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Hazard perception in emergency medical service responders

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ABSTRACT

The perception of on-road hazards is critically important to emergency medical services (EMS) professionals, the patients they transport and the general public. This study compared hazard perception in EMS and civilian drivers of similar age and personal driving experience. Twenty-nine EMS professionals and 24 non-professional drivers were given a dynamic hazard perception test (HPT). The EMS group demonstrated an advantage in HPT that was independent of simple reaction time, another indication of the validity of the test. These results are also consistent with the view that professional driving experience results in changes in the ability to identify and respond to on-road hazards. Directions for future research include the development of a profession-specific hazard perception tool for both assessment and training purposes.

1. Introduction

Hazards are defined as either an object (e.g. vehicle merging into a lane) or condition (e.g. a construction zone) that increases the risk of injury. In the traffic safety literature, *hazard perception* is operationalized as the ability to identify and respond to hazardous elements in the roadway environment (Horswill and McKenna, 2004). Efficient hazard perception allows individuals to anticipate a hazard from situational cues and respond appropriately and has been identified as a skill that is related to safe driving (e.g., Mills et al., 1998).

Spicer initiated the investigation of hazard perception (1964, as cited in Horswill and McKenna, 2004) in a study asking drivers to identify important elements from a series of driving videos. Younger, collision-involved drivers were found to be less accurate than those who were collision-free. Similarly, Pelz and Krupat (1974) found a significant difference in response latency; drivers with no collision history revealed faster responses to road hazards presented in video clips 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 (Hull and Christie, 1992). Additionallly, scores on brief, standardized, dynamic hazard perception tests (HPTs) have been associated with collision involvement (Deery, 1999; McKenna and Crick, 1991 Quimby and Watts, 1981).

Although the body of literature on hazard perception has grown considerably over the past several decades, theoretical treatment of its development and manifestation has been relatively sparse. Several authors have discussed the “mental model” that is required for efficient hazard perception (Underwood et al., 2002; Scialfa et al., 2011), which is deficient in novice drivers and those with a greater propensity for collisions. More recent treatments (e.g., Vaa, 2013) incorporate hazard perception as the result of stimulus-driven and experience-based inputs that combine with emotional states and task goals to influence driving behaviors, including the allocation of attention and scanning that sub-serve safe driving.

Many of these elements are central to the Salience, Effort, Expectancy and Value (SEEV) model, which asserts that the allocation of visual attention to an area of interest, such as a hazard, is dependent on those factors (Horrey et al., 2006). In the continuously changing driving environment, there are multiple areas and stimuli to which drivers must attend in order to detect hazards. Within the SEEV model, experience provides the driver with an expectancy of the location of potential hazards and their associated value (i.e., the consequences of not performing an evasive maneuver). This, in turn, allows the driver to expend less effort to allocate attention appropriately within and around the roadway.

Hazard perception is a skill and, as such, develops with and is influenced by practice (Crundall and Underwood, 1998; Crundall et al., 2005; Fisher et al., 2003). Compared to their more experienced counterparts, novice drivers are often relatively poor at perceiving on-road hazards (Fisher et al., 2006; McKenna et al., 2006). Benefits gained through maneuvering through consistent driving

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scenarios include the less effortful mapping of potential conflicts onto subsequent behaviors (Schneider and Shiffrin, 1997; Logan, 1988), contextual cuing (Jiang and Wagner, 2004; Brockmole and Henderson, 2006), decreased workload (Young and Stanton, 2007), and more efficient scanning behaviour (Mourant and Rockwell, 1972; Deery, 1999; Underwood, 2007; Chan et al., 2010). As would be expected with any skill, training can improve hazard perception, even in those considered to be highly experienced drivers (Horswill et al., 2013).

Given that hazard perception is a skill developed through experience, one might expect that those in occupations requiring a great deal of driving, particularly under demanding conditions, would evidence better performance in tests of hazard perception. Stated differently, a valid test of hazard perception skill will reveal group differences when the groups involved differ in their training and/or driving experience. Thus, HPT deficiencies in novice driers, older drivers and collision-involved drivers attest to the disriminant validity of the HPT.

Crundall et al. (2003, 2005) expanded this line of investigation by including a comparison group with a different level of experience. Experienced police, novice drivers and a civilian group matched on age and time since initial licensure were shown three different series of video clips; pursuit clips of vehicles at high speeds, emergency response drives with lights and sirens, and control drives. Attention was measured by recording participants' eye movements. Novices demonstrated the longest gaze duration towards road hazards. 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 (longer for police), and towards unprotected pedestrians (longer for police).

It is likely that increased exposure to the task for police required fewer attentional resources to be allocated to pursuit, which allowed more resources to be directed toward areas of potential hazards. Consistent with this view, Horswill et al. (2013) assessed the hazard perception of experienced drivers compared to police using a dynamic hazard perception test of civilian driving. Police responded to hazards 1.27 s faster than their experienced civilian counterparts, an advantage that was independent of a measure of simple spatial reaction time. Taking a very different approach to this topic, Borkenhagen et al. (2014) reported that EMS professionals are quite aware of roadway conditions and road users that pose hazards for them and have, in many instances, developed personal strategies to mitigate risk while driving.

The current study compared EMS ambulance operators to civilians on a dynamic HPT that has been used previously (Scialfa et al., 2011) and manifests good psychometric properties. It was used to determine if EMS professionals are, in general, better able to identify and respond to on-road traffic conflicts and thus, is a test of the validity of the HPT.

2. Methods

2.1. Participants

The University of Calgary Conjoint Health Research Ethics Board approved this study. A sample of 53 participants were recruited and tested, 29 Calgary Zone EMS and a control group of 24 civilian drivers. Table 1 presents descriptive statistics for the groups on collected demographics and driving history. EMS participants were recruited through notices distributed within Alberta Health Services (AHS) Calgary Zone Emergency Medical Services. All study advertisements indicated that the session was a study of the University of Calgary and was not a training session run by AHS. This was done to ensure that participants did not feel pressured to participate as a job requirement. EMS participants were paid $25 (CDN) per hour for their time.

The control group was recruited using the University of Calgary undergraduate student participant pool and through "snowball sampling". Students participating were granted course research credit for completing the study. All participants in the control group held a standard driver's license (Class 5 in the province), while EMS held a somewhat more demanding (Class 4) license. There were no significant differences between the EMS and civilian groups' reported age, years of licensure, collision history during civilian driving, or exposure. Within the EMS group, participants reported an average of $M = 6$ years (range 1–17) of professional 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. The test uses a series of broken rings printed in rotations of 90°; participants were asked to indicate which side the gap of the ring faced. Acuity was measured from 20/400 to 20/10 in 0.05 logMAR increments.

Photopic contrast sensitivity was measured using the VISTECH VCTS 6000, which estimates sensitivity at 1.5–18 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 Test. Participants were asked to organize coloured discs in increasing wavelength. 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 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 ranged from 2.75 cm × 2.8 cm to 13 cm × 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 10–62 s filmed in Vancouver, B.C., Canada, and surrounding areas using a Sony Handycam Camcorder, model HDR-SR11 in AVCHD 16 M (FH) format at a resolution of 1920 × 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 et al., 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