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Prevalence and distribution of young driver distraction errors in naturalistic driving

Cher Carney
University of Iowa

Daniel V. McGehee
University of Iowa

Michelle L. Reyes
University of Iowa

Comments

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Prevalence and Distribution of Young Driver Distraction Errors in Naturalistic Driving

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16. Abstract

Naturalistic driving studies are the latest resource for gathering data associated with driver behavior. The University of Iowa has been studying teen driving using naturalistic methods since 2006. By instrumenting teen drivers' vehicles with event-triggered video recorders (ETVR), we are able to record a 12-second video clip every time a vehicle exceeds a pre-set g-force threshold. Each of these video clips contains valuable data regarding the frequency and types of distractions present in vehicles driven by today's young drivers.

The 16-year old drivers who participated in the study had a distraction present in nearly half of the events that were captured. While a lot of attention has been given to the distractions associated with technology in the vehicle (cell phones, navigation devices, entertainment systems, etc.), the most frequent type of distraction coded was the presence of teen passengers engaging in conversation (45%). Cognitive distractions, such as singing along with the radio, were the second most common distraction. Cell phone use was the third most common distraction, detected in only 10% of the events containing distraction.

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Prevalence and Distribution of Young Driver Distraction Errors in Naturalistic Driving

FINAL REPORT
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Authors
Cher Carney, Daniel V. McGehee, Michelle L. Reyes

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A report from
Human Factors and Vehicle Safety Research Division
The University of Iowa
Public Policy Center
227 South Quadrangle
Iowa City, Iowa 52242-1192
Phone: (319)335-6800 Fax: (319)335-6801

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ABSTRACT

Background: Distractions represent a substantial driving safety concern and some have been identified as particularly dangerous for young drivers. These include peer passengers and technology—particularly cell phones. While there is an abundance of studies examining the risks of distracted driving using simulators and test tracks, we still do not know the true frequency with which driver distraction occurs. Naturalistic driving studies are one means of accomplishing this goal.

Method: Data from 30 16-year olds was collected using an event triggered video recorder installed in the subjects' vehicle. The data consisted of 12-second video clips (8-seconds prior to trigger and 4 seconds after), collected each time the accelerometer inside the recorder exceeded a pre-set lateral or longitudinal g-force. Videos containing safety-relevant events were kept for further analysis. All distractions present in the vehicle during the eight seconds prior to the trigger were reviewed and coded by video analysts.

Results: A total of 2,726 videos containing safety-relevant events were captured, with 52% of them showing some form of distraction present in the vehicle. Teen passenger distractions were the most frequent type of distraction present overall, cognitive distractions (i.e., singing to the music) were second and cell phone related distractions the third most frequent. Females were more likely to have distractions present, overall. Specifically, they were seen singing along to the music nearly twice as often, three times more likely to be engaged in personal hygiene related activities, four times more likely to be seen talking on the phone and seven times more likely to be texting than their male counterparts. Three-quarters of the events due to braking had distraction present compared to only half of the cornering events and half of the acceleration events. Passengers were present in only about half of the events coded as aggressive or reckless and only one-third of the crashes and near-crashes. However, when passengers were present, distraction was also coded as present over 90% of the time, with the passenger being coded as the distraction approximately two-thirds of the time.

Conclusions: Teen passengers are associated with distraction rather than more reckless driving. Crashes are equally likely to have distraction coded as present, about half of the time. Females, in particular, show more distraction in both safety-relevant and crash events. This data provides valuable insight about the activities that teen drivers are engaging in while driving. Using this methodology we found that exposure to technology-related distractions is consistent with surveys, observational studies and data from crash statistics. Additional studies are needed, as these data can help to direct future research regarding teen driving, distraction, and crash risk.

INTRODUCTION

Distraction is an extremely important issue in any discussion of driving, particularly teen driving. The highest incidence of distracted driving crashes and fatalities involve drivers under the age of 20. In 2009, 16% of teen drivers involved in a fatal crash were reported to have been driving distracted (NHTSA, 2010).

Inexperience (McKnight & McKnight, 2003; Greenberg et al., 2003; Patten et al., 2006), overconfidence (Finn and Brag, 1986; Brown and Groeger, 1988; Matsuura, 2005), social pressure (Farrow, 1987; Simons-Morton, 2005; Allen & Brown, 2008), a tendency to underestimate risk (Evans & Wasielewski, 1983; Horrey et al., 2008; Albert and Steinberg, 2011), and to engage more often in risky behaviors (McEvoy et al., 2006; Sayer, Deveonshire and Flannagan, 2005) are just some of the factors confronting the teen driver. Any or all may increase the chance of young drivers engaging in distracted driving, and if they do, make it more likely that their distraction will have an unfavorable outcome.

Driver distraction has been defined a number of ways over the years, but the most recent, widely accepted definition is a "diversion of attention away from activities critical for safe driving towards a competing activity, which may result in insufficient or no attention to activities critical for safe driving" (Regan et al., 2011). Distractions can be involuntary or voluntary, categorized as visual, auditory, cognitive and/or physical, and attention can be diverted by an object or an event inside or outside the vehicle.

Survey data from the last 10 years indicates that driver-reported distraction has not changed much. In a national survey of over 4,000 drivers conducted in 2002, drivers indicated that the distracting behaviors they engaged in most frequently while driving were talking with passengers (81%), changing a radio station or CD (66%), eating/drinking (49%) and using a cell phone (25%) (Royal, 2003). A more recent national telephone survey conducted in 2010 by the National Highway Traffic Safety Administration assessed attitudes, knowledge and behaviors regarding the distracted driving of over 6,000 drivers ages 18 and over (Tison, Chaudhary and Cosgrove, 2011). Other than an increase in cell phone use, nearly ten years later the reports are quite similar. Again, the most common distractions were reported to be conversing with other passengers (80%), adjusting the car radio (65%) eating/drinking (45%), and using a cell phone (40%). When it came to cell phone use, 70% of drivers ages 18-20 reported answering calls, 38% making calls, and 44% reported sending text messages while driving.

Even though distractions range widely, there are some that have been identified as particularly dangerous for young drivers. These include factors that have been the focus of much recent research: peer passengers and technology—particularly cell phones.

Cell Phones

In the last ten years, the number of cell phone subscriptions in the US has increased substantially—more than doubling from 141 to 326 million subscriptions from 2002-2012. (CTIA 2013; http://www.ctia.org/advocacy/research/index.cfm/aid/10323). Interestingly, that is more that the estimated US population (319 million). Results of NHTSA's 2011 National Occupant Protection Use Survey (NOPUS) estimate that at any time during the day, approximately 9% of drivers are using cell phones while operating a vehicle (Pickrell & Ye, 2013).

For teens, in particular, the cell phone is one of the principal modes of communication (Lenhart, Ling et al., 2010). According to the 2011 Pew Internet Project survey of teens, 77% own a cell phone (Lenhart, 2012). In a national survey of 16 and 17 year old drivers, conducted by the Pew Research Center in 2009, 52% reported using a cell phone while driving. However, a more recent analysis of data from the NEXT Generation Health Study found a much higher number, stating that 80% of teen drivers reported that they had talked on the cell phone while driving at least once in the last 30 days (Ehsani, Brooks-Russell et al., 2013).

Several experimental studies have examined the impact of cell phones on driving performance. Use of a phone while driving has been found to increase the frequency and size of steering wheel corrections and to cause more delayed and intense braking (Reed & Green, 1999; Hancock et al., 2003). Strayer and Johnston (2001) found that drivers talking on cell phones had slower reaction times and were twice as likely to miss traffic signals. The research suggests that even though drivers appear to be looking at critical objects in the driving environment, they fail to attend to them because their attention is drawn inward, toward the phone conversation (Beede & Kass, 2006; Strayer & Drews, 2007).

