



Q1 Teens' distracted driving behavior: Prevalence and predictors

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A B S T R A C T

Introduction: Teen drivers' over-involvement in crashes has been attributed to a variety of factors, including distracted driving. With the rapid development of in-vehicle systems and portable electronic devices, the burden associated with distracted driving is expected to increase. The current study identifies predictors of secondary task engagement among teenage drivers and provides basis for interventions to reduce distracted driving behavior. We described the prevalence of secondary tasks by type and driving conditions and evaluated the associations between the prevalence of secondary task engagement, driving conditions, and selected psychosocial factors. *Methods:* The private vehicles of 83 newly-licensed teenage drivers were equipped with Data Acquisition Systems (DAS), which documented driving performance measures, including secondary task engagement and driving environment characteristics. Surveys administered at licensure provided psychosocial measures. *Results:* Overall, teens engaged in a potentially distracting secondary task in 58% of sampled road clips. The most prevalent types of secondary tasks were interaction with a passenger, external distraction, and texting/dialing the cell phone. Secondary task engagement was more prevalent among those with primary vehicle access and when driving alone. Social norms, friends' risky driving behaviors, and parental limitations were significantly associated with secondary task prevalence. In contrast, environmental attributes, including lighting and road surface conditions, were not associated with teens' engagement in secondary tasks. *Conclusions:* Our findings indicated that teens engaged in secondary tasks frequently and poorly regulate their driving behavior relative to environmental conditions. Peer and parent influences on secondary task engagement provide valuable objectives for countermeasures to reduce distracted driving among teenage drivers.

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45 1. Introduction

46 Teens' over-involvement in crashes has been attributed to a variety of
47 factors such as driving inexperience, risk-taking behavior, and distracted
48 driving (Shope, 2006; Shope & Bingham, 2008; Simons-Morton et al.,
49 2011). Driver distraction, a specific case of inattention, is associated
50 with the engagement in a subsidiary, secondary task that diverts a
51 driver's attention from the primary driving task (Goodwin, Foss,
52 Harrell, & O'Brien, 2012). Compared to older drivers, teens' limited
53 driving experience and youthful characteristics may also contribute to
54 their higher risk for distraction when engaging in secondary tasks
55 while driving (Bingham, Zakrajsek, Almani, Shope, & Sayer, 2015;
56 Klauer et al., 2014). In 2013, among drivers age 15–19 years old, 10% of
57 fatal crashes were attributed to driver distraction, the highest of all
58 age groups (NHTSA, 2015). Nevertheless, the extent to which teens'
59 distracted driving contributes to the occurrences of crashes may be
60 underreported, possibly due to drivers' reluctance to admit driving
61 distracted, recall bias, and the uncertainty of linking specific secondary
62 tasks to crashes. With the rapid development of in-vehicle interactive

technologies and the increased accessibility to portable electronic de-
vices, the potential for distracting secondary task engagement, especially
among teen drivers, has increased dramatically. Being early adopters,
teen drivers are more likely than older drivers to embrace such new
technologies and use them while driving.

Based on data from naturalistic driving studies, Klauer et al. (2014)
reported frequent and varied secondary task engagement among both
novices and adults, some of whom (particularly those that took the
driver's eyes off the forward roadway) were associated with increased
crash and near crash likelihood. A more recent naturalistic study that
used an in-vehicle event recorder system to capture teenage driver
behavior and crashes reported that secondary tasks of many types
occurred proximal to 76% of the evaluated rear-end crashes (Carney,
Harland, & McGehee, 2016).

Teens' risky driving behavior, including secondary task engagement,
has been linked to multiple psychosocial, demographic, and environmen-
tal factors (Bingham et al., 2015; Gershon, O'Brien, Zhu, & Simons-Morton,
2016; Goodwin et al., 2012). Studies that focused on social factors found
that greater parental involvement in and monitoring of teens' driving
(both pre- and post-licensure) were associated with less risky driving
behavior (Gershon et al., 2016; Mirman, Albert, Jacobsohn, & Winston,
2012; Prato, Toledo, Lotan, & Taubman-Ben-Ari, 2010; Simons-Morton &

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85 Ouimet, 2006). A cross-sectional survey study reported higher secondary
86 task engagement of teens compared to their parents and a significant
87 correlation between teens' and parents' secondary task engagement
88 (Bingham et al., 2015). Peer influence is another significant social aspect
Q10 Q9 associated with teens' driving behavior (Shope et al., 2006; Simons
90 et al., 2011; Simons-Morton et al., 2012; Taubman-Ben-Ari, Kaplan,
91 Lotan, & Prato, 2015). Carter, Bingham, Zakrajsek, Shope, and Sayer
92 (2014) showed that teens' perception of their peers' distracted driving
93 was associated with the teens' own distracted driving.

94 Driving with a teenage passenger is considered to be a risk factor
95 uniquely associated with teen drivers (Klauer et al., 2011; Ouimet
96 et al., 2015; Williams, Ferguson, & McCartt, 2007). Teenage passengers
97 can increase crash risk through social influence, either by exerting
98 pressure to increase risk, or by engaging in social norms that favor
Q11 more risky driving (Ouimet et al., 2015). Ouimet et al. (2010) found
100 that driving with a passenger significantly increased the likelihood of
101 teens' involvement in fatal crashes, and the risk increased with the
102 number of passengers. However, with respect to distracted driving,
103 Foss and Goodwin (2014) showed a moderating effect of passenger
104 presence on teen drivers' tendency to engage in secondary tasks.
105 Another factor associated with teens' risky driving behavior and crash
106 risk is vehicle ownership (or primary vehicle accessibility; Gershon
107 et al., 2016; Scott-Parker, Watson, King, & Hyde, 2011; Williams, Leaf,
108 Simons-Morton, & Hartos, 2006). Teens driving their own vehicle
109 tended to engage in more risky driving behaviors compared to teens
110 who shared their vehicle with another family member (García-España,
111 Ginsburg, Durbin, Elliott, & Winston, 2009; Mayhew, Simpson, & Pak,
112 2003; Prato et al., 2010; Scott-Parker, Goode, & Salmon, 2015; Williams
113 et al., 2006).

