Published in final edited form as:

J Safety Res. 2017 December ; 63: 157–161. doi:10.1016/j.jsr.2017.10.002.

Teens' distracted driving behavior: Prevalence and predictors

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Abstract

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, talking/singing (no 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. Practical applications: Peer and parent influences on secondary task engagement provide valuable objectives for countermeasures to reduce distracted driving among teenage drivers.

Keywords

Distracted driving; Naturalistic study; Teen drivers; Secondary task engagement; Risk

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1. Introduction

Teens' over-involvement in crashes has been attributed to a variety of factors such as driving inexperience, risk-taking behavior, and distracted driving (Shope, 2006; Shope & Bingham, 2008; Simons-Morton et al., 2011). Driver distraction, a specific case of inattention, is associated with the engagement in a subsidiary, secondary task that diverts a driver's attention from the primary driving task (Goodwin, Foss, Harrell, & O'Brien, 2012). Compared to older drivers, Teens' limited driving experience and youthful characteristics may also contribute to their higher risk for distraction when engaging in secondary tasks while driving (Bingham, Zakrajsek, Almani, Shope, & Sayer, 2015; Klauer et al., 2014). In 2013, among drivers age 15–19 years old, 10% of fatal crashes were attributed to driver distraction, the highest of all age groups (NHTSA, 2015). Nevertheless, the extent to which Teens' distracted driving contributes to the occurrences of crashes may be underreported, possibly due to drivers' reluctance to admit driving distracted, recall bias, and the uncertainty of linking specific secondary tasks to crashes. With the rapid development of in-vehicle interactive technologies and the increased accessibility to portable electronic devices, 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 environmental 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 & Ouimet, 2006). A cross-sectional survey study reported higher secondary task engagement of teens compared to their parents and a significant correlation between Teens' and parents' secondary task engagement (Bingham et al., 2015). Peer influence is another significant social aspect associated with Teens' driving behavior (Shope, 2006; Simons-Morton et al., 2011; Simons-Morton et al., 2012; Taubman-Ben-Ari, Kaplan, Lotan, & Prato, 2015). Carter, Bingham, Zakrajsek, Shope, and Sayer (2014) showed that Teens' perception of their peers' distracted driving was associated with the Teens' own distracted driving.

Driving with a teenage passenger is considered to be a risk factor uniquely associated with teen drivers (Klauer et al., 2011; Ouimet et al., 2015; Williams, Ferguson, & McCartt, 2007). Teenage passengers can increase crash risk through social influence, either by exerting

pressure to increase risk, or by engaging in social norms that favor more risky driving (Ouimet et al., 2015). Ouimet et al. (2010) found that driving with a passenger significantly increased the likelihood of Teens' involvement in fatal crashes, and the risk increased with the number of passengers. However, with respect to distracted driving, Foss and Goodwin (2014) showed a moderating effect of passenger presence on teen drivers' tendency to engage in secondary tasks. Another factor associated with Teens' risky driving behavior and crash risk is vehicle ownership (or primary vehicle accessibility; Gershon et al., 2016; Scott-Parker, Watson, King, & Hyde, 2011; Williams, Leaf, Simons-Morton, & Hartos, 2006). Teens driving their own vehicle tended to engage in more risky driving behaviors compared to teens who shared their vehicle with another family member (García-España, Ginsburg, Durbin, Elliott, & Winston, 2009; Mayhew, Simpson, & Pak, 2003; Prato et al., 2010; Scott-Parker, Goode, & Salmon, 2015; Williams et al., 2006).

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

This analysis of naturalistic driving data provides objective assessment of the relative prevalence of secondary task engagement in various driving conditions and examines associations of secondary task prevalence with driving attributes, vehicle ownership, passenger presence, and psychosocial factors.

2. Method

2.1. Participants

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

2.2. Vehicle instrumentation

Participants' private vehicles were installed with a Data Acquisition System (DAS) that included a multi-axis accelerometer, Global Positioning System (GPS), as well as video cameras to monitor the driver's face, hand, and body positioning, the driver's forward and rear views, and the car dashboard. Two cameras were used to capture the vehicle interior. Data were collected from 2010 to 2014, for a period of up to 21 months, which included a minimum of 9 months of supervised practice driving and 12 months of provisional licensure.

2.3. Dataset

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

2.4. Secondary task

Based on the 6-second video segments, a total of 37 different types of secondary tasks were identified and coded. The secondary tasks were then assigned under 11 categories including: interaction with a passenger, talking/singing (no passenger), cellphone manual use (dialing/texting/browsing), food and drink intake, Interaction with objects in the vehicle, personal hygiene, interaction with in-vehicle systems, external distraction, dancing, reaching, and other.

