Mobile phone use and traffic characteristics

George Yannis[1]*, Panagiotis Papantoniou[2], Nikolaos Petrellis[3],

[1]Ph.D, Associate Professor, tel. +30-210-7721326, e-mail: geyannis@central.ntua.gr

[2]Civil Engineer, PhD Candidate, tel. +30-210-7721380, e-mail: ppapant@central.ntua.gr

[3]Civil Engineer, tel. +30-210-7721380, e-mail: nikospet312@hotmail.com

[1,2,3] National Technical University of Athens

School of Civil Engineering

Department of Transportation Planning and Engineering

5, Iroon Polytechniou str., GR-15773 Athens, Greece

Fax: +30 210 7721454

* Corresponding author: George Yannis, Associate Professor
National Technical University of Athens, School of Civil Engineering,
Department of Transportation Planning and Engineering,
5 Iroon Polytechniou str., GR-15773 Athens
Phone: +30 210 7721326, Fax: +30 210 7721454
E-mail: geyannis@central.ntua.gr

ABSTRACT

The objective of this research is the analysis of the impact of cell phone use on vehicle traffic speed and headways. For this purpose, a field survey was carried out in real traffic conditions, unlike most related studies that are based on either questionnaire responses or driving simulator experiments. In particular, traffic data were recorded on a four-lane urban arterial segment by means of a video camera and a speed gun. Linear regression models were developed for the analysis of the effect of cell phone use and other variables on traffic speed and time / space headways. It was found that vehicle speed is increased for young drivers (aged 18-25 years), male drivers and taxi drivers, and decreased for older drivers (>55 years) and for drivers using their cell phone while driving. Vehicle's time headways were not found to be affected by cell phone use. However, headspaces, estimated as the product of vehicle speed and time headways, were found to be decreased for drivers using their cell phone, young drivers and older drivers. Moreover, headspaces increased with the difference in speed and in headway of the vehicle ahead. Overall, drivers between 25-55 years old are associated with larger space headways regardless of the use of cell phone, possibly due to a combination of adequate driving experience and skills. Cell phone use results in lower speeds, suggesting a driver's compensatory effect on the distraction caused by the cell phone use, an effect also identified in previous research. This distraction is also reflected in the reduced space headways associated with cell phone use for all drivers. The reduction is more pronounced when the speed and headway difference between successive vehicles was not significant in the first place, as is the case for vehicle platoons.

KEYWORDS

cell phone; driving; speed; headways; regression.

BACKGROUND AND OBJECTIVES

Worldwide, use of cell phones while driving has raised strong concerns about the impact on road safety and several research actions are under way (NHTSA, 2006; McEvoy et al. 2007). On the basis of the concept of humans' inherently limited focus capabilities (Kahneman 1973), early research results showed that cell phone communication is a quite demanding cognitive and operational task, which may compromise decision making while driving (McKnight and McKnight 1993). Nowadays, approximately 44 countries have banned the use of handheld phones while driving (Cellular-News, 2007; Sundeen, 2005)

In particular, the use of cell phones is blamed for increased risk of provoking or failing to avoid a road accident, mainly within simulated experiments within recent researches. The effect is attributed in Laberge-Nadeau et al. (2003) to the distraction of driver's attention. Furthermore, the effect of cell phone use on road accident risk is quantified in Redelmeier and Tibshirani (1997), who suggest that road accident risk is quadrupled when using cell phone while driving, not only during the actual cell phone communication, but also during the short period following the end of the call. Lam (2002) investigated the association between various types of distractions, inside and outside the vehicle, and the increased risk of car crash injury among drivers of different ages. More specifically, it was reported that the risk of road accident injury of young drivers (25-29 years old) who used a cell phone was estimated to be almost 2.5 times higher than those not being distracted. On the other hand, the pattern of effects for older drivers is also somewhat equivocal. The impact of cell phones on older drivers appears to be more detrimental in some studies (Brookhuis et al., 1991), but not in other ones (Alm and Nilsson, 1995). In another simulator experiment (Wilcox, 2004) it was found that drivers who used their cell phone while driving experienced an increased risk of provoking a road accident compared to drivers who did not use their cell phone while driving; interestingly, this effect was non significant for male drivers.

