Secondary Behavior of Drivers on Cell Phones

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Received 23 October 2014, Accepted 14 February 2015

Objectives: The objective of this study was to determine whether cell phone use by drivers leads to changes in the frequency of other types of potentially distracting behavior. There were 2 main questions of interest: (1) As each driver changes cell phone use, does he or she change the amount of driving time spent on other distracting behavior? (2) As each driver changes cell phone use, does he or she change the amount of driving time spent looking away from the driving task?

Methods: Day-to-day driving behavior of 105 volunteer subjects was monitored over a period of 1 year. The amount of driving time during each trip spent on tasks secondary to driving (or looking away from the driving task) was correlated to the amount of time on a cell phone, taking into account the relationships among trips taken by the same driver.

Results: Drivers spent 42% of the time engaging in at least one secondary activity. Drivers were talking on a cell phone 7% of the time, interacting in some other way with a cell phone 5% of the time, and engaging in some other secondary activity (sometimes in conjunction with cell phone use) 33% of the time. Other than cell phone use, the most common secondary activities were interacting with a passenger (12% of driving time), holding but not otherwise interacting with an object (6%), and talking/singing/dancing to oneself (5%). Drivers were looking straight forward 81% of the time, forward left or right 5% of time, in a mirror 4% of the time, and elsewhere (eyes off driving task) 10% of time. On average, for each 1 percentage point increase in cell phone talking, the other secondary behavior rate decreased by 0.28 percentage points (P < .0001), and the rate of eyes off driving task decreased by 0.02 percentage points (P = .0067). For each 1 percentage point increase in the amount of other cell phone interaction per trip, the other secondary behavior rate decreased by 0.08 percentage points (P = .0558), but the rate of eyes off driving task increased by 0.06 percentage points (P < .0001).

Conclusions: Although using a cell phone can be distracting from the driving task, other secondary activities can be equally or more distracting, at least as measured by eye glances away from the road ahead and mirrors. In this group of drivers, dialing, reaching for, and answering the cell phone were associated with increased eyes off driving task, as opposed to the decrease in eyes off driving task associated with talking on the phone. Predictions about the effect of cell phone usage on driver distraction need to consider what other behavior is being displaced by the time spent on the phone. A focus by researchers, policy-makers, and the media on the distraction of using cell phones while driving may lead drivers to disregard the risk of other secondary behavior that is even more distracting.

Keywords: distraction, driver behavior, reaction time, safety

Introduction

Driver distraction, defined as any activity that could divert a driver’s attention away from the primary task of driving, has become an increasing concern to both the highway safety community and the general public. Distractions can cause drivers to glance away from the road ahead, take their hands off the steering wheel, or overlook critical information about the driving environment, all leading to increased risk of a collision (Governors Highway Safety Association 2011). According to the NHTSA (2014), some form of driver distraction was a factor in 16% of crashes in the United States in 2012.

Potentially distracting driver behavior includes conversing with passengers, adjusting the radio, eating/drinking, and using cell phones. In a national telephone survey of 4,000 drivers conducted in 2002, 47% of respondents reported talking to passengers, 33% reported adjusting the radio, 14% reported eating or drinking, and 8% reported making phone calls during at least three-quarters of their driving trips (Royal 2003). In a similar survey conducted in 2010, 52% of respondents reported talking to passengers, 34% reported adjusting the radio, 14% reported eating or drinking, and 15% reported making phone calls during all or most of their driving trips (Tison et al. 2011). Therefore, the frequency of cell phone use while driving has increased while...
the frequency of other common distractions has remained the same.

Naturalistic studies have documented not only the frequency but the duration of various distracting behavior while driving. For example, Klauer et al. (2006) estimated that drivers spent 54% of the time engaged in at least one activity secondary to driving. Sayer et al. (2007) estimated that drivers spent 15% of the time conversing with passengers and 6% of the time grooming. Koppel et al. (2011) estimated that drivers spent 18% of the time engaged in activity that could potentially distract them.

