Assessing the Variation of Driver Distraction with Experience, Phase I

By David Martinelli, Leonel Medellin
And Nagaanupama Akuraju

West Virginia University

Technical Report Documentation Page

1. Report No. WVU-2006-03	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Assessing the Variation of Driver Distraction with Experience, Phase I		5. Report Date July 2008	
		6. Performing Organization Code	
7. Author(s) David Martinelli, Leonel Medellin, Nagaanupama Akuraju		8. Performing Organization Report No.	
9. Performing Organization Name and Address West Virginia University PO Box 6103 Morgantown, WV 26505		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. DTRS99-G-0003	
12. Sponsoring Agency Name and Address WVDOH 1900 Kanawha Blvd Charleston, WV 25305		13. Type of Report and Period Covered Final	
		14. Sponsoring Agency Code	
15. Supplementary Notes COTR:			
16. Abstract Driver distraction has been a major concern in highway safety since the past. A driver is said to be distracted when he spends longer time than required looking at something that attracts his attention, thus leading to a deviation from the primary task of driving (1). The National Highway Traffic Safety Administration (NHTSA) estimates that 25% to 30% of all crashes are due to the various kinds of driver distraction (2). Driver distraction can either be due to on-road, in-vehicle factors or driver factors. Cell phones, GPS, stereo systems, conversation with other people I the vehicle, etc., include the major in-vehicle distraction factors, while billboards along the roadway and the traffic itself account for most of the on-road distraction factors. Driver physical and mental workload, fatigue, age form the driver factors. It is evident from past research that an increased level of distraction or inattention of drivers leads to traffic crashes. The distraction or inattention levels vary from driver to driver. Fatality rates and age are said to follow a U-shaped function, i.e., the fatality rates decrease as driver age increases and after a certain time they start increasing (3).			
17. Key Words Driver distraction, experienced drivers		18. Distribution Statement No restrictions. This document is available from the National Technical Information Service, Springfield, VA 22161	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 10	22. Price

TABLE OF CONTENTS

ASSESSING THE VARIATION OF DRIVER DISTRACTION WITH EXPERIENCE

INTRODUCTION

Driver Distraction has been a major concern in highway safety since the past. A driver is said to be distracted when he spends longer time than required looking at something that attracts his attention, thus leading to a deviation from the primary task of driving (1). The National Highway Traffic Safety Administration (NHTSA) estimates that 25% to 30% of all crashes are due to the various kinds of driver distraction (2). Driver distraction can either be due to on-road, in-vehicle factors or driver factors. Cell phones, GPS, Stereo Systems, conversation with other people in the vehicle, etc., include the major in-vehicle distraction factors, while billboards along the roadway and the traffic itself account for most of the on-road distraction factors. Driver physical and mental workload, fatigue, age form the driver factors. It is evident from past research that an increased level of distraction or inattention of drivers leads to traffic crashes. The distraction or inattention levels vary from driver to driver. Fatality rates and age are said to follow a U- shaped function i.e., the fatality rates decrease as driver age increases and after a certain time they start increasing (3).

PROBLEM STATEMENT

Driver distraction and inattention varies with age and experience of the drivers. Past research indicates that young and novice drivers exhibit more distraction when compared to experienced drivers. A comparison of the inattention exhibited by novice drivers and experienced drivers would help us understand the level of distraction of young and novice drivers. The distraction caused can be due to several factors like roadside advertisements, surrounding traffic, cell phone use, traffic signs, etc. Distraction in this case can be assessed by determining the time spent in looking at something that is not relevant to the primary task of driving and vehicle control i.e., looking away from the center of roadway, increased number of glances away from the center of roadway, etc.

LITERATURE REVIEW

The literature review considered to examine the relation between driver experience and extent of distraction and the use of eye tracking system to test the relation between the two. Research has shown that young drivers tend to speed in traffic, pull into smaller gaps and glance away from the road (Ferguson, 2003; Strayer and Drews, 2004; Underwood, Crundall and Chapman, 2002).

Level of Experience and Distraction

Drivers need to be cautious and react quickly to a situation. Any kind of distraction delays this process. According to S. J. Kass et al.,(4) *"As drivers move through the environment, they must identify the relevant information in rapidly changing traffic patterns (e.g., distance to other vehicles, closing speed) and be prepared to react to events that may occur in order to avoid accidents"*. Novice drivers due to the lack of experience might not be able to deal with complex road conditions when compared to experienced drivers (4). On the other hand, though young

drivers lack experience, take risks and have higher chances of getting distracted when compared to experienced and older drivers, the fatality rates increase with age (3).

Factors causing Distraction

Numerous factors have been considered that lead to driver distraction. These include vehicle factors, roadside factors and driver factors. Cell phones, Audio Players, GPS, etc. form the vehicle factors while roadside advertisements, traffic, environment, etc. form the roadside factors. Driver factors that might cause distraction include driver alertness, fatigue, mental workload and condition. A few factors that are considered in our study are discussed in here.