2.5. Environmental measures

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

2.6. Psychosocial survey measures

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

2.7. Analysis

Two-tailed population proportion tests were used to assess the differences in the proportions of sampled segments with and without any secondary task. Mixed effects logistic regression models with random intercept were used to analyze the association between driving conditions and secondary task prevalence. The mixed effect logistic regression analysis included a total of 78 participants that had at least one sampled video segment in each driving condition (e.g., daylight and darkness). The analysis of the association between passenger presence and secondary task prevalence excluded the category 'interacting with a passenger' to avoid confounding. Finally, Pearson correlations assessed the associations

between Teens' psychosocial measures and the proportion of secondary task engagement per road segment.

3. Findings

3.1. Secondary task engagement

The analyses indicated that in 58% of the sampled video segments teens engaged in at least one task secondary to driving. As shown in Fig. 1, the most prevalent type of secondary task was interaction with a passenger, which occurred in 20% of the drives. Out of a wide range of secondary tasks, the next relatively common tasks included talking/singing (no passenger) (17%), external distraction (i.e., attending stimuli outside the vehicle) (12%) and manual cellphone use (i.e., texting/dialing/browsing) (5%). Engagement in secondary tasks varied among participants, with a median of 0.75 tasks per road segment, ranging from 0–3 tasks per road segment.

3.2. Prevalence by environmental factors

Fig. 2 illustrates the relative proportion of sampled road segments with and without a secondary task in the different driving conditions. Each driving attribute had two possible conditions on the x-axis. As seen in Fig. 2, participants mostly drove under favorable driving conditions (e.g., during the daytime or on dry road conditions) and were less exposed to conditions that are considered to be more demanding (e.g., driving on wet road conditions or in the dark). Proportion tests yielded significant differences in secondary task engagement for vehicle accessibility and passenger presence (*chi-square* (1) = 5.713, $p = 0.017$ and *chi-square* (1) = 23.699, $p < 0.001$, respectively).

Mixed effect logistic regression analyses indicated that vehicle accessibility and passenger presence were significantly associated with the secondary task prevalence. Teens with primary vehicle access were 50% more likely to engage in a secondary task compared with teens who shared a vehicle with another family member (OR = 1.502, 95% CI = 1.05–2.14). Driving alone more than doubled the likelihood to engage in a secondary task compared to driving with a passenger (OR = 2.13, 95% CI = 1.576–2.89). Other measured environmental attributes were not significantly associated with the prevalence of secondary task engagement.

3.3. Association with psychosocial factors

Pearson correlations were used to evaluate the association between Teens' psychosocial characteristics and secondary task prevalence (see Table 1). The analysis indicated that perceived social norms favoring risky driving were significantly associated with higher proportion of secondary tasks per road segment ($r = 0.36$, $p < 0.001$). Accordingly, friends' risky driving behavior ($r = 0.26$, $p = 0.02$) was significantly correlated with a higher proportion of secondary tasks per road segment. However, greater parental limitations on driving was significantly associated with lower proportion of secondary tasks per road segment ($r = -0.29$, $p < 0.01$). Other measures relating to Teens' characteristics, including risk perception and sensation seeking, were not significantly correlated with the prevalence of secondary task engagement.

4. Discussion and conclusions

The current study evaluated secondary task prevalence in association with environmental and psychosocial attributes. Overall, 58% of sampled road segments included at least one potentially distracting secondary task. The prevalence of secondary task engagement was slightly higher than reported for SHRP2, a large, national, naturalistic driving study of drivers of all ages (52%, Dingus et al., 2016). This high level of secondary task engagement is not surprising, as teens tend to be early adopters of new technologies and may overestimate their ability to multi-task while driving. As such, teens may be more prone to engage in secondary tasks while driving (Klauer et al., 2014).

The relative proportion of secondary task engagement in each environmental attribute did not vary according to the characteristics and demands of the driving condition. Essentially, secondary task engagement was prevalent in situations of both demanding and not demanding driving conditions. This may suggest that participants failed to adapt to the complexity of the driving task and cognitive resources required.

