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Is the Technology in Your Car Driving You to Distraction?

David L. Strayer[1]

Abstract

Driver distraction is increasingly recognized as a significant source of injuries and fatalities on the roadway. Distraction can arise from visual/manual interference, for example, when a driver takes his or her eyes off the road to interact with a device. Impairments also come from cognitive sources of distraction when attention is withdrawn from the processing of information necessary for the safe operation of a motor vehicle. In the latter case, the driver's eyes may be on the roadway and his or her hands on the steering wheel, but he or she may not be attending to the information critical for safe driving. Concern over distracted driving is growing as more and more wireless devices are being integrated into the vehicle. We developed and validated a metric of distraction associated with the diversion of attention from driving. Our studies show that the distraction potential can be reliably measured, that cognitive workload systematically varies as a function of the secondary task performed by the driver, and that some activities, particularly newer voice-based interactions in the vehicle, are associated with surprisingly high levels of mental workload. Changing the culture of distracted driving will require a combination of scientifically based education concerning the hazards of inattention, regulations that target the root causes of distraction, and enforcement of the distracted driving laws.

Keywords

distracted driving, inattention, multitasking, dual-task processing, driver, distraction, cognitive workload

Tweet

It's the "Wild West" on the roadway today. Motorists fiddling around with all their wireless gadgets are creating an epidemic of distracted driving on our streets.

Key Points

- Distracted driving is increasingly recognized as a significant source of injuries and fatalities on the roadway. In fact, motor vehicle crashes are the leading cause of accidental injury deaths in the United States.
- Driver distraction can arise from visual/manual interference, for example, when a driver takes his or her eyes off the road to look at or manually interact with a device. Impairments also come from cognitive sources of distraction when attention is withdrawn from the driving task.
- Smartphones are proving to be a game changing technology with regard to driver distraction. Not only can motorists use their smartphone to talk and text, but the wireless technology also allows them to interact with social media and other "infotainment" systems. With the explosive growth in new technology, the problem of driver distraction is poised to become much more acute.
- Research suggests caution with the integration of voice-based technology in the vehicle as it may have unintended consequences that adversely affect traffic safety.
- Changing the culture of distracted driving will require a combination of scientifically based education concerning the hazards of inattention, regulations that target the root causes of distraction, and enforcement of the distracted driving laws.

Introduction

Everyone knows what distracted driving is. You can see it when a distracted driver runs a red light, drifts out of his or her lane of travel, looks but fails to see other vehicles, bicycles, pedestrians, or otherwise causes mayhem on the roadway. The National Public Radio show *Car Talk* even has a campaign imploring the motoring public to "HANG UP AND DRIVE!" (Car Talk, 2015). Distracted driving is increasingly

[1]University of Utah, Salt Lake City, USA

Corresponding Author:
David L. Strayer, University of Utah, 380 S. 1530 E. Rm. 502, Salt Lake City, UT 84112, USA.
Email: David.Strayer@utah.edu

recognized as a significant source of injuries and fatalities on the roadway. The National Highway Traffic Safety Administration (NHTSA) estimated that inattention accounted for at least 25% of all police reported crashes (Ranney, Mazzae, Garrott, & Goodman, 2001; Wang, Knipling, & Goodman, 1996). More recently, a study examining the video records obtained from approximately 1,700 crashes found that 58% involved inattention or situations where the driver was engaged in a non-driving-related activity in the moments preceding the crash (e.g., Carney, McGehee, Harland, Weiss, & Raby, 2015).

Driver distraction can arise from visual/manual interference, for example, when a driver takes his or her eyes off the road to look at or manually interact with a device (this is commonly referred to as "structural interference"—for example, your eyes cannot focus on two disparate locations at the same time). Impairments also come from cognitive sources of distraction when attention is withdrawn from the processing of information necessary for the safe operation of a motor vehicle (Strayer, Watson, & Drews, 2011). With cognitive distraction, the driver's eyes may be on the roadway and their hands on the steering wheel, but they may not be attending to the information critical for safe driving.

