an ambulance using lights and sirens a civilian vehicle
    a. Is requested to yield but not required
    b. Must pull to the right
    c. Must pull to the right and stop
    d. May continue to travel at the same rate, but must not turn left.

2. When a car is approached head on by an ambulance using lights and sirens on a four lane highway with no median divider
    a. No action is necessary since the ambulance in coming in the opposite direction
    b. The car is requested to yield, but is not required to do so
    c. The car must pull to the right
    d. The car must pull to the right and stop

3. Minimum following distance behind an ambulance using lights and sirens in a city is
    a. 150 ft
    b. 200 ft
    c. once city block
    d. there are no laws regulating following distances

4. An ambulance is using lights and sirens, when it approaches a red light at an intersection it
    a. is requesting cars with the green light to yield, but yielding is not required
    b. must stop before proceeding through the red light
    c. must slow to less than 40km before proceeding through the red light
    d. may proceed through the red light without slowing down or stopping as long as it is not endangering others

5. The speed limit for an ambulance using lights and sirens is
    a. Up to 25km over the posted limit
    b. Up to 25% over the posted limit
    c. No greater than the posed limit
    d. Any speed, regardless of the posted limit, as long as the safety of other is taken into account.

Appendix B

Driver Behaviour Questionnaire

The following questionnaire is part of a study assessing self-perception of driving behaviour. We want to know about your **current** driving behaviour, so please answer the questions based on your driving behaviour in the **past 2 years**. Answer to the best of your memory, and keep in mind that your responses are anonymous and confidential. It is important that you answer the questions honestly.
Each question asks "how often do you" do specific behaviours while driving. Please indicate how often you engage in each behaviour by circling the appropriate response. Definitions of each option are listed below.

Never: you do not ever do this
Very rarely: you hardly ever do this, but you have done it a few times
Occasionally: you do this every now and then
Often: you have done this many times
Nearly all the time: you almost always do this
Always: you do this all the time

	How often do you...	**Never**	**Very rarely**	**Occasionally**	**Often**	**Nearly all the time**	**Always**
21.	Drive as fast along country roads at night on low beams as you would on high beams	0	1	2	3	4	5
22.	Try to pass in risky circumstances when stuck behind a slow-moving vehicle on a two-lane highway	0	1	2	3	4	5
23.	Forget to turn off your "turn" signal	0	1	2	3	4	5
24.	Drive slowly on purpose or "tap" your brakes because someone is following you too closely	0	1	2	3	4	5
25.	Fail to see a playground or school zone sign	0	1	2	3	4	5
26.	Misjudge the space available in a parking lot and nearly (or actually) hit another vehicle	0	1	2	3	4	5
27.	Go out of your way to avoid having to make a left turn	0	1	2	3	4	5
28.	Drive the wrong direction down a deserted one-way street	0	1	2	3	4	5
29.	Refuse to make space for someone who is trying to merge into your lane	0	1	2	3	4	5

	How often do you...	Never	Very rarely	Occasionally	Often	Nearly all the time	Always
30.	Take a chance and run a red light	0	1	2	3	4	5
31.	When turning right, nearly hit a cyclist who has come up beside you	0	1	2	3	4	5
32.	Drive with a seat belt on	0	1	2	3	4	5
33.	Deliberately disregard the speed limit late at night or very early in the morning	0	1	2	3	4	5
34.	Miss a sign or a turn because you were talking to a passenger	0	1	2	3	4	5
35.	Drive the speed limit in a playground or school zone	0	1	2	3	4	5
36.	Swear or yell at other road users	0	1	2	3	4	5
37.	Underestimate the speed of an oncoming vehicle when passing on a two-lane highway	0	1	2	3	4	5
38.	When merging into traffic, get “surprised” by a vehicle that you didn’t notice until it was quite close to you	0	1	2	3	4	5
39.	Drive the speed limit on a highway	0	1	2	3	4	5
40.	Drive even though you realize that you may be over the legal blood-alcohol limit	0	1	2	3	4	5
41.	Signal your turn when approaching an intersection	0	1	2	3	4	5
42.	Get into the wrong lane when approaching an intersection or roundabout	0	1	2	3	4	5
43.	Fail to check your mirrors before pulling out, changing lanes, turning, etc.	0	1	2	3	4	5
44.	Notice only too late that you drove through a red light	0	1	2	3	4	5
45.	Get told by a passenger to calm down because you are angry at other drivers	0	1	2	3	4	5
46.	Brake too hard on a slippery road or steer the wrong way in a skid	0	1	2	3	4	5

