EXECUTIVE REPORT

CELL PHONES, TIREDNESS, DROWSINESS AND DISTRACTIONS AT THE WHEEL

Fundación MAPFRE

Date
October 2021

Authors

Fundación MAPFRE
https://www.fundacionmapfre.org/

Mindful Driving
https://i-movilidad.com/

Adhara Research
https://www.adhararesearch.com/

Acknowledgements

To all drivers participating in the study.

Foreword

And what if we are wrong?

Dear reader involved in the prevention of traffic injuries:

I am pleased to present to you this study on the effects of hands-free phone use on rested and tired, drowsy drivers.

Why did we do this study? Because we wanted to see with our own eyes (and with our own data) what effect such a common occurrence as hands-free phone use while driving has on driving attention and traffic safety.

For this reason, we invited a group of 24 drivers, half rested (at the start of the day and having slept normally the night before) and half tired and drowsy (also at the start of the day, but after a full night shift), to sit in front of a realistic computerized driving simulator and navigate through a variety of everyday traffic environments. At this point I would like to personally thank the 24 volunteers who participated in the data collection, as well as our travel partners for this study: *Mindful Driving* and *Adhara Research*.

To determine attention levels, we used validated algorithms that combine brain activity readings (electroencephalogram) with other physiological variables such as hand sweating (skin conductance) and heart rate. The study included the generation of brain maps which have enabled us to visualize the changes in people's "thinking". Driver performance was determined with the help of an advanced driving simulator that records all the key driving parameters: route, safety distances, respect for traffic signals (red lights, in particular), use of gears and pedals, fuel consumption, and so on.

Our analysis of the initial data, collected prior to the start of the telephone call, reveals that:

- Women are less likely than men to engage in aggressive driving patterns, to drive outside their lane, to crash, or hit pedestrians. In general, it could be said that they are "more cautious", as supported by their lower overall real-life accident rates.
- Older people commit fewer traffic light violations, but are involved in more of the risky situations described above.
- Younger people drive more aggressively or are involved in crashes more often than older people, and use more fuel; again, because of their driving style.
- Tired drivers drive less aggressively and at lower speeds, as a defense strategy against fatigue, but run more red lights.
- People who are rested or not sleepy experience fewer aggressive driving events, lane departures, collisions and hit fewer people.

On the other hand, and touching on the key findings related to cell phone use, the main messages that can be extracted from this study are:

- Hands-free cell phone calls while driving drastically reduce attention at the wheel: 36% in the case of a relaxed call, 40% in the case of a stressful call, and 53% in the case of a WhatsApp conversation.
- Any call matters: even a relaxed call implies significantly reduced attention while driving.
- Any use of a cell phone doubles the probability of aggressive driving (e.g., not respecting the stopping distance to the vehicle in front), lane departure, collision with another vehicle, or hitting a pedestrian. More specifically, and in comparison to a "relaxed" call, a "stressful" call triples the number of aggressive driving events, lane departures, collisions and incidents involving pedestrians. WhatsApp use increases the number of such events by 4.5 times (again compared to a "relaxed" call).
- Phone conversations using the hands-free system also increase the risk of running a red light: this type of violation is tripled for a stressful call compared to a relaxed call and quadrupled for WhatsApp conversation.
- But fuel consumption also increases by 9.5% when we make a hands-free phone call.
- Driving while tired leads to a generalized increase in brain activity in all of the experimental conditions. In other words, tired and drowsy driving puts a much greater strain on the brain than driving while rested.
- In fact, fatigue is at least as bad for driving attention as cell phones: focus in tired drivers drops by 52.5%, in other words, it is less than half that of a rested driver. In fact, the reduction in attention caused by tiredness or drowsiness is even greater than that caused by a relaxed call and almost as significant as that corresponding to WhatsApp use.
- In the case of drivers who are tired or drowsy and who then attempt to hold a WhatsApp conversation, it is clear that this effort overwhelms their mental capacities and their driving focus plummets.
- When trying to respond to the researchers' request to make a phone call or have a WhatsApp conversation, women put in place specific "defense strategies" such as stopping to use the phone, waiting for a red light and prolonging their stop, and so on. Men, in general, "obey" the researchers better and focus more on their phones, but at the cost of more incidents behind the wheel of the simulator.

One of the most surprising results in this study is that, at least during the initial minutes, a phone call seems to be able to "reactivate" the attention of a tired or drowsy driver, so we could even suggest that it has an "awakening effect". For this reason, and as a last resort, it is recommended that drowsy drivers talk to passengers or explain aloud what is happening in terms of driving: although we should not forget at this point that the only truly safe advice to give in the event of tiredness or drowsiness is to stop and rest or sleep. This "awakening effect" may be diluted after the first three minutes of conversation, which could be extremely dangerous due to the accumulation of fatigue or drowsiness.

