PHONING WHILE DRIVING: AN EXPERIMENTAL STUDY IN COLOMBIA

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ABSTRACT

While this is a common behaviour, it has been found that mobile phone use while driving increases the risk of traffic accidents due to a decrease in the driver reaction. To study the factors that define this behaviour it is important to refine policies to limit this. Using data from stated preference surveys implemented in Tunja (Colombia) a random coefficient model was used to explain why drivers use mobile phones while driving, using variables such as gender, license date of issue, the speed reduction, importance of the phone call, travelling with someone else, speed and traffic fines. In this context it was found that the most important variable was the traffic fine with an elasticity of -1,236.

Keywords: Mobile phone use while driving, accident risk, logistic regression model.

INTRODUCTION

The analysis of the effects that mobile phone use produce while driving is a topic of great interest in the scientific community. Research based on simulated situations (Drews *et al.*, 2008) and in real cases (Collet and Guillot, 2010a, Collet and Guillot, 2010b) conclude that using a mobile phone while driving increases the risk of exposure to traffic accidents; despite this, it is estimated that more than half of people use their mobile phone while driving (Utter, 2001). Experiments based on driving simulators have shown that drivers change their level of attention when driving and making a phone call simultaneously (Beede and Kass, 2006; Strayer and Drews, 2007). Overall, it has been proven that distraction when talking on the phone reduces the driver's ability to react in relation to other activities which may occur while driving like the use of music players (Consiglio *et al.*, 2003; Rodríguez, 2006).

Besides the distraction, which can be dangerous for young drivers who represent traffic accidents in many countries and it is the main cause of death (Hafetza *et al.*, 2010), it has been reported that driving while talking on mobile phones cause on reflexes similar effects produced by the ingestion of a quantity of alcohol sufficient to produce an alcohol of 1 g/1 (Rodríguez, 2006; Ministerio de Educación y Ciencia, 2004).

Many drivers seem to be unaware of the risk (Horrey *et al.*, 2008; Rosenbloom, 2006) and although it is believed that it is safer to use additional hands-free devices, recent studies show an increased risk of accidents, both for mobile phone use without add-ons and for hands-free use, resulting in statistically significant risk estimates in relation to any of the types of mobile phones (Backer and Sagberg, 2011). In fact, we have found that using the headset can be even more dangerous as drivers try to compensate for the risk when using a mobile phone without additional devices (Reimer *et al.*, 2010) but they forget to do it when using a hands-free phone (Ishigami and Klein, 2008).

Apart from the above, it is important to clarify that the use of mobile phones in vehicles is not harmful per se because the evidence suggests that the mass of mobile phones allows a timely response from the emergency services to the accident site, helping to reduce the number of fatalities in traffic accidents (Loeb *et al.*, 2009; Fowles *et al.*, 2010).

Due to the obvious risk in many countries it is illegal to drive and use a mobile phone simultaneously (Macario *et al.*, 2010). In Colombia it is forbidden to use mobile communication systems or telephones installed in vehicles when driving, except if they are used with accessories or auxiliary equipment that allows for hands-free use (Imprenta Nacional de Colombia, 2010), the fine for committing this offense is 15 days minimum salary, which in the year 2010 corresponds to $257,500 Colombian pesos, roughly $135.

Mobile phone use is becoming more widespread in the population and this use is also extended to the driving population despite the risk and prohibition. Colombia ended 2009 with 42,025,520 active mobile subscriber lines (ASOCEL, 2010), i.e. 0,93 mobile phones per capita if the indicator is calculated with the demographic projections of the National Department of Statistics (DANE, 2010). The motorization rate has also grown and now takes 0.0659 per vehicle, but it is expected that by 2040 this will increase to 0.1686 (Acevedo, 2009). These two realities coupled with the improper behaviour of drivers in the country make up a major problem in the area of road safety that certainly deserves consideration from the standpoint of transportation engineering.

For this reason, in this research the most important variables that influence the behaviour of drivers regarding the use of mobile phones in Colombia are studied, as a case study the city of Tunja, on the basis that the behaviour is a fundamental issue in the field of road safety, which cannot be forgotten if we are to understand what can lead drivers to take these risks (Sánchez, 2008). This proposal may have important implications for the implementation of policies to reduce accident rates since it contributes to the understanding of the behaviour of drivers.