	How often do you...	Never	Very rarely	Occasionally	Often	Nearly all the time	Always
47.	Fail to yield right-of-way to a bus that is signaling its intention to pull out	0	1	2	3	4	5
48.	Check your rear-view mirror before braking	0	1	2	3	4	5
49.	Miss a turn because you didn't read the name on the street sign in time	0	1	2	3	4	5
50.	Ignore a yield sign and almost collide with traffic having the right-of-way	0	1	2	3	4	5
51.	Fail to notice when a traffic light turns green	0	1	2	3	4	5
52.	Misjudge the distance between oncoming vehicles when turning left and narrowly miss a collision	0	1	2	3	4	5
53.	Have difficulty seeing a traffic sign due to rain or snow	0	1	2	3	4	5
54.	Disregard red lights or stop signs when driving late at night along empty roads	0	1	2	3	4	5
55.	Yield to other vehicles that are turning although you have the right-of-way	0	1	2	3	4	5
56.	Miss a stop sign and narrowly avoid colliding with traffic having the right-of-way	0	1	2	3	4	5
57.	Deliberately disregard pedestrians about to cross or already crossing the road	0	1	2	3	4	5
58.	Drive while looking at a map or GPS device, changing the radio station, etc.	0	1	2	3	4	5
59.	Turn into the wrong lane when completing a left turn	0	1	2	3	4	5
60.	Get involved in unofficial 'races' with other drivers	0	1	2	3	4	5
61.	Decide not to answer your hand-held cell phone while you are driving	0	1	2	3	4	5
62.	Mistakenly stop or brake at a green light	0	1	2	3	4	5
63.	On a two-lane road, attempt to pass a vehicle that you hadn't noticed was signaling its intention to turn left	0	1	2	3	4	5

	How often do you...	Never	Very rarely	Occasionally	Often	Nearly all the time	Always
64.	Drive with both hands on the wheel	0	1	2	3	4	5
65.	Find yourself stopped in the middle of an intersection or in a pedestrian crosswalk because of stopped vehicles ahead	0	1	2	3	4	5
66.	Have difficulty seeing a traffic light at dawn or dusk	0	1	2	3	4	5
67.	Fail to notice someone stepping out from behind a bus or parked vehicle until it is nearly too late	0	1	2	3	4	5
68.	Search for something in the car while you are driving	0	1	2	3	4	5
69.	Hit something when backing up that you did not see	0	1	2	3	4	5
70.	Fail to notice someone waiting at a crosswalk	0	1	2	3	4	5
71.	Sound your horn to indicate your annoyance to another road user	0	1	2	3	4	5
72.	Fail to signal your turn when approaching an intersection	0	1	2	3	4	5
73.	Drive faster than the speed limit on a highway	0	1	2	3	4	5
74.	Speed up in order to make it through yellow lights	0	1	2	3	4	5
75.	In a line of cars turning left onto a main road, pay such close attention to the main stream of traffic that you nearly hit the car in front of you	0	1	2	3	4	5
76.	Groom yourself while driving (apply makeup, shave, comb hair, etc.)	0	1	2	3	4	5
77.	Fail to yield to traffic coming from the right at an uncontrolled intersection	0	1	2	3	4	5
78.	Make an illegal U-turn at an intersection	0	1	2	3	4	5
79.	Fail to notice pedestrians crossing when turning into a side-street from a main road	0	1	2	3	4	5

	How often do you...	Never	Very rarely	Occasionally	Often	Nearly all the time	Always
80.	Find yourself driving too fast when approaching an intersection and have to brake hard to stop	0	1	2	3	4	5
81.	Forget that you have your high beams on until ‘flashed’ by other motorists	0	1	2	3	4	5
82.	Follow another vehicle into an intersection without realizing that the light has changed to red	0	1	2	3	4	5
83.	Talk on your hand-held cell phone when you are driving	0	1	2	3	4	5
84.	Avoid driving at night	0	1	2	3	4	5
85.	Find yourself straying out of your lane	0	1	2	3	4	5
86.	Drive faster than the speed limit in a playground or school zone	0	1	2	3	4	5
87.	Signal left but then turn or make a lane change to the right (or vice versa)	0	1	2	3	4	5
88.	Intending to drive to destination A, you realize that you are actually en route to destination B, perhaps because destination B is your more usual destination	0	1	2	3	4	5
89.	Obey speed limits late at night and very early in the morning	0	1	2	3	4	5
90.	Drive so close to the car in front of you that it would be difficult to stop if they braked suddenly	0	1	2	3	4	5
91.	Miss your exit on a highway and have to make a detour	0	1	2	3	4	5
92.	Feel angered by another driver’s behaviour and chase after him/her with the intention of giving him/her a piece of your mind	0	1	2	3	4	5
93.	Fail to signal when you are making a lane change	0	1	2	3	4	5
94.	Realize you have no clear recollection of the road along which you have just been traveling	0	1	2	3	4	5

