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The traffic and safety effect of smartphone texting and web surfing during driving in cities: A driving simulator study

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Presentation Outline

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Background

- The impact of mobile phone on driver behavior and safety has been **extensively investigated**.
- **Literature findings** revealed increased accident probability, reaction time, speed variance, lane deviations and decreased mean speed.
- A few studies have tried to investigate the impact of **smartphone applications** use while driving and few of them analyzed Google maps.
- The present study aims to further enrich the research concerning the **use of internet through smartphone while driving** by analyzing the influence of smartphone texting and web surfing.

Experimental procedure

- **36 drivers** (19 males and 17 females) participated in a **driving simulator experiment** and were clustered into two age groups, aged 18-24 and 25-33.
- **A questionnaire** supplemented the experiment by identifying drivers' profiles and focused on the smartphone use and their familiarity with urban road.
- The simulated experimental procedure included driving in an **urban environment** consisted of a two-way road segment, with one or two lanes per direction and a speed limit of 60 km/h.
- During each session **2 unexpected incidents** were scheduled to occur at random points (kid chasing a ball while crossing the road).

Experimental procedure

- **Four driving scenarios** were tested and were distinguished by day and night time driving conditions, along with a low and high traffic volume.
- Drivers were distracted using **three different smartphone applications**: Facebook, Facebook Messenger and Google Maps, in each of the four scenarios.
- Three distraction actions were performed:
  - navigate in their Facebook feed,
  - texting via Facebook Messenger and
  - search for a location via Google Maps.

Methodological approach

- **Several driving indicators** were extracted from the simulator for each participant and a master database was constructed.

- A statistical analysis was conducted and included two levels of analysis:
  - **Five regression models** were developed in order to analyze the **impact of smartphone use** in terms of mean speed, its variance, mean headway distance, its variance and accident probability.
  - **Two generalized linear models** were developed in order to **compare the impacts** of different smartphone applications use in terms of mean speed variance and mean headway distance variance.

Mean speed impacts

- Texting or web surfing while driving led to **8% decrease** in mean speed and **26% decrease** in mean speed variation (compensatory behaviour).
- **Google Maps** had the highest impact in the mean speed variation model, followed by Facebook Messenger and Facebook.
- A **male driver** who is distracted using **Google Maps** is the profile with the greatest influence in the model.

Mean speed linear model		B	t	e	e*
Discrete	Texting/Web surfing [Ref.: No distraction]	-2.733	-4.963*	**-0.08**	1.33
	Traffic volume [Ref.: Low]	-6.720	-12.202*	-0.20	3.27
	Enjoying driving [Ref.: No]	3.026	2.558*	0.09	-1.47
	Gender [Ref.: Male]	-2.055	-3.715*	-0.06	1.00
Constant		36.420	24.770*		
R^2		0.415			

Mean speed variation linear model		B	t	e	e*
Discrete	Texting/Web surfing [Ref.: No distraction]	-2.918	-9.079*	**-0.26**	-6.10
	Traffic volume [Ref.: Low]	1.470	4.573*	0.13	3.07
	Change driving behavior while using mobile phone [Ref.: Stop the vehicle]	0.957	3.775*	0.04	1.00
Continuous	Daily frequency of texting/ web surfing	-0.366	-1.783*	-0.0003	-
Constant		11.218	15.552*		
R^2		0.303			

Mean speed variation GLM			Male		Female	
	B	Wald	B	Wald	B	Wald
Facebook Messenger	-5.502	211.790*	-5.714	116.002*	-6.206	153.920*
Google Maps	**-5.894**	217.209*	**-6.466**	139.674*	-6.158	123.624*
Facebook	-5.204	191.813*	-5.880	128.394*	-5.347	110.420*
Non distracted driving	0	-	0	-	-0.960	4.936*

* Significant coefficients at the 95% confidence level

Mean headway distance impacts

- Texting or web surfing while driving led to **5% decreased** headway distance and **19% decreased** headway distance variation.
- **Facebook** had the highest impact in the headway distance variation model, then Google Maps and Facebook Messenger.
- The riskiest profile is a driver who is distracted by **using Facebook** while driving at **high traffic volume**.

