Eye Tracking Methodology For A Static Driving Hazard Perception Task

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ABSTRACT

CCS CONCEPTS

• **Computer systems organization → Embedded systems**.

KEYWORDS

eye tracking, visual attention, hazard perception

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1 INTRODUCTION

Driving can be one of, if not the most dangerous behaviors we engage in everyday when factoring in the potential cost of injury or possibly death. While many individuals consider these risks, some groups, particularly novice drivers, which are at a greater risk for accident involvement (McKnight and McKnight, 2003) fail to recognize potential hazards. In an attempt to increase driving safety, many road licensing agencies have sought to increase training for novice drivers. One such example of this is the inclusion of a hazard perception assessments to measure an individual's ability to detect and respond to common roadway hazards. (Wetton et al., 2011).

While there are a multitude of reasons why novice drivers may not correctly perceive hazardous scenarios, the current literature suggests that novice drivers have an incorrect or underdeveloped mental model of common roadway hazards (Horswill and Mckenna, 2004). Additionally, novice drivers exhibit a tendency toward inefficient scanning (Chapman et al., 2002, FALKMER and GREGERSEN, 2005) of the roadway and subsequently not attending to potentially dangerous hazards.

Hazard perception assessments typically include video-based dynamic scenes of hazardous situations that drivers may encounter on the roadway.So far These tests have been employed in both the United Kingdom and Australia. (GOV.UK, 2023) Due to the success of these programs in their respective countries, interest has grown in the potential for hazard perception tests to assess and possibly increase the hazard perception abilities of novice drivers. As this interest grows other countries have begun developing localized driving perception assessments creating a demand for further research. (Lyon et al., 2011, Tūskė et al., 2019)

This research has three main goals. First, to determine if eye tracking methodology on a static hazard perception task could discriminate between novice and experienced young adult drivers. Second, due to the growing evidence that suggests novice drivers are not capable of estimating hazard risk, this study hypothesizes that hazard ratings will be lower for novice drivers and they will spend a greater amount of time to scan the static roadway scenarios and spend greater time attending to hazards. Lastly, cluttered scenes tend to be more demanding than non cluttered scenes in hazard detection (Ho et al., 2001) ,the relationship between driving experience, subjective clutter ratings and latencies in time to visually attend to roadway hazards will be examined.

2 BACKGROUND

Current hazard detection assessments involve selecting potential hazards with either a mouse pointer or touch screen interface and then retrospectively reporting the level of hazard of the scene. There have been some use cases, like in the case of (Alberti et al., 2012) that incorporated an eye tracking methodology to assess the effectiveness of a three-dimensional riding simulator, and its potential to increase hazard perception abilities, but with such a complex method it may not be available for wide scale use. While video-based dynamic scenes are often used for hazard perception assessment, it seems that static scenes are just as effective and may prove to be easier to administer and access when used in tandem with an eye tracking methodology. (Scialfa et al., 2013) This research has two main goals. First, to understand the effects that driving experience may have on the fixation and completion time while observing static driving hazard perception scenes. Second, it is known that cluttered scenes are more demanding for hazard perception scenarios (Ho et al., 2001) so, this study will examine the relationship between driving experience, subjective clutter ratings and mean fixation time of nonhazardous roadway clutter.

3 METHODS

3.1 Apparatus

The experiment will be conducted using a 24" Dell LED monitor with a screen resolution of 1920×1080 and participants will input their responses using the keyboard and mouse. Participants' eye movements will be tracked using the Gazepoint GP3 desk mounted eye tracker which will sample the position of a participant's eyes at a rate of 60Hz at an accuracy of 0.5-1 degree of visual angle.

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3.2 Stimulus

Stimuli was obtained from a set of 503 Youtube-sourced forward-facing dashcam videos for experimental use. 250 videos contain no proximate hazard, and are broadly environmentally-matched to the 253 hazard videos, which have been annotated for temporal and non-temporal features provided by (Wolfe et al., 2020). Images were taken from these videos before an expected hazardous event (in the case of scenes containing a road hazard) to produce a static hazard perception task.

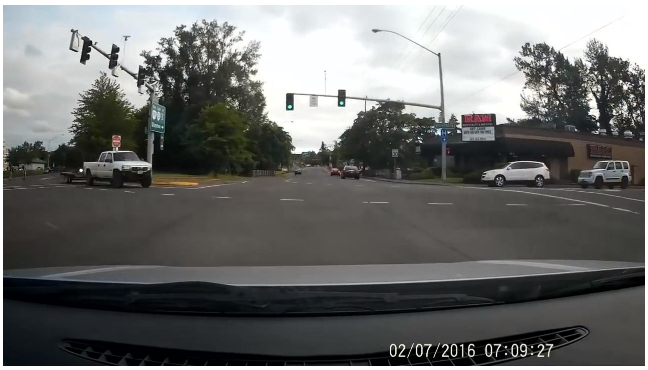

Figure 1: A scene containing a hazard and high clutter.