It is worth noting that operating an automobile is the single riskiest activity that most readers of this article engage in on a regular basis. Motor vehicle crashes are the leading cause of accidental injury deaths in the United States and are the leading cause of all deaths for people between the ages 1 to 33 and 56 to 71 (National Safety Council [NSC] White Paper, 2010). Driving is a complex skill that takes years to master. Support for this assertion is provided by the U-shaped function relating fatal crash rates for different age drivers. Normalized by million miles driven, fatal crash rates steadily decline from novice/teen drivers until crash rates asymptote around 30 years of age as drivers gain more and more experience on the roadways. Around age 65, fatal crash rates begin to steadily increase, reflecting the changes in cognition associated with senescence.

It should go without saying that we need our whole brain to operate a motor vehicle. Our visual and auditory cortices process the sights and sounds of driving. The parietal cortex is important for spatial navigation and complex motor movements. The temporal and parietal cortices support the declarative and procedural memories needed for driving. The motor cortex is important for steering and braking responses. The prefrontal cortex is critical for controlling our actions, helping to keep us on task, avoid distractions, make good decisions, and prioritize the different activities as we drive down the road. In fact, the U-shaped function relating fatal crash rates for different age drivers is closely correlated with the rise and decline in prefrontal cortical regions of the brain (Watson, Miller, Lambert, & Strayer, 2011). In short, driving is a whole-brain activity; motorists use their brain all the time when performing the complex task of driving an automobile.

Driver Distraction and the "Wild West"

Public concern over driver distraction grew as radios became a standard feature in many vehicles. In fact, in the early 1930s, several states considered legislation banning listening to the radio while driving (none of these were enacted into law). Martin Cooper invented the cellular phone in 1973, and by the late-1990s, motorists' concurrent use of the cellular phone had become routine. In 2001, the State of New York enacted the first law in the United States prohibiting handheld cell phone use while driving, and 14 states currently have laws prohibiting motorist's use of a handheld cell phone (Governors Highway Safety Association [GHSA], 2015). However, all states allow adult drivers to converse using a hands-free cellular device. The use of a cellular device to send and receive SMS or text messages became commonplace by the mid-2000s, and in 2007, the State of Washington became the first to pass a law banning the practice while driving. Currently, 44 states in the United States prohibit texting while operating a motor vehicle (GHSA, 2015).

Smartphones are proving to be a game changing technology with regard to driver distraction. Indeed, former National Transportation Safety Board (NTSB) chairwoman Deborah Hersman characterized the situation as being *like the Wild West* (Lindblom, 2015). Not only can motorists use their smartphone to talk and text, but also the wireless technology allows them to navigate with GPS, stream music, search the Internet, engage using social media, and interact with other "infotainment" systems. Some of the applications provided on the smartphone may improve traffic safety (e.g., using audio-based GPS to navigate rather than paper maps or dead reckoning). However, if the driver attempts to program the device while driving (even by using voice-based commands; see below), or to look at the graphical display, then the safety benefits may well be negated. Other functions are likely to provide entertainment with little cost to road safety. For example, listening to music streamed on the device does not impair driving (see below for details). However, if the driver takes his or her eyes off the road to select a station or playlist, then this visual/manual interaction is no different than sending a text message or dialing a phone number.

The visual/manual/cognitive demands in the vehicle are increasing at a rapid pace. There is also growing concern that some of the social media features on these devices may have addictive qualities (e.g., Atchley & Warden, 2012; Billieux, Maurage, Lopez-Fernandez, Kuss, & Griffiths, 2015). The majority of new vehicles have voice commands (e.g., voice dialing, changing the radio, adjusting the climate control), multifunction graphical displays (e.g., the 2015 Tesla Model S is configured with a 17″ touchscreen display), assistive-technologies (e.g., lane departure warnings, adaptive cruise control, collision mitigation systems), and infotainment systems that support an ever-growing list of features (e.g., Facebook, Instagram, Twitter, Snapchat). New wearable devices may also provide additional sources of distraction (e.g., Apple Watch, Fitbit, Google Glass). Some companies are now marketing a heads-up display for the car. For example, Navdy (see navdy.com) has developed and is marketing a “heads-up” display that will project FaceTime video streams, text messages, and other navigation information to the driver’s forward field of view.

Much of the advanced technology being introduced into new cars represents a hybrid with both visual/manual and cognitive demands. For example, drivers may press a button to initiate a navigation search (e.g., find a sushi restaurant nearby) and the results may be displayed on the center-stack visual display. After perusing the display, the driver may touch the desired restaurant description and then receive turn-by-turn navigation information (both auditory and visual) until they reach their destination. It is important to understand how these complex multimodal interactions affect driving performance; they are neither purely visual/manual nor purely cognitive in nature.