EXPERIMENTATION

This research project is rooted in a choice experiment that simplifies the decisions of the individual (driver) to treat their behavior analytically (Train, 2003). Although some behavioural theories and models have been recently developed to try to explain the decisions related to economic and psychological matters (Kahneman, 2003), it is clear that individuals can make a decision out of habit, social convention or intuition (Orro, 2005). In any case, individual behaviour can be described through an election process in which the decision maker generates only one alternative; to do this, it was taken into account who the decision maker is, how the set of alternatives available are generated, which attributes characterize alternatives and what rules determine the choice.

Specifically the choice experiment was based on a hypothetical situation that was taught to drivers as indicated below: "Suppose you are driving on an urban road and agree that you must make a call, your phone is available, but there is no opportunity to use the headset". Given this situation two mutually exclusive and collectively exhaustive alternatives arose: (i) Using a mobile phone and (ii) not using the mobile phone.

The set of variables with which the experiment was designed is described as follows: urgency, because it has been shown that driver behaviour differs depending on the type of conversation (Dula *et al.*, 2010), and it also affects the risk of accidents both at high or low traffic congestion (Hennesy and Wiesenthal, 1999; Hennesy and Wiesenthal, 2000); the condition of traveling alone or with company, as the evidence indicates that drivers are more likely to use their mobile phone when traveling alone (Walsh *et al.*, 2008) and because apparently it increases the risk of accidents among young drivers when traveling with company (Williams *et al.*, 2007); traffic conditions, since with more exposure there is an increased risk (Forkenbrock and Weisbrod, 2001) which may affects the use of mobile phones; the speed, which is associated with the risk and severity of accidents (Kononen *et al.*, 2011); and the cost of the fine, which restricts the driver's behaviour (Kowalaski and Lundman, 2010) against the possibility of committing an offense.

Table I – Levels of the experimental variables

Variable	Level	Description
Urgency	0	Urgent Call
	1	A normal call
Travellers	0	Traveling alone
	1	Traveling with someone
Traffic conditions	0	Traffic allows to move freely
	1	The traffic prevents the desired speed
	2	Traffic congestion makes it very difficult to travel
Speed	0	20 km/h
	1	40 km/h
	2	60 km/h
Cost of the fine	0	$257,500
	1	$515,000
	2	$1,030,000

The determination of the levels of each variable (Table I) was based on reference values identified in a focus group meeting in which, through the application of structured and unstructured interviews, various categories were identified from personal drivers' experiences towards the research object; these initial values were adjusted after applying a pilot test to 20 drivers, having in mind not to use a very large number of levels to avoid an increase in the resulting combinations. The combination of variables and levels formed an experiment $2^3 \cdot 3^3$ with a total of 216 treatments.

The experimental design was based on the principles of orthogonality, level balance and minimum overlap (Zwerina *et al.*, 2005) and although the Koçur traditional tables were available (Koçur *et al.*, 1982), we preferred to get the orthogonal main effects plan through the algorithm SAS search software (Sartori, 2006), finding a design of 16 treatments that allows us to study the main effects of the variables (Table II).

Table II – Orthogonal design of main effects

Treatment	Urgency	Accompany	Traffic	Speed	Fine
1	0	0	0	0	0
2	1	1	1	1	0
3	0	1	2	2	0
4	1	0	1	1	0
5	0	1	0	1	1
6	1	0	1	0	1
7	0	0	2	1	1
8	1	1	1	2	1
9	1	0	0	2	2
10	0	1	1	1	2
11	1	1	2	0	2
12	0	0	1	1	2
13	1	1	0	1	1
14	0	0	1	2	1
15	1	0	2	1	1
16	0	1	1	0	1

The design was divided into two blocks so that each individual was faced with only eight treatments, which is considered reasonable because facing more than 9 choice cases is overwhelming for some respondents (Sartori, 2006).

The survey also inquired about the most important socio-demographic attributes of individuals (Brusque and Alauzet, 2008) and showed the characteristics of mobile phone use when driving. The following information was kept in mind: age, gender, mobile operator, last approved educational level, main activity, driver's license issue date and it was determined if the individual had been fined at one time for talking on a mobile phone.

At the same time, they were asked about the following: if the individuals have used the phone while driving, the frequency of this practice, if they use the headset, if they reduce speed while talking on a mobile phone, if at least one time they have been in an accident or almost been in an accident by using mobile phones and risk perception of this practice.

