Accident Analysis and Prevention 99 (2017) 306–311

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Constructing a publically available distracted driving database and research tool

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ARTICLE INFO

Article history:
Received 23 May 2016
Received in revised form 1 December 2016
Accepted 5 December 2016

Keywords:
Distracted driving
Research database
Driving performance

ABSTRACT

Background: The goal of the current work was to create a publicly available visualization tool of distracted driving research, the purpose of which is to allow the public and other stakeholders to empirically inform questions of their choice that may bear on policy discussions.
Methods: Fifty years of distracted driving research was used to design a comprehensive database of studies that evaluated the effects of distraction on driving performance. Distraction sources (e.g., texting, talking, visual distraction) and performance measures were defined, and the sample of studies were evaluated and categorized by their measures.
Results: The final product yielded 342 studies using various methodologies. Across all measures, 1297 found distractions degraded driving performance, 54 found distraction improved driving performance, and 257 found distraction had no effect on driving performance. An analysis of the most common phone distractions (texting and talking) showed that texting almost always results in degraded performance. Aggregate data reveal no difference in performance decrements for hand-held or hands-free phones even though single studies of those variables vary in their outcomes.
Conclusions: This project illustrates how scientific research can be made publically available for use by a diverse audience of stakeholders. An important result of this project is that data aggregated along a simple set of characteristics such as whether or not performance is decreased, improved or not affected, can reveal trends in the data that are less clear from any individual study.

1. Introduction

Distracted driving research over the past 50 years across various modalities has concluded that driver distraction from visual, mechanical, or cognitive sources can lead to crashes, injuries, and fatalities. However, during the past 10 years a new crash causation research methodology, Naturalistic Driving Studies (NDS), has concluded that although cognitive distraction can have a measurable effect in the laboratory, the actual risks to driving are much lower in comparison (Klauer et al., 2006). Despite the contrary findings of many other studies, the conclusions of this NDS method have been used to call into question the need to regulate in-vehicle systems that are hands-free, but still cognitively demanding despite the controversy of the validity of the findings in NDS (Knipling, 2015).

Controversy is not atypical in the scientific literature, though it can be difficult for policy makers or the public to understand how to reconcile contradictory data with a large body of literature. Historically, people have relied on literature reviews or meta-analyses to help with this problem. Although literature reviews can successfully provide some research context they become outdated as more research is conducted by failing to capture emerging trends. For example, "Driver distraction: A review of the literature ; (Young et al., 2007) is a frequently cited literature review. It focused primarily on mobile phones, in-vehicle devices, and understanding the adaptive strategies despite the various other forms of distraction and other degradations of driving performance. It could not, for example, anticipate the explosion of app-based communication and how data might change as a result. Further, given publication lag for the paper and the lag of the papers it reviews, the results are well over a decade old by 2016.

Though meta-analyses provide additional analyses that are useful for understanding datasets, they share the same limitations as literature reviews. Meta-analyses are limited to studies with specific initial criteria in order to conduct the intended analyses. For example, one of the most cited meta-analyses, 'A meta-analysis

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http://dx.doi.org/10.1016/j.aap.2016.12.005
0001-4575/

of the effects of texting on driving' (Caird et al., 2014), examined experimental studies of texting and driving. The initial search for the paper yielded 1476 studies, but once exclusion criteria were applied, only 28 studies were included. The findings are useful to understand the impact of text messaging on driving, but the example illustrates the limitations of meta-analysis as a data aggregation tool if the goal is to provide a more comprehensive picture of the research literature.

The purpose of the current work is to outline a method used to create a database of 50 years of published (publically available but not solely limited to peer-reviewed) work to represent the effect of distraction on driving performance. Further, an example of how such a database can be made publically available in the form of an online tool to permit public exploration and visualizion of the data is considered. The database is not intended to solely represent purely theoretical work that might have implications for driving. The database focuses on the effect of different sources of distraction on various aspects of driving performance, including, but not limited, to crashes. The intent is to be as comprehensive as possible for inclusion in the database, as long as the study was about the effect of distraction on some aspect of driving performance. By showing data comprehensively and in aggregate, the database will function as a communication tool to show the scope and breadth of research that indicates the risk of distracted driving, how those risks vary by distraction type, and where common misconceptions about risk (such as the difference between hand-held and hands-free devices) are at odds with the data. The database can also serve as a research tool to allow researchers to explore areas of ambiguity, controversy, or lack of study in the distracted driving literature. The current work will illustrate how this method can achieve these goals by examining how the dataset informs the debate around two commonly discussed issues in distracted driving: the difference between hand-free and hand-held devices and the effect of cognitive distractions on performance.