What is clear from the findings of this study is that driving safety is the result of a combination of aspects including attention to driving, degree of task automation (something related to experience) and strategies for managing changes in cognitive demands (probably learned and influenced by the driver's own personality), among other things.

The results of this study can be classified into two types: those that were expected and those that were unexpected or that cannot be fully explained with the methods used in this study. In the latter case, the general conclusion is that these results should be further explored in future research. As always, all the conclusions must be critically appraised and it must be recognized that, as I often acknowledge, "in this world, the number of questions exceeds the number of answers."

According to two recent press releases from the Directorate General of Traffic, "Distractions at the wheel caused more than 300 deaths in 2020", and "using the cell phone manually while driving continues to be the most frequent distraction among drivers." However, the real role that hands-free phone use plays in distraction-related road accidents remains to be ascertained.

In any case, I believe that this study should make us ask ourselves the following question: And what if we are wrong? I honestly don't think so. I think that, at the time and with the information available in 2003, allowing hands-free phone use was the right decision. Today, however, and with what we now know, we must see things differently. Knowing that our focus is reduced by half, we should redouble our efforts to raise awareness of the risks of using a cell phone with the hands-free system. A 50% attention level, combined with our automation of many of the mental processes associated with driving, may be sufficient under normal traffic conditions and in the absence of unforeseen events. But a distracted brain may not be able to identify potential risks in time or react adequately to avoid an accident.

The cell phone has changed our lives in ways that were unimaginable two decades ago, and its benefits are undeniable. It is the right time, we believe, to insist on the only safe message to give to drivers: *only talk on the phone when you have stopped your vehicle in a suitable safe zone*.

Jesús Monclús
Director of Prevention and Road Safety
Fundación MAPFRE

1. Review of background information

For years, numerous international studies have been warning about the negative impact of cell phone use on road safety.

1. **Distractions have become the leading cause of road deaths, claiming the lives of more than 300 people each year in Spain**, according to the latest data published by the DGT (September, 2021).

2. **Cell phones have become the leading source of distraction, followed by tiredness**, as shown by the Emotional Driving study, based on a survey of more than 2000 drivers throughout 2019. In that study, 9 out of 10 drivers considered cell phones to be a source of distraction at the wheel. 6 out of 10 mention tiredness, in second position in the ranking of distractions.

The new Traffic Law, which is currently pending in the Spanish parliament and expected to come into force in 2021, will stiffen the penalties for driving while holding a cell phone device in your hand while driving, with fines of 500€ and the loss of 6 points from your license.

Fundación MAPFRE has run many awareness campaigns in the majority of the countries where it operates to warn drivers about the dangers of using cell phones at the wheel, such as the one carried out together with ALSA in 2018, and the #SpeakUp campaign by the World Health Organization (WHO) in 2019.

2. Goals

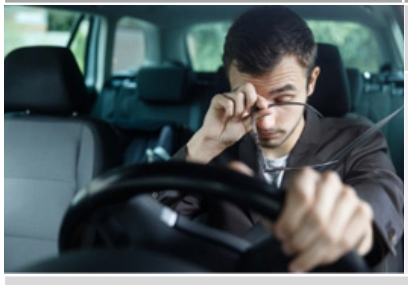
This study was a Fundación MAPFRE initiative, aimed at conducting research on the **impact the use of cell phones (smartphones) and drowsiness/fatigue have on drivers and driving.**

3. Method

3.1. Study sample

24 habitual car drivers, with at least 2 years driving experience.

- 12 subjects took the test WITH NO FATIGUE OR DROWSINESS.
- 12 subjects took the test IN A STATE OF FATIGUE AND DROWSINESS.

TIRED AND DROWSY	20-30 years old	31-45 years old	46-65 years old
	4 subjects	4 subjects	4 subjects
	50% men/women	50% men/women	50% men/women
Drive at least once a month			

NOT TIRED OR DROWSY	20-30 years old	31-45 years old	46-65 years old
	4 subjects	4 subjects	4 subjects
	50% men/women	50% men/women	50% men/women
Drive at least once a month			

Image 1. Sample characteristics.

3.2. Experiment design

The experiment was conducted using a state-of-the-art driving simulator, which provided valuable information on how each experimental situation affected the participants' driving: driving errors, traffic violations, and fuel expenditure.

All the participants had to follow the directions of a pre-designed route with a controlled level of difficulty and in which different everyday and unforeseen situations were introduced to test their focus and driving skills. The total driving time for the test was 12 minutes.

With the aim of surpassing previous declarative studies on the distracting effect of cell phones, this research determined driving attention level based on the measurement of neurophysiological indicators for each participant:

- **Brain activity (EEG),** through the use of a portable electroencephalograph.
- **Heart rate (HR)** and **galvanic skin response (GSR),** through a sensor placed on a finger.

