Review of driving performance parameters critical for distracted driving research

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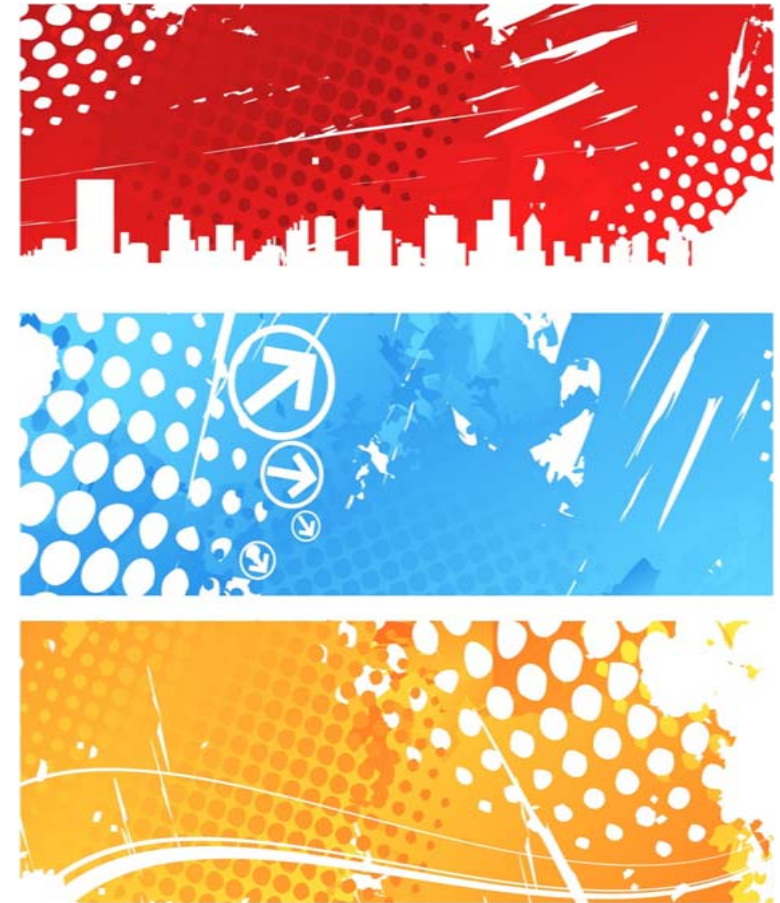
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Objective and structure

Objective

The objective of this paper is a comprehensive review of driving performance parameters critical for distracted driving research

Structure

- Driver distraction experiments
- Driving performance measures
- Discussion

Introduction

- **Human factors** are the basic causes in 65-95% of road accidents (Salmon et al., 2011).

- Human factors involve a large number of specific factors that may be considered as accident causes, including (Yannis et al., 2013):
  - **Driver injudicious action** (speeding, traffic violations etc.)
  - **Driver error** or reaction (loss of control, failure to keep safe distances, sudden braking etc.)
  - **Behaviour** or inexperience (aggressive driving, nervousness, uncertainty etc.)
  - **Driver distraction** (cell phone use, conversation with passenger etc.)
  - **Driver impairment** (alcohol, fatigue etc.)