The study was applied to the driving population with own cars in the city of Tunja. Based on information obtained in the pilot test a simple model was estimated that included the urgency, the condition of the trip, the speed and the amount of the fine; taking a 95% confidence level and, preliminary estimated values and its asymptotic standard error, it was found that the required sample size based on each parameter (Ortúzar and Willumsen, 2011; Bliemer and Rose, 2009) would be 15, 384, 188 and 24, respectively, being critical the sample size to estimate the parameter of the trip condition by requiring 384 observations, it means at least 50 individuals since each respondent contributes in the total sample with an amount of 8 observations, equal to the number of hypothetical choices answered. Theoretically, this would be the minimum sample size to be considered (Bliemer and Rose, 2009); however, it was decided to survey 176 individuals in 8 places in their own vehicles, using a systematic sampling technique in parking lots of major malls and major gas stations in the city.

Stated Preference Data (SP) were collected during the month of November 2010 and subsequently a survey revealed preference (RP) was applied to a sample of 96 individuals, investigating the behaviour assumed by the last time the mobile phone was used effectively while driving. Data collected were subjected to descriptive statistical analysis and with the main variables it was proceeded to estimate SP, RP, and jointly SP/RP models, through binary Logit and random coefficients. It was decided to discard the use of linear probability models as it has been shown that they do not provide an adequate response in modelling dichotomous decision processes (Alamilla and Arauco, 2009).

RESULTS AND DISCUSSION

A total of 176 individuals were interviewed, with a mean age of 36 years, 72,7% males , predominance of workers (72,2%) and students (10,8%), and a level of studies in most cases allowed them to achieve a high school diploma or college, as seen in Figure 1. It was found that the distribution of these variables is consistent with the distributions that were observed in the city in previous studies (Neiza and Fresno, 2004; Palacios and Silva, 2004; Medina, 2004).

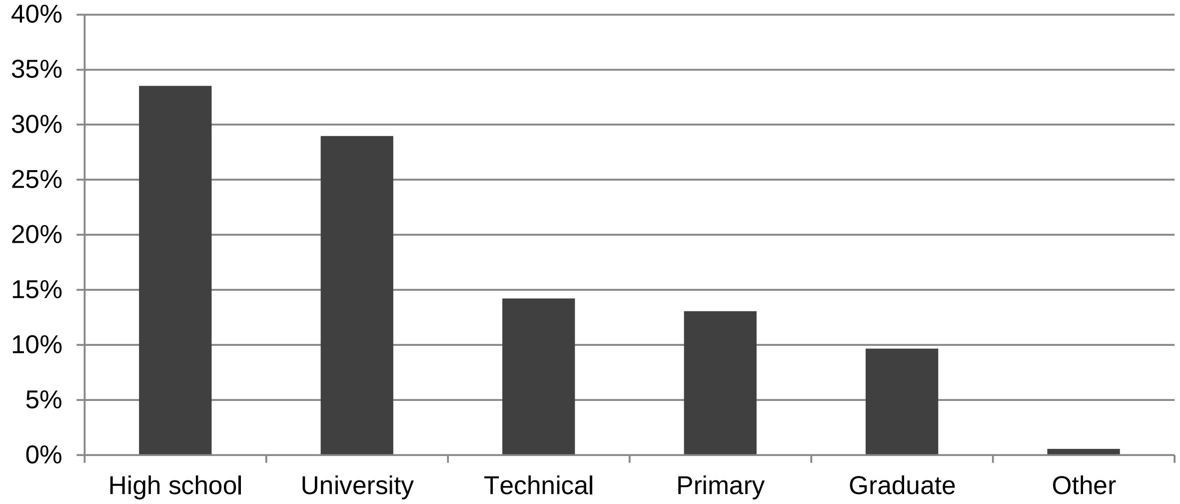

Figure 1 – Educational level attained by respondents

All respondents reported having an active mobile phone and found that 71,02% belong to the mobile operator COMCEL, followed by MOVISTAR with 17.05% and TIGO with a share of 7,95%, while 3,98 % of respondents did not reveal their mobile operator; when comparing this distribution with the records of the sector in Colombia (ASOCEL, 2010) a reasonable correspondence was found indicating that the sampling technique used was successful. 60,2% revealed to have been fined for traffic violations and 11,3% of these reported having been fined for using mobile phones while driving, although these indicators were not subjected to validation as it was not possible to get access to traffic violations information, it is considered representative of the environment in which the survey was conducted.

As it is seen in Figure 2, over 50% of respondents said that it is very risky to use mobile phones while driving, but 82.4% of respondents reported doing so, arguing that it is generally an uncommon practice (Figure 3).