In other researches, the effect of cell phone use while driving is examined in terms of road safety, through the analysis of the respective effect on traffic speeds and vehicle headways. It is argued that drivers may attempt to compensate for the increased mental effort resulting from the use of cell phone while driving by adapting their speed accordingly (Haigney et al. 2007). In particular, it has been found that drivers reduce their speed while using their cell phone (Strayer and Drews 2001). The adjustment of driving speed while using a cell phone appears to be largely affected by the road environment; in particular, speed reduction is expected to be higher in the more complex urban settings (Törnos and Bolling 2005). Related effects may also rise from individual driver characteristics, such as age and gender. For instance, young drivers do not appear to significantly reduce their travel speed when using their cell phone, whereas older drivers reduce their speed in accordance to the complexity of the trip. Moreover, higher speed reductions while using a cell phone were observed among older female drivers, in relation to male drivers of the same age groups (Nowakowski et al. 2008).

Alternatively, vehicle headways may be examined as measure of driving behaviour when using a cell phone; however the related findings are more contradictory. For example, a recent research (Rosenbloom 2006) reports a statistically significant reduction of vehicle headways in drivers using their cell phones, whereas in (Strayer and Drews 2001), headways of drivers using their cell phones were found by 12% higher than those of drivers who did not use their cell phone while driving.

Regarding the impact of using a hands-free mobile phone, Rosenbloom (2006) examined the impact of using a hands-free mobile phone while driving on vehicle speed and headways, and found that drivers who performed short phone calls reduced their speed while talking on the mobile phone, in contrast with other drivers who engaged in lengthy conversations and increased their speed. In addition to this, the results of a simulator study (Charlton S., 2009), dealing with the effect of the hands-free use of mobile phone while driving, suggested that drivers who used the mobile phone recorded the highest accident rates. Through another simulator study (Strayer et al., 2006), a performance comparison was made between cell phone drivers, either on hand-held or hands-free mode, and drivers who were legally intoxicated from ethanol. As regards the speed profiles, intoxicated drivers reduced speed more than cell phone drivers, but in both cases speed appeared to be lower than the average speed of participants in the single-task driving.

Despite the large number of studies on cell phone use and driver behaviour and safety, it should be noted that in several cases the available results are compromised by features of the experimental design, as regards both the data collection and analysis methods. More specifically, most researches use driving simulator (Alm and Nilsson 1995, Ranney et al. 2005, Rakauskas et al. 2004, Törnos and Bolling 2005) or stated preference data (Chen 2007, Gras et al. 2007), i.e. the effects are seldom explored in real traffic conditions, therefore different types of bias may be involved in each case.

In a meta-analysis of the effects of cell phones on driver performance, Caird et al., (2008) categorised the research setting into laboratory, simulation and on-road. On road studies, as the present one, are very few regarding studies taking place in a laboratory or a simulator. Moreover, most researches examine the dependant variables of speed and reaction time, and only few examine headways, which is nevertheless equally important for traffic flow and road safety.

Within this framework, the objective of the present research is to extend existing research on the effect of using a cell phone while driving on road safety. On that purpose, a field survey is carried out in actual traffic conditions in an appropriate setting. Moreover, both traffic speeds and vehicle headways are examined as per the influence of cell phone use while driving. This research was carried out in Athens, Greece, where a very low drivers compliance is observed, combined with a lack of systematic police enforcement of the use of cell phones while driving.

METHODOLOGY AND DATA COLLECTION

Field survey and data processing

Traffic data were recorded on a four-lane urban arterial segment on Katehaki Ave., near the National Technical University of Athens Campus, in Athens, Greece (see Figure 1), by means of a video camera (for the measurement of vehicle arrivals and headways) and a speed gun (for the measurement of vehicle speeds). Measurements concerned vehicles traveling along the right and the middle lanes, on typical weekdays and during off-peak hours, in order to avoid congestion conditions and enable accurate and meaningful measurement of speeds and headways. Two researchers were involved in the data collection; one researcher measured vehicle speed by using a speed gun, whereas another researcher recorded the driver's age group and gender, as well as the vehicle type and cell phone use. In total, 3,048 consecutive vehicles were captured during the roadside survey. No particular problems were encountered during the survey, and therefore measurement errors are expected to be negligible.

