Journal of Safety Research 61 (2017) 177–185

Contents lists available at ScienceDirect

Journal of Safety Research

journal homepage: www.elsevier.com/locate/jsr

Distracting behaviors among teenagers and young, middle-aged, and older adult drivers when driving without and with warnings from an integrated vehicle safety system

David G. Kidd, [a,*] Mary Lynn Buonarosa [b]

[a] Insurance Institute for Highway Safety, United States
[b] University of Michigan Transportation Research Institute, United States

ARTICLE INFO

Article history:
Received 28 July 2016
Received in revised form 14 November 2016
Accepted 27 February 2017
Available online 11 March 2017

Keywords:
Distracted driving
Collision warning systems
Driver age
Operant conditioning
Risk compensation

ABSTRACT

Introduction: Negative reinforcement from crash warnings may reduce the likelihood that drivers engage in distracted driving. Alternatively, drivers may compensate for the perceived safety benefit of crash warnings by engaging in distractions more frequently, especially at higher speeds. The purpose of this study was to examine whether warning feedback from an integrated vehicle-based safety system affected the likelihood that various secondary behaviors were present among drivers ages 16–17, 20–30, 40–50, and 60–70. *Method:* Participants drove an instrumented sedan with various collision warning systems for an extended period. Ten 5-second video clips were randomly sampled from driving periods at speeds above 25 mph and below 5 mph each week for each driver and coded for the presence of 11 secondary behaviors. *Results:* At least one secondary behavior was present in 46% of video clips; conversing with a passenger (17%), personal grooming (9%), and cellphone conversation (6%) were the most common. The likelihood that at least one secondary behavior was present was not significantly different during periods when drivers received warnings relative to periods without warnings. At least one secondary behavior was 21% more likely to be present at speeds below 5 mph relative to speeds above 25 mph; however, the effect of vehicle speed was not significantly affected by warning presence. Separate models for each of the five most common secondary behaviors also indicated that warnings had no significant effect on the likelihood that each behavior was present. *Conclusions:* Collision warnings were not associated with significant increases or decreases in the overall likelihood that teen and adult drivers engaged in secondary behaviors or the likelihood of the behaviors at speeds above 25 mph or below 5 mph. *Practical applications:* There was no evidence that forward collision warning and other technologies like those in this study will increase or decrease distracted driving.

1. Introduction

Reducing injuries and deaths in motor-vehicle crashes resulting from distracted driving continues to be an important traffic safety priority. Based on national police-reported data on fatal crashes, driver distraction was a factor in 2955 (10%) of the 29,989 fatal crashes in the United States in 2014 (National Highway Traffic Safety Administration (2016a)). However, this statistic almost certainly underestimates the contribution of distraction to fatal crashes, as there is rarely objective evidence at the crash scene that a driver was distracted. Most research on distracted driving and most countermeasures targeting driver distraction have focused on cellphone use, but cellphones are only one facet of the problem. In 2014, police reported that a driver was manipulating, talking on, or listening to a cellphone in only 385 (13%) of the 2955 fatal crashes judged to be related to distraction. Thus, attention must be given to activities other than cellphones to fully address distracted driving.

People engage in a variety of secondary behaviors that distract them from the driving task. For example, Farmer, Klauer, McLafferty, and Guo (2015) examined a random sample of trips of 108 drivers monitored for 12 months during 2003–04. Drivers spent 42% of their driving time engaged in at least one secondary behavior. The most common were interacting with a cellphone (12% of driving time), interacting with a passenger (11% of driving time), and talking or singing without a passenger (5% of driving time).

Distracted driving is particularly concerning for novice teenage drivers, whose inexperience, immaturity, and propensity to take risks contribute to an elevated crash risk relative to adults (Durbin, McGehee, Fisher, & McCartt, 2014). Self-report surveys indicate that many teenagers use phones while driving but not as frequently as

* Corresponding author at: Insurance Institute for Highway Safety, 1005. N. Glebe Rd., Arlington, VA 22201, United States.
E-mail address: dkidd@iihs.org (D.G. Kidd).

http://dx.doi.org/10.1016/j.jsr.2017.02.017
0022-4375/

young adults. In a national telephone survey conducted in 2015, 47% of drivers age 16–18 said they typed or sent a text message or email, and 63% talked on a cellphone at least once while driving in the past 30 days. In comparison, 59% of drivers ages 19–24 and 65% of drivers ages 25–39 years reported sending a text message or email in the past 30 days, and 77% and 78%, respectively, said they had talked on a cellphone while driving (AAA Foundation for Traffic Safety, 2016).

Research based on real-world behavior coded by observers standing on the roadside or from video recordings of daily driving suggest that teenage drivers engage in secondary behaviors as often as most adults Klauer et al. (2014) coded the presence of several secondary behaviors in randomly sampled video clips from the daily driving of 42 newly licensed teenage drivers followed for 18 months and 109 adult drivers ages 18 to 72 followed for 1 year. The overall proportion of clips with a secondary behavior was similar for teenage drivers (9.9%) and adult drivers (10.9%). Kidd, Tison, Chaudhary, McCartt, and Casanova-Powell (2016) examined the prevalence of 12 categories of secondary behaviors among drivers of over 16,500 vehicles observed from the roadside. Drivers estimated to be ages 20–59 were not significantly less likely to be engaged in at least one of the coded secondary behaviors than a driver thought to be younger than 20, but drivers in both of these age groups were significantly more likely to be engaged in at least one secondary behavior than drivers age 60 and older.

