Distracted driving: What is the state of the science, and what are our knowledge gaps?

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INTRODUCTION
In recent years the topic of driver distraction has generated considerable attention as a traffic safety concern. But it is not a new phenomenon. Early in America’s driving history there was debate, as car radios were first being introduced, about whether they should be banned because of the potential to distract drivers (Novak, 2013). Legislators in a number of states proposed fining drivers, while other states suggested that criminalizing installation would help keep drivers safe. The legislation was not enacted and a study on the topic found no relationship between listening to the radio and car crashes (Novak, 2013). Since that time people have found many more ways to divert attention away from the driving task, such as reading maps, books and newspapers, shaving, brushing teeth, putting on makeup, eating and drinking, and gazing at distractions outside the vehicle, to name but a few. More recently, the prominence of distracted driving as a traffic safety concern was elevated to a top priority of the Department of Transportation by the former U.S. Secretary of Transportation, Ray LaHood, as concerns grew about the proliferation of in-vehicle connectivity and mobile “infotainment” devices that increasingly are being used during driving. Much of this attention has focused on the use of electronic devices, not surprising given their dramatic growth, but evidence from naturalistic driving studies, in which drivers are monitored while they are driving, suggests distracted driving results from many different activities. Moreover, the problem of distracted driving is not likely to go away with the ever expanding opportunities for staying in touch while driving.

The purpose of this special issue is to assemble the latest research on driver distraction to determine what we currently know and what we need to know, which form the basis of recommendations about future research needs. The authors were brought together as part of the Engaged Driving Initiative (EDI) Expert Panel created by State Farm Mutual Automobile Insurance Company (State Farm®). This effort was administered by the Association for the Advancement of Automotive Medicine (AAAM) and chaired by Susan A. Ferguson, PhD. The Expert Panel members, all of whom are recognized experts in the field of distracted driving research and policy, bring to the table a wide range of expertise. Each panel member was asked to summarize the state of the art in their respective areas of expertise and to point to the most important questions that still need to be addressed along with research methods to answer them.

WHAT IS DISTRACTED DRIVING AND HOW DO WE MEASURE IT?
In the opening paper of the series, Michael Regan, PhD, with the University of New South Wales, Sydney, Australia, and David Strayer, PhD, University of Utah, address the key issue of what driver distraction is and how we define it. Although there is little agreement in the literature about the terms “driver inattention” and “driver distraction,” the authors take the view that the overarching topic of interest is driver inattention with driver distraction being just one of the processes that can give rise to it. They present a taxonomy of driver inattention that was developed by Regan and others from in-depth examination of real-world crashes and contrast it with one developed from a theoretical perspective. The results of a recent study to validate the Regan et al. taxonomy using real-world crash data also are presented. Research recommendations are aimed at validating the taxonomy and better understanding the categories of inattention and their impact on driving performance, crash type, and crash risk.

The second paper, authored by Daniel McGehee, PhD, University of Iowa, discusses the important issue of measurement. As Dr. McGehee points out, given the numerous sources of distraction, the measurement of attention and distraction is necessarily complex. He describes a series of metrics that can be used in tightly-controlled, experimental settings to measure two general categories of
distraction; visual and cognitive. The ultimate goal of such measurements is to help identify interfaces that are visually and cognitively demanding. Dr. McGehee points to the future need of driver metrics to go beyond measurement of task load to measure how drivers self-regulate when they choose to be distracted.

In the next paper, Donald Fisher, PhD, University of Massachusetts-Amherst and Dr. David Strayer provide a model of the relationship between crash risk and a driver’s situation awareness. Driver’s situation awareness is considered as reflective of the dynamic mental model of the driving environment and is dependent upon several psychological processes including Scanning the driving environment, Predicting and anticipating hazards, Identifying objects in the driving scene, Deciding on an action, and Executing an appropriate Response (SPIDER). An Order-of-Processing (OP) model makes explicit the SPIDER-relevant processes and how they predict the likelihood of a crash when the driver is or is not distracted by a secondary task.

Many of the experimental studies that have examined the relationship between distraction and driving performance have used a methodology in which drivers are asked to undertake secondary tasks while driving (often in simulated driving environments) and the associated effects on driving performance are measured. John Lee, PhD, University of Wisconsin, Madison makes the point that this approach largely ignores how drivers decide whether to engage in secondary tasks while driving and under what conditions they engage and disengage from driving. In this regard, the effects of distraction may be very sensitive to timing with respect to roadway and other demands. In other words, the effect of distraction on performance may be as much about when drivers perform tasks, as it is about what task drivers perform. He makes the point that driving does not always demand full attention and much of the time it does not receive full attention. Thus, lack of full attention does not always compromise driving performance. Dr. Lee talks about the implications for automated driving technology which may allow drivers to disengage from the driving task but also require them to re-engage as conditions change. The paper concludes with implications for design, evaluation, and research.

**PREVALENCE OF DRIVER DISTRACTION AND CRASH RISK**

The next two papers provide a review of the literature on prevalence and risks of driving while distracted employing different sources of data. Each source of data has its strengths and limitations, but in comparing estimates from a variety of sources it is possible to arrive at a more robust understanding of the variation in such estimates. In the first paper, Linda Angell, PhD, Touchstone Evaluations, Inc. discusses the various methodologies that have been used to measure distracted driving prevalence and risk, their strengths and limitations. Dr. Angell makes the case that combining the various methodologies, what she terms convergence science, can allow a better understanding of these issues than any one single approach. When different sources of data are considered together consistent patterns often emerge. The paper goes on to compare prevalence and risk of distracted driving using data from studies that use non-naturalistic driving data.

