

# TRA2020 – Rethinking transport

Towards clean and inclusive mobility • Helsinki 27–30 April 2020

## Analysis of the impact of nighttime driving to drivers' behavior in rural roads through a driving simulator experiment

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### Introduction

Road safety is a complicated scientific field of transport research due to the **multi-dimensional nature of accident occurrence**.

A disproportionately large number of accidents occur at night: the rate of fatal accidents has been reported to be **three to four times higher at night** compared to daytime, especially since traffic flow is significantly lower at night than during the day.

Driving during night, in the absence of ambient light, visual information in the driver's field of view is **dramatically reduced**, with the result that the driver faces two main problems:

- **difficulty in perceiving** "potential" risks;
- mainly from **the lights of upcoming vehicles**, both closely related to the significant reduction of "functional" low-light vision.

The objective of this study is to **investigate and specify in mathematical terms, the impact of night-time driving** on drivers' behavior in rural areas through a driving simulator experiment.

### Methodology

- FOERST **Quarter-cab driving simulator** total field of view 170 degrees, validated against a real-world environment
- **35 participants** (66% males) (age: 24,6±2,5 y.o.)
- At first, **one practice drive** (10-15 minutes)
- Afterwards, the participant drives **at two rural routes** (approx. 10 minutes), single carriageway, zero gradient, mild horizontal curves: **one at daytime conditions** and then one in fully simulated **night-time conditions**
- During each trial, **2 unexpected incidents** occurred: sudden appearance of an animal (deer or donkey) on the roadway

### Analysis

- At first **preliminary statistical approach** was carried out in order to have a first indication of which, probably, will be the impact of night-time driving on several driving parameters.

Figure 1. Screenshots from the simulated environment in night-time and day-time driving conditions

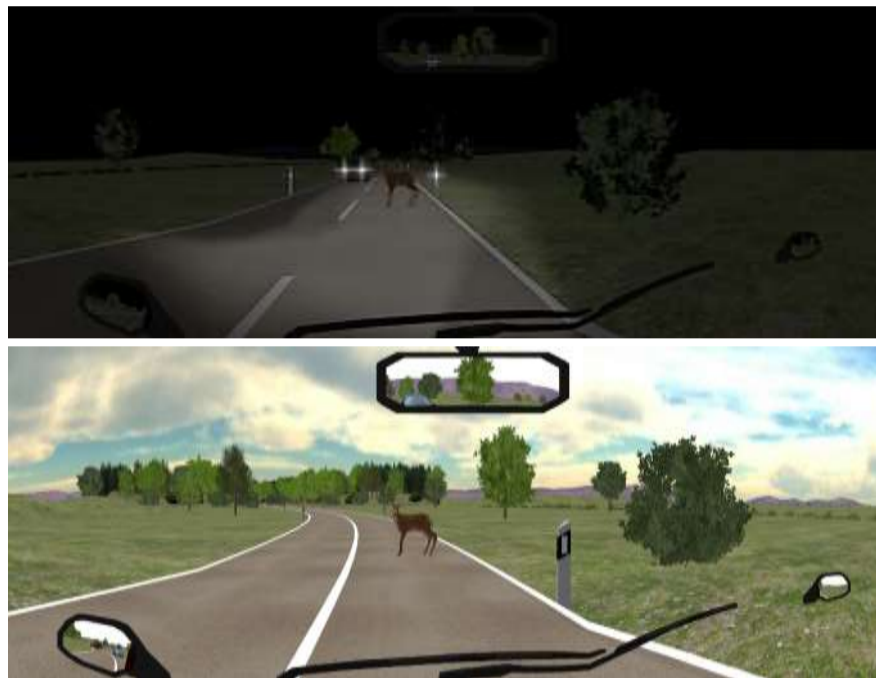
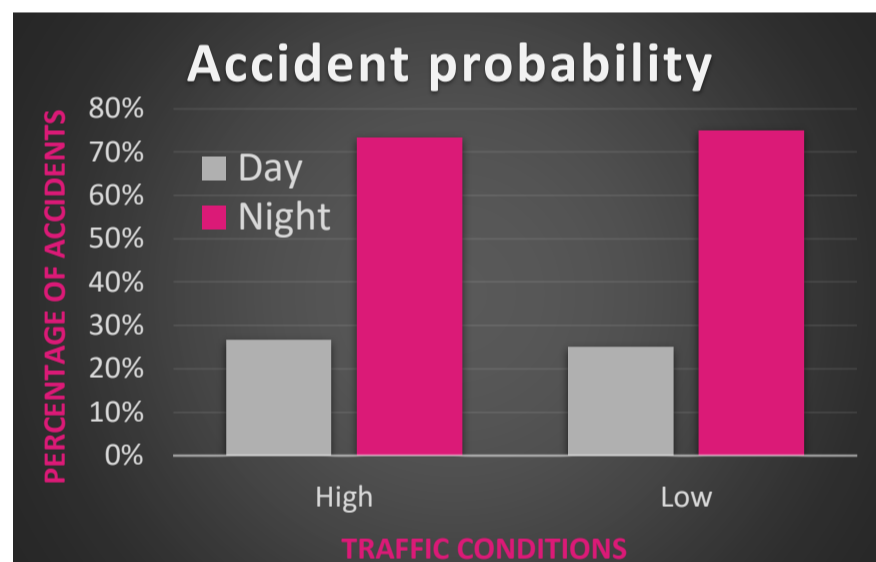