Mean headway distance linear model		B	t	e	e*
Discrete	Texting/Web surfing [Ref.: No distraction]	-6.166	-2.175*	**-0.05**	3.08
	Traffic volume [Ref.: Low]	-63.951	-22.559*	-0.56	31.92
	Enjoying driving [Ref.: No]	-11.875	-1.759*	-0.10	5.93
	Change driving behavior while using mobile phone [Ref.: Stop the vehicle]	-4.007	-1.759*	-0.02	1.00
	Daily routes on urban roads [Ref.: 0]	2.049	1.993*	0.02	-1.02
	Gender [Ref.: Male]	5.573	1.856*	0.05	-2.78
Continuous	Age	-1.072	-2.353*	-0.0001	-
Constant		139.089	8.951*		
R^2		0.664			

Mean headway distance variation linear model		B	t	e	e*
Discrete	Texting/Web surfing [Ref.: No distraction]	-10.317	-6.586*	**-0.19**	-7.81
	Traffic volume [Ref.: Low]	-21.988	-14.034*	-0.41	-16.63
	Day/ Night [Ref.: Day]	-3.990	-2.547*	-0.07	-3.02
	Gender [Ref.: Male]	4.192	2.656*	0.08	3.17
	Weekly driven kilometers on urban roads [Ref.: 0]	1.322	2.298*	0.02	1.00
Constant		49.778	16.861*		
R^2		0.490			

Mean headway distance variation GLM			Low traffic		High traffic	
	B	Wald	B	Wald	B	Wald
Facebook Messenger	-22.833	101.195*	-32.177	86.122*	-38.651	353.113*
Google Maps	-27.375	219.310*	-38.359	316.690*	-41.818	434.222*
Facebook	**-28.873**	259.400*	-40.108	299.465*	**-43.088**	694.942*
Non distracted driving	0	-	0	-	-25.746	224.347*

* Significant coefficients at the 95% confidence level

Accident probability impacts

- Texting or web surfing while driving led to **75% increased** accident probability.
- The **greatest impact** on the accident probability model was shown by the web surfing and texting use while driving.
- "Internet use while driving" variable had **53% greater influence** on increasing accident probability compared to the "traffic volume" variable.

Accident probability binary logistic model		B	Wald	e	e*
Discrete	Texting/Web surfing [Ref.: No distraction]	0.728	3.579*	**0.75**	-1.53
	Traffic volume [Ref.: Low]	-0.862	4.743*	-0.49	1.00
	Age group [Ref.: 18-24 years old]	-0.483	2.830*	-0.52	1.07
	Day/ Night [Ref.: Day]	-0.980	6.205*	-0.68	1.40
Continuous	Days driving on urban roads	-0.163	4.846*	-0.46	-
Degrees of freedom		5			
Null log-likelihood		304.985			
Final log-likelihood		171.669			

* Significant coefficients at the 95% confidence level

Conclusions

- Web surfing or texting has the **greatest negative impact** on driving behavior compared to other risk factors, such as traffic volume and lighting conditions.
- Smartphone use **increases significantly the accident probability**, while at the same time reduces the mean speed. It seems that the drivers acknowledge that this is a **difficult and dangerous driving condition** but this compensational strategy is not successful as indicated by the increased accident probability.
- The increased accident probability can be explained by the fact that drivers maintain **shorter headways** and have a reduced perception of traffic.
- **Google Maps and Facebook had the highest impact** on mean speed variation and on headway distance variation respectively.

Future research

- Investigation of driving behaviour characteristics under the distraction of smartphone use in an **on-road driving experiment**.
- Inclusion of **different age group** drivers (above 33 years old) in combination with the implementation of **different statistical methods**.
- The experiment implementation in **other road types** and under adverse **weather conditions**.
- Examination of **different ways of smartphone use**, such as holding it or sending voice messages through vehicle technology in order to compare the different types of smartphone usage.

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Thanks for your attention

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