2. Method

2.1. Study inclusion

The database started with a literature search of online databases (i.e. Google scholar, Psych INFO) using keywords common to distracted driving literature (i.e. driving; distracted; attention; inattention; vehicle; conversation; texting). Based on this initial search; information was recorded from each study; including the number of times the study had been cited. The studies were then ordered from most to least cited articles and the ten most highly cited studies were used as anchors. The goal of the anchors was to expand the dataset to find references that have been cited by high impact papers but that may not have been captured by the search terms. After using this method for eight of the anchors; no new studies were found. We chose ten anchor studies opposed to eight to account for possible error with this technique by producing a larger set to use for later updates. In the future; the list of anchors may contain additional highly cited studies. The additional references found by the anchor studies will remain in the database even as new anchors are added. Additional works were found by using the reference list and citation map of those anchors. There was redundancy in the resulting studies using the ten most cited studies; and it was assumed that using more studies as anchors would yield works that had already been added to the database. Assuming the highly cited anchor studies to be cited in reputable recent publications; ongoing updates will use these anchors to keep the database current by creating lists of citations of those studies. The ten anchor studies selected had the highest impact; which was calculated by dividing the total number of citations by the years since the article had been published. The average impact was 45.7 and the range was 33–66 and were published between 1997 and 2009. The list of the ten anchor studies is as follows in ordinal order of use: "Cell phone-induced failures of visual attention during simulated driving" (Strayer et al., 2003); "Association between cellular-telephone calls and motor vehicle collisions" (Redelmeier and Tibshirani, 1997); "Driven to distraction: Dual-task studies of simulated driving and conversing on a cellular telephone" (Strayer and Johnston, 2001); "Role of mobile phones in motor vehicle crashes resulting in hospital attendance: a case-crossover study" (McEvoy et al., 2005); "A comparison of the cell phone driver and the drunk driver" (Strayer et al., 2006); "Driver distraction: The effects of concurrent in-vehicle tasks; road environment complexity and age on driving performance" (Horberry et al., 2006); "Mental workload while driving: Effect on visual search; discrimination; and decision making" (Recarte and Nunes, 2003); "Text messaging during simulated driving" (Drews et al., 2009); "Effects of visual and cognitive load in real and simulated motorway driving" (Engström et al. 2005) and "Driver distraction in commercial vehicle operations" (Olson et al., 2009).

Inclusion was not restricted to any specific methodology, but certain methodologies were excluded. To provide an unbiased representation of the studies, participants could only be represented once, which consequentially removed meta-analyses, literature reviews, and conference proceedings that were later published in journals. Studies using surveys as the only method were excluded because no causation source could be definitively derived from the data, although a majority of survey studies consisted of distracted driving behavior prevalence. Studies that did not evaluate driving performance or relevant factors were also excluded from the sample, including costs-benefits analyses, position statements, evaluations of warning systems, or evaluations of other non-relevant factors.

2.2. Study classification

The term "study" is used to represent a single published research event in which the effect of a distraction source on a performance variable was examined. Where a publication has multiple such events (where there are multiple, independent experiments in a paper, each examining a separate set of participants), each event is called an "experiment,ëven if a non-experimental method was used. 'Participants' referred to the individuals that completed the experiment to provide the experimenter with data. Though it is possible that some participants completed multiple studies with the same or different experimenters, there is no way to track each participant individually. Within an experiment, there might be multiple "measurements" of the effect of a distraction. Studies/experiments were categorized based on the distraction sources (independent variables), performance measures (dependent variables), sample size, publication type (i.e., peer or non-peer reviewed), and method (e.g., simulator, on-road, naturalistic, or laboratory). Participant variables, such as age, gender, and personality, were excluded as these were not reliably available across all studies.

2.3. Distraction types

The distraction sources were defined as indicated below. In cases where categories were unclear or in conflict, we used the stated purpose in the study as a guide.

Talking was limited to communication between two persons as opposed to communication to a device, such as talking to "Siri.T̈he talking modality was used to sort the distraction type into four categories: 1) a handheld phone conversation, conversation while a device is explicitly held, 2) hands-free talking where no device was held, 3) passenger, where the conversational partner was in the