The results of several more recent naturalistic driving studies, however, have found that drivers who were simply talking on the cell phone (hand-held or hands-free) were not at an increased risk of being involved in a crash or near crash (Fitch, Soccolich et al., 2013; Hickman, Hanowski et al., 2010; Klauer, Dingus et al., 2006). In addition, some research has found that, in certain situations, talking on the phone while driving may be helpful, working as a deterrent to drowsy driving (Jellentrup, Metz et al., 2011). Thus, the net effect on safety is difficult to discern.

Texting

It seems that texting might be becoming the preferred mode of communication between teens. Between 2009 and 2010, adolescent females sent and received an average of 3,952 texts per month, while adolescent males sent and received an average of 2,815 texts per month. Data from Nielson show a 256% increase in monthly data usage among 12-17 year-olds from 2010-2011.The 2011 NOPUS observed a marked increase in 16-24 year-olds visibly manipulating the phone while driving, from 1.5 percent in 2010 to 3.7% in 2011 (Pickrell & Ye, 2013).

Several simulator studies have examined the effects of texting on driving performance. Results of one such study by Drews, Yazdani et al. (2009) found that compared to normal driving, a collision is six times more likely when a driver is texting. Kircher, Vogel et al. (2004) found that drivers who were asked to read and respond verbally to a text message drove slower and had longer brake reaction times. And, Hosking, Young et al. (2006) found that novice drivers had their eyes off the road four times as much when they were texting compared to when they were not. Additional research has shown that texting makes drivers less able to maintain their lane position (Drews et al., 2009) and impairs reaction time to traffic signs (Hosking, Young et al., 2009).

A recent naturalistic driving study that examined the use of cell phones while driving found that text messaging increased the risk of a crash or near crash by two times. With texting being one of the activities resulting in the longest eyes off road time—an average of 23 seconds total (Fitch, Soccolich et al., 2013).

Among 16-17 year-olds who own cell phones, 34% reported that they have texted while driving (Madden and Lenhart, 2009). In a survey of over 500 teen drivers in North Carolina, 4% reported "often" initiating a text conversation, 11% "often" replied, and 23% "often" read text messages while driving (O'Brien, Goodwin et al., 2010). The dangers of cell phone use and texting are not specific to drivers of any particular age group or experience level (Strayer & Drews, 2004; Kass et al., 2007). However, the fact that younger drivers are more likely than older drivers to engage in this behavior increases their risk.

Passengers

Research has shown that when teen drivers have teen passengers their crash risk increases. Thor and Gabler (2010) found that when carrying passengers, drivers ages 16-18 had about a 50% increased risk of a crash compared to adults. Chen et al. (2000) found that transporting passengers increased the relative risk of a fatal crash for 16- and 17-year-old drivers by a factor of nearly four. Tefft, Williams et al. (2012) estimated that 16-17 year-olds increase their risk of a fatal crash by 44% when carrying one passenger under the age of 21, double their risk with two passengers, and quadruple their risk with three.

One reason for this increase in crash risk is distraction. The National Motor Vehicle Crash Causation Survey (NMVCCS) dataset that shows passenger distraction was present in 48% of the young driver crashes involving any kind of distraction (Thor and Gabler, 2010). Such distraction might account for the substantial increase in crash risk that accompanies each additional teen passenger (Chen, Baker et al., 2000; Mayhew et al., 2003; Williams, 2003). Williams, Ferguson et al. (2007) found that "speeding, driver error, and single-vehicle crashes are more frequent with teenage passengers, and these characteristics increase with the number of teenagers in the vehicle."

According to an online survey of 1,000 15-17 year-olds, 47% of teenagers admitted that they were distracted just by having other people in the vehicle with them (The Allstate Foundation, 2005); 44% of teens said that they were safer drivers when they drove *without* their friends. A 2008 survey of over 1,700 California high school seniors found that nearly 45% reported passenger(s) talking, yelling, arguing or being loud, and 22% said that passengers distracted them by "being stupid" or "fooling around" (Heck and Carlos, 2008). Distractions due to passengers playing music or dancing were reported by 15.5%, while 7.5% reported deliberate distractions like tickling the driver or trying to manipulate the vehicle controls.

Distraction is particularly likely when teen passengers are present, not only because they distract teen drivers directly, but they increase the driver's tendency to engage in risky behavior. Albert and Steinberg (2011) describe cases where young drivers overestimate risk when alone, but do not think through consequences and underestimate crash risk when they are with other teens. A naturalistic study of novice teen drivers found that teens were 2.5 times more likely to engage in one or more risky driving behaviors when driving with a teen passenger.

While there is an abundance of studies examining the risks of distracted driving using simulators and test tracks, we still do not know the true frequency of driver distraction. Until recently, the only method for gathering information regarding how often drivers engage in distracting behaviors was through observational studies, survey data and police reports. There are many limitations associated with these methods, including;

- Observational studies are limited by researchers' ability to both see and understand what is happening inside the vehicle.
- Survey research shows that self-reporting of negative behavior is lower than the actual occurrence of that behavior.
- Drivers may be unwilling (or unable, in the case of fatalities) to admit to police officers that they were distracted at the time of a crash. In addition, there are often inconsistencies in the way in which distractions are reported (if at all), making it extremely difficult to compile reliable information.

Naturalistic driving studies are the latest resource for gathering data associated with driver behavior. The University of Iowa has been studying teen driving using naturalistic methods since 2005 (McGehee et al., 2007; Carney et al., 2010; McGehee et al., 2013). By instrumenting teen drivers' vehicles with event-triggered video recorders (ETVR), we are able to record a 12-second video clip every time a vehicle exceeds a pre-set g-force threshold. Such threshold exceedances are usually associated with abrupt braking or steering. Each of these video clips contains valuable data regarding the frequency and types of distractions being engaged in by today's young drivers.

For this study, a "distraction" is defined as anything that takes the driver's mind, eyes or hands away from operation of the vehicle. It is important to state that, we do not presume the presence of a distraction to mean the driver was distracted, or that any of the distractions caused an event to occur. For example, it is quite possible that singing could be distracting but it could also keep a driver who is tired awake. Similarly, a passenger could be distracting, or they could be helpful to the driver by pointing out an impending hazard. The aim of this study was simply to examine the naturalistic driving data of newly licensed teen drivers to determine the types of distractions that are present in the vehicle during driver errors. In addition, we examined whether certain distractions were more often present during specific types of driving errors, and whether more serious events were associated with specific distractions.

METHODS

Participants

The data used for this analysis was drawn from a naturalistic driving study of teen drivers conducted at the University of Iowa. That study examined three groups of 30 teen drivers: 14.5 year-olds (Iowa is one of six states that allows 14 year-olds to drive independently), 16 year-olds with previous driving experience, and newly licensed 16 year olds. Half of the teens were provided with feedback regarding their driving (i.e., intervention group) and the other half was not (i.e., control group) (McGehee et al., in progress). The sample for this study consisted of the thirty 16 year-olds in the control group of the previous study; the sample was balanced by gender. Participants were recruited from high schools within a 30-mile radius of the Iowa City area through letters sent home to parents. Teens were required to be the primary driver of a vehicle and to drive at least 1.5 hours per week. Participants received $250 in compensation for taking part in the study.

Equipment

Participants had their vehicles equipped with an event-triggered video recorder (ETVR) made by DriveCam. The system is a palm-sized device that integrates two video cameras, a two-axis accelerometer, a 12-second video data buffer, an infrared illuminator for lighting the vehicle's interior at night, and a cellular transmitter. The device is mounted on the inside of the vehicle's windshield behind the rearview mirror (Figure 1).

Figure 1. DriveCam Event-Triggered Video Data Recorder

The ETVR captures video from both inside and outside the vehicle (Figure 2), as well as audio. Video data is continuously buffered, but only writes to internal memory when an acceleration threshold is exceeded. Each video clip captures the eight seconds preceding and the four seconds following a threshold exceedance.