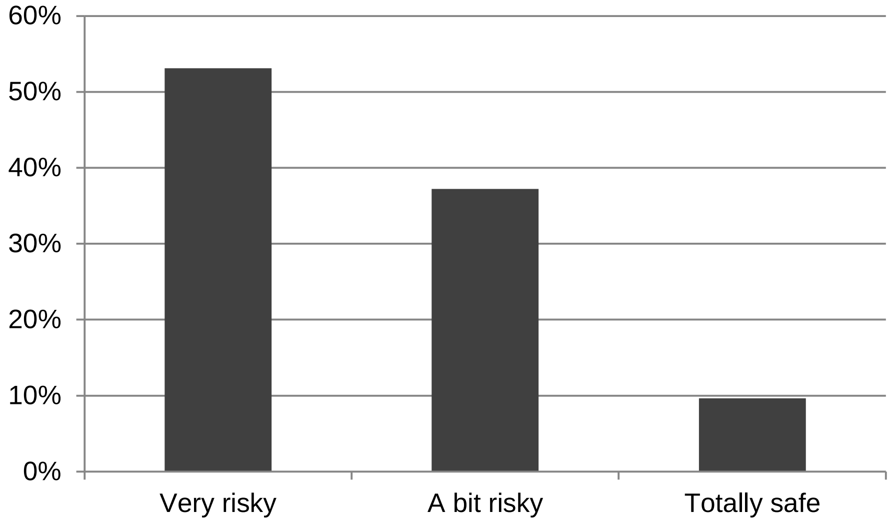

Figure 2 – Risk perception versus mobile phone use while driving

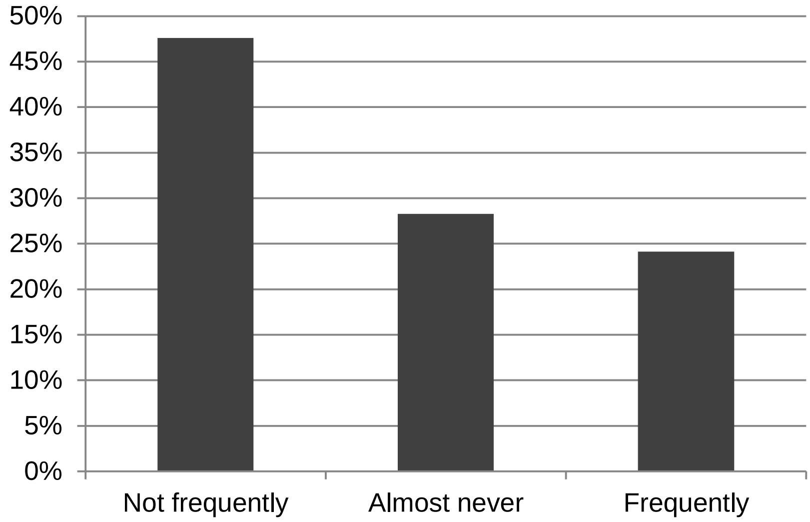

Figure 3 – Frequency of mobile phone use while driving

Among those who said they use mobile phones while driving, only 30.3% reported using hands-free devices, although the majority (66.9%) said they slow down while doing so, which is consistent with the perception of risk manifested. It was also found that 20% of respondents have had accidents or have been at risk of an accident when using a mobile phone while driving.

A total of 31 participants were identified, regarding the use of mobile phones, of which 4 respondents always chose the alternative of using the mobile phone regardless of the situations and, the remaining 27 always chose the alternative of not using it. The comments from these individuals, which expressed compensatory behaviours, were excluded from the estimation of the models, so we worked with a total of 1,160 PD observations, exceeding the minimum sample size of 384 observations previously calculated. Table III summarizes the treatment given to the qualitative variables.

Table III – Orthogonal design of main effects

Variable	Treatment	
Gender	1: Male	0: Female
License issue date	1: First year	0: Older
Speed reduction	1: Speed reduction	0: No speed reduction
Importance of Call	1: Important call	0: Unimportant call
Travellers	1: Traveling with someone	0: Traveling alone

Other variables that were not statistically significant in the evaluated models, such as the level of congestion, are presented in the tabulations; however, it is considered useful to make a brief discussion of some of them. The educational level of individuals is presented in models with a positive sign, with significance of 32%, indicating that individuals with a higher level of education are more prone to use their mobile phones while driving. The same happened when the models included a dummy variable to differentiate individuals who had been fined, finding that individuals who have been fined are more likely to use the mobile phone while driving, with a significance level of 88%.