	How often do you...	Never	Very rarely	Occasionally	Often	Nearly all the time	Always
95.	Stare at a crash or spectacle you are passing	0	1	2	3	4	5
96.	Turn left into the path of an oncoming vehicle that you hadn't seen	0	1	2	3	4	5
97.	Drive with only one hand on the wheel	0	1	2	3	4	5
98.	Check your mirrors before pulling out, changing lanes, turning, etc.	0	1	2	3	4	5
99.	Purposely avoid busy or complex roads and intersections	0	1	2	3	4	5
100.	Have to brake in the middle of a curve or on a ramp because you are driving too quickly	0	1	2	3	4	5
101.	Stop for red lights or stop signs when driving late at night along empty roads	0	1	2	3	4	5
102.	Have problems seeing at night because of oncoming headlights, even when they are properly dimmed	0	1	2	3	4	5
103.	Switch on one thing, such as the headlights, when you meant to turn on something else, such as the wipers	0	1	2	3	4	5
104.	Fail to check your rear-view mirror before braking	0	1	2	3	4	5
105.	Realize that the vehicle ahead has slowed, and have to slam on the brakes to avoid a collision because you were distracted or preoccupied	0	1	2	3	4	5
106.	Eat or drink while you are driving	0	1	2	3	4	5
107.	Forget where you parked your car	0	1	2	3	4	5
108.	Choose not to drive because you believe that you may be over the legal blood-alcohol limit	0	1	2	3	4	5
109.	Yield right-of-way to a bus that is signalling its intention to pull out	0	1	2	3	4	5
110.	Confuse your foot pedals, and accelerate when you want to brake (or vice versa)	0	1	2	3	4	5

	How often do you...	**Never**	**Very rarely**	**Occasionally**	**Often**	**Nearly all the time**	**Always**
111.	Drive when you are drowsy	0	1	2	3	4	5
112.	Drive especially close to or ‘flash’ the car in front of you to try and get them to go faster or get out of your way	0	1	2	3	4	5
113.	Text message, email, etc. while driving	0	1	2	3	4	5
114.	Check your speedometer and discover that you are traveling faster than the posted speed limit	0	1	2	3	4	5
115.	Signal when you are making a lane change	0	1	2	3	4	5
116.	Drive without a seat belt on	0	1	2	3	4	5
117.	Stop in a merge lane while waiting for a larger gap in traffic	0	1	2	3	4	5
118.	Find that you are being passed by other drivers because you are driving slower than the speed limit	0	1	2	3	4	5
119.	Attempt to leave a parking space in the wrong gear	0	1	2	3	4	5
120.	Pay more attention to buildings or billboards you are passing than the road in front of you	0	1	2	3	4	5
121.	Allow passengers to ride in your vehicle without their seat belts on	0	1	2	3	4	5
122.	Attempt to turn a corner at too high a speed	0	1	2	3	4	5
123.	When driving uphill on a rural road, fail to stay to the right	0	1	2	3	4	5
124.	Fail to check a railway crossing, just because it is controlled by a crossing arm or flashing lights	0	1	2	3	4	5
125.	Drive too fast in a parking lot (over 15km/h)	0	1	2	3	4	5

UNIVERSITY OF CALGARY **Appendix C**

<u>Consent Form for Focus Group or Hazard Perception Test Study</u>

Researcher Name:

Kate Johnston
Department of Psychology
Tel: (403) 220-4951
Email: kate.johnston@ucalgary.ca

Charles Scialfa, Ph.D.
Department of Psychology
Tel: (403) 220-4951
Email: scialfa@ucalgary.ca

Research Associate: David Borkenhagen
Department of Psychology
Tel: (403) 220-4951
Email: d.borken@gmail.com

Title of the project: SAMU: Safety Ambulance driver Monitoring Unit

Project Sponsor: Auto 21 Networks of Centres of Excellence

This consent form, a copy of which has been given to you, is only part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study.

Purpose of the Study:

Driving is a complex and risky task particularly for emergency responders such as police, firefighters and EMS drivers. It is important therefore to develop efficient and valid ways to educate, inform and train them of the hazards they will confront in the performance of their duties. The aim of this study is to gather information from emergency responders on the types of hazards they encounter, to search existing databases for commonly occurring roadway hazards and to administer to drivers a validated hazard perception test.