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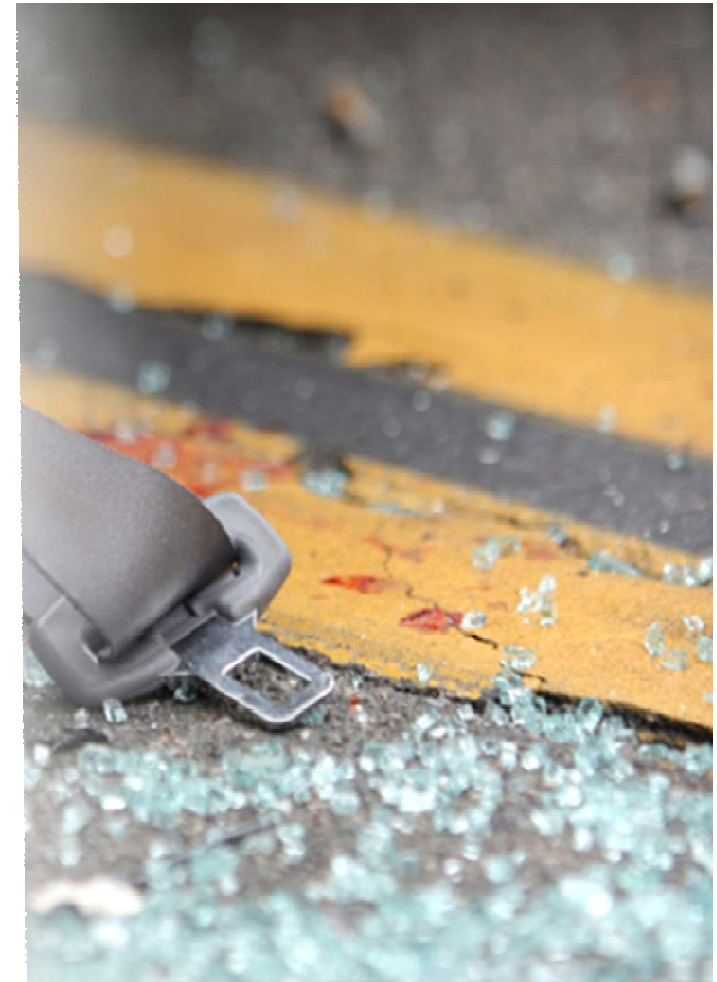
Driver distraction

- **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"

- Driver distraction may include four different types: **physical** distraction, **visual** distraction, **auditory** distraction and **cognitive** distraction (Ranney et al., 2000)

- Driver distraction factors can be subdivided into those that occur outside the vehicle (**external**) and those that occur inside the vehicle (**in-vehicle**).

Driver distraction experiments

The following **experiment types** of assessing driving behaviour and driver distraction exist (Papantoniou et al., 2015):

- Driving simulator experiments

- Naturalistic driving experiments

- On road experiments

- In-depth accident investigation

- Stated preference surveys

Driving simulator experiments

Examination of a range of driving performance measures in a controlled, relatively realistic and safe driving environment

Advantages
- Collection of data which would be very difficult to collect under real traffic conditions
- Exploration of any possible driving scenario
- Driving conditions are identical for all drivers

Disadvantages
- Non totally realistic simulated road environment
- Possibility of adopting a different driving behaviour
- Feeling of safety
- Simulator sickness

Naturalistic driving experiments

A research method for the observation of everyday driving behaviour of road users

Advantages
• Large degree of control over the variables that affect driving behaviour
• Researchers study issues that cannot be investigated in a lab
• Help support the external validity of research

Disadvantages
• Difficult to determine the exact cause of a behaviour
• The experimenter cannot control outside factors
• Traffic incidents are very rare

On-road experiments

Studies using instrumented test vehicles to gain greater insights into the factors that contribute to road user accident risk and the associated crash factors at specific conditions.

Advantages
- Large degree of control over the variables that affect driving behaviour
- Study of actual observed behaviour