We designed an experiment that incorporated four experimental conditions related to cell phone use. Each subject drove for 3 minutes under each of the conditions, along segments of the pre-designed route with equivalent difficulty.

ONLY DRIVING: during this phase, the subjects drove using the driving simulator, following the simulator's instructions along a predetermined route, without any cell phone-related distractions.

RELAXED CALL DRIVING: during this phase the participants received a friendly call involving a trivial conversation.

STRESSFUL CALL DRIVING: this was a call in which the caller forced a tense and fast-paced call, raising the tone of the conversation to one of high emotional tension and cognitive demand.

USE OF WHATSAPP WHILE DRIVING: during this phase the participants had to maintain a conversation via WhatsApp, through text messages. During the conversation they also had to take a selfie and send it to the other person.

4. Main results

Our study offers interesting conclusions on the consequences of both cell phone use and fatigue (independently as well as the combined effect of the two factors).

4.1. Conclusions related to cell phone use

Three situations were evaluated in relation to the use of the cell phone while driving:

1. Answering a **relaxed call** while using the hands-free system.

2. Answering a **stressful call** while using the hands-free system.

3. Holding a written conversation via **WhatsApp** and taking a selfie.

Any use of the cell phone was found to be very distracting for the experienced drivers in our experiment who were rested and alert. In general, a greater cognitive effort was observed, with increased activity in the areas associated with sensory processing, visual, motor and planning tasks. And this effect was more pronounced the more complicated or stressful the cell phone task. Consequently, in our experiment we observed:

- **Significantly reduced driving focus**:

  – Relaxed call: -36%

  – Stressful call: -40%

  – WhatsApp conversation: -53%.

- **The probability of committing serious driving errors**, such as suffering a lane departure, collision or hitting a pedestrian, is doubled. The analysis of the three cell phone uses studied leads to several interesting conclusions:

  – A simple, relaxed call is the action that most increases the probability of committing a serious driving error. Drivers let their guard down and make more than twice as many mistakes as when driving without using their cell phone.

  – Using WhatsApp while driving is the second most risky action, doubling the probability of a driving error compared to driving without using a cell phone mobile. The use of WhatsApp also shows us that some drivers, more noticeably women, initiate precautionary driving actions designed to minimize the risk generated by the situation, for example: reducing their speed, taking advantage of stops caused by red lights, and so on.

- **Traffic violations: there is a significant increase in traffic violations such as running a red light.**
  - Relaxed call: average 10.7 traffic violations / hour
  - Stressful call: average 31.7 traffic violations / hour
  - WhatsApp conversation: average 45.2 traffic violations / hour
- **Significant increase in fuel consumption**
  - Using the cell phone while driving not only affects our road safety, but also the driver's "pocket" and the environment.
  - Average increase in fuel consumption of 9.5%.

4.2. Conclusions related to tiredness/drowsiness at the wheel

Driving while tired leads to a generalized increase in brain activity in all of the experimental conditions. In other words, being tired and drowsy driving puts a greater strain on the brain than driving while rested.

The comparative analysis of the neurophysiological activity in tired/drowsy drivers and the sample of rested/alert drivers **shows that tired/drowsy driving more than halves (-52%) the level of attention to driving.** This in itself is a good illustration of the enormous impact that tiredness/drowsiness has on our ability behind the wheel.

4.3. Conclusions related to the use of cell phones in addition to fatigue/drowsiness

The analysis of the simulator results from the tired/drowsy test subjects offers an unexpected finding: the same drivers who started the test with their driving focus reduced by 50%, showed increased attention to driving both during the 3 min relaxed call and the 3 min stressful call. This is what we have termed the "**AWAKENING EFFECT**".

Indeed, the telephone conversation the participants had with us resulted in them waking up and becoming more focused on driving.

The study's technical managers consider it important to continue investigating how the awakening effect responds to calls of a medium or long duration (in our experiment each of the calls while driving lasted no longer than three minutes). It is plausible that this effect is temporary, lasting only a short time, probably a little more than three minutes. Once a certain time limit has been exceeded, the driving focus could drop off again. We were not, however, able to demonstrate this in our experiment.

Contrary to what happens during calls, **a WhatsApp conversation overwhelms the capabilities of a tired/drowsy driver and their driving focus plummets, dropping by 67%** compared to the driving attention demonstrated by a driver who is neither drowsy nor tired while driving without using a cell phone.

4.4. Other conclusions related to the driver profile

- **Women:** make fewer driving errors than the other drivers. They are more cautious.
- **Men:** make more mistakes than the other drivers.
- **Older people:** commit fewer traffic violations, but make more driving errors.
- **Young people:** commit more traffic violations and use more fuel, due to their driving style.
- **Tired / drowsy drivers:** these commit the most traffic violations, along with young people.
- **Rested / not drowsy drivers:** these commit fewer traffic violations than the other drivers.

Fundación MAPFRE