Figure 2. Exterior and Interior Video View Captured by DriveCam Cameras

DriveCam uses thresholds that roughly correspond to g-forces (+/- 10 percent). These thresholds refer to accelerometer readings that reflect changes in vehicle velocity or the lateral forces acting on the vehicle when cornering. If the acceleration exceeds the threshold value, an event is triggered. The trigger thresholds for this research project were:

- *Shock trigger threshold*: The force level for a “shock trigger” from any direction. Shock triggers are most often caused by severe impacts. The threshold setting for this study was ±1.50g.

- *Longitudinal trigger threshold:* The force level required to trigger the system with a positive or negative acceleration. Longitudinal triggers are most often caused by hard braking. The threshold setting used for this study was ±0.45g.

- *Lateral trigger threshold:* The force level required to trigger the system with a lateral acceleration. Lateral triggers are most often caused by hard cornering or swerving. The threshold setting used for this study was ±0.50g.

Settings were determined based on the guidance and experience of the manufacturer, as well as on those used in other naturalistic driving studies (Dingus et al., 2006). Our objective was to maximize the number of truly safety-relevant events captured, while minimizing the number of invalid triggers to be analyzed.

All data were automatically downloaded on a daily basis via a secure cellular connection. Once downloaded, the encrypted data were filtered to remove invalid triggers such as bumps. The data were then compiled for coding. DriveCam performed a preliminary examination of the videos to ensure that only valid triggers were included in the data made available to the University of Iowa team for detailed coding.

Procedure

The installation of each DriveCam system was completed at a local retail electronics store and took approximately 30-45 minutes. During installation, the cameras were adjusted to ensure that the view inside the vehicle captured all occupants. Window clings stating that those traveling in the vehicle might be recorded were affixed to the inside of each vehicle’s windows in an effort to notify all occupants that they could be filmed.

Participants were assigned to either the intervention or control condition in blocks of two within license group to ensure that enrollment in the two conditions was uniform throughout the study. The data used for this study was collected from the control group participants. These participants were informed that they had been randomly assigned to the control group and that they (as well as their parents) would not be receiving any feedback regarding their driving during their six months of participation.

Video coding

Every event captured by the system was reviewed to determine its cause and then classified into one of the following categories (Table 1):

Table 1. Classification of event types

Safety-relevant events	
Incident	A threshold exceedance in which the driver's action was responsible for a safety-relevant event.
Invalid trigger with feedback	Activation of the system due to something other than unsafe driving behavior (e.g., the vehicle hitting a bump or manual activation by someone in the vehicle) in which the video reviewer documented a safety-relevant concern (e.g., unbelted occupant, cell phone use, failing to stop for traffic signs/signals).
Near-crash	A threshold exceedance in which the participant performed an evasive maneuver in order to avoid a collision.
Crash	The participant collided with an object or vehicle.
Good response	A threshold exceedance in which the driver responded appropriately to an external event.*
Invalid events	
Invalid trigger	Activation of the system due to something other than unsafe driving behavior (e.g., the vehicle hitting a bump/pothole in the roadway or manual activation).
Non-participant	An event that occurred while someone other than the participant was driving the vehicle. These video events were not reviewed.

*Note: although classified as valid triggers, videos with good responses were not included in the analyses of safety-relevant events.

Once the causes of the events were determined, only those determined to be safety-relevant were analyzed further, invalid events were discarded. The events were scored to populate a database containing the nature of the event, its cause, the number of vehicles involved, and the action of the driver. Additional data, including information about safety belt use, the presence of loud music, and aggressive or reckless driving and the number, location, and age of passengers was also entered into the database. Environmental factors such as weather, lighting, road conditions, road geometry, and road type were also recorded.

Distraction Coding

For this analysis, particular attention was paid to the coding of driver-related factors such as distraction, when present. All safety-relevant events for the 30 drivers were re-examined to ensure that distraction coding was comprehensive and consistent. Distractions were coded only if they occurred during the eight seconds prior to the event trigger. This was done in order to exclude distractions that might have been caused by the trigger itself (e.g., a passenger's reaction to a driver's fast turn). Up to three distractions could be coded for each event. Table 2 shows all main categories of distraction coded for this study. Each category is broken down into individual distractions. Definitions guided the analysts in coding the events.

Table 2. Distraction Codes and Definitions

Cognitive Distractions	
Looked but did not see/inattentive	Driver appears to be looking at the roadway but has a delayed response or no response at all to the hazard or situation ahead; driver seems surprised or states that they were unaware.
Reading	Driver is reading papers, a magazine, book or map. If reading information from a phone or mp3, code as phone or mp3.
Talking/singing to themselves	Driver is talking or singing to themselves, regardless of the volume. Humming or whistling is also coded.
Dancing to the radio	Driver is moving any part of their body along with the music.
Route planning/navigating	Driver is talking aloud or with passenger regarding a route or maneuver they will need to take.
Listening to headphones	Driver is wearing headphones/earbuds.
Upset emotionally	Driver is obviously emotionally upset (e.g., crying, angry yelling).
Passengers	
Teen in adjacent front seat	Teen passenger seated in the front is distracting in some way (see Table 3 for passenger distraction coding)
Teen in rear seat	Teen passenger seated in the back is distracting in some way (see Table 3).
Adult in adjacent front seat	Adult passenger seated in front is distracting in some way (see Table 3).
Adult in rear seat	Adult passenger seated in the back is distracting in some way (see Table 3).
Child in adjacent front seat	Child passenger seated in the front is distracting in some way (see Table 3).
Child in rear seat	Child passenger seated in the back is distracting in some way (see Table 3).
Object/Animal/Insect	
Moving object in vehicle	An object moving around inside the vehicle gains the attention of the driver.
Insect in vehicle	An insect flying around inside the vehicle gains the attention of the driver.
Pet in vehicle	Any interaction with a pet inside the vehicle.
Object dropped by driver	Driver drops an object inside the vehicle and their attention is directed toward the object.

Reaching for object (not cell)	The driver is attempting to locate/reach for an object inside the vehicle.
Cell Phone	
Talking/listening	Driver is engaged in a cell phone conversation.
Cell phone use	Driver is scrolling, or dialing the cell phone.
Hands-free cell phone use	Driver is operating a hands-free cell phone.
Locating/reaching for/putting away	Driver is reaching for the cell phone.
Texting	Driver is reading/writing texts.
Other Electronics Device (PDA/MP3/IPod/Nav system)	
Viewing device	Driver is looking at the device.
Operating device	Driver is using the device.
Locating/reaching for device	Driver is reaching for device.
In-Vehicle Systems	
Adjusting climate controls	Driver is reaching for/adjusting the HVAC system.
Adjusting radio/music	Driver is reaching for/adjusting the radio/music.
Inserting/retrieving CD	Driver is inserting/retrieving CD from player.
Adjusting other device (unknown)	Driver is adjusting another in-vehicle device (sunroof, seat, windows, etc.).
External	
Looking at an external incident	Driver is looking outside the vehicle at some type of traffic incident/collision.
Pedestrians located outside the vehicle	Driver is looking at/engaging with a person located outside the vehicle
Animal located outside the vehicle	Driver is looking at an animal located outside the vehicle
Object located outside the vehicle	Driver is looking at something located outside the vehicle, most likely on the side of the roadway.
Another vehicle	Driver is distracted by another vehicle or person(s) inside another vehicle. The vehicle can be driving or parked and contain passengers or not.
Construction	Driver is distracted by construction, worker, or equipment along roadway.
Looking out left window	Driver is looking out of the left window.
Looking at left mirror	Driver is looking at the left mirror.
Looking in rearview mirror	Driver is looking out the rearview mirror (not at backseated passenger).
Looking at right mirror	Driver is looking at the right mirror.

