



14th World Conference on  
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# Review of driving performance parameters critical for distracted driving research

Panagiotis Papantoniou, Eleonora Papadimitriou, George Yannis



Department of Transportation Planning and Engineering, National Technical University of Athens, Athens, Greece

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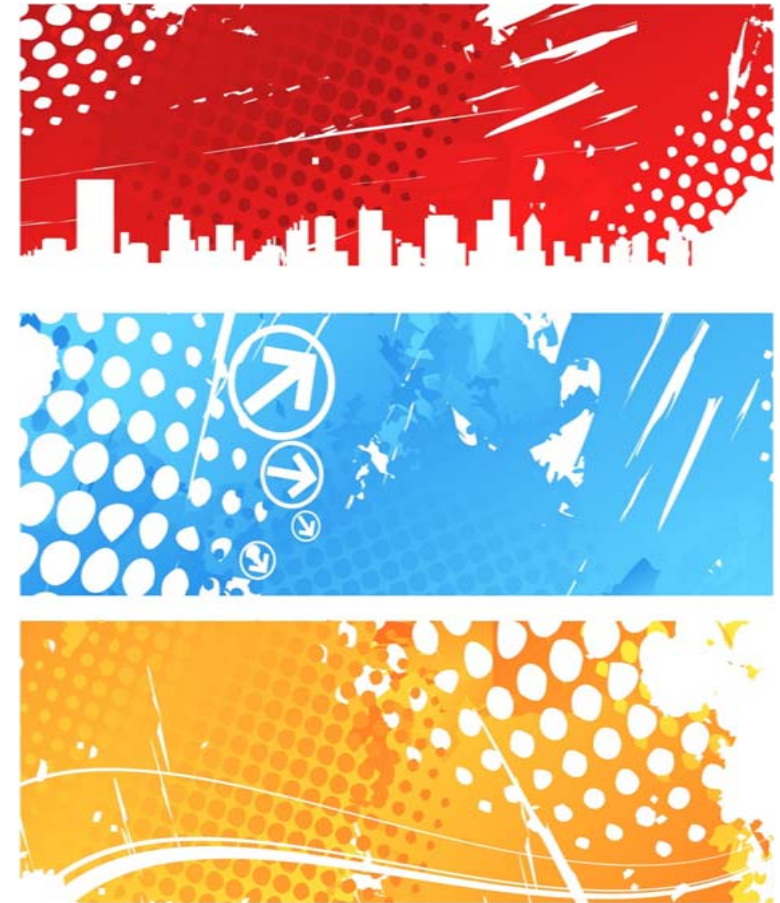
# Objective and structure

## Objective

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

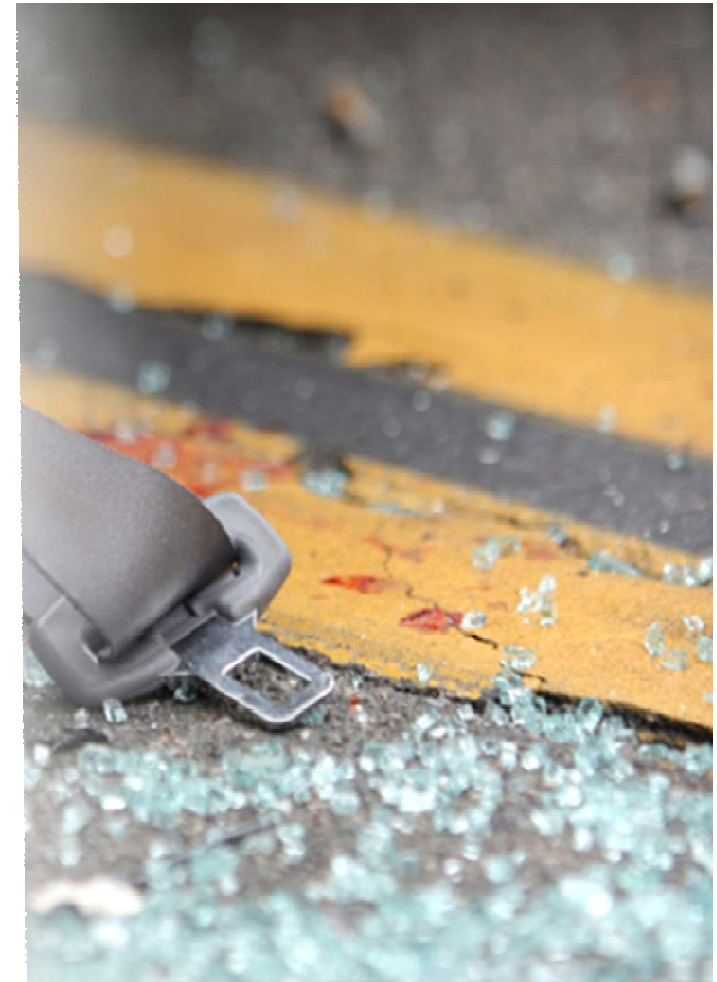
## Structure

- 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.)