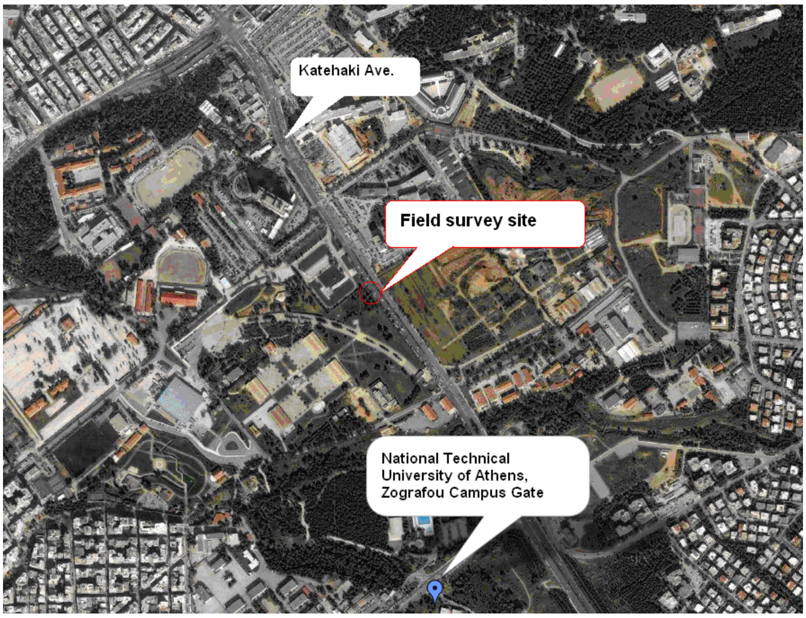

Figure 1. Field survey site

The data was then cross-checked through the video recordings. Moreover, vehicle headways were measured for each vehicle as the time difference of the front of the vehicle passing from the specific cross-section and the vehicle ahead of it. This was achieved by means of detailed analysis of the video recording as shown in Figure 2. This data was stored in a database, which was completed with additional data from the video recording, including driver age and gender, vehicle type and use of cell phone.

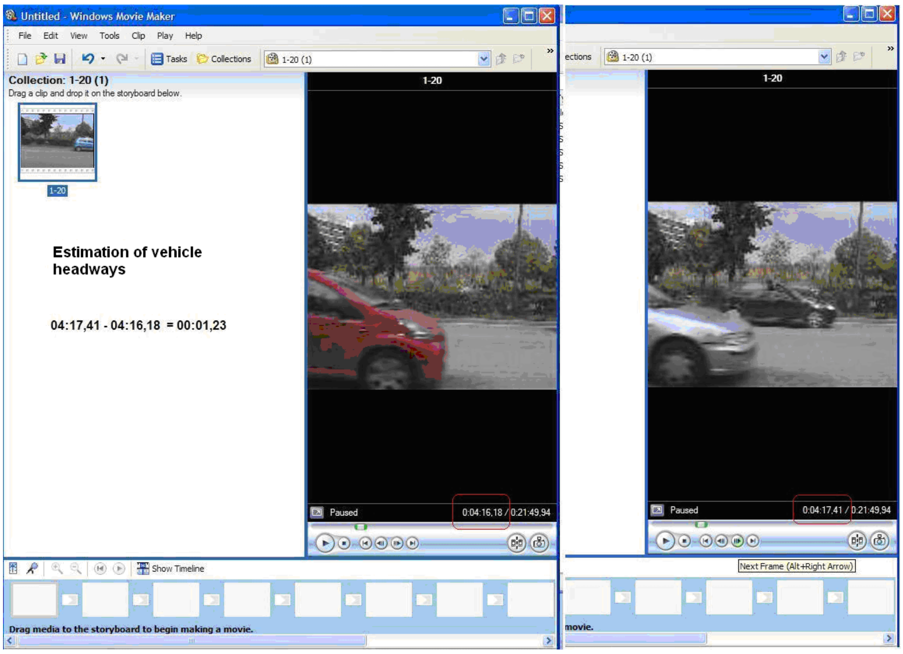

Figure 2. Estimation of vehicle headways

In particular, the variables eventually obtained include:

- vehicle speed (v)
- driver gender (gender)
- driver age group (18-25, 25-55, >55)
- use of cell phone (yes / no)
- Headway (Hw)
- Headspace (Hs), i.e. headways expressed in distance by multiplying the vehicle speed with the time headway. It is noted that the length of the vehicle ahead is included in the headspace.
- The absolute difference in the speed of each vehicle from the vehicle ahead (dv)
- The absolute difference in headway of each vehicle from the headway of the vehicle ahead (dhw).

The last two variables (dv, dhw) were introduced in order to capture the fact that vehicle headways are largely affected by traffic conditions (free flow or congestion), resulting in dependences between speed and headway of a given vehicle and those of the vehicle ahead.

Analysis methods

In order to estimate the effect of using cell phones while driving, linear regression models were examined, under the assumption that traffic speed and headways / headspaces are continuous normally distributed response variables, leading to the following linear modeling formulation:

$$y_i = \Sigma \beta x_i + \varepsilon_i$$

Where y_i is the response variable, x_i are continuous or discrete explanatory variables,
β are parameters to be estimated
and ε_i the error component $\varepsilon \sim N(0, \sigma^2)$

For the comparative assessment of variable effects within and across the three models, relative effects (e*) were calculated, on the basis of elasticities (e). In particular, point estimates of elasticities (e_i) are provided by the following formula, for each value (i) in the sample:

$$e_i = (\Delta \text{Log } y_i \ / \Delta x_i)\ (x_i / y_i) = \beta_i\ (x_i / y_i)$$

Then the mean estimate (e) is calculated as the average of (e_i) values. It is noted that, although elasticities are most meaningful when comparing the effects of continuous variables, the formula was also applied for the categorical variables, as a means for the assessment of relative effects.

RESULTS

Modeling vehicle speeds and headspaces

Two models were developed through the statistical analysis regarding vehicle speed and headspaces. Both models were accepted as R^2 coefficient is greater than 0.45 in each model and (almost) all variables were statistically significant at a 90% confidence level.

The first model developed concerned vehicle speeds, and explanatory variables included the use of cell phone, the driver's gender, the age groups 18-25 and > 55 years and the "taxi" vehicle type. The parameter estimates and their statistical significances are summarized in the left part of Table I. It is noted that a variable is considered to be statistically significant at a 90% confidence interval, when its t-value is higher than 1.64 and consequently its p-value is lower than 0.100.

Accordingly, following the results for drivers' speed, an effort was made to develop respective models for the effects of cell phone use on average vehicle headways. However, headspace was proved to be a more efficient dependent variable than headways, and therefore only the final model concerning headspaces is presented here (see right part of Table I). In this case, statistically significant effects include the use of a cell phone, the age group 25-55 years (marginally significant), the difference in speeds and the difference in headways from the vehicle ahead. It is observed that some of the variables that were significant in the speed model were not found to be significant in the headspace model (e.g. gender, taxi), and vice versa (e.g. difference in headways). Moreover, interactions between variables were tested, but were not found to add explanatory power in the model.

Table 1. Generalized linear modelling results for vehicle speed and headspace.