- Billboards and roadside advertisements have been considered as factors contributing to driver distraction. In fact, it is a difficult task to establish a relationship between advertising billboards and safety due to several theoretical and methodological reasons (5). Inspite of the complexities involved, researchers have examined the effects of billboards on safety. The results are mixed and inconclusive (5).
- Statistical analysis by Schlatter et al. concluded that the number of crashes increased by 50% in the test scenario where drivers carried cell phone conversations compared to the control scenario (2).
- The driving performance decreased with an increase in cognitive load, it deteriorated more in case of an increase in visual load (6). The drivers seem to look at the road when thinking about something but they are distracted.

METHODOLOGY:

Distraction in this study is defined as looking away from the center of roadway at something not relevant to driving for more than 2 seconds. This study makes use of a faceLAB eye tracking system. It consists of a set of two cameras fixed on the dash board and a laptop that records and saves the data. It tracks the pupil movement and gaze of the driver. As the cameras are small and need not be in contact with driver as compared to the head mounted system, they do not pose any additional distraction or inconvenience to the drivers. “The eye glance technique measures visual behavior by recording the frequency and duration of eye glances at particular objects in the driver’s visual field (7). When drivers perform a secondary task while driving, they usually complete this task through a series of brief glances (1 to 2 seconds) at the object interspersed with glances at the roadway. Eye glance studies record and measure the frequency and duration of glances towards the secondary task which gives a measure of the total “eyes off road time”, and hence the visual demand or interference associated with performing the task (7). Analysis of the driver’s visual behavior was made depending on the time spent looking at the road and other events or attractions along the road (7).

Drivers of different experience levels are considered in this study. Young and novice drivers, 16 to 18 years old, obtaining their training in driving from a driving school comprise the first pool of subjects. Drivers with less than a year driving experience, between the ages of 18 and 25, formed the second pool of subjects. Experienced (5 or more years of experience) drivers between the ages of 30 to 50, comprised the third pool of subjects. Drivers older than 50 years were not included as the distraction levels would be higher for older drivers (3). A sample of 30 subjects in each pool was considered to be sufficient as there might be some discrepancies in some cases and the data cannot be used in such cases. Approvals from the Board of Education, parents of

high school students, Principal and instructors of the high school drivers were obtained. The drivers were given sufficient information about the project before they drove and their consent was obtained on signed forms. Consent forms were obtained from parents of drivers who are less than 18 years of age. The distraction exhibited by all of these subjects is to be analyzed to know the relation between driver experience and distraction. Distraction is assessed based on the time spent looking at something that is not related to or required for driving, failing to stop at sign and signals and going out of lane.

All the drivers were asked to drive a section of road and their eye movements were tracked as they drive using faceLAB eye tracking system. The instrument was calibrated and adjusted for each driver before use in order to track the pupil movement accurately. A member from our team was present in the rear seat of the car along with the instructor for high school students and in the front passenger seat for experienced drivers. The drivers from the second and third pools drove the same route while the high school drivers took different routes. The instructors chose the route for high school students depending on the experience of the drivers.

All the other drivers drove along the same section of road that is familiar to everyone to maintain uniformity of results. They drove a three mile section of state route 705 which is a familiar urban roadway. The selected section is a four lane road with a two way center turn lane through out the section selected. The section has six traffic signals, several commercial advertising boards and several driveways. In order to avoid the variation in results due to the traffic conditions prevailing, the study was conducted only during off-peak hours i.e., to avoid heavy traffic which increases the average time the driver is on the road causing a deviation in our study.

The eye tracking system used records the eye movement of the driver as he drives along the road. Due to its smaller size (as shown in figure 1) and no direct contact with the driver, it does not cause any additional distraction. A plane was created representing the center of roadway using the faceLAB software. Similar planes were created for rearview mirror and the side mirrors too. The eye tracking system works along with the faceLAB software and creates a video with digital data that enables us to know where the driver is looking at each $1/60^{th}$ of a second. The WorldView software enables us to see and analyze the video at a later time. A snap shot of the visual data provided by the software is shown in figure 2. This data was later converted to text using the same software which provides data relevant to the driving task such as glance behavior, name of the object the driver is looking, blink, gaze orientation, head orientation, etc.

The driver eye glance behavior and time spent at something irrelevant to the driving task will yield the extent of distraction exhibited by the in-car and on-road factors.

ANALYSIS

The visual data converted to text gives several variables such as the head orientation of the driver, the gaze direction, the object the driver was looking, object towards which the head was oriented, blink frequency, experiment time, gaze quality, blink duration, pupil diameter and various other parameters. The parameters that are relevant in the determination of the various factors under consideration such as number of glances away from the center of roadway, average duration of glances away from the center of roadway, time spent looking at the center of

roadway, that enable us to understand the extent of distraction are being analyzed. The text format cells are imported into Microsoft Excel and calculations to determine the above mentioned factors are carried out. The data obtained needs to be analyzed using statistical software (e.g. STATA) to understand the relation between driver experience and distraction exhibited.