114 Finally, the possible associations between environmental factors
115 (such as time of driving, weather, and roadway conditions) and teens'
116 secondary task engagement while driving have not been clearly
117 determined. Two previous naturalistic driving studies reported no asso-
118 ciations between the prevalence of secondary task engagement and
119 characteristics of the driving environment (e.g., road surface conditions,
120 time of drive; Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006; Stutts,
121 Reinfurt, & Rodgman, 2001). In contrast, data from a roadside observa-
122 tional study indicated that the prevalence of secondary task engagement
123 was greater in less demanding driving environments (Kidd, Tison,
124 Chaudhary, McCartt, & Casanova-Powell, 2016). However, little else is
125 known about driving environment characteristics and teenage drivers'
126 engagement in secondary tasks while driving.

127 This analysis of naturalistic driving data provides objective assess-
128 ment of the relative prevalence of secondary task engagement in
129 various driving conditions and examines associations of secondary
130 task prevalence with driving attributes, vehicle ownership, passenger
131 presence, and psychosocial factors.

132 2. Method

133 2.1. Participants

134 A total of 83 newly licensed teenaged drivers (53% females) partici-
135 pated in the study, with an average age of 16.48 years old ($SD = 0.33$).
136 All participants were recruited in Virginia. Identical twins and teens
137 with diagnosed Attention Deficit Hyperactivity Disorder (ADHD) were
138 excluded from the study. No other selection criteria were applied.
139 Parental consent and teens' assent were obtained according to an
140 approved institutional protocol.

141 2.2. Vehicle instrumentation

142 Participants' private vehicles were installed with a Data Acquisition
143 System (DAS) that included a multi-axis accelerometer, Global Position-
144 ing System (GPS), as well as video cameras to monitor the driver's face,
145 hand, and body positioning, the driver's forward and rear views, and the

car dashboard. Two cameras were used to capture the vehicle interior. 146
Data were collected from 2010 to 2014, for a period of up to 21 months, 147
which included a minimum of 9 months of supervised practice driving 148
and 12 months of provisional licensure. 149

2.3. Dataset 150

This dataset was generated based on 6-second video clips from road 151
segments that were sampled at random from each participant. The 152
sampling matrix used for generating this dataset was based on propor- 153
tion of hours traveled for each subject and yielded 1,060 trips. Each 154
sampled video segment was assessed by two highly experienced coders 155
who determined and documented the driver behavior (including 156
secondary task engagement) and driving characteristics according to a 157
systematic protocol. 158

2.4. Secondary task 159

Based on the 6-second video segments, a total of 37 different types of 160
secondary tasks were identified and coded. The secondary tasks were 161
then assigned under 11 categories including: texting/dialing cell phone, 162
external distraction, reaching, interacting with in-vehicle systems, 163
interacting with objects in the vehicle, interaction with a passenger, 164
singing/dancing and talking to self, self-grooming, talking/listening cell 165
phone, food and drink intake, and other. 166

2.5. Environmental measures 167

The following factors were documented for each driver and each 168
trip: vehicle ownership, vehicle occupancy, weather conditions (not 169
adverse/adverse), surface conditions (dry/wet), traffic density (free 170
flow/with restrictions), lighting conditions (daylight/dark), road align- 171
ment (straight/curved), travel way features (not divided/divided). 172
Vehicle occupants, road conditions, and time of driving were assessed 173
by experienced coders who reviewed every video clip of each recorded 174
trip and identified the driver, passenger presence, number of passengers, 175
and passenger attributes, such as gender and age. Lighting conditions 176
(daylight/dark) were determined by the recorded times of sunrise and 177
sunset of the day the trip occurred. 178

2.6. Psychosocial survey measures 179

A battery of questionnaires was administered at licensure, with 180
measures that assessed the following variables: driver's risk perception, 181
sensation seeking, self-reported risky driving, risk-taking friends, 182
friends' substance use (alcohol, tobacco, and other drugs), perceived 183
parental trust, parental restrictions on driving, parental monitoring 184
knowledge, and parental limits on driving. For a detailed description 185
of psychosocial measures, reference Gershon et al. (2016). For all used 186
psychosocial measures, Cronbach's alpha values were ≥ 0.7 . 187

2.7. Analysis 188

Two-tailed population proportion tests were used to assess the 189
differences in the proportions of sampled segments with and without 190
any secondary task. Mixed effects logistic regression models with 191
random intercept were used to analyze the association between driving 192
conditions and secondary task prevalence. The mixed effect logistic re- 193
gression analysis included a total of 78 participants that had at least 194
one sampled video segment in each driving condition (e.g., daylight 195
and darkness). The analysis of the association between passenger 196
presence and secondary task prevalence excluded the category 197
'interacting with a passenger' to avoid confounding. Finally, Pearson 198
correlations assessed the associations between teens' psychosocial 199
measures and the proportion of secondary task engagement per road 200
segment. 201

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