The second paper, authored by Thomas Dingus, PhD, Virginia Tech Transportation Institute, discusses prevalence and risk associated with distraction based upon naturalistic driving data, wherein drivers are monitored throughout their daily driving providing continuous records of their driving for extended periods of time. This method captures information about driver behavior right before a crash or near crash occurs. The frequency of secondary task behavior and the associated risk for safety-critical incidents are estimated for three populations of drivers (i.e., adults, light vehicle; teenagers, light vehicle; and adults, heavy vehicle). Relative risk estimates provide insight into the risk associated with engaging in a variety of single tasks. When combining frequency of use with risk estimates, it is possible to identify those secondary tasks that create the greatest overall risk to driving safety. There have been a number of estimates, using diverse sources of data, of the relative crash risk associated with various distracting activities. These estimates are not always in agreement. Both papers point to the need for additional research, using a variety of data sources, to better understand the magnitude of these crash risks. The database from the recent Second Strategic Highway Research Program (SHRP 2) Naturalistic Driving study, available in mid-2014, will contain a much larger number of crashes and near crashes than has been available in the past and will allow more robust studies of prevalence and crash risk from secondary task behavior.

**TEENAGE DRIVERS: A SPECIAL CASE?**

Teenage drivers are a special group when it comes to driving risk. The combination of their inexperience and immaturity leads to crash rates that are much higher than those of older, more experienced drivers. This has led to driving laws for younger, beginning drivers that impose different requirements on them, for example,
graduated licensing and zero tolerance laws. In that regard, distracted driving is no different. Dennis Durbin, MD, with The Children’s Hospital of Philadelphia and his co-authors, Dr. Daniel McGehee, Dr. Donald Fisher, and Anne McCartt, PhD, with the Insurance Institute for Highway Safety, review these special considerations as they pertain to distracted driving among teenage drivers, including the widespread prevalence of mobile device use by teens, their lack of driving experience, the influence of peer passengers as a source of distraction, the role of parents in influencing teens’ attitudes and behaviors relevant to distracted driving and the impact of laws designed to prevent mobile device use by teen drivers. They conclude with recommendations for research in the specific areas they have identified.

LAWS AND ENFORCEMENT

Strong laws with publicized strong enforcement are a proven countermeasure for changing driver behavior. As distracted driving has increased with the proliferation of electronic devices, federal and state governments have responded primarily with policies and laws that target different aspects of cell phone use such as talking on the phone and texting. Cathy Chase, Advocates for Highway and Auto Safety, summarizes the evolution of state and federal governmental actions to address this public health problem and points to additional steps that could be taken in the areas of law enactment and federal regulation. She also summarizes the findings of a number of public opinion polls which point to a high level of support for such laws, particularly bans on texting while driving.

A critical requirement when states pass laws aimed at changing driver behavior is to evaluate whether these laws have been successful in affecting behavior and crash risk. In the final expert panel paper Dr. Anne McCartt, David Kidd, PhD, and Eric Teoh, MS, of the Insurance Institute for Highway Safety, review the research evidence regarding effectiveness of these laws with respect to reducing the frequency of phone use and crash rates. They also point to the challenges inherent in conducting such research in light of the large variations in the laws themselves, the difficulties of observing the targeted behaviors, and the inadequacy of the data on driver cell phone use prior to a crash. They make the case for additional research aimed at better understanding the crash risk associated with distracted driving and evaluations of cellphone bans, including a fuller range of the effects of bans on behavior, such as the type of phone use (e.g., texting, conversation), phone type (e.g., hands-free, hand-held), or circumstances of use (e.g., stationary vehicle, moving vehicle).

FUTURE CHALLENGES

Given the burgeoning use of cell phones, and especially smart phones, across the U.S. population, extensive research has been undertaken to understand the performance decrements that could result from cell phone use while driving, as well as the prevalence of use and associated crash risks. Recent naturalistic driving studies have shown that cell phone use is just one of a number of secondary tasks that drivers engage in while driving, and may not be the most prevalent. As a result, researchers stress the importance of considering the range of behaviors that result in distraction while driving, not just cell phone use. As well, the landscape of potential in-vehicle distractions is constantly shifting. Crash avoidance safety features that warn drivers of unsafe behaviors or impending hazards are becoming more widespread in the vehicle fleet (e.g., lane departure warning systems, blind spot warning systems, forward collision warning systems). Such systems are designed to alert drivers to unsafe situations and sometimes take avoidance measures if hazards are detected. Such systems offer potential safety benefits, but there is also the potential for drivers’ attention to be diverted away from the driving task as they juggle the various inputs from these technologies. Some of these systems can take action on behalf of the driver, potentially allowing the driver to disengage from the driving task. On top of that there is a growth in in-vehicle connectivity and mobile infotainment devices that allow drivers to access messages, emails, texts, and internet services. These trends in vehicle safety technology and infotainment systems make the challenge of keeping drivers engaged in the driving task an increasingly important research, design, and policy issue. It will be critical to understand the risks and benefits of such systems, and whether they ameliorate or exacerbate the frequency or outcomes of distracted driving. A major theme emerging from the panel discussions and papers as discussed by Dr. Lee in this special edition, is that perhaps we should be focusing less on the sources of distraction and more on understanding why and under what circumstances drivers choose to disengage from the driving task. As Dr. McGehee points out, given the ever-increasing exposure to electronic devices in the vehicle which paradoxically has been accompanied by a declining U.S. crash rate, understanding and measuring this distraction-crash puzzle will be central to the future of distraction measurement.

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REFERENCES