Some studies have concluded that cell phone use greatly increases crash risk (McEvoy et al. 2005; Redelmeier and Tibshirani 1997). Others have concluded that the effects of cell phone use on crash risk (Young 2012) or the risk of crashes combined with surrogates of crashes (Fitch et al. 2013; Klauer et al. 2006) are much smaller or nonexistent. The extreme variability in the effect estimates is partly due to different methodologies, but some discrepancies are difficult to explain. Therefore, the true effect of cell phone use on crash risk remains uncertain. In addition, despite the documented increase in cell phone use while driving, crash rates in the United States have been declining (NHTSA 2014).

Farmer et al. (2015) reported that the risk of a near crash or crash increases when drivers are using cell phones, especially when they are reaching for or dialing the phone. However, they did not find any dose–response relationship between increasing cell phone use and overall crash risk. They hypothesized that cell phone use while driving is somewhat risky compared with distraction-free driving but that cell phone use may reduce activities that are even riskier. The objective of the present study was to test this hypothesis by documenting trends in cell phone use and other secondary behavior for a sample of individual drivers over the course of 1 year.

Method

Subjects were part of a naturalistic study that continuously monitored drivers for approximately 12 months (Dingus et al. 2006). Vehicles were fitted with an instrumentation package that monitored longitudinal and lateral acceleration and lane-keeping behavior. In addition, there was continuous recording of video from 5 camera views: a forward view, a rearward view, a view out the right side, a view of the driver’s face and out the left side, and an over-the-shoulder view of the driver’s hands. This video was used to classify driver behavior.

Estimating the time spent interacting with a cell phone while driving required careful review of the video data. The definition of cell phone interaction included (1) talking/listening/using voice commands, (2) locating/reaching/answering, (3) dialing, (4) viewing, (5) holding on lap or in hand, and (6) other (e.g., wearing headset and unsure if in use). Previous studies have reported the most common driver distractions to be conversation with a passenger, eating or drinking, dropping or reaching for something in the car, and adjusting the radio or climate controls (Stutts et al. 2003; Treat et al. 1977). The same categories were coded for the present study, as well as fixing hair or makeup, reading or writing, and looking away from the road at something outside of the vehicle (see Table A1, online supplement). Because this was a time-consuming task, it was not feasible to examine every video clip. Instead, a random sample of each driver’s trips was selected.

There were 75,115 trips conducted by the 105 primary drivers, lasting at least 7 min and with reasonably clear video. Assuming that drivers engage in distracting behavior on average 20% of the time, an overall sample of at least 1,600 would be necessary to estimate secondary behavior within a 2% margin of error. A stratified random sample of each driver’s trips was selected—2 trips from each month that the driver was in the study—resulting in 2,053 trips coded. Approximately half of the sampled trips lasted between 7 and 19 min, and the other half were 20 min or longer. For trips lasting longer than 30 min, a starting point was selected at random and then 30 consecutive minutes were coded. Distracting behavior/secondary tasks were coded for each 0.14 s of sampled video. In addition, drivers’ eye glance locations were coded for approximately half of each driver’s sampled trips (see Table A2, online supplement; 1 trip per month; 1,019 trips).

The amount of driving time during each trip spent on other distracting behavior (or looking away from the driving task) was correlated to the amount of time spent on a cell phone using the MIXED procedure in SAS (SAS Institute 2011), taking into account the relationships among trips taken by the same driver. The model was defined as 

\[
\pi_{ij} = \delta + \gamma_1 (\text{indicator of female driver}) + \gamma_2 (\text{indicator of driver younger than 21}) + \gamma_3 c_{ij},
\]

where \(\pi_{ij}\) represents expected percentage of time spent on other distracting behavior and \(c_{ij}\) represents percentage of time spent on a cell phone by driver \(i\) during sampled trip \(j\). Therefore, \(\gamma_3\) represents the change in the expected percentage of time spent on other distracting behavior for each 1 percentage point increase in cell phone use. The correlations between measurements taken over time were assumed to be the same for every driver, and measurements taken on different drivers were assumed to be uncorrelated (i.e., an exchangeable correlation structure).

