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Associations of distraction involvement and age with driver injury severities

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ABSTRACT

Introduction: This paper investigates the associations between the severity of injuries sustained by a driver who is involved in a two-vehicle crash, the existence and type of driver distraction as well as driver's age. Few studies investigated distraction as it relates to injury severity. Moreover, these studies did not consider driver age which is a significant factor related to driving behavior and the ability to respond in a crash situation. *Methods:* An ordered logit model was built to predict injury severity sustained by drivers using data from the U.S. National Automotive Sampling System's General Estimates System (2003 to 2008). Various factors (e.g., weather, gender, and speeding) were statistically controlled for, but the main focus was on the interaction of driver age and distraction type. *Results:* The trends observed for young and mid-age drivers were similar. For these age groups, dialing or texting on the cell phone, passengers, and in-vehicle sources resulted in an increase in a likelihood of more severe injuries. Talking on the cell phone had a similar effect for younger drivers but was not significant for mid-age drivers. Inattention and distractions outside the vehicle decreased the odds of severe injuries. For older drivers, the highest odds of severe injuries were observed with dialing or texting on a cell phone, followed by in-vehicle sources and talking on the cell phone. All these sources were associated with an increased likelihood of injury severity. Similar to young and mid-age drivers, distractions outside the vehicle decreased the odds of severe injuries. Other distraction types did not have a significant effect for the older age group. *Conclusions:* The results support previous literature and extend our understanding of crash injury severity. *Practical applications:* The findings have implications for policy making and the design of distraction mitigation systems.

1. Introduction

With the increasing sophistication of entertainment and driving assistance technologies on board, drivers are exposed to more distraction sources than before. Performing non-driving-related tasks imposed by these sources can divert driver's attention away from activities critical for safe driving (Lee, Young, & Regan, 2009). Recent naturalistic studies suggest a high prevalence of distraction in pre-crash moments. In the 100-car naturalistic study where 109 drivers were monitored, 80% of 82 crashes (mostly fender benders not reported to police) and 65% of 761 near-crashes that were recorded involved observable distractions (including eyes-off-road and conversing on the phone or with passengers) within 3 s before the event; whereas prior estimates had been in the range of 25% (Dingus et al., 2006). Similarly, a large naturalistic truck study identified driver distraction to be the immediate reason in 17% of crashes (Starnes, 2006).

Contrary to the high prevalence of distraction in pre-crash moments, it appears that distraction engagement in general is much lower. For example, in a study by Stutts et al. (2005) where video cameras were installed in the vehicles of 70 drivers in North Carolina and Philadelphia (where use of handheld phones was legal) and data were collected over a week, 34% of drivers used their cell phones while driving, but the time they spent on their cell phones was only 4% to 9% of their total driving time. In the same study, 90% of drivers adjusted their on-board radios or CDs, but the time they spent on these tasks constituted only 1.5% of their total driving time. Such contrary statistics provide additional motivation for studying these relatively low exposure activities that prevail in so many crash and near-crash events.

Willingness to engage in distracting activities as well as the ability to handle the effects of distractions varies across different age groups. In general, compared to mid-age drivers, younger drivers have worse vehicle control skills, less efficient visual scanning behaviors, and higher levels of risk taking tendencies including speeding (Boyce & Geller, 2002; Lee, 2007). This group of drivers also have a level of distraction engagement comparable to that of mid-age drivers (McCartt, Braver, & Geary, 2003), however, likely cannot handle the effects of distractions as well as mid-age drivers given their driving inexperience. Older drivers have a diminished ability to respond to hazardous situations due to age-related degradation in perception, cognition, and reaction (Ball, Owsley, Sloane, Roenker, & Bruni, 1993; Brennan, Welsh, & Fisher, 1997) and tend to exhibit compensatory behaviors such as

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driving slower than young and mid-age drivers (Reimer, Mehler, Wang, & Coughlin, 2012). Although this group of drivers may be less willing to engage in distracting activities compared to mid-age drivers (McCartt et al., 2003), if they are faced with an activity competing with the driving task, they may not be able to handle it given their relatively little spare capacity to deal with a competing activity (Koppel, Charlton, & Fildes, 2009).

Differential effects of distractions on the behavior of different age groups are expected to influence crash outcomes differently. Although several studies investigated the effect of various factors (e.g., speed, seat belt use, environmental conditions, vehicle types, crash types, as well as drivers' and other occupants' characteristics) on crash injury severities (Eluru & Bhat, 2007; Farmer, Braver, & Mitter, 1997; Huelke & Compton, 1995; Kim, Nitz, Richardson, & Li, 1995; Kockelman & Kweon, 2002), limited literature focused on driver distraction (Hanley & Sikka, 2012; Liu & Donmez, 2011; Neyens & Boyle, 2008; Zhu & Srinivasan, 2011), and no studies to our knowledge investigated the interactions between age and distraction.