Disadvantages
- Data not collected over a longer time period and in response to selected interventions
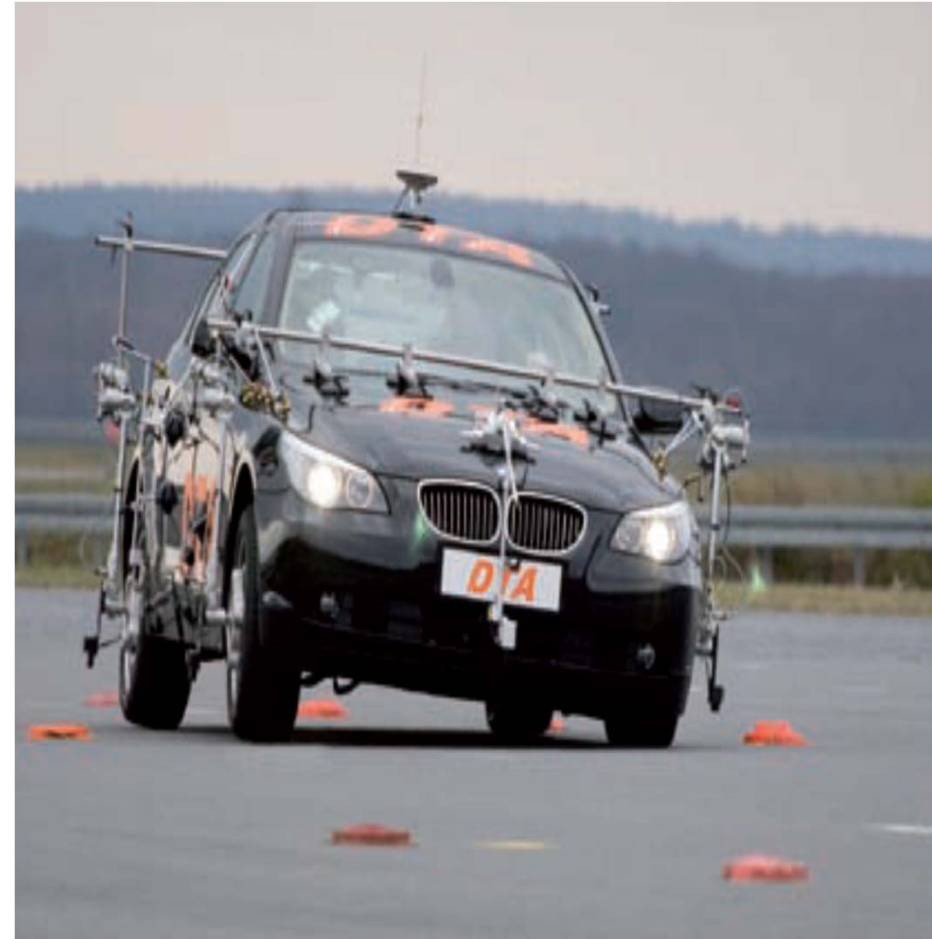
In depth accident investigation

In-depth accident data describe the causes of accidents and injuries and aim to reveal detailed and factual information from an independent perspective on what happens in an accident

Advantages
- Collection of data which would be very difficult to collect under real traffic conditions
- Exploration of any possible driving scenario
- Driving conditions are identical for all drivers

Disadvantages
- Non totally realistic simulated road environment
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Surveys on opinion and stated behaviour

In stated behaviour surveys, a reference questionnaire is built, based on a list of selected topics and a representative sample of population is interviewed. It is preferred to be combined with other types of experiments.

Advantages
- Survey design may control for external factors
- Allow to investigate new situations, outside the current set of experiences

Disadvantages
- Often hypothetical nature of questions
- Actual behaviour is not observed
- Over- or under-representation of actual behaviour

Driving performance measures (1/2)

- The selection of the specific measures for driver distraction 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**

- Published studies reviewed examine driver distraction through driving simulator experiments, concern recent research and report **quantitative results**

Driving performance measures (2/2)

- Longitudinal Control Measures
  - Speed
  - Headway
- Lateral Control Measures
  - Lateral position
  - Steering wheel control
- Reaction Time Measures
- Gap acceptance measures
- Eye movement measures
- Workload measures
  - Subjective measurement
  - Physiological measurement
  - Performance measurement
- Safety measures

Assessment of studies

- In most cases, driver distraction is measured in terms of its impact to driver **attention**, driver behaviour and driver accident risk

- The **diversity** in the measures used, in combination with the diversity in the design of the experiments often complicates the synthesis of the results

- Studies focusing on **visual distraction** are more focused on driver **attention** measures while studies examining motor and **cognitive** distractors such as cell phones are more directly concerned about **driving performance** measures

Discussion (1/2)

- Driver distraction is a **multidimensional** phenomenon which means that no single driving performance measure can capture all effects of distraction

- The decision regarding which set of measures is used should be guided by the specific **research question**

- All types of experiments should carefully follow some basic experimental design principles, allowing for **reliable** analysis of the data

- Every experiment type has **benefits** and **deficiencies**. Combination and meta-analysis of experiments results may bring more reliable conclusions

- **Sample size** should correspond to the number of variables to analyse

- Internal structure of experiments has a direct impact to the results **reliability**

- Valid data analysis requires multi-annual effort to address the high complexity

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