	Vehicle speed (V)			**Headspace (Hs)**		
Variable	**β**	**t-test**	**p-value**	**β**	**t-test**	**p-value**
Constant	51.49	118.897	0.000	-8.666	-1.738	0.082
Taxi	0.692	1.914	0.055	-	-	-
Gender	-0.688	-2.537	0.011	-	-	-
Age 18-25	0.441	1.642	0.100	-	-	-
Age 25-55	-	-	-	7.299	1.386	0.166
Age >55	-1.503	-3.828	0.000	-	-	-
Cell phone use	-0.726	-1.849	0.064	-28.824	-3.271	0.001
Speed difference dv	-	-	-	7.134	16.995	0.000
Headways difference	-	-	-	7.174	46.108	0.000
R^2	0.45			0.47		

In particular, male drivers, young drivers (18-25 years) and taxi drivers travel at increased speeds, whereas older drivers (>55 years) travel at reduced speeds while speaking. Most importantly, the use of a cell phone while driving results in reduced speeds for all drivers. Moreover, cell phone use is significantly associated with reduced headspaces. On the other hand, increased speed and headway differences between consecutive vehicles result in increased headspaces as well.

Focusing on the effect of cell phone use, it can be assumed that the reduction in vehicle speeds of drivers using their cell phone results in a road safety benefit, given that lower travel speeds are generally correlated with lower accident risk. However, it is revealing perhaps, apart from the physical distraction of the handheld mode, an attempt of drivers to counter-balance the increased mental workload resulting from the conversation. On the other hand, the reduction of vehicle headspace for drivers using their cell phone while driving may be considered as a confirmation of the distraction caused by cell phone, leading the driver to fail maintaining the appropriate headspace. Reduced headspaces are generally associated with increased rear-collision risk.

A final note on the modelling results concerns the headspace model. In particular, looking at the parameter estimates of this model, it may appear that the model yields negative headspaces, under certain conditions i.e. when the difference in speed and the difference in headways are zero, or when the difference in speeds and headways are low and cell phone use is involved. It is underlined, however, that a difference of speeds and headways equal to zero between consecutive vehicles is a purely theoretical case, which was certainly not observed within the - more than 3,000 vehicles - present sample. On the contrary, a rather complex relationship between difference in speeds and headways was observed, and this relationship appeared to vary at different traffic conditions, an issue that will be also discussed in the following sections. It is further underlined that, for each one of the sample vehicles, the headways estimated from the model were always positive.

Variables sensitivity and elasticity

For the better understanding of modelling results, variable sensitivity tests were carried out. In this section sensitivity graphs related to headspace effects are presented in Figures 3 and 4. In particular, Figure 3 concerns the sensitivity of headspaces to the difference in speeds for drivers using or not using a cell phone while driving. In this case, the difference in headways was taken to be equal to 4 sec, i.e. as the average value calculated from the sample. As mentioned above, the absolute difference in headways may be considered to take any positive value except zero, an assumption that was confirmed by the measurements carried out in this research.

It can be seen that headspaces increase with the difference in vehicle speeds for all drivers; however, drivers using their cell phones have smaller headspaces regardless of the difference in speeds with the vehicle ahead. It is also noted that these general patterns are not affected by age effects.

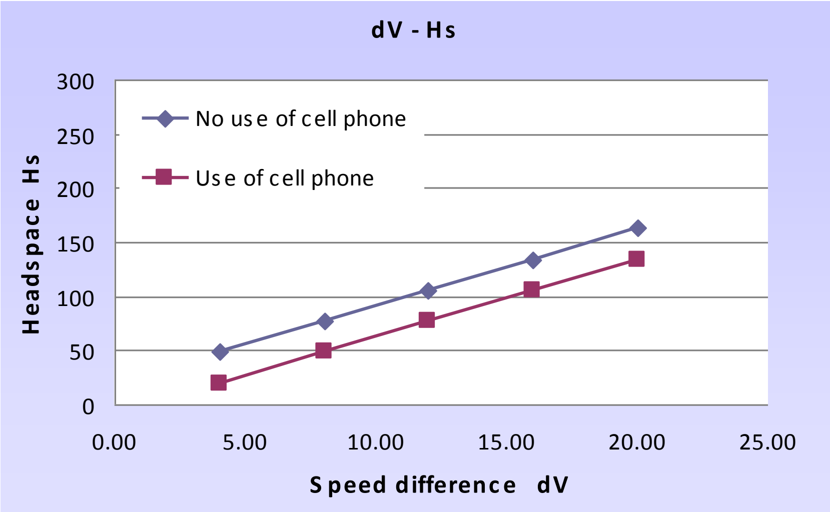

Figure 3. Sensitivity of headspace to the difference in speed from the vehicle ahead (age <25 or >55 years, dHw=4 sec)