Looking out passenger window	Driver is looking out of the passenger-side window.
Looking over shoulder	Driver is looking over their shoulder, in their blind spot.
Dining	
Eating with a utensil	Driver is eating food with a utensil.
Eating without a utensil	Driver is eating food without a utensil.
Drinking from a covered container	Driver is drinking through a straw or from a covered container.
Drinking from uncovered container	Driver is drinking from an open cup.
Reaching for/putting away food or drink	Driver is reaching for or putting away food or drink.
Personal Hygiene	
Combing/brushing/fixing hair	Driver is grooming or styling hair. Driver may or may not be looking in a mirror. (Habitual hair twirling or brushing hair out of eyes was not coded.)
Applying makeup	Driver is applying makeup with or without the use of a mirror.
Shaving	Driver is shaving with or without the use of a mirror.
Brushing/flossing teeth	Driver is brushing/flossing teeth/ using toothpick.
Biting/picking nails	Driver is biting or picking at nails with or without looking at their hands.
Removing/adjusting jewelry, sunglasses, hat, or clothing	Driver is removing or adjusting jewelry, sunglasses, hat or clothing.
Looking in the vanity or rearview mirror at themselves	Driver is looking at themselves in the rearview or vanity mirror.
Other	Driver is cleaning/adjusting/altering or removing something on their person.
Internal	
Looking down inside the vehicle	Driver is looking down inside the vehicle.
Looking at event recorder	Driver is looking directly at the event recorder.
Looking in back seat	Driver is looking in the back seat.

In addition to coding the presence of a distracting passenger, it seemed important to indicate the type of distracting behavior the passenger was engaging in. We adapted the codes used by Heck and Carlos (2008) to capture additional details surrounding the distracting behavior of passengers. Table 3 shows the passenger distractions coded for this study.

Table 3. Passenger Distractions Codes

Passenger Distractions	
Code	
The driver is involved in a conversation with a passenger	This is coded when the passenger is talking to the driver or the driver is talking to a passenger. Includes laughing together.
Passenger is angry/emotional	The passenger is yelling at the driver or another passenger. The passenger is crying or upset.
Passenger is being noisy	The passenger is singing, yelling, whistling, etc.
Passenger is moving around inside the vehicle	The passenger is switching seats, wrestling with another passenger, dancing.
Passenger touches the vehicle controls	The passenger changes the radio station, temperature controls or music volume.
Passenger diverts the driver's attention from driving	The passenger is giving the driver directions or showing the driver something.
Passenger is on phone	Passenger is involved in a cell phone conversation.
Passenger is texting	Passenger is texting.
Passenger has a mishap	Passenger spills or drops something or accidentally touches a vehicle control.
Passenger is purposely distracting driver	Passenger is poking, tickling, grabbing or hitting the driver.

Data Analysis

Only safety-relevant events described above were analyzed—good responses were not analyzed. Safety-relevant events were comprised of true triggers (i.e., incidents, near-crashes, and crashes), and of invalid triggers where safety concerns were observed. It should be noted that true triggers were less likely to be affected by characteristics of the driving environment, while invalid triggers were often directly related to the prevalence of things like rough roads. However, both cases provided a window into driving behavior and captured potential safety-related events. Therefore, invalid events that contained safety-relevant behaviors, such as not wearing seat belts, were combined with safety-relevant events in our analysis.

Descriptive statistical analyses were conducted to determine the frequency and types of distractions present in vehicles. Prevalence of distraction by gender was also analyzed. Distractions present during braking, turning and acceleration events were examined as well as those present during aggressive/reckless driving events. The most serious events—near crashes and crashes—were also explored.

RESULTS

A total of 2,726 safety-relevant events were captured for the thirty, 16-year-old teens in the control group. Of these events, over 50% had some type of distraction present during the 8 seconds prior to the trigger. Of the 50% of events with distraction, more than 75% had a single distraction present, 21% had two distractions, and 2% had three distractions present either simultaneously or sequentially during the 8 seconds prior to the event trigger. Therefore, for the 1,412 events in which a distraction was present, 1,770 distractions were coded. Table 4 summarizes the percent of events that had no, one, two, or three or more distractions.

Table 4. Summary of Number of Distractions Detected

Number of distractions	Number of Events	Percent of Total Events
None	1314	48%
One	1089	40%
Two	288	11%
Three or more	35	1%

Figure 3 shows the percent of events containing distractions by gender. Results indicate that females were more likely than males to have distractions present during events (58% vs. 45% of events). When distraction was coded for female driving events, 79% had a single distraction, 19% had two distractions, and 2% had three or more distractions during a single event. For male drivers, when distraction was coded, 75% of the time there was a single distraction, 23% there were two, and 3% had three or more distractions.

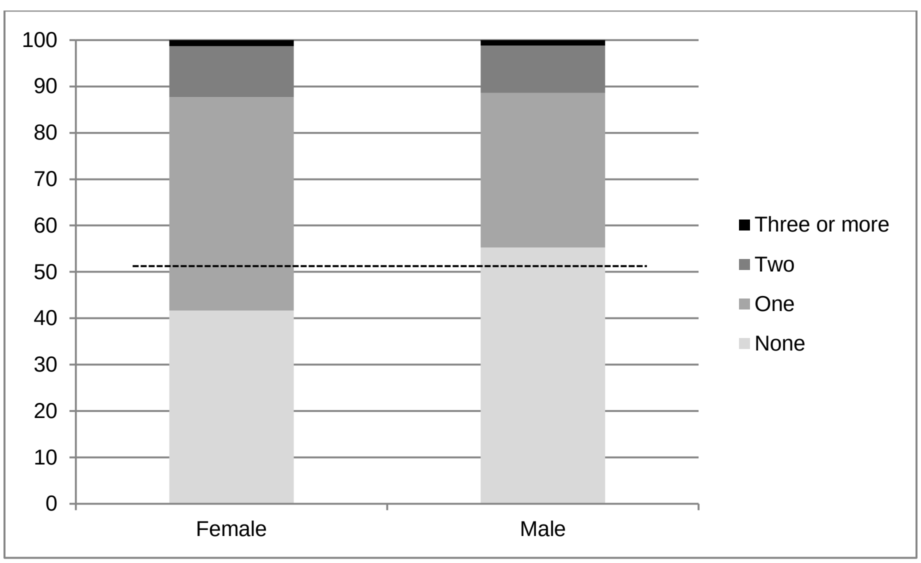

Figure 3. Number of distractions by gender with the dotted line showing the mean percent events containing at least one distraction

Drivers triggered an average of 91 events, ranging from two drivers who did not trigger any events to a driver who triggered 373. The proportion of events with distractions varied from 100% to 20%, with the mean proportion being 53%. The distribution of events both with and without distractions present is displayed in Figure 4.

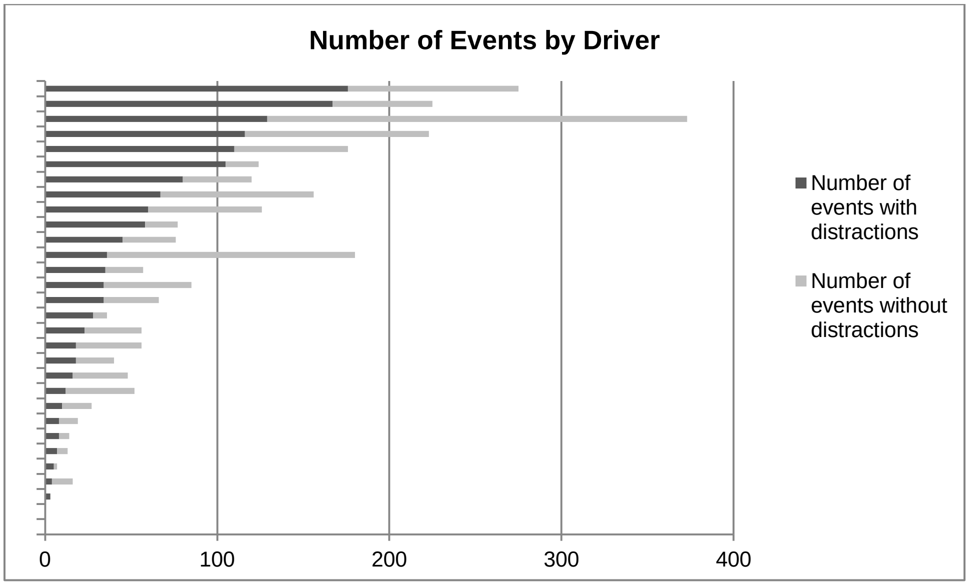

Figure 4. Number of events with and without distraction by driver

An analysis of all 1,770 coded distractions found that 45% involved a front or rear-seated teen passenger, 29% were cognitive distractions, and 8% where distractions was related to cell phone use. The other 18% of distractions were: external (5.6%), use of in-vehicle systems (3.4%), personal hygiene (2.9%), dining (2.1), passengers other than teens (1.5%), internal (1.4%), object/animal/insect (0.7%), and other devices (PDA, mp3, iPod) (0.7%). The breakdown by gender can be seen below in Figure 5.