Consistent with findings from previous naturalistic studies (Foss & Goodwin, 2014), the current study found that teen engagement in secondary tasks while driving varied by passenger presence. The prevalence of secondary task engagement while driving alone was more than twice the prevalence while driving with a passenger. Metz, Landau, and Just (2014) evaluated the association between passenger presence and distracted driving of adult drivers, and found that experienced drivers tended to engage in secondary tasks less frequently in the presence of a passenger. Kidd et al. (2016), on the other hand, found no difference in the prevalence of secondary task engagement among drivers with or without passengers. The classification of secondary tasks and passenger age varied across these studies.

Vehicle access was also found to be associated with Teens' tendency to engage in distracted driving. Teens' with primary vehicle access were 50% more likely to engage in a secondary task while driving compared with teens who only had access to a shared vehicle. This finding is consistent with previous research, indicating that primary vehicle access is one of the key determinants of Teens' driving exposure, kinematic risky driving behavior, and crash risk (Lee, Simons-Morton, Klauer, Ouimet, & Dingus, 2011; Scott-Parker et al., 2011; Williams et al., 2006). Accordingly, it is possible that some of the increased kinematic risky driving behaviors and higher crash risk of teens with primary vehicle access could be attributed to their increased tendency to engage in potentially distracting behaviors (García-España et al., 2009; Gershon et al., 2016).

The findings indicated that some psychosocial attributes were also associated with secondary task prevalence. Higher parental-imposed driving limitations were associated with lower prevalence of secondary task engagement, and higher susceptibility to peer influence was associated with higher secondary task prevalence. Social norms of favoring risky driving behavior were associated with higher prevalence of secondary task engagement. These psychosocial factors partially explain the variability in Teens' tendency to engage in secondary tasks. Interestingly, these same variables have been found to be associated with

other types of risky driving behaviors among teens, including kinematic risky driving (Hartos, Eitel, & Simons-Morton, 2002; Simons-Morton & Ouimet, 2006; Taubman-Ben-Ari et al., 2015). Our findings indicate that some psychosocial factors are associated with various risky driving outcomes, and therefore may serve as useful objectives for interventions to reduce Teens' crash risk and crash outcomes.

The findings suggest the following possible objectives for intervention development: (a) reduce the prevalence of secondary tasks of all types; (b) discourage secondary task engagement particularly under higher demand driving contexts; (c) foster peer norms consistent with safe driving, including not engaging in secondary tasks; and (d) encourage parent limits on teenage driving, particularly secondary task engagement.

Finally, despite the potential undesirable outcomes of secondary task engagement while driving, it is likely that this form of distracted driving cannot be prevented completely. It can be anticipated that as we move towards autonomous driving, drivers will spend more time and available resources in engaging in secondary tasks while driving. Notably, our findings suggest the importance of encouraging responsible secondary task engagement consistent with the complexity of the task and driving conditions. As such, further research should focus on distinguishing between secondary tasks by incorporating their complexity, the amount of resources they require and the level of distraction they generate. Integrating these task characteristics will allow us to identify critical predictors for the most distracting tasks.

5. Strengths and limitations

The strengths of this study are its objective assessment of secondary task engagement based on a relatively large naturalistic dataset of teen drivers. Additionally, data were collected for an extended period of 12 months within a wide range of environmental conditions and included an extensive number of psychosocial measures. However, there were also some limitations to the study. The drivers who participated in the study were all volunteers from one specific geographic location and as such might not be representative of teen drivers from other regions. The findings regarding the association between secondary task engagement and psychosocial measures were significant yet relatively weak and therefore should be interpreted with caution. Also, the data regarding secondary task engagement was obtained by sampling road segments and therefore the findings provide only estimates of prevalence. Finally, in this paper we focused on the prevalence of tasks secondary to driving, but some tasks are more risky than others. Future research should examine the prevalence of high-risk secondary tasks and consider additional factors such as the duration of task and time with eyes off the forward road during engagement.

Acknowledgments

This research was supported by the intramural program of the Eunice Kennedy Shriver National Institute of Child Health and Human Development, contract # N01-HD-5-3405.

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Fig. 1.
Proportion of secondary tasks by type in sampled road segments.

Fig. 2.
Proportion of road segments for each of the driving conditions with at least one secondary task.

Table 1

Association between psychosocial measures and proportion of secondary task engagement.

Psychosocial measures	Pearson R	p-Value
Risk perception	−0.113	0.317
Sensation seeking	0.050	0.658
Social norms	0.360	0.001
Parental trust	−0.007	0.948
Parental knowledge	−0.031	0.782
Parental driving restrictions	−0.190	0.090
Parental driving limitations	−0.289	0.009
Friends' risky driving behavior	0.255	0.022
Friends' substance use	0.193	0.085