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Systematic review of observational studies on secondary task engagement while driving

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ABSTRACT

The last decade has seen a worldwide exponential increase in the use of mobile information systems, especially smartphones. This trend covers all areas of life, and also seems to include phone use while driving. In order to assess the scope of secondary task occupation, especially smartphone use while driving, observation studies from outside the car have been established as an efficient and valid method. A review of international studies using traffic observation was done finding 51 publications with a total of 117 observation studies with more than 1,800,000 single observations at more than 17,500 sites from nine different countries. The review describes the relevant aspects of the observation methods and gives an overview about the trends found in the data. As the methods differ widely over the years as well as between the countries and studies, an integration of the results is not possible. However, from all studies it is very clear that smartphone use has increased including not only phoning while driving but also, more important to traffic safety, using apps and texting on the smartphone. Additional observable secondary tasks were only rarely examined. Thus, further research using observational studies is strongly recommended. Suggestions are given with regard to the methodology which can contribute to get comparable and valid results across countries and studies.

1. Introduction

Distraction seems to become one of the major causes of traffic accidents. In Austria, driver distraction is recorded as a causing factor in vehicle crashes by the police since 2012. Here, in 2016, distraction was the most common cause for traffic crashes, assigned to 38% of crashes with injured or killed people (Statistik Austria, 2017). Singh (2015) reported for the US that recognition error, which included driver's inattention, internal and external distractions, and inadequate surveillance, was the most frequently assigned critical reason, linked to 41% of crashes.

There is still a discussion about which kinds of distraction increase the risk of an accident. While the first case-control studies seemed to indicate that talking on the phone increases accident risk (Redelmeier and Tibshirani, 1997), more recent studies' interpretations are under dispute (see Victor et al., 2014; Dingus et al., 2016, and Young, 2017, for differing views on the SHRP2 naturalistic driving data; https://insight.shrp2nds.us/). Meta-analyses on experimental studies of secondary tasks while driving generally find negative effects on driving performance (e.g. Caird et al., 2014; Ferdinand and Menachemi, 2014; Oviedo-Trespalacios et al., 2016; Papantoniou et al., 2017; Vollrath et al., 2014). Compensatory behavior of drivers is discussed to be mediating the detrimental effects of secondary tasks on crash risk. This can be done by (a) only engaging in secondary tasks in relatively low risk driving situations (e.g. Huth et al., 2015; Metz et al., 2015) and (b) by driving within larger safety margins (e.g. slower and with a longer headway; e.g., Fitch et al., 2014; Oviedo-Trespalacios et al., 2017) while engaging in secondary tasks.

However, in order to estimate crash risk due to distraction and to discuss the scope of the problem, information about the prevalence of different kinds of distraction while driving without a crash is required. Only if this information is collected and matched to the prevalence of distraction in crashes, a crash risk can be calculated. Additionally, analyzing the frequency and circumstances (e.g. only when stopping at red traffic lights) of distracted driving can also be used to examine if and to what extent the compensatory behavior of drivers exists and to find out if certain sub-groups of drivers are especially prone to be distracted. This information can be gathered using different methods, the

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most important of which are questioning drivers about their behavior or observing this behavior while driving (either in naturalistic driving studies or by traffic observations).

Questioning drivers enables to gain detailed information about what drivers do, in which situations they feel safe to do so and if there are any person characteristics (e.g., personality traits like sensation seeking, age and sex of the driver, driving experience etc.) which influence the engagement in secondary tasks. However, drivers may be not willing or able to truthfully and completely describe their behavior. It may also be difficult for them to estimate the frequency and duration of secondary task engagement. Automatic behaviors that are performed frequently will not be stored in long-term memory.

In contrast, traffic observations provide highly reliable, objective information of secondary task behavior when driving in different situations. As pointed out above, this information is a necessary prerequisite to assess crash risk due to secondary task engagement. However, information about the drivers is limited to observable information like age and sex. Moreover, only secondary tasks can be assessed which can be observed. As the most distracting tasks while driving are those where drivers look away from the road and operate a device, observations are well able to account for these most relevant distractions. However, it should be noted that traffic observations are not the method of choice for all types of distraction, like, for example, being mentally distracted. Observations do also not allow distinguishing between certain tasks like, for example, operating a phone to select a number, to read and write a text message, to watch a video, to enter a new destination in your navigation app etc. If this differentiation is of interest, interview studies are recommended. However, from the viewpoint of traffic safety the knowledge about the frequency of phone use (looking at it and operating it) is already very valuable per se. Thus we decided to focus this review on observation studies.