Compared to their male counterparts, females had three times the number of events with personal hygiene coded as a distraction and more than double the cell phone related distractions. They were also 1.5 times more likely to have cognitive distraction present. Distractions from teen passenger as well as external distractions showed no difference in frequency with regard to gender.

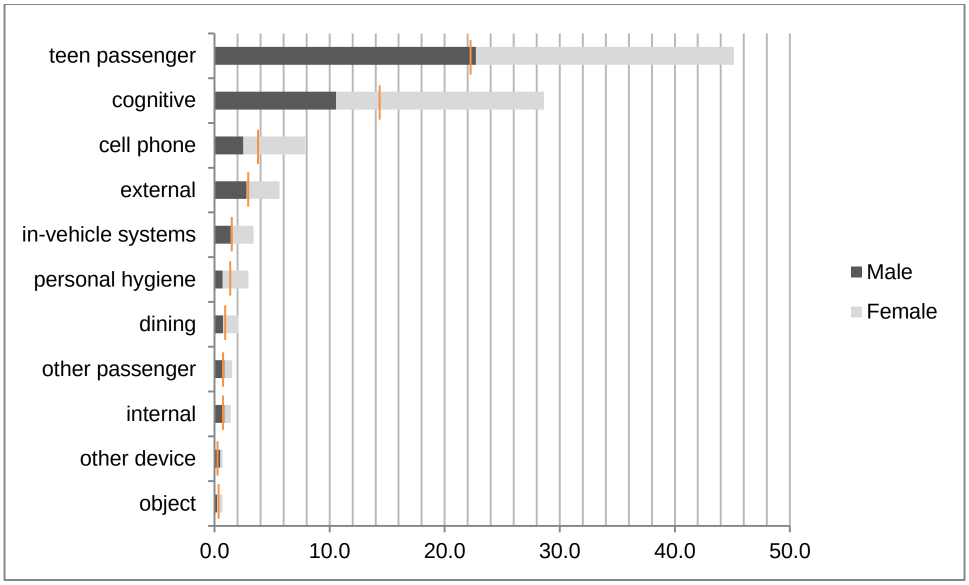

Figure 5. Breakdown of distractions by gender

Most Prevalent Distractions

Cell Phone Distractions

Cell phone was the third-most-often coded distraction type, with nearly 8% of all distractions coded being related to cell phone usage. Over two-thirds (68%) of the cell phone distractions occurred when females were driving, compared to 32% for males. When cell phone use was visible, 61%% of the time they were engaging in visual manual tasks such as dialing or texting 34% of the time drivers were talking or listening, and 5% of the time they were reaching for/putting away the phone. Females were nearly four times more likely than males (27% vs. 7%) to be talking on the cell phone while driving and 7 times more likely to be engaged in texting (30% vs. 4%).

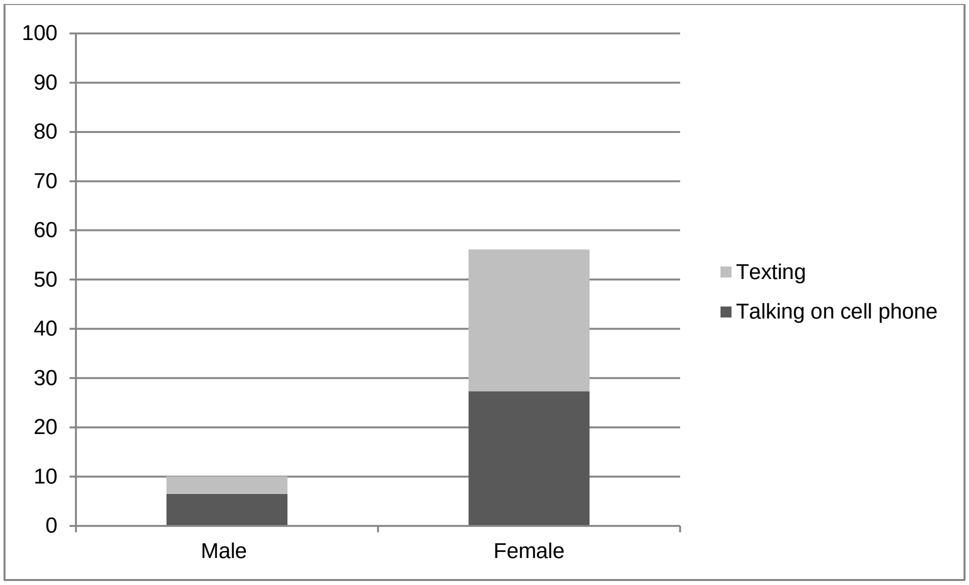

Figure 6. Cell phone distraction by gender

Cognitive Distractions

Cognitive distractions were the second most frequent type of distraction, accounting for 29% of all distractions. Nearly two-thirds (63%) of all cognitive distractions occurred when females were driving. When cognitive distractions were broken down, singing or talking to oneself accounted for 82% of these distractions. Females were almost twice as likely to be distracted by singing/talking to themselves as males (53% vs. 28%).

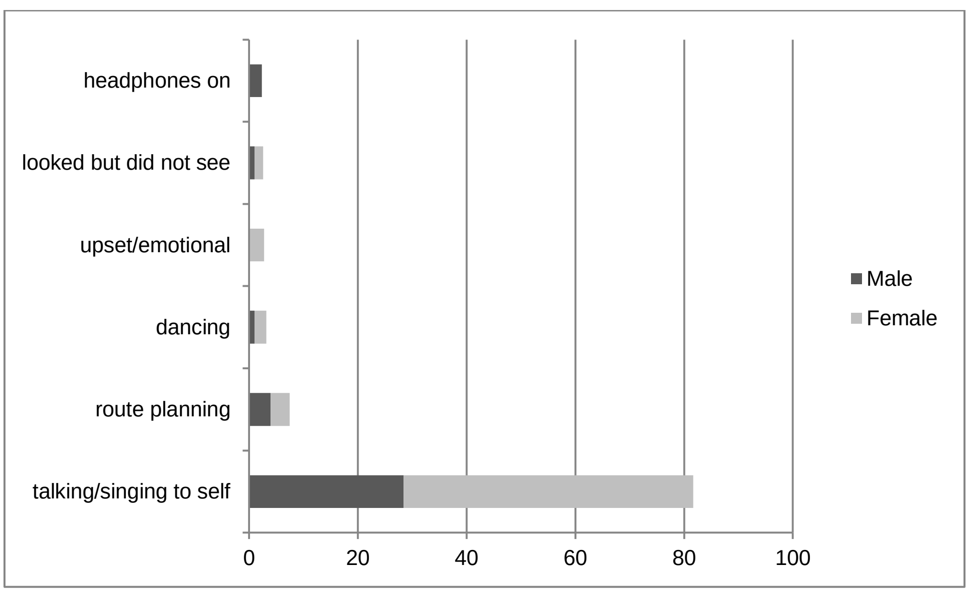

Figure 7. Cognitive distractions by gender

Passenger Distractions

Teen passengers were present in 947 of the 2,726 total safety-relevant events. That is slightly more than one third of the total number of events. When male teens had teen passengers, 60% of the time there was only one, 23% of the time they had two, and 17% of the time they had three or more. For female drivers with teen passengers, 66% had a single passenger, 19% had two, and 15% had three or more.