Results

Cell Phone Usage and Other Secondary Behavior

Drivers were interacting in some way with a cell phone 12% of the time and engaging in some other secondary behavior 33% of the time. The most frequent types of cell phone interactions were talking/listening, which accounted for 7% of driving time, and holding, which accounted for 4% of driving time. All but one of the sampled trips included some form of secondary behavior (including cell phone interactions). Secondary behavior rates for individual drivers ranged from 5 to 98% of driving time. Overall, drivers spent 42% of the time engaging in at least one secondary behavior.

Table 1 categorizes the percentage of driving time engaged in various secondary activities according to the speed of the vehicle. Secondary behavior was less common at high speeds.
At speeds of 60 mph or greater, drivers engaged in secondary behavior 33% of the time. On the other hand, drivers in stopped vehicles engaged in secondary behavior 53% of the time. For the other speed categories there was no clear trend—secondary behavior rates ranged from 39 to 45%.

Driver secondary behavior is less problematic when the vehicle is stopped, so the remaining analyses were restricted to times when the vehicles were moving. Data were excluded for any video frames with speeds either zero or unknown. Assuming that the unknown records in Table 1 had the same percentage of zero speeds as the known records, it was estimated that the study subjects were driving moving vehicles for 31,874 hs over the duration of the study. Table 2 categorizes the percentage of moving vehicle time engaged in secondary behavior by age and gender of the driver. Overall secondary behavior rates ranged from 28% for male drivers 45 and older to 65% for female drivers ages 21–24.

Other than cell phone use, the most common secondary activities were interacting with a passenger (12% of driving time), holding but not otherwise interacting with an object (6%), and talking/singing/dancing without a passenger (5%). Adjusting the radio or climate control accounted for only 3% of driving time, even though it occurred during 73% of the trips. On the other hand, interacting with passengers occurred during 33% of the trips. The frequency of some secondary activities varied depending on whether or not the driver was interacting with a cell phone (Table A3, see online supplement). For example, interacting with a passenger was nearly nonexistent while talking on a phone. In addition, eating/drinking was much less prevalent when the driver was interacting with a cell phone.

Whereas the above describes the reductions in other secondary behavior while using a cell phone, a more general question is whether or not periods of frequent cell phone use tend to involve less other secondary behavior (even when the phone is not in use). For that purpose, the percentage of driving time spent on each secondary activity was computed for each of the sampled trips. Some type of cell phone interaction occurred during 34% of the trips. For those trips that did not include any cell phone interaction, 33% of driving time was spent on other secondary behavior. For trips that did include cell phone interactions, 31% of driving time was spent on other secondary behavior. For trips during which drivers spent at least 30% of the time interacting with a cell phone, 28% of the time was spent on other secondary behavior (Table 3).

Table 4 summarizes the results of the linear regression of overall secondary behavior rates (including all cell phone interactions) during each trip on driver gender and age and the cell phone use rates. In other words, how does the addition of a cell phone change the overall distraction level of the driver? Drivers younger than 21 had higher secondary behavior rates than drivers 21 and older. Female drivers had somewhat higher rates than male drivers, but the difference was not statistically significant. On average, for each 1 percentage point increase in cell phone talking, the overall secondary behavior rate increased by 0.67 percentage points \((P < .0001)\). For each 1

