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Review of driving performance parameters critical for distracted driving research

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Abstract

While driving simulators allow for the examination of a range of driving performance measures in a controlled, relatively realistic and safe driving environment, driver distraction is a multidimensional phenomenon which means that no single driving performance measure can capture all effects of distraction. Furthermore, the large number of driving related outcomes each simulator provides, indicates that the decision regarding which measure or set of measures is used should be guided by specific criteria. The objective of this paper is a comprehensive review of driving performance parameters critical for distracted driving research. For this purpose an extended literature review took place in order to investigate the critical parameters which are examined in the scientific field of driver distraction. Firstly, all driving performance parameters examined in driving simulator experiments are identified and analysed including lateral control, longitudinal control, reaction time, gap acceptance, eye movement and workload measures, while a list of the most common driving simulator dependent variables is cited. Subsequently, a thorough literature review is carried out including 42 studies examining driver distraction through driving simulator experiments which were published in scientific journals, concern recent research and report quantitative results. In this framework, the respective driving performance measures are recorder aiming to investigate which and how they are analysed. A basic remark concerns the quantitative measures used to express driver distraction. In most cases, driver distraction is measured in terms of its impact to driver attention, driver behaviour and driver accident risk. It is noted that the specific measures used vary significantly. However, the diversity in the measures used, in combination with the diversity in the design of the experiments (i.e. road and traffic factors examined, number and duration of trials) often complicates the synthesis of the results, especially for the less commonly examined distraction factors.

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1. Introduction

Road accidents constitute a major social problem in modern societies, accounting for more than 1.2 million fatalities in 2013 worldwide (WHO, 2014). Furthermore, human factors are the basic causes in 65-95% of road accidents (Sabey and Taylor, 1980; Salmon et al., 2011; Treat, 1980). The remaining factors include the road environment (road design, road signs, pavement, weather conditions etc.) and the vehicles (equipment and maintenance, damage etc.), as well as combinations of these three contributory factors.

Driver distraction constitutes a particular human factor of road accident causation. Driver distraction is generally defined as “a diversion of attention from driving, because the driver is temporarily focusing on an object, person, task or event not related to driving, which reduces the driver’s awareness, decision making ability and/or performance, leading to an increased risk of corrective actions, near-crashes, or crashes” (Regan et al., 2008). More specifically, driver distraction involves a secondary task, distracting driver attention from the primary driving task (Donmez et al., 2006; Sheridan, 2004) and may include four different types: physical distraction, visual distraction, auditory distraction and cognitive distraction.

The objective of this paper is a comprehensive review of driving performance parameters critical for distracted driving research. For this purpose an extended literature review took place in order to investigate the critical parameters which are examined in the scientific field of driver distraction. The paper is structured as follows. In the beginning, driving performance measures examined are presented and analysed including lateral control, longitudinal control, reaction time, gap acceptance, eye movement and workload measures. Then, an extended literature review is carried out regarding all available experiment types of assessing driver distraction. In the next step, a review of driving simulator studies on driver distraction is presented, based on specific selection criteria. More specifically, studies reviewed examine driver distraction through driving simulator experiments, were published in scientific journals, concern recent research and report quantitative results. Finally, the results are presented and discussed and some concluding remarks are provided.

2. Driving performance measures

As there are a lot of different methods and measures that exist for evaluating driving performance, the selection of the specific measures for driver distraction research, as in other areas of research, should be guided by a number of general rules related to the nature of the task examined as well as the specific research questions.

This chapter reviews a range of assessment measures that have been used in order to assess the impact of distraction on driving performance including lateral control, longitudinal control, reaction time, gap acceptance, eye movement and workload measures. Finally, a list of the most common driving simulator dependent variables is cited and some general remarks are provided.

2.1. Longitudinal control measures

A range of Longitudinal Control Measures can be examined in driver distraction research. Two of the most common are speed and headway which are further analysed below.

2.1.1 Speed

The relationship between speed and accidents is widely recognized in the road safety community and as such, speed is a commonly used dependent variable in transportation human factors research including driver distraction research. A number of speed related measures can be calculated including, average speed, speed variability, 85th percentile speed, maximum speed (Hogema and van der Horst, 1994; Manser and Hancock, 2007)

On distracted driving, the most common pattern is to adopt slower speed to increase available response time (Chu, 1994). Drivers use this strategy in order to exert some control over their circumstances and compensate for increased reaction time. It has also been shown that drivers display greater speed variability and throttle control while talking to the cell phone (Haigney et al., 2000; Rakauskas et al., 2004; Yannis et al., 2010; Beede and Kas, 2006).

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