Of the 947 events in which teen passengers were present, 709 were coded as the passenger being a distraction. Therefore, 75% of the time, when passengers were present in the vehicle, they were involved in some type of activity that could have been distracting to the driver. Gender had little effect on the percent of events containing passenger distraction—49% for males and 51% for females.

When a single teen passenger was present, 70% of the time teen passenger distraction was coded. As the number of passengers increased, so did the percent of events coded for passenger distraction; to 83% for two teen passengers and 85% for three or more passengers. The most frequent passenger distraction coded was conversation, present 73% of the time a teen passenger was present. Other types of activities that passengers engaged in included: making loud noises (11%), giving directions or showing the driver something outside the vehicle (6%), and texting (5%). These four categories made up almost 95% of the passenger distractions coded. Interestingly, as the number of passengers increased in the vehicle, the percent of events with passengers talking to the driver and texting decreased, while the percent of events with passengers making loud noises increased. In fact, the percent of events with passengers “yelling, screaming or singing” was 2.5 times greater when there were 3 or more passengers present in the vehicle than when there was only 1.

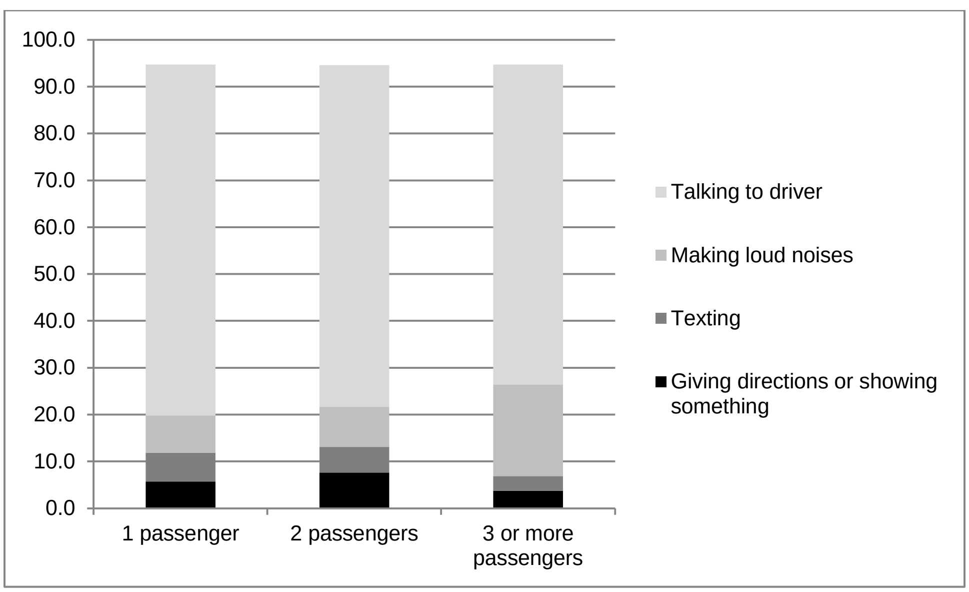

Figure 8. Passenger distractions by number of passengers present

Distractions by Event Type

Distractions present during different types of events were examined in the next section. Safety-relevant incidents, such as braking, cornering and acceleration events which triggered the event recorder due to g forces that exceeded the lateral or longitudinal thresholds were looked at first. Next we examined those safety-relevant incidents that were coded by reviewers as being aggressive/reckless driving. Aggressive and or reckless driving was defined as "purposeful, dangerous and unnecessary actions which put the driver and others at risk of injury". And finally, we examined near crashes and crashes. Near crashes were defined as an event in which an evasive maneuver was necessary to avoid a collision. Crashes were defined as a collision with another vehicle or object.

Prevalence and Type of Distractions Present during Braking, Cornering and Acceleration Events

There were a total of 2527 safety-relevant incidents triggered by lateral or longitudinal forces, not due to a near crash or crash. Of these incidents, 193 (8%) were caused by hard braking and 2251 (89%) were caused by cornering. The additional 3% were caused by acceleration. An examination of these incidents found that a distraction was present for nearly 75% of the braking events but for only 49% of the cornering events and 55% of the acceleration events.

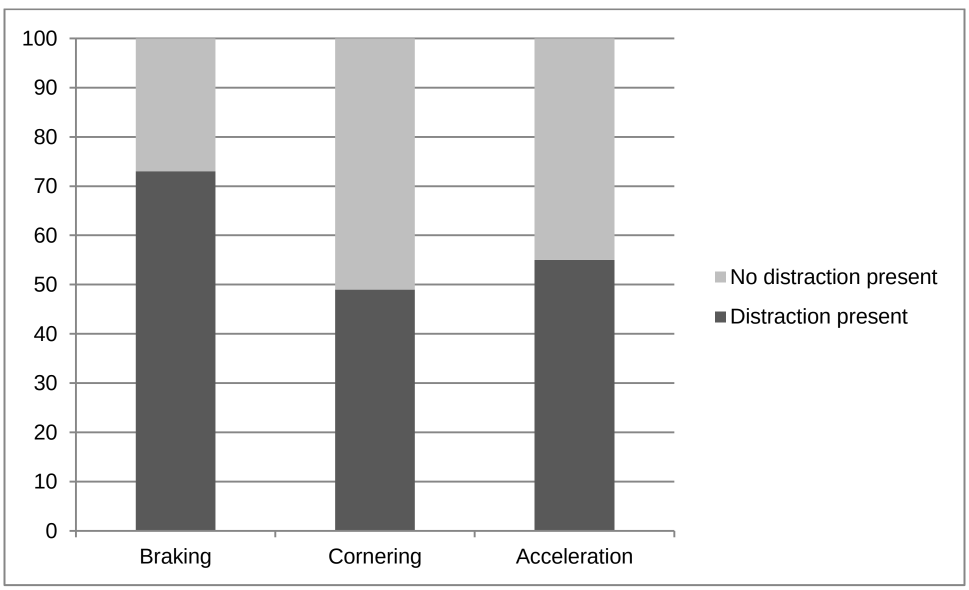

Figure 9. Prevalence of distraction during braking, cornering and acceleration events

Teen passengers were equally likely to be coded as a distraction for both braking and cornering events (47% and 45% respectively), but were coded as a distraction slightly more often when acceleration triggered the event (52%). Cognitive distraction was the second most coded distraction for all three types of events. However, cognitive distraction was present 1.5 times more frequently during cornering events (31%) than braking (20%) or acceleration (22%). External distractions were present in 18% of the acceleration events, that is 1.5 times more frequently than during braking events (12%) and more than three times as often as during the cornering events (5%). Cell phone distractions were coded in 6% and 7% respectively of the braking and cornering events and less frequently in acceleration events (4%).

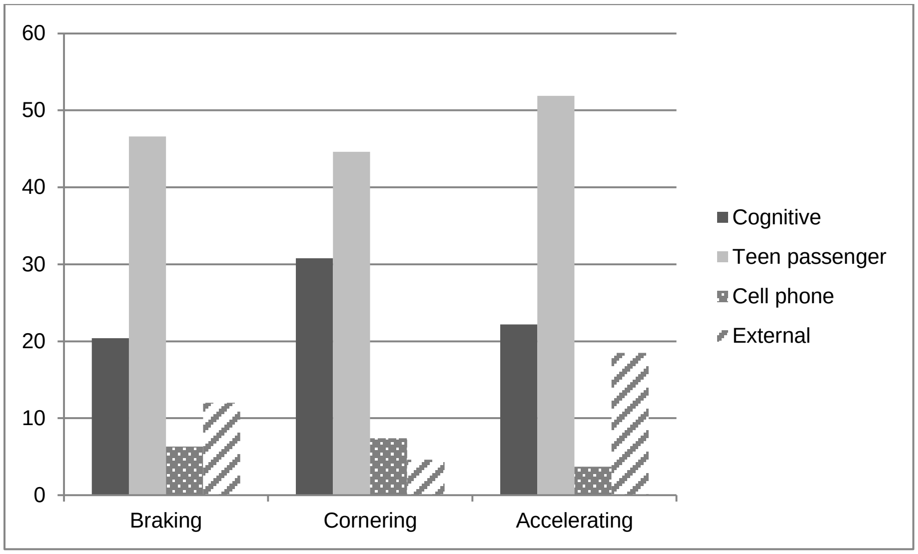

Figure 10. Types of distractions present during braking,cornering and acceleration events

Prevalence and Type of Distractions Present during Reckless/Aggressive Driving Events

There were 347 events coded as aggressive or reckless driving. Only about half (53%) of those had teen passengers present (Figure 11). For those events with a passenger present, 90% had some form of distraction coded, with the teen passenger being the distraction 66% of the time. Of the aggressive or reckless events with no teen passengers, only 47% had some form of distraction coded, with the most frequently coded distractions being singing/talking to themselves (29%), cell phone (23%), and another vehicle or driver (19%).