While reviews of experimental studies (see above) and subjective data on drivers' willingness to engage in secondary tasks while driving (e.g. Lipovac et al., 2017) have been published, to our knowledge, no review of observational studies on the prevalence of secondary tasks while driving has been done yet. Thus, this review aims at summarizing what is known about distracted driving without crashes by means of traffic observations. To this aim, the frequency of different behaviors observed in different countries over time is described. Additionally, the influence of situational and personal characteristics on the frequency of distracted driving is examined. Moreover, the validity of the method (traffic observation) is discussed and some suggestions with regard to good practice of this method are derived.

2. Methods

Studies were identified by searching for "driver distraction" and "observational" in the databases sciencedirect (www.sciencedirect.com), scopus (www.scopus.com) and GoogleScholar (www.scholar.google.com) in January 2016. Peer reviewed journal articles, conference papers, book chapters, and research reports were included. Results' titles were screened for eligibility, excluding all obvious false positives. All remaining studies were then accessed full-text and reviewed for eligibility. References of studies found with this strategy were examined for other relevant literature that was then included (see Fig. 1).

Criteria for inclusion are: (1) Observations of driver secondary tasks were done from outside the vehicle (excluding all naturalistic driving studies), (2) the study's purpose was to estimate the prevalence of secondary task involvement while driving a passenger vehicle (excluding one study, Huth et al., 2015, who followed up and observed only drivers who used their telephone at intersections).

Studies' data was then extracted for all reported details on observation methods and recorded data on drivers and vehicles. These were entered in to a database by two student assistants who periodically checked on each other's work. All entries were then cross-checked by the first author of this paper.

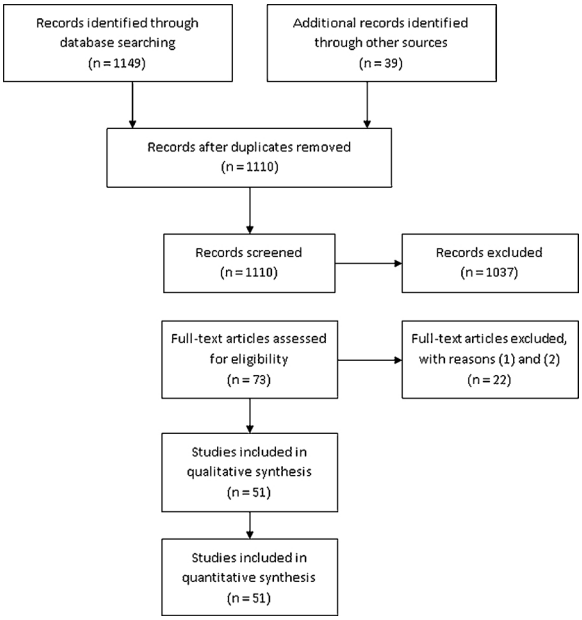

Fig. 1. PRISMA 2009 Flow Diagram for the literature review (Moher et al., 2009).

3. Results

Fifty-one publications of 50 studies were found; containing 117 individual observational campaigns (see Table 1).

3.1. Observational methods

The studies differ with respect to the location where the observations were made, their time and duration as well as their methodology. Most of the studies were done between March and December during daylight. Different methods were used to select the cars to be observed in traffic. Also the tasks to be observed were selected differently. In the following section these methodological aspects will be reviewed.

3.1.1. Types of secondary tasks

Data collection involved the observation of cell phone use in all studies. But the studies were different with respect to levels of details of the assessment of this distraction. In 10 studies (20%) mobile phone use while driving was not further specified (#14, #17, #21, #22, #39, #43, #45 - #47, and #49). 'Hand held cell phone use' was assessed in 28 (56%) studies (#1-#13, #15, #16, and #19-#31). In six studies 'hand held mobile phone use' was further described as "driver is holding a mobile phone to their ear" (16%; #34-36, #41, #44, and #51). The percentage of drivers using their cell phone "hands-free" was assessed in two ways in 24 Studies (48%): either „hands-free "in 12 (24%) studies (#23-#31, #35, #42, and 48) or „speaking with visible headset on "which was the case in 12 (24%) studies (#2-#11, #15, and #19).

"Using the smartphone: Drivers had their smartphone in their hands and were operating it" was assessed in studies #42 and #44 (4% of all studies). In 11 (22%) studies this secondary task was described as „visibly manipulating handheld device "(#7-#11, #19, #33, #35, #39, and #41).

In seven studies (14%) the presence of additional, technics-related secondary behaviors besides cell phone use was also assessed:

- Manipulating in-vehicle systems (#19)
- Adjusting controls: Leaning forward to manipulate controls on the