# 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

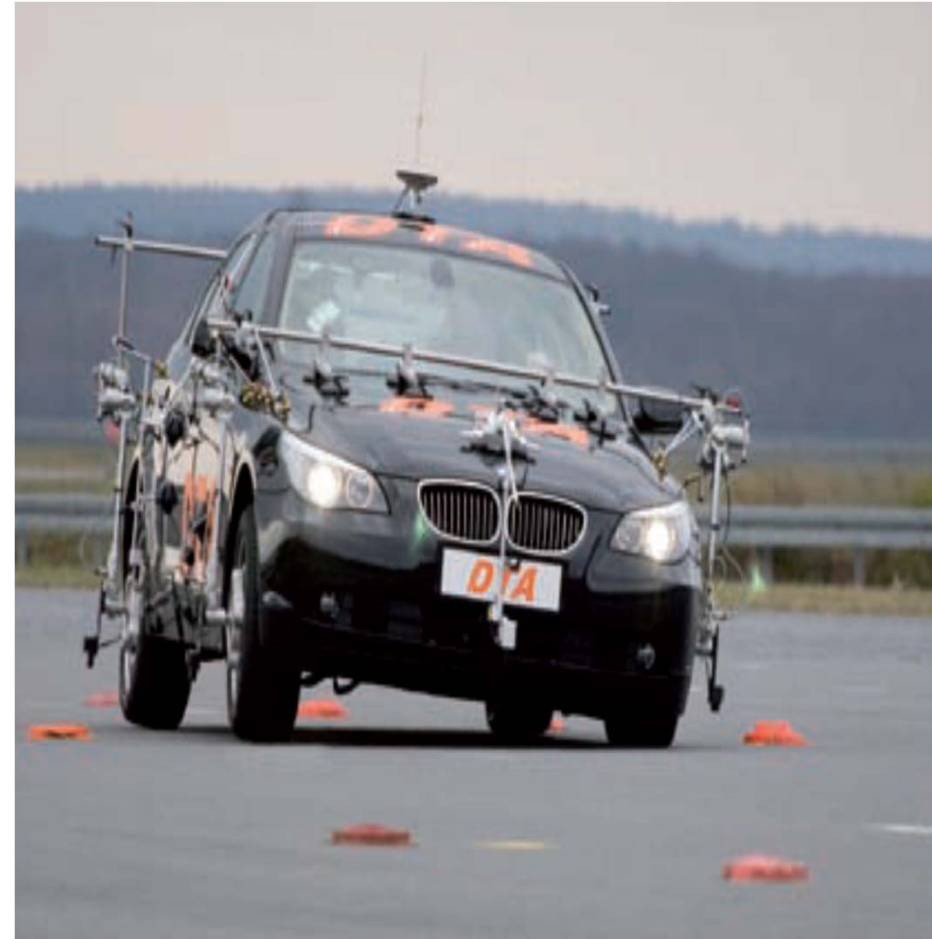
Studies using instrumented test vehicles to gain greater insights into the factors that contribute to road user accident risk and the associated crash factors at specific conditions.

## 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
- Possibility of adopting a different driving behaviour
- Feeling of safety
- Simulator sickness



# 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

Authors	year	Distraction Source							Sample Characteristics						Driving performance measures						Statistical Analyses						
		cell phone	conversation	visual	music	IVS	advertisement signs	eat, drink, alcohol	sample size	% male	25-	26-55	55+	benefits	questionnaire	speed	lane position	reaction time	perception / situation awareness	headway	accident probability	eye glance	acceleration / deceleration	Descriptive statistics	One way ANOVA	Two way ANOVA	Repeated measures ANOVA
1 Laberge et al	2004							80	50%																		
2 Drews et al	2008							96	25%																		
3 Charlton	2009							112	50%																		
4 Yannis et al	2011							42	48%																		
5 Hunton and Rose	2005							111	25%																		
6 Horbery et al	2006							31	-																		
7 Reed-Jones et	2008							32	44%																		
8 Yannis et al	2011							48	50%																		
9 Rakauskas et al	2004							24	50%																		
10 Kass et al	2007							49	49%																		
11 Bruyas et al	2009							30	50%																		
12 Reimer et al	2010							60	60%																		
13 Schlehofer et al	2010							69	36%																		
14 Ma and Kaber	2005							18	50%																		
15 Beeder and Kas	2006							36	-																		
16 McKnight and Mc	1993							150	50%																		
17 White et al	2010							40	50%																		
18 Maciej et al	2011							33	52%																		
19 Noy et al	2004							24	63%																		
20 Donmez et al	2006							28	-																		
21 Donmez et al	2008							48	52%																		
22 Liang et al	2010							16	50%																		
23 Fofanova et al	2011							20	80%																		
24 Muhrer et al	2011							28	50%																		
25 Metz et al	2011							40	55%																		
26 Kaber et al	2012							20	50%																		
27 Zhang et al	2012							24	50%																		
28 Hatfield et al	2008							27	48%																		
29 Chisholm et al	2008							19	53%																		
30 Garay-Vega et al	2010							17	71%																		
31 Young et al	2012							37	46%																		
32 Hughes et al	2012							21	5%																		
33 Jamson et al	2005							48	-																		
34 Donmez et al	2007							29	48%																		
35 Reyes et al	2008							12	50%																		
36 Jamson et al	2010							18	50%																		
37 Benedetto et al	2011							15	80%																		
38 Birrell et al	2011							25	56%																		
39 Terry et al	2008							78	55%																		
40 Young et al	2009							48	60%																		
41 Bendak et al	2010							12	100%																		
42 Edquist et al	2011							48	63%																		
43 Rakauskas et al	2008							45	100%																		
44 Young et al	2008							26	62%																		
45 Harrison et al	2011							40	50%																		



# 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



# Discussion (2/2)

- 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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