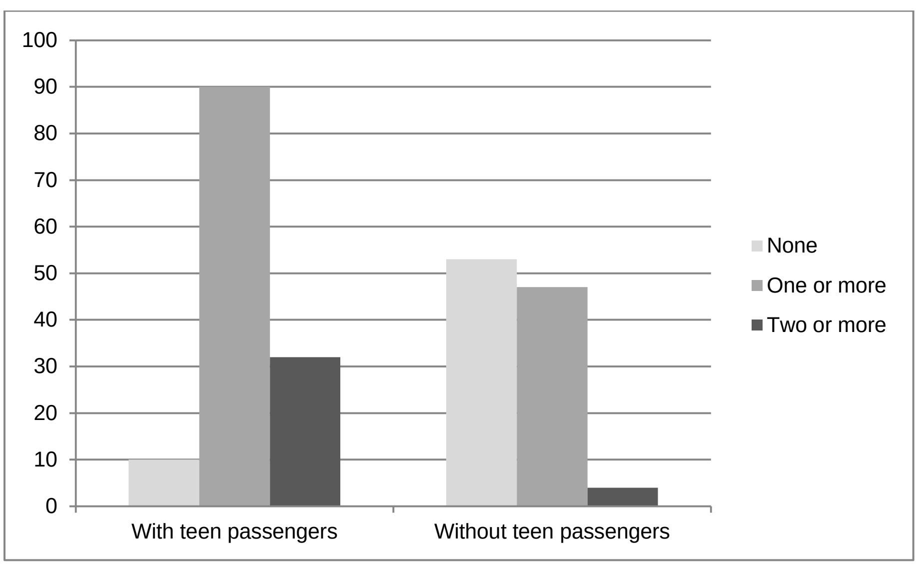

Figure 11. Number of distractions present by passenger presence for reckless/aggressive events

Aggressive or reckless behavior was coded as present in about 2% of the near-crashes and crashes compared to 4.7% of the incidents. In addition, it was coded most often during the acceleration events (37%), compared to only 5% of the braking and 4% of the cornering events.

Prevalence and Type of Distractions Present during Near-Crash/Crash Events

There were 93 events that captured a near-crash (NC) or crash. The most frequent distractions coded were teen passenger, cognitive, and cell phone. These were also the most frequent distractions present in all other safety-relevant events. However, the rate of teen passenger distractions was lower for near-crashes and crashes (35%) compared to all other incidents combined (46%). Cognitive distractions were fairly consistant across event types accounting for 31% of distractions during near-crashes/crashes and 29% during all other incidents. However, the rate of cell phone distractions was 1.5 times higher during near-crashes and crashes than during other incidents and personal hygiene was more than twice as likely to be coded during a near-crash or crash (7% vs. 3%).

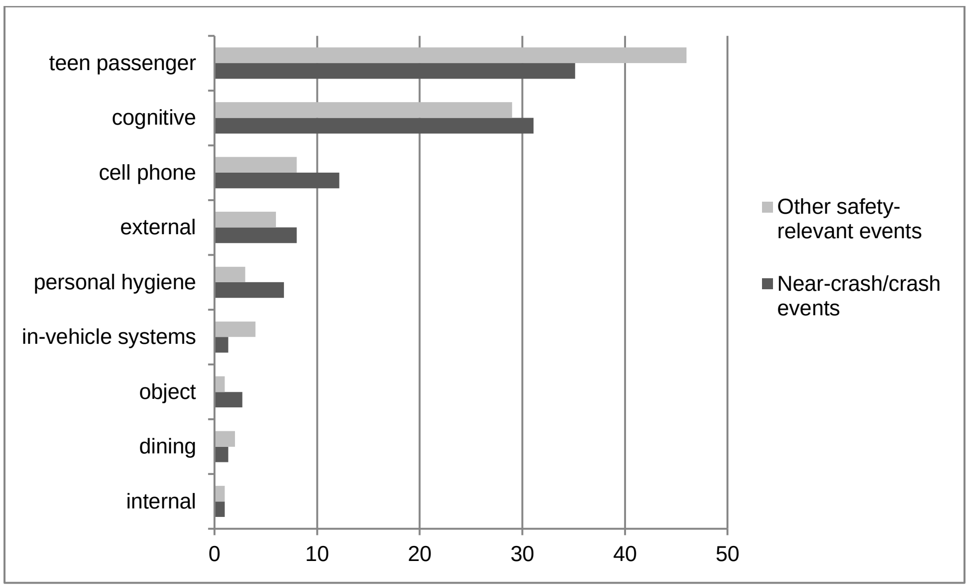

Figure 12. Types of distractions present during near-crash/crash events compared to safety-relevant events

In about one-third (38%) of the near-crashes and crashes, teen passengers were present. Of that 38%, 91% had some form of distraction coded, with the distraction being a teen passenger nearly 60% of the time. Almost 70% of the time, the type of distraction coded for the passenger was simply “having a conversation.” For the near crashes and crashes with no teen passengers present, only 45% had a distraction coded, with over half being coded as singing/talking to themselves (53%) (Figure 8).

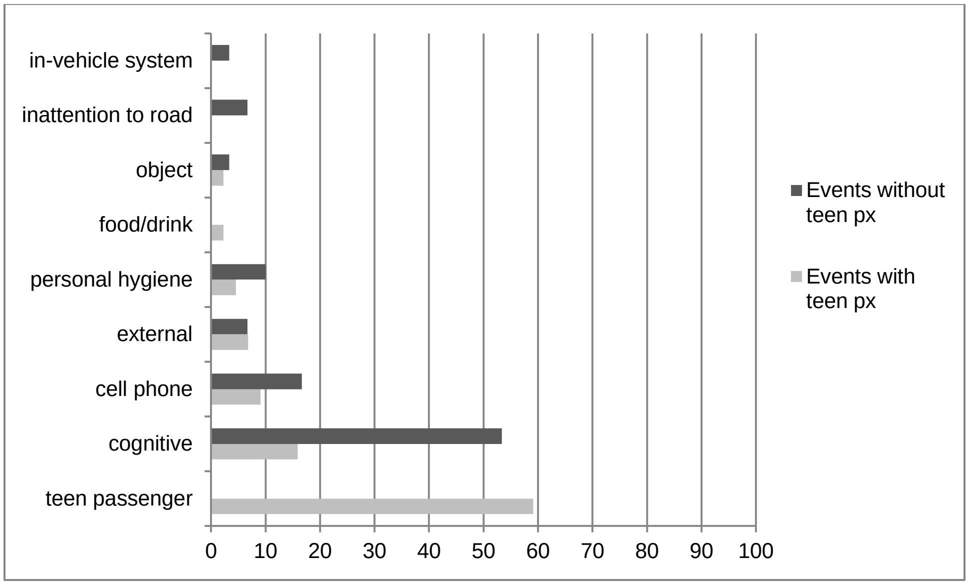

Figure 13. Types of distractions in near crash and crash events by passenger presence

A review of the 53 crashes found that nearly half, 49 percent, did not have any distraction coded as present in the vehicle during the 8 seconds before impact. A single distraction was present leading up to 38% of the crashes and 13% had more than one distraction. When distraction was coded, 39% of the time it was cognitive, 31% of the time it was a passenger and 14% of the time it was related to cell phone use.