### Table 1. Estimated percentage of driving time engaged in secondary behavior by vehicle speed

| Speed (mph) | Total driving hours | Percentage of time interacting with cell phone | Percentage of time talking/singing without passenger | Percentage of time interacting with passenger | Percentage of time adjusting integral device | Percentage of time with any secondary behavior |
|------------|---------------------|-----------------------------------------------|-----------------------------------------------------|-----------------------------------------------|---------------------------------------------|-----------------------------------------------|
| 0          | 3,593               | 13.2                                          | 5.0                                                 | 12.2                                          | 4.6                                         | 53.1                                          |
| 1–9        | 3,542               | 11.9                                          | 4.3                                                 | 10.7                                          | 4.1                                         | 43.2                                          |
| 10–19      | 3,190               | 11.2                                          | 4.6                                                 | 11.7                                          | 3.6                                         | 41.5                                          |
| 20–29      | 3,911               | 11.6                                          | 5.0                                                 | 12.5                                          | 3.8                                         | 44.0                                          |
| 30–39      | 5,133               | 11.9                                          | 6.1                                                 | 12.7                                          | 3.7                                         | 45.0                                          |
| 40–49      | 4,476               | 12.7                                          | 5.4                                                 | 12.4                                          | 3.7                                         | 44.0                                          |
| 50–59      | 4,238               | 11.5                                          | 5.0                                                 | 10.5                                          | 3.7                                         | 38.8                                          |
| ≥60        | 5,869               | 10.2                                          | 4.3                                                 | 9.6                                           | 3.5                                         | 33.2                                          |
| Unknown    | 1,696               | 11.6                                          | 6.0                                                 | 10.3                                          | 3.1                                         | 43.5                                          |
| Total      | 35,647              | 11.7                                          | 5.0                                                 | 11.4                                          | 3.8                                         | 42.5                                          |

### Table 2. Moving vehicle cell phone use rates and other secondary behavior rates by driver gender and age group

| Gender and age group | Total driving hours | Percentage of driving hours interacting with cell phone | Percentage of driving hours with other secondary behavior | Percentage of driving hours with any secondary behavior |
|----------------------|---------------------|--------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------|
| Males                |                     |                                                       |                                                          |                                                        |
| 18–20                | 1,999               | 17.0                                                   | 46.9                                                     | 55.9                                                   |
| 21–24                | 3,254               | 12.4                                                   | 41.6                                                     | 51.9                                                   |
| 25–44                | 9,429               | 6.9                                                    | 27.5                                                     | 33.7                                                   |
| 45–68                | 6,624               | 7.7                                                    | 20.3                                                     | 27.6                                                   |
| Females              |                     |                                                       |                                                          |                                                        |
| 18–20                | 2,524               | 18.5                                                   | 40.2                                                     | 53.4                                                   |
| 21–24                | 3,278               | 20.5                                                   | 49.9                                                     | 64.7                                                   |
| 25–44                | 1,806               | 24.1                                                   | 31.4                                                     | 51.4                                                   |
| 45–68                | 2,961               | 5.4                                                    | 28.0                                                     | 32.4                                                   |
| Total                | 31,874              | 11.5                                                   | 32.5                                                     | 41.5                                                   |

\(^a\)Other than cell phone use.
percentage point increase in cell phone interaction other than talking, the overall secondary behavior rate increased by 0.61 percentage points ($P < .0001$).

The regressions of Table 4 were repeated for each of the individual secondary activities. For each 1 percentage point increase in cell phone talking, the rate of other secondary behavior decreased by 0.28 percentage points ($P < .0001$). In particular, the cell phone talking rate was significantly and negatively correlated with talking/singing without passengers, interacting with passengers, reaching for an object, adjusting an integral device, and drinking. The cell phone talking rate was significantly and positively correlated with interacting with a cell phone but only 5% when talking on the phone. During cell phone interactions other than talking, 9% of driving time was spent with eyes off driving task (Table 5). For trips that did not include any cell phone interaction, 9% of driving time was spent with eyes off driving task (Table 5). For trips that did not include cell phone interactions, 11% of driving time was spent with eyes off driving task.

### Cell Phone Usage and Eye Glance Behavior

One of the 105 drivers had no sampled trips that allowed for coding eye glance (i.e., no clear video). The remaining drivers were classified as having eyes off the driving task whenever they were not looking center, right, and left forward or in the side and rearview mirrors. Overall, drivers were looking center forward 81% of the time, forward left or right 5% of time, in a mirror 4% of time, and elsewhere 10% of time (Table A4, see online supplement). The rates of eyes off driving task for individual drivers ranged from 2 to 25% of driving time.

Eyes off driving task accounted for 10% of driving time when not interacting with a cell phone and 11% when interacting with a cell phone but only 5% when talking on the phone. During cell phone interactions other than talking (e.g., holding or dialing), drivers’ eyes were off driving task approximately 24% of the time. Less than 1% of overall driving time was spent glancing at cell phones. However, 14% of driving time was spent glancing at the cell phone when the driver was interacting with a cell phone other than talking.