Table IV summarizes the estimation results of the models obtained by the technique of maximizing the likelihood. Next to each parameter estimate is the t-statistics in parentheses and at the end the goodness-fit test results are presented that allows to choose the best model; although we tested the estimation PR models and joint PD/PR models, due to the small variation of the values observed in the PR survey it was not possible to obtain quality models so they were discarded.

The review of the consolidated results in Table 4 led us to choose the random coefficient model because it presented the maximum log-likelihood and the best test of goodness of fit when compared to the other estimated models. All signs obtained are consistent with the expected behaviour of the variables and overall the estimated parameters are statistically significant.

Based on the model chosen it was found, with a 90.1% confidence, that women are more likely to use mobile phones while driving; it was also found that people who got their driver's license in the past year are more respectful of the rule prohibiting mobile phone use and reducing speed to make a call, i.e. those with a higher perceived risk of this practice are less likely to use the mobile phone.

It was found that the importance of the call is a determinant when deciding to answer the phone, because regardless of the risk, considering that the issue is important the call is made; whereas travelling with someone else makes people refrain from using their mobile phone, with a significance of 81.9%; these results are consistent with existing literature (Dula *et al.*, 2010; Walsh *at al.*, 2008).

Table IV – SP Models Estimates

Parameter		Logit Model binary	Coefficient Model random
Constant	β_0	0,295	0,967
Gender	β_1	-0,246 (-1,65)	-0,356 (-1,65)
License issue date	β_2	-0,561 (-2,08)	-0,817 (-2,04)
Speed reduction	β_3	-0,283 (-2,09)	-0,414 (-1,99)
Importance of Call	β_4	1,74 (12,57)	2,36 (4,97)
Travellers	β_5	-0,189 (-1,42)	-0,257 (-1,34)
Speed	β_6	-0,010 (-2,19)	-0,0139 (-1,98)
Cost of the fine ($ millions)	β_7	-1,52 (-5,94)	-3,27 (-2,60)
Random coefficient parameter	σ_7	-	-2,89 (-2,05)
Number of observations	N	1160	1160
Estimated parameters	K	8	9
Log-likelihood at convergence	$l(\theta)$	-661,728	-659,018
Log-likelihood ratio	$L.R.$	284,645	290,065
ρ^2		0,177	0,180

Just as it was found that the greater the speed the lower the tendency to call, which undoubtedly places this problem in urban areas where speeds are lower than those in rural areas. Finally, it was found that the cost of the fine determines the decision to use the mobile phone while driving; this is a significant finding because people usually doubt about the efficacy that levels may have in the imposition of fines for violations.

The estimated model was used to analyze the effects that changes produce in the explanatory variables on the probability of using the mobile phone while driving. Increasing the value of the fine, which could be one of the measures derived from this research, reduces the likelihood of using the mobile phone to significantly lower levels than those that currently have; if the fine is increased to 2,75 minimum wage, the probability of using the mobile phone would be 33%.

Additionally, if we can improve risk perception of individuals included in the model as the variable "speed reduction while talking on mobile phone", you get an additional reduction of 5.93% placing the probability of using the mobile phone to 27.07%. Additionally, if the general behaviour of drivers was similar to those who have recently obtained their drivers' license the probability of using the mobile phone would be at 17.49%.

The measure of the impact of a policy that affects some controllable variables might be measured more clearly through direct elasticity; in the case of the elasticity of the fine cost calculated on the basis of average values for the explanatory variables, an equal value to -1.236 was obtained, indicating a high sensitivity in the use of the cell phone against policies that affect the cost of the fines imposed on drivers who do not comply with the standard.

CONCLUSIONS

By estimating choice models such as Logit and random coefficient some variables have been studied to determine the behaviour of drivers regarding the use of mobile phones while driving in Colombia, as a case study in the city of Tunja. The random coefficient model estimated indicates that the main factors that define the use of mobile phones while driving are: gender, license issued date, the perception of risk associated with speed reduction, the importance of the call, the condition of traveling alone or with someone else, the speed and the cost of the fine.

While most individuals consider it risky to use the mobile phone while driving, over 80% of people revealed they have done it; evidencing the ineffectiveness in controlling and, also, it was found that the level of fines imposed to those who violate the rule represents only 6,82% of all reported cases.

For future research it is recommended to use the same methodology including a third alternative to get the experiment closer to reality in those cases where the vehicle is stopped for using a mobile phone; In the same way, it would be interesting to include a new variable related to the risk to be surprised by the transit authority. Furthermore, based on the evidence found, it is concluded that it would be necessary to carry out a specific study to test the hypothesis that "individuals who have been fined are more likely to use the mobile phone while driving".

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