Vehicle safety systems that warn drivers of potential collisions or unsafe driving behaviors are a promising countermeasure for mitigating or preventing crashes, including those where the driver is distracted. Forward collision warnings can redirect a distracted driver's attention to a safety critical event and shorten brake response time (Lee, McGehee, Brown, & Reyes, 2002). Some systems can intervene automatically to mitigate or prevent a crash altogether. Analyses comparing rates of insurance claims or police-reported crash involvements for vehicles with and without forward collision warning and/or automatic braking indicate the technologies are preventing crashes in the real world (Cicchino, 2016; Highway Loss Data Institute, 2012, 2014).

Feedback from collision warnings also may discourage unsafe driving behavior. A collision warning may be a negative reinforcer that leads drivers to discontinue behavior resulting in the warning stimulus (Skinner, 1953). In two field operational tests of an integrated vehicle safety system, adult and novice teenage drivers increased their turn signal use during lane changes when they received lane departure warnings and other warnings from the system (Jermakian, Bao, Buonarosa, Sayer, & Farmer, in press; Sayer et al., 2011). Ben-Yaacov, Maltz, and Shinar (2002) found that drivers who received an audible alarm at headways of <1 s decreased the proportion of time they spent at headways shorter than 0.8 s. Donmez, Boyle, and Lee (2008) found giving visual warnings to drivers who demonstrated excessive visual distraction while using a touchscreen to perform a secondary task resulted in longer glances to the roadway during simulated driving.

Alternatively, feedback from collision warnings may lead to compensatory behavior and increased risk taking that offsets safety gains. Risk compensation and offsetting behavior has been observed in response to various traffic safety measures (Hedlund, 2000; Vrolix, 2006), including collision warnings. For example, Jermakian et al. (in press) found that novice teenage drivers who received warnings from an integrated vehicle safety system spent 17% more time at headways shorter than 1 s when following vehicles relative to a baseline period without warnings, compared with teenage novice drivers who did not receive warnings at all. Interestingly, Sayer et al. (2011) found that warnings from the same integrated vehicle safety system had no significant effect on the proportion of time spent at close following distances for adult drivers (Sayer et al., 2011). This suggests that teenage drivers may offset the safety benefit of collision warnings with riskier driving behavior, which also might include increased uptake of secondary behaviors.

The purpose of this study was to examine whether negative reinforcement from collision warnings decreased the likelihood of secondary behaviors among drivers in different age groups, or if drivers in different age groups compensated for the safety benefits of collision warnings by engaging in secondary behaviors more frequently. Prior research has found no evidence that warnings from an integrated vehicle safety system influenced the prevalence of secondary behaviors among adult drivers (Nodine, Lam, Stevens, Razo, & Najm, 2011; Sayer et al., 2011) or teenage drivers (Jermakian et al., in press). However, these studies had two important limitations. First, the analyses of secondary behavior did not consider specific secondary behaviors. Warnings may influence driver engagement in riskier secondary behaviors such as interacting with a portable device (e.g., Dingus et al., 2016; Kidd & McCartt, 2015).

Another limitation was that the previous studies only sampled video clips from periods when the vehicle was traveling at least 25 mph where the integrated system was active and issued warnings. Drivers are more likely to engage in secondary behaviors when the vehicle is stopped than when it is moving (Funkhouser & Sayer, 2012; Kidd et al., 2016). Negative reinforcement from warnings might prompt drivers to adopt this practice more extensively and postpone engagement in secondary behaviors until the vehicle is stopped. Alternatively, drivers may compensate for any perceived safety benefit of collision warnings by engaging in secondary behaviors more often at higher speeds to offset the reduction in perceived risk afforded by the warnings. The likelihood of compensatory behavior among teenage drivers might be increased relative to various adult driver age groups considering that the same group of teenage drivers followed vehicles ahead more closely when driving with warnings.

2. Method

Data were collected in two separate studies where participants drove an instrumented 2006–07 Honda Accord EX four-door sedan equipped with a prototype integrated vehicle safety system (hereinafter "integrated system"). The integrated system consisted of forward collision warning, lane change/merge warning, lateral drift warning, and curve speed warning. Detailed descriptions of the study vehicles, data acquisition system, and crash warning systems are described in Sayer et al. (2008).

One study (hereinafter "the adult study") included a sample of 108 adult drivers with an equal number of young (ages 20–30), middle-aged (ages 40–50), and older (ages 60–70) people (Sayer et al., 2011). The adult study began with a 12-day baseline period when interior and exterior video recordings and vehicle data were collected with the integrated system turned off but warnings logged silently. This was followed by a 28-day treatment period with the system turned on.

The second study (hereinafter "the teenager study") included a sample of 40 16–17-year-old drivers in the first 6–9 months of their intermediate driver's license with nighttime and teenage passenger restrictions (Jermakian et al., in press). An equal number of the teenagers were randomly assigned to a control group or treatment group. The study began with a 3-week baseline period when the integrated system was turned off and warnings were silently logged for both study groups. This was followed by an 8-week treatment period during which drivers in the treatment group received warnings from the integrated system and warnings were silently logged for drivers in the control group. The study concluded with a 3-week post-treatment period where the system was turned off and warnings were silently logged for both study groups.

Data were collected for the adult study during April 2009–May 2010 and for the teenager study during July 2011–October 2012. Michigan, where the study was conducted, passed a primary-enforced law prohibiting all drivers from texting effective July 1, 2010. There were no Michigan laws specifically restricting adult or novice teenage drivers from talking on cellphones or engaging in any of the other coded secondary behaviors during the study period.