As in Tables 3–4, the more general question is whether periods of frequent cell phone use have higher or lower rates of eyes off driving task. The percentage of driving time spent looking in various directions was computed for each of the sampled trips. For those trips that did not include any cell phone interaction, 9% of driving time was spent with eyes off driving task (Table 5). For trips that did include cell phone interactions, 11% of driving time was spent with eyes off driving task.

Time eyes off road lasting more than 2 s has been associated with higher near-crash/crash risk in prior studies (Klauer et al. 2006). A similar definition was applied in the present study for time eyes off driving task—the number of consecutive seconds during which the driver’s eyes were directed away from the driving task. This could include a sequence of glances to various locations as long as none of them were directed toward the forward roadway or mirrors. Drivers in the present study spent approximately 2% of the time with eyes off driving task lasting more than 2 s. There was no difference in the frequency of long-duration eyes off driving task for trips with or without cell phone interactions.

The percentage of time that each driver spent with their eyes off the driving task was correlated to the percentage of time spent interacting with a cell phone during each trip. Drivers younger than 21 had lower rates of eyes off driving task than drivers 21 and older, and female drivers had higher rates than male drivers, but neither of these estimates was statistically significant (Table 6). Rates of eyes off driving task were not significantly correlated to overall cell phone interaction rates, but they were correlated to the separate tasks of talking on cell phones and other cell phone interactions. The more time drivers spent on cell phone conversations, the less

| Cell phone interaction rate per trip | Percentage of trips | Percentage of time on secondary tasks other than cell phone interaction | Percentage of time on any secondary tasks (including cell phone interaction) |
|-------------------------------------|---------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------|
| 0                                  | 66.1                | 33.5                                                                   | 33.5                                                                     |
| 1–9%                               | 11.8                | 32.2                                                                   | 35.2                                                                     |
| 10–19%                             | 5.3                 | 30.9                                                                   | 42.6                                                                     |
| 20–29%                             | 3.9                 | 34.6                                                                   | 53.1                                                                     |
| 30–100%                            | 13.0                | 28.1                                                                   | 83.0                                                                     |

| Type of cell phone use              | Parameter           | Estimate     | 95% Confidence limits | $P$ value |
|-------------------------------------|---------------------|--------------|-----------------------|-----------|
| Talking/listening                   | Female driver vs. male | 5.05         | ($-1.59$, $11.69$)   | .1343     |
|                                     | Younger than 21 vs. older | 14.81       | ($5.93$, $23.70$)    | .0013     |
|                                     | Cell phone use rate  | 0.67         | ($0.60$, $0.73$)     | <.0001    |
| Other than talking                  | Female driver vs. male | 5.86         | ($-0.79$, $12.50$)   | .0836     |
|                                     | Younger than 21 vs. older | 10.67       | ($1.76$, $19.59$)    | .0194     |
|                                     | Cell phone use rate  | 0.61         | ($0.52$, $0.69$)     | <.0001    |
| Any cell phone interaction          | Female driver vs. male | 4.42         | ($-1.63$, $10.48$)   | .1506     |
|                                     | Younger than 21 vs. older | 10.58       | ($2.47$, $18.69$)    | .0111     |
|                                     | Cell phone use rate  | 0.61         | ($0.56$, $0.66$)     | <.0001    |
time they spent glancing away from the road. On average, for each 1 percentage point increase in cell phone talking, the rate of eyes off driving task decreased by 0.02 percentage points ($P = .0067$). The more time drivers spent on other cell phone interactions, the more time they spent glancing away from the road. On average, for each 1 percentage point increase in other cell phone interactions, the rate of eyes off driving task increased by 0.06 percentage points ($P < .0001$). The more time drivers spent on other secondary behavior, the more time they spent glancing away from the road. On average, for each 1 percentage point increase in other secondary behavior, the rate of eyes off driving task increased by 0.06 percentage points ($P < .0001$).