Accordingly, Figure 4 presents the sensitivity of headspaces to the difference in headways for drivers using or not using a cell phone while driving. In this case, the difference in speeds was kept equal to 5 km/h, i.e. as the average value calculated from the sample. It is noted that a constant difference in speed is considered only for practical reasons; in fact, as mentioned in the previous section, an interrelation between speed and headway difference between consecutive vehicles is expected. However, the investigation of this interrelation is beyond the scope of the present research.

It can be seen that headspaces generally increase with the difference in headways between consecutive vehicles. Drivers using their cell phone have systematically lower headspaces, regardless of the difference in headways.

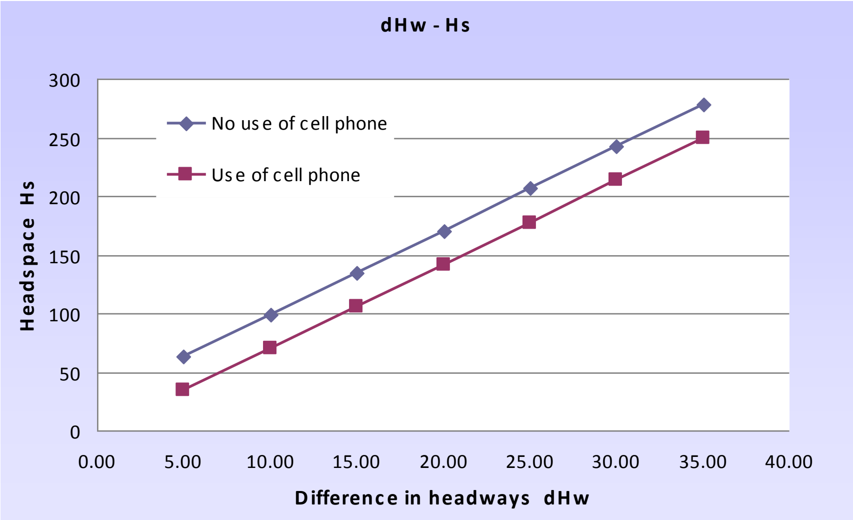

Figure 4. Sensitivity of headspace to the difference in headways from the vehicle ahead

Additional insight may be obtained through the estimation of variable elasticities. These are presented in Table II. The elasticity e is calculated as indicated in section 2.2, whereas its normalization in relation to the lowest value is shown by e*. It can be seen that vehicle speeds are largely affected by driver age and gender, and less affected by the use of cell phone. As regards vehicle headspaces, these are mostly affected by the differences in speeds and in headways from the vehicle ahead, due to the obvious correlation between the three traffic measures. Headspace elasticity to age is also considerable, whereas the use of cell phone presents the lowest elasticity.

Table II. Elasticities of vehicle speeds and headspaces

	Vehicle speed (V)			**Headspace (Hs)**		
Variable	**β**	**e**	**e***	**β**	**e**	**e***
Taxi	0.692	0.00154	1.13	-	-	-
Gender	-0.688	0.00318	2.34	-	-	-
Age 18-25	0.441	0.00228	1.68	-	-	-
Age 25-55	-	-	-	7.299	0.14733	1.63
Age >55	-1.503	0.00297	2.18	-	-	-
Cell phone use	-0.726	0.00136	1.00	-28.824	0.09023	1.00
Speed difference dv	-	-	-	7.134	0.87752	9.73
Headways difference dHw	-	-	-	7.174	1.28655	14.26

Overall, it appears that the use of cell phone is a significant additional determinant of vehicle speeds and headspaces, although other driver and traffic characteristics are the main determinants. In particular, the sensitivity analysis suggests the following:

- The use of cell phone results in smaller headspaces when the difference in speed from the vehicle ahead increases, regardless of driver age.
- The use of cell phone results in smaller headspaces when the difference in headways from the vehicle ahead increases, regardless of driver age.

