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The impact of mobile phone distraction on the braking behaviour of young drivers: A hazard-based duration model

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ABSTRACT

Braking is a crucial driving task with a direct relationship with crash risk, as both excess and inadequate braking can lead to collisions. The objective of this study was to compare the braking profile of young drivers distracted by mobile phone conversations to non-distracted braking. In particular, the braking behaviour of drivers in response to a pedestrian entering a zebra crossing was examined using the CARRS-Q Advanced Driving Simulator. Thirty-two licensed drivers drove the simulator in three phone conditions: baseline (no phone conversation), hands-free, and handheld. In addition to driving the simulator, each participant completed questionnaires related to driver demographics, driving history, usage of mobile phones while driving, and general mobile phone usage history. The drivers were 18–26 years old and split evenly by gender. A linear mixed model analysis of braking profiles along the roadway before the pedestrian crossing revealed comparatively increased decelerations among distracted drivers, particularly during the initial 20 kph of deceleration. Drivers' initial 20 kph deceleration time was modelled using a parametric accelerated failure time (AFT) hazard-based duration model with a Weibull distribution with clustered heterogeneity to account for the repeated measures experiment design. Factors found to significantly influence the braking task included vehicle dynamics variables like initial speed and maximum deceleration, phone condition, and driver-specific variables such as licence type, crash involvement history, and self-reported experience of using a mobile phone whilst driving. Distracted drivers on average appear to reduce the speed of their vehicle faster and more abruptly than non-distracted drivers, exhibiting excess braking comparatively and revealing perhaps risk compensation. The braking appears to be more aggressive for distracted drivers with provisional licenses compared to drivers with open licenses. Abrupt or excessive braking by distracted drivers might pose significant safety concerns to following vehicles in a traffic stream.

1. Introduction

While mobile phones have become ubiquitous to modern society over the past decade, the use of mobile phones whilst driving has also seen dramatic increases, consequently posing a significant public health threat, particularly among the 'tech-savvy' 18–24 year age cohort. The widespread distraction of this age cohort of drivers exacerbates the traffic safety risk of

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this driving cohort, which is widely recognised as a vulnerable road user group for other issues such as aggressiveness and risk-taking behaviours. Horberry et al. (2001) reported that more than 60% drivers who use mobile phone behind the wheel are less than forty years old. A recent survey (AAMI, 2012) among young (18–24 years) drivers in Australia showed that almost one in two drivers use a handheld phone while driving, nearly 60% of them send text messages and about 20% of them even read emails and surf internets while driving. It is of no surprise that young drivers reveal the highest rate of mobile phone use-related injury crashes among distraction-related incidents in New South Wales, Australia (Lam, 2002).

Research on the mobile phone use whilst driving has been the focus of a large body of literature over the past decade. Increased cognitive load—due to talking on a mobile phone whilst driving—has been shown to impair the performance of drivers in numerous measures. Common impaired performances of distracted drivers include a deterioration of speed control, an increase of variation of lateral control, a failure to maintain appropriate headways, an increase in reaction time in responding to hazards, a limitation in visual scanning behaviour particularly a decline in peripheral eye scanning and an impairment in perceiving relevant stimuli (e.g., Caird et al., 2008; Horrey and Wickens, 2006; Regan et al., 2009).

Using an Advanced Driving Simulator Burns et al. (2002) showed that mobile phone conversations impair speed control and response to road signs more than by having a blood alcohol level at the legal limit of 8% or 80 mg/100 ml. Rakauskas et al. (2004) reported that mobile phone conversations caused driver to have a higher variation of accelerator pedal position and drive slowly with a greater speed variation. The speed reduction of distracted drivers has often been interpreted as a risk compensatory effort for the increased mental workload (e.g., Törnros and Bolling, 2006). A desktop simulator study by Dula et al. (2011) reported that driving performances like percent time spent speeding and centre line crossings were significantly higher when drivers were engaged in different types of phone conversations compared to no conversation. Another desktop simulator study by Beede and Kass (2006) reported that talking on a hands-free phone while driving impacts driving performances in four categories of driving behaviour including traffic violations, driving maintenance, attention lapses and response time. Haque et al. (2013) reported that novice and young drivers are more likely to run through the yellow light of a signalised intersection while distracted by a mobile phone conversation, indicating the combined effect of being inexperienced and distracted particularly risky.

One of the most often reported performance detriments as a result of mobile phone distraction is the reaction time—often considered as a surrogate measure of crash risk. A meta-analysis conducted by Caird et al. (2008) reported an average 0.25 s increase of reaction times for all phone related tasks and the amount of decrements varied depending on age, task, event or stimuli. Another meta-analysis by Horrey and Wickens (2006) revealed that the mobile phone distraction increases the reaction times to unexpected hazards with similar effects for hands-free and handheld phone conditions. A recent study by Haque and Washington (2013a) using an Advanced Driving Simulator showed that the cognitive distraction due to mobile phone conversations impaired the reaction times of distracted young (18–26 years) drivers while they responded to a traffic event in their peripheral vision, but not when they responded to a traffic event in their central vision.

Braking performances of distracted drivers have generally been measured by brake response time and amount of braking. Consiglio et al. (2003) examined the braking response of distracted drivers upon the activation of a red lamp in a laboratory setting and found that both hands-free and handheld phone conversations result in a slower response in braking performances. Al-Darrab et al. (2009) reported that the brake response time to a lead vehicle in a real driving environment was positively correlated with mobile call duration, and the impairment was greater during night time driving. An experiment on a test-track facility, where participants distracted by a visual-manual task were instructed to perform a quick stop before reaching the stop line of an intersection upon the onset of a red light, showed that drivers were slower in response to the light change and braked more intensely in distracted condition (Hancock et al., 2003). In another on-road experiment study by Harbluk et al. (2007) reported that there were more occasions of hard braking with the longitudinal acceleration exceeding 0.25 g in demanding cognitive task condition which required drivers to add double digit numbers while driving. A recent driving simulator study by Benedetto et al. (2012) examined the effects of handheld, hands-free mobile and hands-free voice device on various driving performances including the deceleration rate in response to sudden brakes of a lead vehicle. It reported that the use of all the mobile phone devices leads to an increase of the average deceleration in an urban scenario as a compensation for the delay in response time due to mobile phone conversation.

While prior research has documented a variety of performance measures that are impacted by the distracting effects of mobile phone use, comparatively little is known about the braking profile of distracted drivers while they are stopping in response to a routine traffic event. A good understanding of the braking behaviour is important since improper braking might lead to rear-end or angle collisions. Indeed, an analysis on the US crash data has shown that teenage drivers distracted by mobile phones are more likely to be involved in rear-end collisions (Neyens and Boyle, 2007). However, there is a little research on the braking or stopping behaviour of distracted drivers.

As such, the objective of this study was to examine the braking behaviour of young drivers distracted by mobile phone conversations. In particular, the braking behaviour was studied and modelled when drivers stopped in response to a pedestrian at a zebra crossing. A statistical model is used to examine and compare the performance in distracted and non-distracted conditions, after controlling for the effects of various exogenous variables like vehicle dynamics, driver demographics, driving experience, and self-reported history of mobile phone usage. To accomplish these aims, a group of distracted young drivers was exposed to a number of traffic events including an interaction with a pedestrian at zebra crossing while driving a series of routes within the CARRS-Q Advanced Driving Simulator. Preliminary results from this simulator experiment were presented at a local conference in Australia (Haque and Washington, 2013b). This paper includes