It is also worth noting that not all drivers will be enchanted with these new technologies in their vehicle (at least in their current, error prone form). Some of these functions may be intrusive and unwanted by the driver. For example, the GPS navigation system may “help” to navigate to an undesired destination with the system blaring out turn-by-turn directions to the driver. In our on-road testing of new model vehicles (Strayer et al., in press), drivers often found these interactions to be error prone and extremely frustrating. In fact, attempting to use voice commands actually brought one of our participant drivers to tears. The technology installed in your car should not make you cry.

The Science of Driver Distraction

A motorist’s awareness of the driving environment, often referred to as their situational awareness, is a mental state that is dependent upon several cognitive processes (e.g., Durso, Rawson, & Girotto, 2008; Endsley, 1995; Horrey, Wickens, & Consalus, 2006). These include visual *Scanning* of the driving environment for indications of threats, *Predicting* and anticipating where potential threats might materialize if they are not visible, *Identifying* threats and objects in the driving environment when they are in the field of view, *Deciding* whether an action is necessary and what action is necessary, and *Executing* appropriate *Responses*—*SPIDER* for short (Fisher & Strayer, 2014; Strayer, in press).

Successful performance is often dependent upon the allocation of attention to the driving task (Kahneman, 1973). When drivers engage in secondary-task activities that are unrelated to the safe operation of the vehicle, attention is often diverted from driving, impairing performance on these SPIDER-related processes (Regan, Hallett, & Gordon, 2011; Regan & Strayer, 2014). For example, when a driver talks on a cellular phone, visual scanning is disrupted (J. M. Cooper, Medeiros-Ward, & Strayer, 2013; Engström, Johansson, & Östlund, 2005; Harbluk, Noy, Trbovich, & Eizenman, 2007; He, Becic, Lee, & McCarley, 2011; Recarte & Nunes, 2000; Reimer, 2009; Tsai, Viirre, Strychacz, Chase, & Jung, 2007; Victor, Harbluk, & Engström, 2005), prediction of hazards is impaired (Biondi, Turrill, Coleman, Cooper, & Strayer, 2015; Taylor et al., 2015), identification of objects and events in the driving environment is retarded (McCarley et al., 2004; Strayer, Cooper, & Drews, 2004; Strayer & Drews, 2007; Strayer, Drews, & Johnston, 2003; Strayer & Johnston, 2001), decision for action is altered (J. M. Cooper, Vladisavljevic, Medeiros-Ward, Martin, & Strayer, 2009; P. J. Cooper & Zheng, 2002; Drews, Pasupathi, & Strayer, 2008), and appropriate reactions are delayed (Caird, Willness, Steel, & Scialfa, 2008; Horrey & Wickens, 2006). Consequently, activities that divert attention from the task of driving degrade the driver’s situational awareness and may compromise the ability of the driver to safely operate their vehicle.

Benchmarking Distraction

My Applied Cognition Laboratory at the University of Utah has been working to provide a benchmark for the cognitive workload associated with common in-vehicle activities (Strayer et al., in press; see also J. M. Cooper, Ingebretsen, & Strayer, 2014; Strayer et al., 2013; Strayer, Turrill, Coleman, Ortiz, & Cooper, 2014). The prior literature was largely piecemeal, with comparisons using different tasks, different subjects, and a variety of dependent measures. In our studies, we developed and validated a cognitive distraction scale based on converging operations from the laboratory, driving simulator, and using an instrumented vehicle driven in a residential section of Salt Lake City. Our research shows that the distraction potential can be reliably measured, that cognitive workload systematically varies as a function of the secondary task performed by the driver, and that some activities, particularly newer voice-based interactions in the vehicle, are associated with surprisingly high levels of mental workload.

Figure 1 presents the workload ratings obtained when we compared seven different concurrent tasks with a “single-task” condition where the drivers did not perform any concurrent secondary-task activity (Strayer et al., 2013). The seven tasks were listening to the radio, listening to a book on tape, talking to a passenger, talking on a hands-free cell phone, talking on a handheld cell phone, interacting with a simple voice messaging system, and a cognitively demanding Operation Span (OSPAN) task that was used for calibration.[1] In our distraction scale, the non-distracted single-task driving anchored the low end (Category 1) and the mentally demanding OSPAN task anchored the high end (Category 5) of the scale. Using this method, we found that activities such as listening to the radio or an audio book were not very distracting.