DISCUSSION

Most existing research efforts on the effect of mobile phone use while driving on drivers' behaviour are based on either driving simulator experiments or stated preference surveys. Moreover, they focus on the effects on driver’s speed and reaction time. In this research, vehicle headways are selected as an equally important measure of traffic flow and road safety, especially within the context of driver distraction. Moreover, this research contributes to the identification and validation of the effects of using a mobile phone while driving, by using data from an on-road experiment, where vehicles actual speeds and headways were measured on an urban road section, together with driver characteristics, including the use of cell phones.

The modeling results suggest that the use of cell phone brings a slight decrease of vehicle speeds. This effect, also identified in previous research, can be attributed to the fact that drivers reduce their speeds in an attempt to compensate for the increased requirements for cognitive and motor effort coming from the use of a cell phone while driving. Moreover, it was found that young drivers (18-25 years old) drive at increased speeds, whereas older drivers (>55 years old) drive at the lowest speeds. Finally, females drive at lower speeds compared to males, regardless of the use of cell phone.

The use of cell phone while driving was also found to reduce vehicle headspaces. This may suggest that the driver is distracted by the cell phone conversation, failing to keep the appropriate distance from the vehicle ahead. Middle aged drivers (25-55 years old) are associated with increased headspaces, possibly resulting from a combination of more driving experience compared to young drivers and better skills compared to older drivers. Moreover, the effect of traffic conditions on vehicle headspaces was found to be most important. Increased differences in speeds and headways between consecutive vehicles were strongly associated with increased headspaces. This may reflect a vehicle platoon effect, in which lower and more homogenous speeds and headways are observed.

The significant effect of cell phone use on traffic characteristics may also be associated to negative safety effects. In particular, a reduction of vehicle speed (i.e. as the one estimated when using a cell phone while driving) might be associated with a benefit in terms of road safety, given that most cases lower speeds correspond to lower accident risk and accident severity. In this case, however, several researchers argue that this reduction in speed is just another aspect of driver distraction when using a cell phone, and consequently accident risk increases. This assumption is in large part confirmed by the findings of the present research, given the reduced headspaces associated with the use of cell phone while driving.

The next steps of the present research could focus on the investigation of the interrelation between difference in speeds and difference in headways between consecutive vehicles. The analysis of this potentially complex relationship (e.g. a different relationship is expected in low and in high traffic flows) might provide additional insight into the modelling results. Furthermore, starting from the basic linear models presented in this paper, non-linear forms of the examined relationships could be tested, and eventually variation of the distance between the "using" and "not using" a cell phone curves could be tested. In addition, it would be important to investigate the impact of mobile phone use, not only when the drivers talk on mobile phone using a hand-held device but also when they use a hands-free device, a bluetooth, or when they type a sms.

REFERENCES

1. Alm H., Nilsson L. (1995). The effects of a mobile telephone task on driver behaviour in a car following situation. Accident Analysis and Prevention 27 (5), 707-715.

2. Brookhuis, K.A., de Vries, G., de Waard, D., 1991. The effect of mobile telephoning on driving performance. Accident Analysis and Prevention 23 (4), 309–316.

3. Caird J., Willness C., Steel P., Scialfa C. (2008). A meta-analysis of the effects of cell phones on driver performance. Accident Analysis and Prevention 40, 1280-1293.

4. Cellular-News, 2007. Countries that ban cell phone use while driving. http://www.cellular-news.com/car bans/. Accessed December 19, 2007.

5. Charlton S., (2009). Driving while conversing: Cell phones that distract and passengers who react. Accident Analysis and Prevention 41, pp. 160-173.

6. Chen, Y.-L. (2007). Driver personality characteristics related to self-reported accident involvement and mobile phone use while driving. Safety Science 45 (8), 823-831.