Preliminary results are expected by the end of September. This would include percentage of time spent at looking away from the center of roadway, number of glances at the center of roadway, average duration of glances and number of glances at the rear view. After this, an interpretation of the results needs to be done in order to know the variation of the levels of distraction between drivers of different experience levels.

FIGURE 1

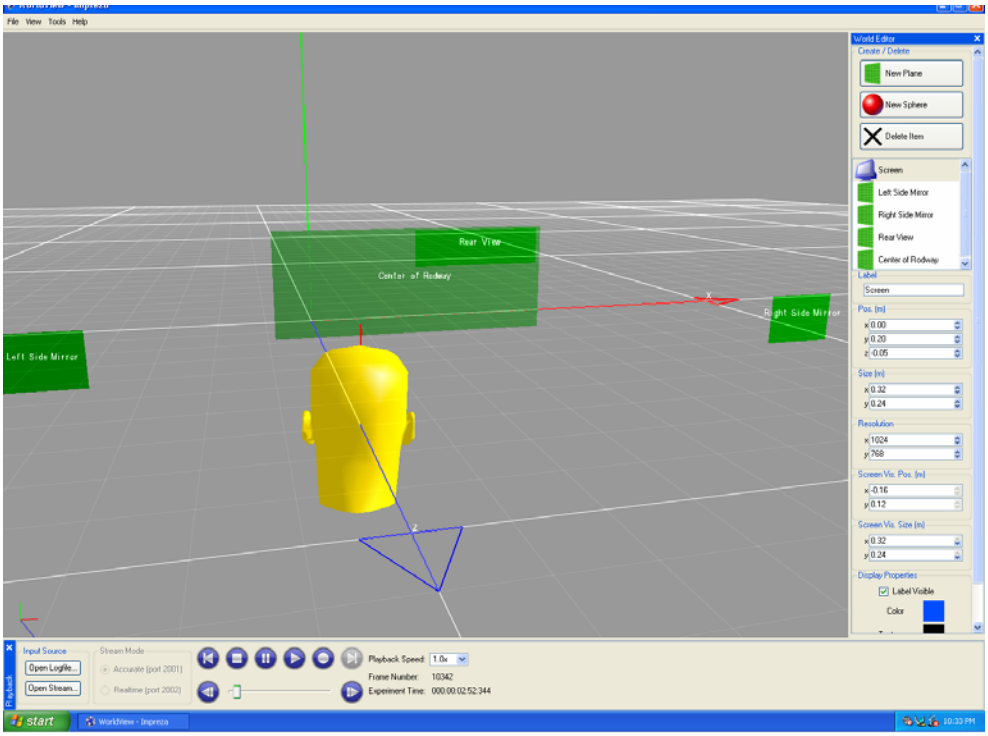

FIGURE 2

REFERENCES

1. Kristie Young, Michael Regan, Mike Hammer (November 2003). *Driver Distraction: A Review of the Literature*. Monash University Accident Research Center, Report No. 206.
2. Kerrie Schlatter, Joseph Pellerito Deborah McAvoy, Jr. and Tapan Datta (2006). Assessing Driver Distraction from Cell Phone Use: A simulator-Based Study. Transportation research Record No. 1980, pp. 87-94.
3. David Strayer and Frank Drews (2004). Profiles in Driver Distraction: Effects of Cell Phone Conversations on Younger and Older Drivers. Human Factors, Vol. 46, No. 4, pp. 640-649.
4. Steven Kass (2007). Effects of Distraction and Experience on Simulation Awareness and Simulated Driving. Transportation Research. Part F, Traffic Psychology and Behavior, Vol. 10, No. 4, pp. 321-329.
5. David Crundall, Editha Van Loon, Geoffrey Underwood (December 2005). *Accident Analysis and Prevention: Attraction and distraction of attention with roadside advertisements*.
6. Anttila Virpi (2005). Surrogate In-Vehicle Information Systems and Driver Behavior in an Urban Environment: A Field Study on the Effects of Visual and Cognitive Load. Transportation Research. Part F, Traffic Psychology and Behavior, Vol. 8, No. 2, pp. 121-133.
7. Joanne L. Harbluk, Y. Ian Noy (February 2007). Impact of cognitive distraction on driver visual behavior and vehicle control. Ergonomics Division Road Safety and Motor Vehicle Regulation Directorate.

8. McMonagle A. *Traffic accidents and roadside features*. Highway Research Board Bulletin, 1952, 55, 38–48.
9. Holohan C., Culler R. and Wilcox B. *Effects of visual distraction on reaction time in a simulated traffic environment*. Human Factors, 1978, 20, No. 4, 409–413.
10. M. Sodhi, B. Reimer, I. Llamazares (2003). Glance analysis of driver eye movements.
11. Dean P. Chiang, Aaron M. Brooks, David H. Weir (2004). On the highway measures of driver glance behavior with an example automobile navigation system. Dynamic Research Inc., Torrance, CA.
12. Qiang Ji, Xiaojie Yang (2002). Real-Time Eye, Gaze, and Face Pose Tracking for Monitoring Driver Vigilance.