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## Road and Rail Infrastructure II

Stjepan Lakušić – EDITOR



Organizer  
University of Zagreb  
Faculty of Civil Engineering  
Department of Transportation



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Department of Transportation

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## DRIVER'S DISTRACTION AND INATTENTION PROFILE IN TYPICAL URBAN HIGH SPEED ARTERIALS

Eleni Misokefalou, Nikolaos Eliou

*University of Thessaly, Department of Civil Engineering, Greece*

### Abstract

Over the last years, distracted driving constitutes a considerably increasing road safety problem with disastrous results and it possesses a leading position among the accident causes. The present study deals with driver's distraction due to out of the vehicle factors. Considering exterior factors as the most significant, we can group them in four categories: built roadway, situational entities, the natural environment, and the built environment. Regarding the fourth category, it is related to the wide variety of civil infrastructure, the commercial land use combined with high vehicle speed. All these contribute to the setup of a very dangerous environment by increasing driver's distraction and inattention. This research is based on a medium scale experimental procedure. The distraction of the driver's attention is evaluated via a continuous recording of his gaze. The main objective of this paper is to assess the side effects of roadside advertising and overloaded informational signs to driver's distraction and inattention. The results of this type of research procedures are very useful as a tool of prevention of the forthcoming pressure for more and more billboards and trademarks on the roads as well as to encourage the adaptation of more precise regulations with regard to the road infrastructure, the placement of roadside elements, etc.

*Keywords: driving, distraction, advertising, billboards, naturalistic, research*

### 1 Introduction

The distraction of driver's attention during the implementation of the driving task is not simply a theory. It is a procedure which is activated and developed depending on many factors. It is detected in all drivers, with varying extent and frequency of appearance, but, in every case, the results of this distraction are intense for the driving task, the driver's safety and, finally, for the rest of road users. Distraction, at all forms, has recently become an object of research, with distraction from a secondary task concentrating most of the research on the subject, particularly after the widespread use of mobile phones and the integration of driver assistance systems in modern vehicles. Naturally, priority is given to drivers of passenger cars without overlooking the other road users' categories such as truck drivers, motorcyclists, bicyclists etc [1].

#### 1.1 Definition and characteristics of driver distraction

The first step to a proper approach is to understand the basic characteristics of a distraction as it appears in general. Distraction may be visual, cognitive, biomechanical and auditory [2]. In the first International Conference on Distracted Driving (2005) the scientific community agreed on a definition for distracted driving: 'Distraction involves a diversion of attention from driving because the driver is temporarily focusing on an object, person, task, or event not rela-

ted to driving, which reduces the driver's awareness, decision-making, and/or performance, leading to an increased risk of corrective actions, near-crashes, or crashes' [3]. The main causes of distraction are classified into two categories: Those coming from the interior of the vehicle and those from the external environment. In the second category, one finds some very important potential sources of driver distraction. In the case of causes related to advertising, it should be particularly emphasized that the purpose of their presence at some point at the roadside, or even in a moving vehicle in the road, is to capture the driver's gaze in order for him/her to devote the required time so as to assimilate the information obtained. Roadside advertising billboards are designed by their very nature to attract attention. Crucially, though, the related potential threat to road safety is generally not acknowledged by the industry [4].