7. Gras M.E., Cunill M., Sullman M.J.M., Planes M., Aymerich M., Font-Mayolas S. (2007). Mobile phone use while driving in a sample of Spanish university workers. Accident Analysis and Prevention 39, 347-355.

8. Haigney D.E., Taylor R. G., Westerman S. J. (2000). Concurrent mobile phone use and driving performance : task demand characteristics and compensatory processes. Transportation Research, Part F: Traffic Psychology and Behavior 3 (3), 113-121.

9. Kahneman, D. (1973). Attention and Effort. Englewood Cliffs, NJ: Prentice-Hall.

10. Laberge-Nadeau C., Maag U., Bellavance F., Lapierre S.D, Desjardins D., Messier S., Saïdi A. (2003). Wireless telephones and the risk of road crashes. Accident Analysis and Prevention 35, 649-660.

11. Lam L.T. (2002). Distractions and the risk of car crash injury: The effect of drivers' age. Journal of Safety Research 33 (3), 411-419.

12. McEvoy, S.P., Stevenson, M.R., McCartt, A.T., Woodward, M., Haworth, C., Palamara, P., (2005). Role of mobile phones in motor vehicle crashes resulting in hospital attendance: a case-crossover study. British Medical Journal 331 (7514), 428.

13. McKnight A.J., McKnight A.S. (1993). The effect of mobile phone use upon driver attention. Accident Analysis and Prevention 25, 259-265.

14. NHTSA, 2006. The impact of driver inattention on near-crash/crash risk. Available at: http://www-nrd.nhtsa.dot.gov/departments/nrd-13/810594/images/810594.pdf.

15. Nowakowski C., Friedman D., Green P. (2001). Cell phone ring suppression and HUD Caller ID: Effectiveness in reducing momentary driver distraction under varying workload levels. Technical Report UMTRI 2001-29, October 2001, Available on-line: http://www.umich.edu/~driving/publications/UMTRI-2001-29.pdf [Accessed Jul. 28, 2008].

16. Rakauskas M., Gugerty L., Ward N., (2004). Effects of naturalistic cell phone conversations on driving performance. Journal of Safety Research 35, pp. 453-564.

17. Ranney T., Watson G.S., Mazzae E.N., Papelis Y.E. (2004). Examination of the distraction effects of wireless phone interfaces using the National advanced driving simulator. Preliminary Report No DOT 809 737, NHTSA, Virginia, April 2004. Available on-line: http://www.nhtsa.gov/staticfiles/DOT/NHTSA/NRD/Multimedia/PDFs/VRTC/ca/capubs/Wireless1F_PrelimReport.pdf [Accessed Jul. 28, 2008].

18. Redelmeier, D.A., Tibshirani R.J. (1997). Association between Cellular-Telephone Calls and Motor Vehicle Collisions. New England Journal of Medicine 336 (7), 453-458.

19. Rosenbloom T. (2006). Driving performance while using cell phones: An observational study. Journal of Safety Research 37, 207-212.

20. Sundeen, M., 2005. Cellphones and Highway Safety: 2005 State Legislative Update. National Conference of State Legislatures, Denver, CO. http://www.ncsl.org/programs/transportation/cellphoneupdate05.htm.

21. Strayer D.L., Drews F.A. (2001). Effects of cell phone conversations on younger and older drivers.University of Utah, Salt Lake City. Available on-line: http://www.psych.utah.edu/AppliedCognitionLab/Aging.pdf [Accessed Jul.28, 2008].

22. Strayer D., Drews F., Crouch D (2006). A comparison of the cell phone driver and the drunk driver. Human Factors 48, pp. 381-391.

23. Törnos J.E.B., Bolling A.K. (2005). Mobile phone use - Effects of handheld and handsfree phones on driving performance. Accident Analysis and Prevention 37, 902-909.

24. Wilcox S.D. (2004). Comparison of driving in a simulated environment while using the cell phone with and without a headset. Published in Design Science, 2 August 2004. Available on-line: http://www.natarus.com/safedriving/NatarusSafeDrivingPressKit_06-03-05.pdf, p. 13.