Zhu and Srinivasan (2011) focused on truck drivers and found that distraction is associated with increased crash severities. Hanley and Sikka (2012) observed the opposite effect for passenger vehicles with distracted drivers being less likely to be involved in injury-related crashes compared to non-injury-related crashes. Further, they also identified a higher likelihood of driver distraction being underreported in no-injury crashes, leading to an understating of the true effect of driver distraction for no injury crashes if bias is not controlled for. Both Neyens and Boyle (2008) and Liu and Donmez (2011) considered different distraction types and identified that only certain distraction types (e.g., in-vehicle sources) are associated with increased crash severities. However, these studies also focused only on specific groups of drivers (i.e., teenage and police drivers, respectively). Our paper extends the scope of previous research by considering drivers of all age groups rather than just young drivers. With the proliferation of technology and in-vehicle devices used by drivers of all ages, this study aims to assess the relation of age–distraction interaction with driver injury severities. Investigation is carried out by employing an ordered logit model to predict how driver distraction and age relate to the odds that a driver will sustain a severe injury.

2. Method

Data from the U.S. National Automotive Sampling System's General Estimates System (GES) from the year 2003 to the year 2008 were used in the analysis. The GES data set is a stratified weighted sample of crashes, representing national crash trends, and includes information on several aspects of a crash such as driver and passenger demographics, crash types, and injury severities. GES classifies injury severity by an ordinal scale with levels of no, possible, non-incapacitating, incapacitating, and fatal injuries. Driver distraction type is also included and is based on the observations or deductions of the reporting police officer.

As a first step in understanding the associations between age–distraction interaction and driver injury severities, our analysis focused on two-vehicle crashes, for which the first harmful event is the direct crash of two moving vehicles. The victims of two-vehicle crashes represent the largest proportion of all crash victims (approximately 80%) according to GES data from 2003 to 2008, and it is reasonable to consider the vast majority before evaluating other crash types.

2.1. Categories of age and distraction type used in analysis

Common age thresholds used in driving safety and injury assessment are 25 and 65 (Liu, Utter, & Chen, 2007; Margolis et al., 2002; McGwin, Sims, Pulley, & Roseman, 2000). Thus, we adopted these thresholds for categorizing both drivers' and passengers' age. Occupants' (i.e., drivers and passengers) age was categorized into three levels: less than 25 years old, 25 to 64 years old, and 65 years old and up.

Broadly, driver distraction can be defined as "the diminished attention of the driver to the driving task" (Donmez, Boyle, & Lee, 2006). Attention may diminish due to an external source (e.g., using a cell phone) or internally (e.g., being lost in thought). Some definitions focus on the former (i.e., they define driver distraction as a consequence of external sources). For example, Stutts, Reinfurt, Staplin, and Rodgman (2001) state that distraction occurs when a driver is delayed in recognizing information necessary to drive safely because some event, activity, object, or person within or outside the vehicle compels the driver to shift attention away from the driving task.

In this paper, we adopt the broader definition of driver distraction to assess associations between various sources of distractions and crash outcomes. Distractions induced by sources external to the driver, which are reported in GES and used in our analysis, are as follows: talking on a cell phone (no distinction of handheld vs. hands-free), dialing/texting on a cell phone, in-vehicle distractions (i.e., in-vehicle physical activities such as eating, drinking, and using entertainment and A/C systems), passenger-related distractions, and distractions outside the vehicle (i.e., paying attention to non-driving-related objects outside of the vehicle, for example, commercial boards, natural scene, or people off the road).

As for internal sources, we investigate lost in thought and looked but did not see. Lost in thought and looked but did not see are referred to as inattention in GES; they are also often referred to as cognitive distraction in the literature (Liu & Donmez, 2011; Neyens & Boyle, 2007). Both terms are somewhat misleading given that inattention can be caused by a broad set of sources. Similarly, most, if not all distractions lead to a cognitive interference. We adopt the term "inattention" to maintain consistency with GES.

Different types of distractions were coded in GES as mutually exclusive, that is, a driver was not reported to have more than one type. The cases for which the distraction field had missing information or was coded as "unknown" were excluded from analysis. In order to detangle the effects of different distraction types, crashes where both drivers were identified to be distracted were also excluded.

2.2. Proportion of drivers by age and distraction type

A total of 115,796 GES samples were used in the model; a weighted total of 15,406,515 drivers. Table 1 presents the unweighted sample sizes, whereas Table 2 presents weighted proportions of drivers observed across different distraction types and age groups. In general, mid-age drivers constituted 51% of the sample, followed by young drivers at 46%, and finally old drivers at 3%. Twenty-three percent of the drivers were reported to be distracted, with the majority being inattentive (19%).

It should be noted that the percentage of distraction presence in the GES data is much smaller compared to the findings of recent naturalistic

Table 1
Unweighted sample sizes used in each distraction type–driver age category.

Type of distraction	Driver's age (unweighted sample size)			Total
	Young	Mid-age	Old	
Inattention	7,206	9,809	2,372	19,378
In-vehicle sources	564	794	60	1,418
Passenger-related distraction	233	369	14	616
Dialing/texting on cell phone	146	155	4	305
Talking on cell phone	208	231	14	453
Sources outside the vehicle	678	1,096	144	1,918
No distraction	44,329	46,274	1,096	91,699
Total	53,364	58,728	3,704	115,796