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Capturing the effects of texting on young drivers behaviour based on copula and Gaussian Mixture Models

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ABSTRACT

This research effort aims to investigate the impact of texting on young drivers' behavior and safety based on data from driving simulator experiments, for different driving contexts, like motorways, urban and rural roads, during daytime and night, and for alternative weather conditions ('clear sky' and rain). The study offers a complete and comprehensive investigation of the effects of texting on driving behavior, able to provide evidence on policy-making. For the purposes of this study, a driving simulator experiment was carried out where 34 young participants drove predefined driving scenarios. Initially, multivariate copula analysis was used in order to explore statistical inferences among variables, especially since it retains a parametric specification for bivariate dependencies and allows testing of several parametric structures to characterize them. Secondly, alternative copula configurations were tested, which showed that texting and other road and environmental characteristics affect young drivers behavior and in particular more than one outcome can occur at the same time. Finally, Gaussian Mixture Modeling (GMM) was employed, demonstrating that the variables' pairs that presented the strongest correlations were lane departure and speed, as well as speed and reaction time. GMMs application showed that drivers using mobile phones who were involved in a collision presented a different driving behavior compared to the drivers who were occupied but were not involved in a collision.

1. Introduction

In today's society where mobile phones are one of the dominant means of communication and information, the use of mobile phones and especially texting (a distracting activity) has been acknowledged as a major concern for traffic safety. A recent study has reported that 70% of young drivers surveyed, initiate texts while driving, while 81% reply to texts, and even higher numbers (92%) read messages while driving (Atchley, Atwood, & Boulton, 2011). Driving and the use of mobile phones have long been an area of interest in the field of road safety, as an acknowledged hazardous activity. The distraction posed by phones is only becoming worse as smartphone technology evolves and the range of available features expands. Social media are now another popular means of communication with social networking and media platforms amplifying the distraction caused by phones. Furthermore, with the development of application features for smartphones, for various social media platforms (e.g. Facebook, Twitter, Pinterest, Instagram, etc.), users are sent push notifications at any time.

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One of the most popular distraction features of cell phones though, is the capability to text message. However, even though this behavior is generally perceived as hazardous, surveys always indicate high numbers of drivers admitting that they read or text message while driving.

According to Charlene, Lambert, and Regan (2012) in a Nationwide online survey in New Zealand, it was reported that over half of the responders send or read between 1 and 5 text messages while driving in a typical week, even though an 89% agreed that texting and driving generally impairs driving performance. However, Metz, Landau, and Just (2014) while investigating the frequency of secondary tasks in driving in a naturalistic study, observed that especially demanding visual manual secondary tasks, including the handling of a mobile phone, occurred more often in a standstill situation of the vehicle.

The identification of the impact of texting on driver behavior in real-life settings is a difficult task as the use of mobile phones is rarely reported. However, texting while driving is considered as a distracting activity which increases crash and near crash risk. A research developed by the Texas Transportation Institute, using a naturalistic driving approach, indicated that when reading or writing texts, drivers exhibited reductions in reaction time almost double that what was previously thought and it was also shown that nearly identical impairment in the reading and writing conditions occurs, thus suggesting that both these actions may be equally dangerous (Cooper, Yager, & An, 2011). Drews, Yazdani, Godfrey, Cooper, and Strayer (2009), using a driving simulator experiment, reported that participants responded more slowly to the onset of braking lights when engaged in text messaging compared to a free driving condition. In the 100-car naturalistic driving study it was reported that hand held wireless devices were associated with the highest frequency of distraction-related events for both incidents and near-crashes (Dingus et al., 2006).

Research has also shown that drivers engaging in visual and or manually complex tasks present a three times higher near-crash, crash risk than drivers who are attentive, and also drivers who glance away for a period higher than 2 s, double their crash risk (Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006). Additionally, lane departures are identified to be a common outcome related to texting and driving through the literature (Alosco et al., 2012; Crandall & Chaparro, 2012; Mckeever, Schultheis, Padmanaban, and Blasco, 2013). An experiment using an advance driving simulator in Australia, revealed that drivers' ability to maintain lateral position on the road and also to detect and respond to traffic lights was significantly reduced while texting (Hosking, Young, & Regan, 2009). In He, Chaparro, Wu, Crandall, and Ellis (2015), using a lane change task and smartphone technology, mutual interference of texting and driving was studied. Similarly, another driver simulator experiment reported a 66% of subjects overall exhibiting lane departures while texting (Rumschlag et al., 2015).

Increased accident risk is also a common outcome when studying the effects of texting. In a naturalistic driving setting which lasted over a period of 1 year, Farmer, Klauer, Mcclafferty, and Guo (2014), reported that the risk of a near crash/crash event was approximately 17% higher when drivers were interacting with a mobile phone, due to action of reaching for/answering/dialing, which increased risk by three times. In accordance to the results of this study, Olson, Hanowski, Hickman, and Bocanegra (2009) reported that drivers were 23.2 times more likely to be involved in a safety-critical event while text messaging. Similarly, Drews et al. (2009) reported that an 86% of the collisions presented in the simulated environment were caused while participants were text messaging while operating the vehicle.

The above described results indicate that texting while driving has an important impact on driving behavior and overall road safety. These safety related concerns indicate the need to fully comprehend how texting and the use of mobile phones in general impact driving through continuous research and to further seek measures to eliminate such behaviors.

The influence of texting on driving behavior has been very well studied and provided consistent results regarding behavior while engaged in the secondary task. However, literature has focused on the individual outcomes texting imposes on driving behavior i.e. reaction time is reduced or the vehicle is off tracked while texting. A rising issue is whether these effects of texting occur simultaneously, and if yes which effects present the highest correlation. Within this context, the current study aims to collect and analyze information on driver behavior when faced with the secondary task of texting on a representative sample of young drivers by means of a driving simulator experiment and particularly, to examine the simultaneous effects of texting and driving while examining different road and traffic conditions (urban-rural environment, normal-increased traffic conditions), and environmental conditions (good weather, rainy weather, night time).

2. Methodology

2.1. Simulator experiment

The impact of texting on driving was examined through a simulator experiment (Christoforou, 2012; Gartzonikas, 2012; Yannis, Laiou, Papantoniou, & Christoforou, 2014). In this experiment 34 participants between 18 and 28 years old took part, with an average driving experience of 3.5 years. The sample of drivers consisted of 19 males and 15 females, and in order to be familiar with the device, each participant used their own mobile phone during the experiment. The discretization between touch screen and keyboard (KB) devices was 60% and 40% respectively. The participants of the experiment were first asked to complete a questionnaire about their personal driving characteristics with regards to texting. In general the data from the study comply with the literature, with 47% of the 34 participants stating that they often read or text message while driving.