## 1.2 Frequency of driver distraction

The importance of this issue emerges from data which shows distraction from a secondary task as a cause of serious accidents as well as crashes. A characteristic research was carried out by the Virginia Tech Transportation Institute (VTI) for NHTSA, the '100-Car Naturalistic Driving Study' [5]. During the 100-Car Naturalistic Driving Study, driver involvement in secondary tasks contributed to over 22 percent of all crashes and near-crashes recorded during the study period. These secondary tasks, which can distract the driver from the primary task of driving (steering, accelerating, braking, speed choice, lane choice, manoeuvring in traffic, navigation to destination, and scanning for hazards), are manifold and include such things as eating/drinking, grooming, reading billboards, using and adjusting in-vehicle entertainment devices, conversation with passenger(s), viewing the scenery, tending to children and pets, smoking, cell phone use and related conversation, use of other wireless communication devices, and note-taking, to name a few [3]. Not all distracters involve secondary tasks initiated by driver – they can be events, objects, activities or people both inside/outside the vehicle [6]. At this point it should be noted that, as near crash is defined the subjective judgment of any circumstance that requires, but is not limited to, a rapid, evasive manoeuvre by the subject vehicle, or any other vehicle, pedestrian, cyclist, or animal to avoid a crash [5]. The statistics are confirmed by the data from accidents in many countries (e.g. accident data from United States in 2008 (NHTSA, 2009) and Greek Police for 2009 and 2010 [7]). Particularly for billboards, Crundall et al. study [4] supports that though it is acknowledged that research into advertisement distraction has been extremely limited [8], the few studies that have been conducted have demonstrated that drivers do look at and process roadside advertisements [9], and that fixations upon advertisements can be made at short headways or in other unsafe circumstances [10]. Previous studies of accident statistics have also identified external distractors, including advertisements, as a significant self-reported cause of traffic accidents [11]. Particularly, for roadside distractors, evidence is mounting that roadside distractions (and advertising in particular) present a 'small but significant' risk to driving safety [12]. Conservative estimates collated from a review of several accident databases put external distractors responsible for up to 10% of all accidents [13]. This is confirmed also by a recent simulator study [14] in which there is a tentative suggestion that more crashes occur when billboards are present.

## 1.3 Methods of evaluating driver distraction

The only certain way for the researcher to detect driver's distraction is via the results that distraction produces. The use of standardized methods gives the researchers the possibility to exchange data, conclusions and best practices [15]. Therefore, it is important to detect the most suitable method of data collection [16]. This aim can be achieved via a comparative study between the allocated methods, examining the advantages and disadvantages of

every method separately as well as the usefulness and necessity of the results that every one of them produces. An analysis of this kind was made in the study of Eliou and Misokefalou [15]. The most popular among the available methods are based on elements of accidents, on experiments, on observation and surveys. Furthermore, there are some kinds of methods that are not included in any of the previous categories like Peripheral Detection Task and Visual Occlusion.

## **2 Method**

### **2.1 Selection of the appropriate method**

The method considered the most appropriate is an observational–naturalistic study, which takes place in the field, using specially equipped vehicles. The objective is to record the driver's eye movements in order to measure the frequency and the duration of the glances at every object considered a potential source of visual distraction. The available equipment (Facelab machine) is capable of making continuous data recording. The main advantage is that with this method, in contrast with all the others categories, driving comes as close to the real thing as possible which is important for the research when we study human reactions. Naturally, there are some limitations both in designing and carrying out the experiment. The most important of these is the limited number of participants in comparison with other methods like questionnaires study, the unfamiliar vehicle which causes stress to the driver, the anxiety because of the sense of being monitored as the vehicle is equipped with cameras and, finally, the subjective discretion of the analyst–observer at the data processing.

Captiv software, which is compatible with FaceLab L2100, was used for the analysis of the results. This software gives the opportunity to analyze the data in detail by recording the total time that the billboard captured driver's gaze during driving. At this point it should be noted that as a distraction, in this study, the continuous or intermittent but repeated capture of the gaze from a theme for longer than total of two seconds are considered, as glances that last more than this time are related to driving errors [16].

### **2.2 Participants**

Using volunteer drivers, who were required to drive a car on the Thessaloniki's Ring Road, under the supervision of the researcher, who was always in the passenger seat checking the proper function of the system, the obtained results are characterized by a high degree of reliability and validity. Ten drivers (mean age =28.3 years, range = 25 to 30 years) participated in the survey (7 males, 3 females). The drivers were selected by age criterion. All drivers were familiar with the road, as they use it on a daily basis, but the subject of the study was completely unknown to them. Each of them, in order to become familiar with the vehicle, drove the selected route 2 times before the third run which was the one that we focused our attention at during the analysis process.