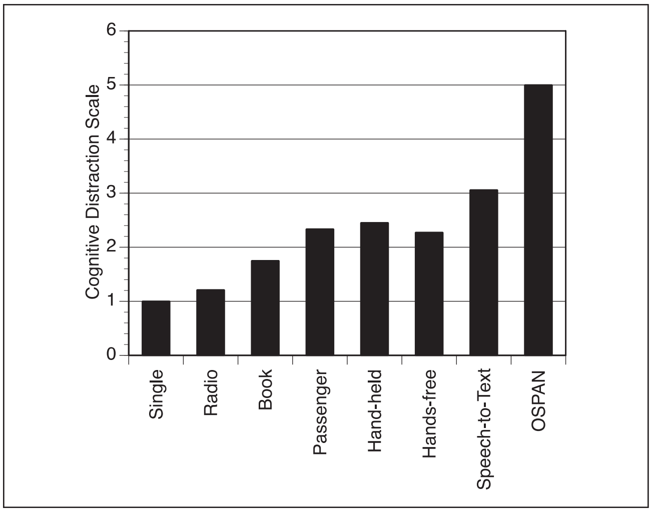

Figure 1. The cognitive distraction scale developed by Strayer et al. (2013).

Other activities, such as conversing with a passenger or talking on a handheld or hands-free cell phone, are associated with moderate/significant increases in cognitive distraction. Finally, activities such as using a speech-to-text system to send and receive short text or email messages produced a surprisingly high level of cognitive distraction.

The speech-to-text system that we evaluated in the laboratory is noteworthy because the speech-recognition portion of the system was perfectly reliable and there was no requirement to review, edit, or correct garbled translations. In our research protocol, perfect speech recognition was implemented using a "Wizard-of-Oz" paradigm (Kelley, 1983; Lee, Caven, Haake, & Brown, 2001), in which the participant's speech was secretly entered into the computer by the experimenter with no transcription errors. Consequently, drivers did not need to take their eyes off the road or their hand off the steering wheel when making these voice-based interactions. Nevertheless, this "best case" speech-to-text email/text message system received a Category 3 rating on the cognitive distraction scale.

In our 2014 research (Strayer et al., 2014), we examined voice-based interactions in greater detail. We found that just listening to voice messages without the possibility of generating a reply was associated with a cognitive workload rating comparable with that of conversing on a cell phone (i.e., Category 2). However, when drivers composed replies to these messages, the workload rating increased to a Category 3 rating on the cognitive distraction scale. Like our earlier testing, this laboratory-based system was perfectly reliable. We also found no systematic difference between the natural (i.e., human) and synthetic (i.e., computerized) delivery of the messages. This latter finding suggests that there is little to be gained by improving the quality of the synthetic speech, at least with regard to the driver's mental workload.

Our 2014 research also evaluated Apple's intelligent personal assistant, *Siri*, to send and receive text messages, update Facebook or Twitter, and to modify and review calendar appointments. To create a completely hands-free version of the interaction, a lapel microphone was clipped to the participant's collar and they activated Siri with the command "Hello Siri," at which point a researcher manually activated the device. Drivers neither looked at nor made physical contact with the iPhone during these interactions. Even so, the workload ratings for these interactions exceeded Category 4, with an obtained rating of 4.15 on our workload scale. Moreover, there were two crashes in the driving simulator study when participants were using Siri.

To understand the workload rating associated with interacting with Siri, it is useful to consider what is *not* causing the effect. The high level of workload is not due to visual/manual interference. Recall that participants never looked at or touched the iPhone during the session. This indicates that the impairments were cognitive in nature, associated with the allocation of attention to the task. The high level of workload is also not due to the quality of vocal input or audio output. Participants wore a lapel microphone that allowed them to speak in a normal voice and the audio was played clearly over stereo speakers in the lab, simulator, or car.

The primary difference between our laboratory-based speech-to-text system and the Siri-based interactions was the reliability of the system (see also Strayer et al., in press). Siri was error-prone, producing different responses to seemingly identical commands. In other circumstances, Siri required exact phrasing to accomplish specific tasks and subtle deviations from that phrasing would result in a failure. Moreover, when there was a failure to properly dictate a message, it required starting over because there was no way to modify/edit a message or command. For these reasons and others, voice-based interactions using an intelligent personal assistant such as Siri are significantly more mentally demanding than interactions with a passenger in the vehicle or a conversation on a cell phone.