What Will I Be Asked To Do?

Focus Groups – Focus groups will last 1-2 hours and involve structured discussion of experiences and thoughts on hazards encountered during emergency responses. There will be a short presentation on hazard perception, a questionnaire and a discussion. The discussion portion would be recorded so we can review, extract and document important thoughts expressed.

Hazard Perception Testing - Study participants will be asked to view a sequence of driving scenes presented on a computer monitor and to identify road hazards in those driving scenes by touching the computer monitor.

By definition, a road hazard is a situation in which there will likely be a collision or near collision between your vehicle and another road user (i.e. another vehicle, pedestrian, cyclist, motorcycle and wildlife), unless your vehicle takes evasive action (i.e. slows down or changes course to steer around another road user). A second type of hazard occurs when a stationary object such as a road pylon, dead animal or other object such as repair equipment is in the lane occupied by you.

Research participants will be asked to complete a questionnaire that assesses their health and driving difficulties. The entire process will take approximately 1.5 hours.

Your participation is voluntary, and you may refuse to participate in any of the tests or may withdraw, without penalty, at any time during the study. If you choose to withdraw from the focus group discussion, it is not possible to remove the information you provide from the data. However, if you participate in the hazard perception study and decide to withdraw, the data you provided will be destroyed.

Your involvement will not affect your position of employment and your employer will not be informed of your decision to participate. However, because data collection will occur at your place of work, it is not possible to ensure complete confidentiality.

For your participation in either the focus groups or the DHPT study, you will receive a $25 honorarium. You may participate in both and, if so, you will receive $50 in total.

What Type of Personal Information Will Be Collected?

Should you agree to participate, you will be asked to provide some information like your gender, age, health and driving behavior.

Please be assured that no personal identifying information will be included the final report. Only grouped information, averages and associations between different measures will be reported.

What Happens to The Information I Provide?

Participation is completely voluntary, anonymous and confidential. No one except the researcher and his research assistants will be allowed to access any individual information collected. The results of the study will be presented at professional conferences (including those of AUTO21, the sponsoring agency) and in peer-reviewed publications, but only group statistics will be presented so that individuals cannot be identified.

Quotes from the focus groups may be used in summary reports, but you will not be identified as the person who is quoted.

Calgary EMS and Calgary Police Services will receive summary reports of any data collected but there will only be summary group data so that individuals cannot be identified.

During the research, a hard copy of the data will be stored in a lockable filing cabinet, which is only accessible to researcher and research assistants. Electronic forms of the data will also be stored in a password-protected personal computer. All data will be destroyed after 10 years.

Are There Risk or Benefits if I Participate?

There is some chance that you may not feel that you have performed the tests as well as you would like. We want you to be assured that these tests are in the development stage and that some of them may be difficult for all people. But, if you are concerned about your performance, we can talk to you in detail about means you might use to increase your safety while driving.

Signatures (written consent):

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights or release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or new information throughout your participation.

Participant's Name (please print):____

Participants Signature: ____

Researcher's Name (please print): ____

Researcher's Signature: ____

Questions/Concerns

If you have any further questions or want clarification regarding this research or your participation, please contact Dr. Charles Scialfa at 220-4951 or scialfa@ucalgary.ca.

If you have any concerns about the way you've been treated as a participant, please contact Russell Burrows, Senior Ethics Resource Officer, Research Services, University of Calgary at (403) 220-3782; e-mail rburrows@ucalgary.ca

A copy of this consent form has been given to you to keep for your records and reference. The investigator has kept a copy of the consent form.

Appendix D
Demographic Questions

1. Are you? Male _________ Female __________
2. Age: ________
3. Are you affiliated with Emergency Operations or Inter-Facility Transport? __________
4. Do you work primarily in urban or rural areas? __________
5. How many kilometers do you drive per year in your personal vehicles? ___________
6. How many kilometers do you drive per year while on shift?_____________
7. In what percentage of your shifts are you the driver?_________
8. How many years have you had a driver's license? ________
9. Have you taken the NAPD defensive driving course? If so when?
10. Have you taken a defensive driving course in addition to the NAPD?
    If so when? _________

    If “yes”, please describe this experience

    ____

    ____

11. How many years have you been driving as an emergency responder (Calgary Police Services or EMS)? _______

    Full time_______ Part Time _____

12. Please rate your physical health from 1 to 5 _____________