### **2.3 Experimental site**

The research took place from January 2010 to April 2010, in Thessaloniki's Ring Road, which is a suburban road. The route under observation has a total length of 12.5 km and 12 intersections. For the purpose of the research, drivers drove both directions of the total of 12,5km. The flow of vehicles is continual without being interrupted by traffic lights. The speed limit of the road is 90km/h. The most significant problem of the road is the speed of the passing vehicles in relation to the road geometry as well as the absence of an emergency lane [17].

## 2.4 Material – Data collection

The equipment used in the survey was very carefully chosen in order to produce the optimal quality, completeness and integrity of results. It includes a passenger vehicle and a monitoring and recording system, which detects and records every single movement of the driver's gaze and the driver's head. It is composed of two cameras for the recording of the above, and an external camera for the recording of the road scene. All measurements for the experiment took place during the day, under normal traffic conditions as well as normal weather and lighting conditions.

## 3 Results

In this study, the information isolated and analyzed in depth, is related to the external impulses that cause driver distraction and concentrates interest mainly on billboards near the road and the role of their position in driver's distraction of attention. For this purpose, all billboards along the road were identified and mapped for both directions of the route. Additionally, we noticed a section at a specific junction of the Ring Road, where a large number of illegal posters are placed in disorder which, at first view, leads to a sharp visual disturbance (marked as advertisement billboard number 8 and 20). The analysis included an examination of driver behaviour, meaning the reactions of drivers' pupils while driving under the existence of these potentially evocative distraction elements of the road environment [18].

The following Fig. 1 shows the percentages from the analysis of the gaze direction to the advertisement billboards of the route. Each driver drove the selected route 3 times but we decided to focus our attention at the third one, because of the familiarization of the driver with the vehicle which we analyzed at the method section. As it shows, distraction from advertisement billboards possesses a high percentage of the driving time which ranges from 6 to 8.85% with an average of 7.84%.

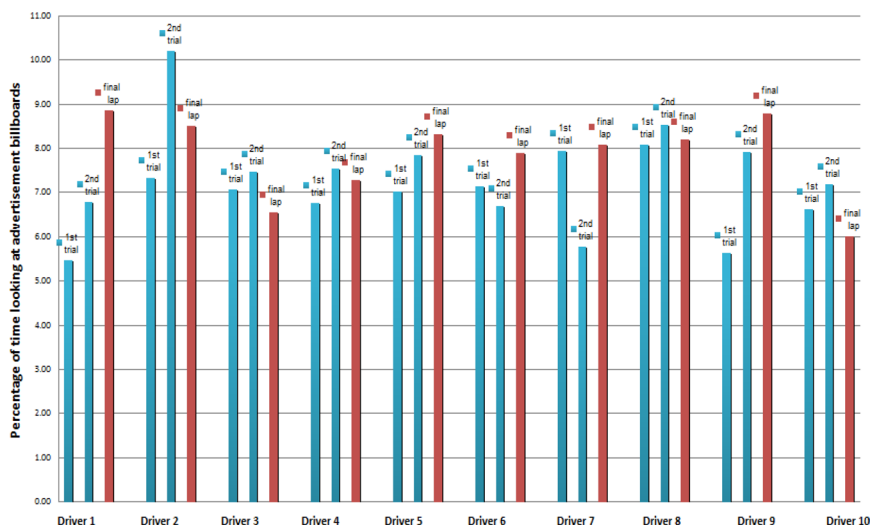
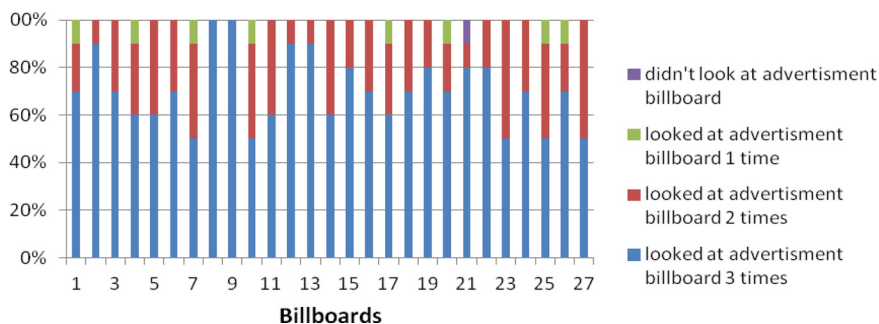