Figure 2. Percentage of accidents occurred in the two different driving scenarios under low and high traffic conditions



Afterwards, **three (3) regression models** were developed to analyze the impact of night-time driving on young drivers' behaviour and safety in rural roads in terms of **speed, accident probability at the unexpected incident, and reaction time**.

Table 1. Log-normal linear regression model for **mean speed**

Independent variables	$\beta_i$	t	Elasticity (ei)	Relevant elasticity (ei)
Night-time driving	-0,02	-6,32**	-0,007	4,155
Traffic conditions	-0,01	-1,99**	-0,002	1,344
Brake	0,01	5,81**	0,015	-9,283
Steering Angle Variability	0,03	18,97**	0,362	-23,700
Age	0,003	1,70**	0,004	-2,754
Driven kilometers per week	7E-05	2,13**	0,002	-1,391
Avoid Driving At Night	-0,01	-2,75**	-0,002	1,000
R <sup>2</sup>	0,88			

Table 2. Binary logistic regression model for **accident probability**

Independent variables	$\beta_i$	t	Elasticity (ei)	Relevant elasticity (ei)
Night-time driving	1,426	9,19**	1,720	4,733
Driving Experience	-0,779	-3,70**	-1,204	3,316
Age	-0,700	3,69**	0,363	1,000
Time headway Variability	0,006	6,47**	0,410	1,129
Gender	0,793	2,25**	0,647	1,780
R <sup>2</sup>	0,128			

Table 3. Normal linear regression model for **reaction time**

Independent variables	$\beta_i$	t	Elasticity (ei)	Relevant elasticity (ei)
Night-time driving	101,03	1,81**	0,078	1,907
Driven kilometers per week	0,969	2,06**	0,069	1,697
Avoid Driving At Night	141,63	2,00**	0,041	1,000
Gender	148,99	2,31**	0,271	6,618
Driving Speed Variability	-24,15	-2,17**	-0,387	-9,431
R <sup>2</sup>	0,226			

### Discussion

Night-time driving in both high and low driving conditions **increases the accident probability to more than 70%**, whereas the accident probability in day time is 3 times lower.

Driving on a rural road during the night, results in a **significant reduction in mean driving speed**

Night-time driving has a statistically **significant and negative impact on the reaction time** of the drivers at an unexpected incident.

The riskiest profile of a driver regarding the reaction time during night-time is a **male driver who self-declare that they avoid driving at night** because he considers this as a dangerous condition.

Drivers seem to have a **compensatory behavior**, as they consider driving at night as a dangerous condition due to limited visibility and for that reason, they **reduce their speed** in order to increase their attention to the driving environment.

This compensatory strategy, however, is **not successful** as indicated by the **worse reaction time and higher accident probability** that they have.

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