DISCUSSION

While a lot of attention has been given to the distractions associated with technology in the vehicle (cell phones, navigation devices, entertainment systems, etc.), the most frequent type of distraction coded was the presence of teen passengers engaging in conversation (present in 57% of the events containing distraction). The 2012 National Survey on Distracted Driving Attitudes and Behaviors, conducted by NHTSA surveyed over 6000 drivers, age 16 to 34, about their attitudes and behaviors related to distracted driving. When they were asked about the activities that they engage in while driving, the highest frequency responses was “talking to other passengers in the vehicle”, with 49% reporting that they always or almost always do so (Schroeder, 2013)

Some research has shown that conversation negatively effects driver performance. Slower reaction times and fewer correct responses to a peripheral detection task were found by Amado et al. (2005). Similarly, increases in RT for drivers engaged in passenger conversations were found by Collet et al. (2009). However, additional research has shown results to the contrary. A simulator study conducted by Drews et al. (2008) found that conversing with passengers was found to have little to no effect on lane keeping, headway or performance on a navigation task and in fact, passengers “took an active role in supporting drivers by directing attention to surrounding traffic when perceived necessary.”

Driving research regarding the effect of passenger conversation on young novice drivers is extremely limited. However, due to the frequency of this behavior and the unclear impact it has on driving performance, much more research is needed.

Cognitive distractions, such as singing along with the radio and talking to oneself, were the second most common type of behavior recorded (present in 36% of events with distraction coded). This result is not surprising, given that listening to music is reported to be the most common activity that drivers engage in (Brodsky, 2013 and Rentrfrow and Gosling, 2003). A survey of American drivers found that 91% play music in the background and 71% sing along (Quicken, 2000). Similarly, a large survey of British drivers conducted in 2007 found that 60% of drivers ages 18-29 reported "I often sing along to the music."

Cell phone use was the third most common distraction, detected in 10% of the events containing distraction. This reflects what has been seen in other observational and naturalistic studies. In 2006, data was collected from 108 participants in Michigan who drove with instrumented vehicles for six weeks. Results showed that younger drivers, ages 20-30, were engaged in a cell phone conversation 8.8% of the time (Funkhouser and Sayer, 2012). Oberservational studies conducted in 2008 examined cell phone use among teen drivers ages 16-17 in both North and South Carolina. Results showed phone use to be present 9.7% and 12.1% of the time respectively (Goodwin et al., 2012). And a more recent observational study conducted in California in 2012 found that 16-24 year old drivers had an 11.4% rate of cell phone use (Cooper et al., 2013).

While cell phone distractions were only the third most frequent distraction present, it is important to note that the numbers of teens with cell phones continues to increase. The Pew Research Center (Lenhart, 2012; Lenhart et al., 2010) found that, in 2011 75% of teens reported having their own cell phone, with the average age of ownership being 11.6 years old. While talking on the cell phone has declined from 38% in 2009 to 26% in 2011, texting has increased. And older teens ages 14-17, went from sending a median of 60 texts per day in 2009 to a median of 100 in 2011. In addition, teens are more frequently becoming the owner of smartphones with access to the internet and social media sites. These facts make it important to continue to review the frequency and effects of cell phone use on teen driver safety.

In addition, there was a clear gender divide in terms of how cell phones were used. Females were just as likely as males to talk/listen or dial the cell phone but 7.5 times more likely to be seen texting. This is in accord with other mobile phone studies which report that females send more and/or longer texts, or are more likely to use texting, than males (Lenhart et al., 2010). Girls ages 14-17 are texting a median of 100 texts a day compared with 50 for boys the same age (Lenhart, 2012). Other gender differences included a higher overall frequency of events with distraction for females (58% vs 45%). Females were also three times more likely to have personal hygiene coded as distraction and 1.5 times more likely to have some form of cognitive distraction present (i.e., singing along to the radio).

Distractions were not evenly distributed across event type. In general, drivers were 1.5 times more likely to have a distraction present during a braking event than during a cornering event. One possible explanation, coming from the control theory perspective, is that drivers use certain strategies to maintain their driving performance at a certain level and may choose to engage in distracting activities less often while preparing for a turn or turning, when workload is higher, especially for novice teen drivers (Sheridan, 2004; Young & Regan, 2007). However, another explanation might be that the impact of distraction on detection and response time to targets has a greater impact on braking events.

Perhaps surprisingly, results showed that when drivers were engaged in reckless or aggressive behavior, they were only slightly more likely to have passengers in the vehicle (53% vs. 47%). Research has shown that some people are simply more likely to seek out "intense" experiences (Zuckerman, 1979; 1994; 2007; 2010). These sensation seeking individuals do not need to have passengers present to get the thrill from driving aggressively or recklessly. Another naturalistic driving study conducted by Virginia Tech found similar results, concluding that risky driving was ***not*** more likely to occur when teen passengers were present. In fact, rates were lower when passengers were present than when the teens drove alone (Simons-Morton et al., 2011). In a study by Arnett, et al. (1997), adolescents self-reported that the presence of friends did not cause more reckless driving behavior. These results confirm that driving style and personality traits play a large role in risky driving and teen crash rates.

Another interesting finding from this research was that in 49% of crashes, there were no distractions present in the 8 seconds prior to the crash. This corresponds to an analysis of the NASS CDS database from 1995 to 1999, which examined driver attention variables at the time of the crash (Stutts et al., 2001). Results of their analysis showed that 48.6% of drivers were classified as attentive at the time of the crash. In addition, our results also showed that those drivers involved in crashes and near crashes were more likely to be alone in the vehicle (62%). When they were alone, if distraction was present, it was most likely to be some form of cognitive distraction. When they had passengers, if distraction was present, the driver was most likely to be engaged in a conversation.

CONCLUSION

Data regarding teen driving distraction has largely come from surveys, observational studies and police reports. These methods have several limitations making it difficult to gather reliable information that describes the driving context surrounding the activity. This study allowed us a rare 12-second look into the vehicle of a teen driver and provided insight into the type and prevalence of distracting activities present. Results showed that distractions are common, present in approximately half of the safety-relative incidents and collisions. The most common distractions were conversations with teen passengers, singing along to the music, and operating a cell phone.

There are a number of limitations associated with this research that are important to acknowledge. First, all of our data comes from the 12-seconds surrounding a hard braking or corning incident. There is no baseline data or random events to compare against. One could argue that, while texting might occur infrequently, when it does occur a triggered incident may be more common, inflating the prevalence of this distraction type. However, teen drivers frequently talk with their passengers leading one to expect that nearly every event captured with passengers present would contain passenger distraction. Interestingly, neither one of these results were seen.

It is also important to be careful when we discuss this data that we do not presume that the presence of a distraction means that the driver was distracted, or that any of the distractions caused the incident to occur. For example, the presence of “singing” in the vehicle, which is coded as a cognitive distraction, might actually stave off mind wandering and drowsiness to enhance focus on the road.

In addition, we were not able to measure many aspects of cognitive distraction, such as inattention, lost in thought or looked but did not see. These types of distractions are extremely difficult, if not impossible to code using naturalistic data. Unless something in the driving environment requires a response from the driver, and that response is either late or does not occur, an analyst will have a difficult time determining the attentional state of the driver at any point in time. Therefore, for this particular study, the code “looked but did not see” was used very rarely--only when the driver was late or neglected to respond to an impending situation ***and*** it was obvious, either from a driver statement or a look of great surprise on their face, that they had not been paying attention to the driving environment.

Due to these limitations it is difficult for us to discuss the results beyond general exposure and we cannot generalize our results to safety consequences. However, we did find congruence between many of our results and those seen in other naturalistic and observational studies as well as data from crash statistics. In addition, we are able to provide valuable insight about the activities that teen drivers are engaging in while driving. These data can help to direct future research regarding teen driving, distraction, and crash risk.

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