Figure 1 Percentage of driving time looking at advertisement billboards



The detailed analysis of the data came from the eye gaze, in terms of glance duration and frequency, and has led us to the following conclusions:

- All roadside billboards of the route distract the majority of the drivers (gaze captured for more than 2 seconds).
- At the route points with many placed billboards, in a short distance (e.g. advertisement billboard number 9 and 21), the majority of drivers are distracted as their gaze is captured by more than one billboard. At these points, intermittent but repeated capture of the drivers' gaze is observed.
- Billboards attract women's gaze more than men's. The average percentage of the total time that women look at advertisement billboards is 8.7%, while for men it is 7.5%.
- The billboards found in the centre or near the central field of vision are more likely to attract the driver's gaze.
- At the section which contains a high gather of posters placed in disorder, a large number of illegal posters attract multiple glances from drivers so that the visual disturbance leads to confusion.
- During the third route, 50 percent of drivers' gaze is captured by more advertisement billboards than during the first route.
- Fig. 2 obviously shows that there are certain advertisement billboards that capture drivers' gaze during all three rides. The percentage of billboards that capture drivers' gaze mostly at the second and the third route is limited.



**Figure 2** Percentages of drivers distracted from billboards at all three, at two, at one and at none of the routes

From the survey a result arises that the presence of distraction, and more specifically the one caused due to billboards, is common in drivers and depends largely on the characteristics of the billboards and their position in the field of vision.

## 4 Discussion

Distraction of driver's attention during driving is a major road safety problem, which threatens not only the driver's safety but also the safety of other drivers and road users. The focus of the research on drivers of passenger vehicles is due to the fact that those drivers constitute the largest category of road users with growing involvement in accidents, which are caused by the distraction of driver's attention. The goal of the research is to identify and clarify the causes, the frequency of appearance and the way that certain factors influence the distraction of attention of each driver, focusing on the role played by roadside advertising in Greece as a parameter of the distraction of the driver's attention.

The methods commonly used in a study of driver distraction aren't all feasible or effective to the same extent. The chosen method allows continuous data recording with its main advantage being the fact that driving is as close to the real thing as possible. Thus, the results are characterized by a high degree of reliability and validity. It, also, gives the opportunity

to the participant to have an adjustment period with the vehicle in order to obtain a normal driving behaviour. The small possibility of the researcher to control the situations and create desirable driving scenarios is among the disadvantages of this method. The environmental conditions, also, cannot be controlled. Another disadvantage is the increased cost of the method due to the eye tracker. Finally, as a disadvantage of the eye tracker we could mention the difficulty of the car installation, as well as its sensitivity to changes (e.g. light conditions). This research concluded that all roadside billboards of the route distract the majority of the drivers, with signs in the raw causing a greater distraction. Also, the more centrally positioned in the field of vision the signs are placed, the more eye-catching they are. There is a need to relate the drivers' distraction to specific aspects of advertising signs (size, message content, position by the road).

Much of the data analyzed requires collaboration with experts such as psychologists and doctors in order to provide an integrated approach. Furthermore, a comprehensive policy to reduce the visual pollution near roads, such as billboards, can help not only to improve the road aesthetic but also to significantly improve road safety by eliminating driver's visual distraction of attention [1].

To sum up, it is a fact that driver distraction is a major cause of accidents; therefore, the responsibility over the issue translates into efforts to reduce the number of injured and dead drivers. This research will be extended, in the future, to Urban Freeways in the major Greek cities (Athens and Thessaloniki). The same experiment is already in progress in Athens, with a sample of 20 participants.

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