Our most recent research (Strayer et al., in press) has found that voice-based interactions made using standard equipment in new vehicles or using voice-based commands with smartphone technology resulted in levels of mental workload that were similar to that produced by the cognitively demanding OSPAN task. This observation bears repeating: When drivers were using these voice-based systems the workload ratings approached the Category-5 level (i.e., the same workload that was obtained when drivers were performing the OSPAN task)! No one in their right mind would perform the OSPAN task of their own volition while driving a motor vehicle. Moreover, we also found residual effects of these voice-based interactions that persisted for more than 15 s after the voice-based interaction had terminated. The research suggests caution with the integration of voice-based technology in the vehicle as it may have unintended consequences that adversely affect traffic safety.

Red Herrings and Other Issues

Driver Distraction and Crash Risk

It is notoriously difficult to determine the crash risk associated with driver distraction. The Fatal Analysis Reporting System (FARS; 2015) database has proven to be inadequate for establishing the crash risk caused by driver distraction, partially due to the fact that, unlike alcohol intoxication, distractions often leave no physical evidence at the scene of a crash (NSC White Paper, 2013). There are several empirical methods for studying driver behavior, each with strengths and weaknesses. Some of these methods are used primarily in experimental research (e.g., test track, instrumented vehicle, and driving simulation) where the primary goal is to understand basic mechanisms underlying driving behavior. These experimental studies converge with the 70-year literature on attention and establish that when attention is diverted to an activity unrelated to the safe operation of a motor vehicle, driving performance is impaired.

Other methods are used in a non-experimental context (e.g., epidemiological, observational, naturalistic), where the primary goal is to gain a better understanding of the determinants of crash risk. There appears to be less convergence with this latter correlational approach (e.g., epidemiological studies report that the odds ratio[2] for a crash is four times higher when drivers are using a cell phone; for example, McEvoy et al., 2005; Redelmeier & Tibshirani, 1997), whereas estimates from naturalistic studies suggest that the odds ratio for talking on a cell phone is often not different from and sometimes below one (e.g., Klauer et al., 2014). However, the validity of these naturalistic studies has recently been called into question (Knipling, 2015).

Passenger Conversations

Do in-vehicle conversations with a passenger impair driving to the same extent as cell phone conversations? The answer depends, in part, on the age and experience of the driver and passenger. The teen driver/passenger dyad is a distracting combination. For example, the video analysis by Carney et al. (2015) found that the driver conversing or otherwise interacting with a passenger was the most common factor in teen-driver crashes (15%), followed by the driver being engaged in a cell phone conversation (12%). However, the pattern changes for adult drivers. Epidemiological evidence (Rueda-Domingo et al., 2004; Vollrath, Meilinger, & Kruger, 2002) indicates that the crash rate drops below 1.0 when there is an adult passenger in the vehicle (i.e., there is a slight safety advantage for having another adult passenger in the vehicle). Drews et al. (2008) found that adult passengers are often actively engaged in supporting the driver by pointing out hazards, helping to navigate, and reminding the driver of the task (i.e., exiting at the rest stop). In other cases, the conversation was temporarily halted during a difficult section of driving and then resumed when driving became easier. In effect, the passenger acted as another set of eyes that helped the driver control the vehicle, and this sort of activity is not afforded by cell phone conversations (see also Gaspar et al., 2014).

Self-Regulation

The relationship between driver distraction and crash risk is complicated by how and when drivers choose to engage in a secondary non-driving activity. Drivers may attempt to self-regulate their non-driving activities to periods where they perceive the risks to be lower. Strayer and Cooper (in press) suggested that there are two forms of self-regulation in driving: *proactive* and *reactive.* An example of the proactive self-regulation is when motorists choose to place a call or send a text when stopped at a traffic light (Huth, Sanchez, & Brusque, 2015). By contrast, reactive self-regulation refers to situations where a driver moderates his or her usage in *real time* based upon driving difficulty or the perception of driving errors. An example of reactive self-regulation is when the driver terminates his or her call when the demands of driving increase (e.g., when they enter a school zone).