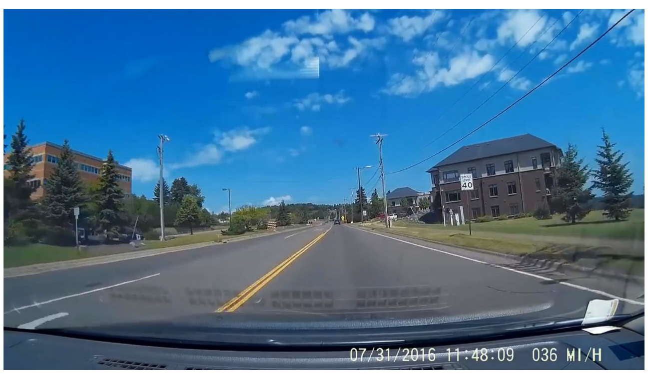

Figure 2: A scene containing no hazard and low clutter.

3.3 Participants

The experiment will recruit 12 participants between the ages of 18 30. Participants will be recruited from the Eye Tracking Methodology and Applications class as well as from the broader Clemson University campus. Participants will be recruited by word of mouth.

3.4 Experimental design

The experiment will employ a two factor mixed methods design. The independent variables of driving experience and static image clutter will vary on two levels respectively. Experience will vary between novice and experienced levels and image clutter will vary between low and high. The experiment will consist of a single block with 10 images. This block will contain static roadway scenes that will vary in the amount of clutter in them, with four images in that will contain no roadway hazard. The order of the images presented to the participants will be randomized. The dependent measures will include response time (time to attend to all the hazards in the scene and depress the space bar), response accuracy (correctly attending to roadway hazards), and eye tracking metrics (fixation duration and total number of fixations in the areas of interest (AOI).

3.5 Procedures

Prior to the experiment, participants will read an informational letter and were required to provide verbal consent to be able to participate as part of the study for class. Participants will be asked to fill out a demographic survey that asks for information including gender, age and number of years as a licensed driver. Participants will then have the instructions explained. The instructions will be to identify potential hazards in static images as quickly and as accurately as possible and then press the space bar to continue on to a brief questionnaire that will ask them to give a rating of how hazardous and cluttered the driving scene is. The eye tracker will be calibrated to the participant's eyes using the Gazepoint software before the start of each block.

4 RESULTS

Descriptive statistics for the groups are provided in figure 3.Between the experienced and novice drivers, t-tests showed no significant difference in age.

Demographic information	Novice(n=6)mean(SD)	Experienced(n=6)mean(SD)
Age(yr)	21.17(2.1)	26(2)
Gender(M/F)	(2/4)	(4/2)
Number of years education(yr)	14.67(1.2)	18.17(2.23
number of years licensed(yr)	3.5(.5)	8.17(1.8)

Figure 3: Demographics

4.1 Eye tracking metrics

No significant difference was found between novice and experienced drivers on time until first fixation in the scenarios where hazards were present. Significant differences were found in the novice and experienced drivers on the number of fixations in the area of interest of the hazard after the first viewing with novice drivers (M=4, SD=1.2) looking longer and looking back at the hazard more than the experienced group (M=1.5,SD=1.7).

4.2 Hazard rating, clutter rating and hazard perception

Out of the 10 scenarios, 2 produced a greater a higher mean hazard rating from the experienced drivers(M=4.2,SD=.56) than from the novice drivers(M=1.5,SD=.1.2), a difference that was significant(p<.001). For the rest of the 8 scenes no significant difference was found in hazard perception scores.

Out of the 10 scenerios, 5 scenerios produced a higher clutter rating for the novice drivers (M=3.9,SD=.8) than the experienced drivers (M=2.4,SD.3). The rest of the scenerios did not significantly differ in their clutter ratings.

5 LIMITATIONS & FUTURE WORK

There were a number of limitations in this study. First, a small sample size of 12 may not be a large enough sample to generalize. Second, for the sake of brevity participants were only shown 10 static scenarios. This low amount of stimuli could be afffecting the results presented here. Lastly, The sample was a mix of young adults and adults with ages ranging from 20-29 with a mean drivers licensure time of 5.83 years which could have contributed to an inability to discriminate experience differences.

6 DISCUSSION/CONCLUSIONS

It is well known that deficiencies in hazard perception are common in novice drivers which cause a greater risk for accident involvement. (McKnight and McKnight, 2003) Assessments of common roadway hazards like the hazard perception test discussed here can serve as a valuable tool to understand how to increase safety in novice groups while driving. The current research in hazard perception lacks eye tracking metrics that may help in understanding the attention allocation of novice drivers.

While the research reported here did not find wide sweeping significant results there are still interesting contributions which may require further investigation. The first interesting result that was found was the "look back" strategy to hazards used by the novice group. This phenomenon may be due to a difference in driving style personality difference that extends beyond driving experience. It could also prove to be an additional feature to discriminate hazard detection ability for the future but it should be explored in future work.

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