The regression of Table 6 was repeated for each of the individual secondary activities. The rate of eyes off driving task was significantly and positively correlated with reading, writing, interacting with a passenger, looking at or reaching for an object, holding an object, interacting with a PDA, adjusting an integral device, looking at an object outside of the vehicle, eating, and personal hygiene.

Finally, a regression was conducted of the rates of eyes off driving task for more than 2 s on the rates of cell phone interaction and other secondary behavior (Table A5, see online supplement). On average, for each 1 percentage point increase in cell phone talking, the rate of long-duration eyes off driving task decreased by 0.01 percentage points ($P = .0253$). For each 1 percentage point increase in other cell phone interaction, the rate of long-duration eyes off driving task increased by 0.01 percentage points ($P = .0175$). For each 1 percentage point increase in other secondary behavior, the rate of long-duration eyes off driving task increased by 0.01 percentage points ($P < .0001$).

The above regression was repeated for each of the individual secondary activities. The rate of eyes off driving task for more than 2 s was significantly and positively correlated with reading, reaching for an object, holding an object, interacting with a PDA, adjusting an integral device, looking at an object outside of the vehicle, eating, and personal hygiene.

### Discussion

Drivers in this study engaged in behavior unrelated to driving during more than 40% of the time. The most common of these secondary activities were interacting with passengers, talking on a cell phone, talking to oneself, and simply holding a cell phone or other object. The frequency of these secondary activities declined with increasing driver age and at speeds over 50 mph. Slowing down or waiting for slower speeds could be a driver’s way of compensating for otherwise risky behavior. Funkhouser and Sayer (2012) reported that drivers initiated cell phone conversations and glanced at the phone more frequently at lower speeds. Behavior differences by driver age may be due to varying perceptions of the dangers associated with secondary activities. Tison et al. (2011) reported that older drivers were more likely than younger drivers to consider as very unsafe such actions as manipulating a navigation system, talking on a cell phone, eating or drinking, and adjusting the car radio.

When talking on the phone, drivers tended to avoid all other secondary behavior except for holding another object. In particular, interacting with passengers, adjusting the radio or climate controls, eating, smoking, and personal hygiene were less likely when talking on a cell phone. Alosco et al. (2012) concluded that eating impaired driving performance as much as did texting, so in that sense talking on the phone may be preferable to eating. Klauser et al. (2006) reported that near-crash.crash risk increased significantly when drivers were reading, reaching for a moving object, or applying makeup, but the 30% estimated increase when talking on a cell phone was not statistically significant. For self-reported frequent cell phone users, Fitch et al. (2013) found a nonsignificant 16% decline in safety-critical events and a significant 35% decline in eyes off road time when a driver was talking on a handheld cell phone. So, again, talking on the phone may be keeping drivers from engaging in even riskier behavior.

The effects of interacting with passengers are unclear. Koppel et al. (2011) reported that drivers more often looked away from the forward roadway when interacting with front-seat passengers than when eating or grooming. McEvoy et al. (2007) reported that drivers carrying 2 or more passengers were twice as likely to crash as unaccompanied drivers. However, Klauser et al. (2006) found that a driver’s near-crash.crash risk decreased significantly when talking to a passenger. Goodwin et al. (2012) found that drivers ages 16–18 were more

### Table 5. Estimated percentage of moving vehicle time spent with eyes off driving task by cell phone interaction rates per trip

| Cell phone interaction rate | Percentage of time looking forward | Percentage of time looking in mirrors | Percentage of time with eyes off driving task | Percentage of time with eyes off driving task > 2 s |
|----------------------------|------------------------------------|--------------------------------------|-----------------------------------------------|-----------------------------------------------|
| 0                          | 87.3                               | 3.6                                  | 9.1                                           | 1.8                                           |
| 1–9%                       | 85.6                               | 3.9                                  | 10.5                                          | 1.9                                           |
| 10–19%                     | 84.7                               | 3.5                                  | 11.7                                          | 3.0                                           |
| 20–29%                     | 81.2                               | 5.0                                  | 13.9                                          | 2.1                                           |
| 30–100%                    | 85.9                               | 3.9                                  | 10.2                                          | 1.5                                           |