Reactive self-regulation depends upon driver's being aware of their driving errors and adjusting their behavior accordingly. Sanbonmatsu, Strayer, Behrends, Medeiros-Ward, and Watson (in press) found that a driver's ability to reactively self-regulate their multitasking behavior was limited by the same factors that caused the driver to be distracted in the first place. In their study, a positive correlation was found between the self-awareness of driving errors and actual driving errors when drivers were not talking on a cell phone. By contrast, a negative correlation was found between the self-awareness of driving errors and actual driving errors when drivers were talking on a cell phone. Alarmingly, the cell phone drivers who made the most errors were blithely unaware of their driving impairments. Hence, any reactive self-regulatory behavior on the part of a driver using a cell phone would appear to be minimal.

Another alarming statistic is that the least capable at multitasking are the most likely to use a cell phone while driving (Sanbonmatsu, Strayer, Medeiros-Ward, & Watson, 2013). Multitasking activity was found to be negatively correlated with *actual* ability and positively correlated with *perceived* ability (i.e., frequent users exhibited a pattern of overconfidence in their multitasking ability). In fact, the frequency of cell phone use while driving was positively correlated with high levels of impulsivity and sensation seeking and negatively correlated with measures of executive control. Motorists report that they use a cell phone because they harbor the belief they are personally capable of driving safely while doing so. However, they also see other driver's usage as much riskier than their own and consequently tend to support laws to restrict the behavior (Sanbonmatsu, Strayer, Biondi, Behrends, & Moore, in press). That is, motorists want the laws to apply to the other driver.

False Choices

We often hear reports that some drivers attempt to stave off the effects of boredom and fatigue with caffeine and a phone call or text message. The suggestion here is that a driver engaged in a cell phone conversation is likely to be less impaired than a driver who falls asleep at the wheel. However, a much better alternative is not to drive fatigued or distracted, and the fatigued driver conversing on a cell phone is often more impaired than a well-rested cell phone driver. Others have made the claim that prohibiting the more demanding voice-based interactions somehow encourages visual/manual interactions to perform the same activities. But a more rational alternative would be to refrain from performing any activity (voice-based or visual/manual) that is associated with a high level of distraction.

Another common reason motorists give for using cell phones while driving is to improve their productivity (e.g., "I can get more work done on this boring commute"). However, the productivity argument can be discredited for several reasons. First, the distracted driver tends to tie-up traffic on the highways. For example, J. M. Cooper et al. (2009) found that up to 10% of the commute time in rush-hour traffic (*for all drivers*) was caused by the delayed reactions of distracted drivers on the roadway (and this excludes any delays caused by distraction-related crashes). Second, the NSC examined the impact of company-wide policies banning the use of a cell phone while driving and found that worker productivity increased and crash rates decreased with the implementation of a policy banning cell phone use while driving (NSC White Paper, 2015).

What Should Be the Red Line for Driver Workload?

The research described herein can be used to help inform scientifically based policies on driver distraction, particularly as it relates to the diversion of attention to other concurrent activities in the vehicle. Grier et al. (2008) discussed how a "red line" of workload could be empirically established and serve as a guide for policy makers. Once the workload associated with different in-vehicle activities is established, then a reasoned and rational approach to regulation can be undertaken.

One important message that can be derived from the scientific literature is that regulatory policies and educational campaigns should *target the root causes of distraction*, rather than singling out individual technologies. For example, 14 states in the United States have enacted laws prohibiting a driver's use of a handheld cell phone, but all states allow adult drivers to converse using a hands-free device (GHSA, 2015). However, research indicates that there is no difference in the distraction produced by these two modes of cellular communication (see also Ishigami & Klein, 2009; Strayer et al., 2011). As mentioned earlier, your brain is distracted by the cell phone conversation whether it is handheld or hands-free (for a discussion of *why* cell phone conversations cause distraction, see Bergen, Medeiros-Ward, Wheeler, Drews, & Strayer, 2013).

