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## Is it risky to talk, eat or smoke while driving? Findings from a driving simulator experiment

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# Background

- Driver distraction has been associated with important proportion of road accidents, ranging from 10-15% to 25%
- In-vehicle distraction sources appear to have more important effects on driver behaviour than external ones
  - use of mobile phone
  - use of navigation / recreation system
  - conversation with passengers
  - smoking, eating or drinking
  - listening to music
- Several in-vehicle distractions are typical part of everyday driving
  The penetration of new technologies inside the vehicle is expected to increase





The objective of this research is the analysis of the effect of selected in-vehicle distraction sources on driver behaviour and on road safety in rural roads

## Distraction sources

- conversation with passengers (simple or complex)
- eating
- smoking





- Driving simulator experiment, in the simulator of the Traffic Engineering Laboratory of NTUA
- Modelling driver behaviour
  - speed
  - vehicle's distance from the central axis of the lane
- Modelling road safety
  - driver's reaction time at unexpected incidents
  - accident probability



## **Simulator experiment**

- Participants: 42 drivers aged between 18 and 30 years, out of which 20 were males and 22 were females (all were smokers)
- The participants completed a questionnaire on their personal characteristics, their driving habits as regards distraction and their perception on the risk associated with smoking, eating or talking while driving
- The experiment included 3 simulated drives in a rural road environment during good weather conditions.
  - mountainous two-way rural road, without median or roadside barriers, with one bridge and one tunnel (quite typical setting in the Greek mainland)
  - traffic on both road directions
  - speed limit was from 50 to 70 km/h



# **Simulator experiment**

### Simulator experiment characteristics

	Type of section	Section's length (Km)			Incidents		
1	Free driving 1	Begin:	0	End:	0.7	Km:	0.47
2	Simple Conversation while driving	Begin:	0.7	End:	1.9	Km:	1.13 and 1.65
3	Free driving 2	Begin:	1.9	End:	2.5	Km:	2.1
4	Eating while driving	Begin:	2.5	End:	3.6	Km:	3.32
5	Free driving 3	Begin:	3.6	End:	4.45	Km:	3.86
6	Smoking while driving	Begin:	4.45	End:	6.04	Km:	5.37
7	Free driving 4	Begin:	6.04	End:	6.84	Km:	6.39
8	Complex Conversation while driving	Begin:	6.84	End:	8.1	Km:	7.21 and 7.76

- Conversations: surveyor seated next to the driver
- Simple conversation: basic questions on driver's characteristics (age, name, job, hobbies, news etc.)
- Complex conversation: questions requiring some concentration, as well as some logical and mathematical reasoning
- Smoking one cigarette
- Eating a light snack provided by the surveyor
- Unexpected incidents (i.e. presence of an animal) scheduled to occur at fixed points



## Variables

- Simulator experiment
  - speed, acceleration, exceeding speed limit etc.
  - motor revolutions, use of the gears, break etc.
  - road geometry
  - vehicle headways, time to collision etc.
  - vehicle distance from the central road axis, the right road border etc.
  - reaction time at incidents

### Questionnaire

- driver age, gender, experience, annual mileage
- frequency of talking, eating or smoking while driving
- self-reported change in driving behaviour while distracted (e.g. reduce speed, pull over to the right etc.)
- accident involvement, while distracted or in general
- enjoyment of driving



# **Results - Driver's speed (1/2)**

- Four log-normal regression models were developed for mean speed, one for each distraction factor
- Parameter estimates ( $\beta_i$ ), t-tests, elasticities /pseudoelasticities ( $e_i$ )

	simple	e convers	ation	complex conversation		eating			smoking			
Explanatory variables	βi	t	e <sub>i</sub>	β <sub>i</sub>	t	e <sub>i</sub>	β	t	e <sub>i</sub>	β	t	ei
mean motor revolution	8.00E-05	14.8	0.139	8.20E-05	15.4	0.142	8.60E-05	14.6	0.148	-	-	-
mean acceleration	-	-	-	0.03	4.0	0.002	0.045	6.0	0.003	-	-	-
% use of brake	-	-	-	-	-	-	-	-	-	-0.163	-3.0	-0.003
% of the route the 4th gear was used	-	-	-	-	-	-	-	-	-	0.097	7.9	0.011
max distance from the right road border	-	-	_	-	-	_	-	-	-	0.01	2.0	0.015
simple conversation	-0.024	-3.8	-0.004	-	-	-	-	-	-	-	-	-
complex conversation	-	-	-	-0.014	-2.0	-0.003	-	-	-	-	-	-
driver eating while driving	-	-	-	-	-	-	-0.024	-2.7	-0.003	-	-	-
driver smoking while driving	-	-	-	-	-	-	-	-	-	-0.011	-1.5	-0.002
lane width	0.068	4.3	0.182	0.069	4.1	0.187	0.077	4.4	0.205	-	-	-
tangent road section	-0.149	-21.3	-0.022	-0.175	-24.3	-0.035	-0.182	-21.7	-0.023	-0.139	-15.9	-0.02
downhill road section	-	-	-	0.044	4.3	0.003	0.067	6.5	0.006	-	-	-
gender	-0.026	-4.4	-0.008	-0.036	-6.3	-0.011	-0.027	-4.3	-0.008	-0.039	-5.8	-0.011
driver enjoys driving	0.046	4.9	0.025	-	-	-	0.038	3.7	0.021	0.035	3.0	0.019
R <sup>2</sup>		0.6		0.73		0.7			0.48			