### Table 6. Linear regression of moving vehicle rates of eyes off driving task on rates of cell phone interaction and other secondary behavior per trip

| Parameter                         | Estimate | 95% Confidence limits | $P$ value |
|-----------------------------------|----------|-----------------------|-----------|
| Female driver vs. male            | 0.03     | (−1.44, 1.49)         | .9695     |
| Younger than 21 vs. older         | −0.97    | (−2.92, 0.99)         | .3293     |
| Cell phone talking rate           | −0.02    | (−0.04, −0.001)       | .0087     |
| Cell phone nontalking rate        | 0.06     | (0.04, 0.09)          | <.0001    |
| Other secondary behavior rate     | 0.06     | (0.05, 0.07)          | <.0001    |
distracted by teen passengers and less distracted by adult passengers. In a review of evidence on the effects of passengers on crash risk, Williams et al. (2007) reported that passenger presence decreases crash risk for drivers 30 and older, increases crash risk for drivers ages 16–19, and has an uncertain effect on drivers ages 20–29. Tefft et al. (2012) concluded that having passengers younger than 21 increased fatality risk for teen drivers by 44%, but having passengers 35 and older decreased fatality risk by 46%. For the present study, talking on a cell phone and interacting with passengers were almost mutually exclusive.

It is unclear, however, whether talking on the phone caused drivers to ignore their passengers or whether an absence of passengers led to more frequent cell phone use. For trips that did not include any observed interaction with passengers, drivers spent 9% of the time talking on a phone, 3% of the time simply holding the phone, and 1% of the time otherwise interacting with the phone. For trips that did include some interaction with passengers, drivers spent 3% of the time talking on a phone, 4% of the time holding the phone, and 1% of the time otherwise interacting with the phone. Assuming that trips with no passenger interaction represent trips with no passengers, it would seem that drivers spent more time talking on the phone when they were driving alone. This is consistent with other observational studies of teen drivers (Foss et al. 2009) and all drivers (Pickrell and Ye 2013).

Drivers’ eyes were directed toward the vehicle windshield or mirrors approximately 90% of the time. The other 10% of the time their eyes were directed away from the driving task. The amount of time with eyes off driving task was not significantly related to either driver age or gender, but drivers talking on cell phones were less likely to direct their eyes away from the driving task. In contrast, Goodwin et al. (2012) reported that females were more likely than males and drivers using electronic devices were more likely than drivers not using electronic devices to look away from the roadway. However, only one third of the video clips Goodwin et al. coded as electronic device use involved holding a cell phone to one’s ear. Their focus on teen drivers, as well as the fact that their data were more recent, resulted in their seeing much more texting (or suspected texting) than in the present study.

The effect of cell phone use on other secondary behavior and eyes off driving task seems to extend somewhat beyond the time during which the phone is used. Trips with high rates of cell phone use had lower rates of other secondary behavior, but the effect was small, and the tradeoff was not one-to-one. For example, a 10 percentage point increase in the amount of trip time talking on the phone yielded a 3 percentage point decrease in other secondary behavior but still produced a 7 percentage point increase in overall secondary behavior. In other words, suppose a driver spent 7% of a trip talking on the phone and 33% of the trip on some other secondary behavior, so the overall secondary behavior rate was about 40%. If the driver spent 17% of the next trip talking on the phone, then the expected rate of other secondary behavior would be 30%, and the expected overall secondary behavior rate would be about 47%. This would be an improvement only if the secondary behavior being reduced was so risky as to offset the increase in cell phone conversations.

However, talking on the phone actually decreased the amount of trip time with eyes off the driving task. Though trips with high rates of secondary behavior other than cell phone conversation had higher rates of eyes off driving task, those trips with high rates of cell phone talking had lower rates of eyes off driving task. A 10 percentage point increase in the amount of trip time talking on the phone produced a 0.2 percentage point decline in eyes off driving task, even after accounting for some of the reductions in other secondary behavior. Most important, the rate of long-duration eyes off driving task declined significantly as time talking on the phone increased.