Another example, involves the regulation of texting while driving. Currently, 44 states in the United States prohibit texting while operating a motor vehicle (GHSA, 2015). However, many allow the driver to type in a 10-digit phone number, scroll through a playlist, or send and receive an email message. With respect to taking the driver's eyes off the road, their hands off the wheel, and their mind off the drive, there is little difference between sending/reading a text message and sending/reading an email message. Rather than targeting texting, some states have developed regulations that prohibit the driver from manually interacting with any electronic device while the vehicle is in motion. For example, Utah State Law 41-6a-1716 prohibits drivers from manually writing, sending, or reading a written communication including (a) a text message, (b) an instant message, (c) electronic mail, (d) dialing a phone number, (e) accessing the Internet and reviewing or recording a video, or (f) entering data into a handheld wireless communication device. In this instance, the Utah law is consistent with the science on driver distraction as it relates to visual/manual sources of distraction. Moreover, these properly targeted laws are much easier to enforce.

Changing the culture of distracted driving will require sustained effort on several fronts. First, the science needs to be in place for effective decision making. Second, proper education needs to be provided to inform motorists of the hazards associated with different sorts of interactions (for an excellent example, see Zero Fatalities, 2015). Third, regulations need to be crafted that target the root causes of driver distraction. Finally, the regulations need to be enforced. In fact, NHTSA's high-visibility enforcement programs in Hartford, Connecticut, and Syracuse, New York, were found to significantly reduce the number of drivers using handheld devices while driving (Chaudhary, Casanova-Powell, Cosgrove, Reagan, & Williams, 2012).

Several groups, including the NTSB and the NSC have called for a ban on the use of cell phone technology while operating a vehicle. The NSC even has a freely available cell phone policy kit that helps employers implement and enforce a policy based on the empirical research on driver distraction (see http://safety.nsc.org/cellphonekit). Surveys suggest that the driving public would generally favor regulation of this sort. In fact, the AAA Traffic Safety Culture Index (2015), a nationally representative survey of drivers conducted in the United States, found that 86.3% of respondents reported that people talking on a cell phone posed a "very serious" or "somewhat serious" threat to their personal safety and that half of those surveyed support regulations that would prohibit the use of all wireless technology while driving.

The NHTSA is in the process of developing voluntary guidelines to minimize driver distraction created by electronic devices. There are three phases to the NHTSA guidelines. The Phase 1 guidelines, entered into the Federal Register on March 15, 2012, address visual/manual interfaces for devices installed by vehicle manufacturers (National Highway Traffic Safety Administration, 2012). The Phase 2 guidelines, scheduled for release sometime in 2015, will address visual/manual interfaces for portable and aftermarket electronic devices. Phase 3 guidelines (unknown release date) will address voice-based auditory interfaces for devices installed in vehicles and for portable aftermarket devices.

Currently, however, there are no unified regulations regarding the use of wireless technology in the vehicle—The NHTSA Phase 1 guidelines are voluntary and none of the automotive manufactures currently meet these guidelines. With the explosive growth in technology, the problem of driver distraction is poised to become much more acute. *Doing nothing is simply not a viable option*. Crashes attributable to driver distraction are likely to increase, and drivers may well revolt because of all the gadgets in the vehicle.

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Notes

1. The auditory version of the Operation Span (OSPAN) task creates a cognitively challenging dual-task condition (Sanbonmatsu, Strayer, Medeiros-Ward, & Watson, 2013; Watson & Strayer, 2010). While driving, participants were asked to remember a series of two to five words that were interspersed with math-verification problems (e.g., given "[3 / 1] − 1 = 2?" − "cat" − "[2 × 2] + 1 = 4?" − "box" − RECALL, the participant should have answered "true" and "false" to the math problems when they were presented and recalled "cat" and "box" in the order in which they were presented when given the recall probe). It would be difficult to overstate the demanding nature of the OSPAN task.
2. The odds ratio reflects the association between an exposure and an outcome. The odds ratio is determined by the ratio of the odds that an outcome (e.g., a crash) will occur with an exposure (e.g., the driver was using a cell phone) relative to the odds that an outcome (e.g., a crash) will occur with the absence of an exposure (e.g., the driver was not using a cell phone). If the odds ratio is one, there is no association between exposure and outcome. If the odds ratio is less than one, it indicates that the exposure decreases the odds of an outcome (i.e., if the outcome was a crash, the exposure would reflect a *protective effect*). If the odds ratio is greater than one, it indicates that the exposure increased the odds of an outcome (i.e., if the outcome was a crash, the exposure would reflect a *harmful effect*). Redelmeier and Tibshirani (1997), for example, found that odds ratio for crashing was four when drivers were using a cell phone, reflecting a harmful effect of this exposure (i.e., the odds ratio was significantly greater than one).

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