 Statistically significant decrease in speed is associated with all four distraction factors



## **Results - Driver's speed (2/2)**

- Distraction variables: reduced speed, as an attempt to compensate for the additional mental and motor workload.
  - Lower speeds are associated with improved road safety
- Road design variables: increased mean speed at tangent or downhill road sections, and at larger lanes.
- Speeding behaviour variables: speed is affected by acceleration, motor revolutions, use of the breaks and the gears.
  - Gender: males driver at higher speeds than females.
  - Note: The four distraction variables were found to be highly correlated, and could not be included in the same model



# **Results - Vehicle's distance from the lane axis**

#### Log-normal regression model

Explanatory variables	β	t	e <sub>i</sub>
absolute difference between the maximum and the minimum speed	1.80E-02	5.3	1.372
mean motor revolution per minute	-2.5E-05	-2.6	-1.123
lane width	0.148	5.5	9.8
deviation of speed from the mean speed of all drivers	0.002	3.1	-0.088
mean acceleration	-0.035	-3.0	-0.102
incident occurrence	-0.03	-3.0	-0.253
deviation of speed from the mean speed of all drivers	0.037	2.3	0.039
complex conversation	-0.032	-2.8	-0.074
not frequent horizontal curves	0.026	2.1	0.049
R <sup>2</sup>		0.15	

- Distance from the central lane axis is correlated with driver's speed
- Only the complex conversation has significant effect on vehicle's distance from the central axis of the lane
- A complex conversation leads drivers to pull over to the right
  - Drivers attempt to compensate for the risk of distracted driving, especially in such rural undivided roads, where the risk of head-on collision is increased.



## **Results - Driver's reaction time at incidents**

### Log-normal regression model

Explanatory variables	βi	t	ei	
deviation of motor revolution from mean motor revolution	-0.00003	1.7	-0.234	
deviation of point speed from mean point speed of all driver's	0.002	2.4	-0.016	
deviation of distance from then right road border from the mean	-0.119	4.1	0.67	
driving licence for more than 5 years	-0.057	3.4	0.744	
% route the 2nd gear was used	0.332	3.4	0.013	
complex conversation	0.031	1.8	-0.16	
R <sup>2</sup>	0.27			

- Only the complex conversation has significant effect on driver's reaction time at unexpected incidents
- Driver's engagement to a complex conversation increases reaction time at incidents
  - Delayed identification of the unexpected incident and the related collision risk, due to additional mental workload
  - Reduced reaction time is obviously detrimental to road safety
- Note: a control variable was tested for possible 'training' effect in dealing with incidents during the experiment



## **Results - Accident probability (1/2)**

## Binary logistic regression model (Accident: yes / no)

Explanatory variables	β <sub>i</sub>	t	e <sub>i</sub>
deviation of speed from the mean speed of all drivers	0.139	11.2	0.95
mean motor revolution per minute	-0.001	4.9	-2.26
minimum distance from the central axis of the lane	-0.846	7.9	-0.47
incident occurrence	3.118	14.3	15.09
complex conversation	1.205	4.6	1.69
Likelihood Ratio Test	47.59		
Degrees of freedom		4	

- Complex conversation increases accident probability at incidents
- Speeding, incident occurrence and complex conversation have the highest elasticities with respect to accident probability







- Accident probability increases with the difference from the mean speed and with the distance from the central lane axis.
- Difference of 20 km/h from the mean speed of all vehicles results in increase of accident probability from 0 to 30% when the driver is not in a conversation and to 60% when involved in a complex conversation.
- A difference of 30km/h from the mean speed makes accident avoidance in case of unexpected incident while distracted almost inevitable.



# Conclusions (1/2)

- 'Simple' or 'complex' conversation, eating and smoking are all associated with decreased speeds, indicating that drivers attempt to compensate for these distraction factors.
- 'Complex' conversations were also associated with increase of the distance from the central lane axis, increased reaction times at unexpected incidents and increased accident risk.
- Preferences and other personal characteristics were found to affect driver observed behaviour to a minor extent.
- The results are in accordance with previous research, which suggests that conversation while driving may constitute a risk factor.
- The present research contributes the distinction between simple and complex conversation, as well as the linkage between driver speed, incident reaction time and accident risk while distracted.





The decrease in speed and the increase in the distance from the central axis, during a 'complex' conversation, which might be considered beneficial for road safety, cannot counter-balance the driver's distraction, leading to increased reaction times, and eventually increased accident probability, especially at unexpected incidents.