Thus, talking on a cell phone would seem to improve overall driving behavior both by reducing the time spent on other risky behavior and by keeping the driver’s eyes on the road. However, some studies have shown that a person’s visual inspection area tends to become more concentrated as cognitive tasks become more demanding (Harbluk et al. 2007; Hyman et al. 2009; Klauer et al. 2010). Thus, a driver talking on a cell phone may focus more on the road ahead but be less aware of hazards to the rear and sides of the vehicle. This cognitive distraction may continue even after the conversation has ended. Further research is needed to determine the effects of such narrowed focus on crash risk.

Some drivers in the present study were observed using hands-free cell phones, but most of the cell phone conversations required the driver to remove at least one hand from the steering wheel. In addition, although the codes for holding a cell phone or other object included holding it in one’s lap, many of these still involved the driver’s hands. Stutts et al. (2003) estimated that drivers spent 7% of moving vehicle time with no hands on the wheel when talking on a cell phone, 8% when dialing/answering, and 1% when not using the phone. Jamson (2012) reported that simulator driver reaction time to a lead vehicle braking increased from 5 s with 2 hands on the wheel to 6–7 s when drinking or eating. However, reaction time did not increase when drivers were talking on a handheld cell phone or driving with one hand on the wheel and no secondary tasks. Further research is needed to determine the effects of one-handed versus 2-handed steering on real-world crash risk.

Education has not shown much promise as a means for reducing distracted behavior by drivers. Even drivers who judge certain behavior to be unsafe continue to exhibit such behavior (Tison et al. 2011). There has been progress in developing technological solutions to some driver distractions. For example, Benden et al. (2012) evaluated a system that blocks cell phone calls while in a moving vehicle. They concluded that the system was ineffective due to extreme resistance from drivers in the study. Any technological solution must be designed so that it is acceptable to drivers. Perhaps they would be more accepting of systems targeting more complex behavior such as texting, reading, and interacting with vehicle–driver interfaces. The NHTSA (2012) has proposed voluntary guidelines for in-vehicle electronic devices.

Increases in the amount of driving time spent talking on a cell phone are associated with decreases in time spent on other distracting behavior and decreases in eye glances not related to the driving task. Although using a cell phone can be
distracting from the driving task, other secondary activities can be equally or more distracting, at least as measured by eye glances away from the road ahead and mirrors. In this group of drivers, dialing, reaching for, and answering the cell phone were associated with increased eyes off driving task, as opposed to the decrease in eyes off driving task associated with talking on the phone. Predictions about the effect of cell phone usage on driver distraction need to consider what other behavior is being displaced by the time spent on the phone. A focus by researchers, policy-makers, and the media on the distraction of using cell phones while driving may lead drivers to disregard the risk of other secondary behavior that is even more distracting.

Limitations

One of the limitations of the present study may be the coding of eye glance behavior. There was not always a clear view of the driver’s eyes, especially at night or in bright sunlight. Approximately 2% of the sampled video, including all video for one driver, could not be coded for eye glance behavior. Even when coding was possible, the determination of where a driver was looking was somewhat subjective. In addition, eyes off driving task, as defined in the present study, is less inclusive than the definition of eyes off forward roadway by Klauer et al. (2006). Whereas eyes off forward roadway included side and rearview mirror glances, the definition of eyes off driving task considers mirror glances to be part of the driving task. This definition of eyes off driving task still may not be restrictive enough. Glancing out the side windows also can be an important part of the driving task, particularly when approaching or entering intersections.

There may be other relevant secondary activities that were not coded in the present study. For example, Klauer et al. (2006) coded 2 daydreaming categories they called lost in thought and looked but did not see. Lost in thought was defined as “haphazardly looking around but not at any single distraction” (p. 133). Looked but did not see was defined as “looking in the direction of a conflict but does not react in a timely manner” (p. 133). The most frequent potentially distracting activity for Koppel et al. (2011) was a category called touching face/head. Galera et al. (2012) found that driver mind wandering with highly disrupting/distraction content more than doubled the risk of responsibility for crashes.

Funding

This work was supported by the Insurance Institute for Highway Safety.

Supplemental Materials

Supplemental data for this article can be accessed on the publisher’s website.

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