Highway hypnosis and in-car telematics
Influence in driving and safety

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Abstract
This work focuses on the usability of interfaces controlling in-vehicle functions and devices and their influence in driving behavior when under monotony in driving and highway hypnosis. Much academic research has been published in the area of in-vehicle functions interfaces, for systems such as the iDrive, COMAND and MMI, with usability studies and discussions on the new integrated approaches provided by the industry to replace the traditional knobs and switches; in the area of monotony while driving, works assessing from the physiological dimension to changes in road conception rules to counter such problems. Following previous work, aimed at comparing the integrated systems with the “traditional” ones, still widespread, this work introduces both topics into one study: the issue of monotony in driving and highway hypnosis and the influence of the comfort systems interfaces in this road safety subject. The study conducted usability tests with a simulator where drivers go through a monotonous course and in given places perform tasks using the comfort systems while constantly being aware of subtle changes to the surrounding environment. Conclusions point at a tendency to break the monotony effect when using comfort systems, especially in the case of integrated interfaces, although the conclusions regarding the greater difficulty in handling this type of interface are still pertinent.

Keywords
Driving simulator, road safety, human-machine interfaces, highway hypnosis, monotony.

1. Introduction
Road safety is a major issue these days, as more and more vehicles enter the streets worldwide and must interact safely among them and with people. Most automobiles are equipped with systems that are no longer just for driving purposes, but instead designed for comfort and fun purposes, forcing drivers to share their cognitive skills between more different equipments than before, and thus compromising safety.

Highway hypnosis can be described as the “tendency of the automobile driver to become drowsy and to fall asleep during monotonous, uneventful highway driving” (Wertheim, [TB03]). In such a state, the driver’s cognitive skills are diminished and he might get unaware of the driving task, again compromising safety and increasing the risk of accident.

The combination of over-demanding comfort systems requiring excessive cognitive load and monotonous road environment leading to conditions such as highway hypnosis can result in major hazards for road safety. This work tries to analyze the issue by using the methodologies and concepts of interface usability studies and applying them to interfaces for in-car telematics.

There are two types of devices available in automobiles. According to Burnett and Porter in [BP01], we can divide devices available on a vehicle in two categories: driving assisting devices, which directly affect the driving task (steering wheel, pedals...) and comfort devices, which aim at improving the driving experience (radio, climate control...). Porta Nova in [Por06] splits the interfaces for controlling these devices in traditional interfaces, characterized by having most of the commands in the central dashboard console, in separated switches, handles and knobs, and integrated interfaces, consisting of a single set of input and output devices (typically a
rotary switch / buttons and a LCD screen) that control more than one device (typically all of them) altogether.

![Image of interface examples](image)

**Figure 1.** Traditional (left) and integrated (right) interfaces for comfort systems. The integrated system on this figure is the 2002 iDrive on a 7 series BMW. The traditional system is of a 2006 Fiat Grand Punto.

1.1. Monotony and comfort systems

Distraction is a factor that can compromise road safety. Distraction while driving often comes associated with environment complexity, driver age and concurrent in-vehicle tasks, meaning over-demanding driving environments. In this work, we approach the problem through a different angle – the distracting influence of comfort system interfaces usage in under-demanding road environments.

The use of comfort systems, in certain conditions, may become the controlled task rather than the automatic [BG10] and can get the user distracted [Ozk05]. Also, driving in a monotonous, uneventful road can lead the driver into highway hypnosis or DWAM, causing him or her to drive according to a mental representation of the road.

In a situation combining the use of comfort systems and driving in monotonous road environments, how will this affect driving performance? Will the driver pay more attention to the driving task because of the stimulus of manipulating the comfort systems or simply forget that he or she is driving and fully concentrate on using the comfort systems interface?

1.2. Research aims

This work aims at adapting the simulator developed in [Por06] and using it to study the behavior of drivers operating either type of comfort systems interface while driving in a monotonous road environment, and determine the influence of this combination both in the driving performance and in the task completion performance, in an attempt to answer the questions above.

2. Monotony

To introduce the role that monotony has in this work, a reference must be made to the author’s previous work. [Por06] reports on a comparative study for analyzing the influence that traditional and integrated interfaces for comfort systems might have in driving performance. The study’s procedure was to have users driving in the designed simulator in one of two courses (either fast or sinuous) while performing a series of tasks involving the use of the comfort systems interfaces of the two types, and observing the differences on the drivers’ performance, namely driving errors or inability to complete the tasks. Both courses took place in the same set (an urban scenery simulating a small town). The first course was made up mostly of long stretches of straight road with sharp curves which were visible at the distance. The second course was composed of a succession of sharp turns in a constant zigzag through the whole scenario, aimed at keeping high concentration demands on the driver. Although different, some users noticed that the fast course lacked “monotony” and was even too “predictable”, making it simply an easier version of the sinuous course.

The concepts of “monotony” and “predictability” should be clarified before further discussion. “Predictability” relates to determinism, to events that are bound to happen and known to be bound to happen, a condition seldom associated with real world driving: pedestrians may, or may not, be waiting on the next zebra, or they may decide to simply cross the street without looking, or vehicles may come out of any street, or unexpected traffic jams may occur at any time. Real world driving is unpredictable because unexpected events may happen at any time. Even so, it is possible to distinguish between two major driving environments: urban areas and countryside roads. In both, unexpected situations may occur. However, in urban areas, there are zebras, sidewalks, buildings, people all around, parked cars, side streets, lower speed limits, and drivers concentrate on driving and expect anything to happen. In contrast, in countryside roads, there are few distracting elements, the pavement is usually smoother, curves are gradual, speed limits are higher and hazards like sharp
turns and crossroads are mostly detectable in advance, and the driver tends to assume no unexpected events will happen. The difference between these two sceneries is the frequency at which unexpected events occur and the frequency at which the driver expects such events to occur. The latter road environment can be called “monotonous”, because it is mostly eventless and especially because the driver expects it to be eventless.

Monotony is commonly associated with tiredness, sleepiness and fatigue in the context of road safety. Several studies associate decreased driving performance to driver monotony [Stee04]. But all three concepts mentioned earlier are associated with the human (physiological and psychological) dimensions of monotony only, not taking the nature of the task into account. Nelson [Nels97] mentions that monotony “is no longer regarded solely as something within the brain (...) it depends of what you are, what you are doing and where you are doing [it]”, introducing the idea of task-induced fatigue, and the concept of monotony associated with the driving task. In this sense, a task is considered monotonous when the stimuli remain unchanged or change in a predictable way over time.

Highway hypnosis is a term introduced by Shor and Thackray [ST70] described as “the tendency of the automobile driver to become drowsy and to fall asleep during monotonous, uneventful highway driving.” Two similar theories attempt to explain this concept. In [Wert91], Wertheim proposes the idea of controlled versus automatic attention, the former being associated with perception and sensorial feedback and the latter being associated with an internal mental process where outside input is no longer essential. In [Kerr91], Kerr proposes DWAM – Driving Without Attention Mode – according to which, under monotonous road conditions and in the absence of external stimuli, the driver shifts from external to internal stimuli, driving according to an internal model of the driving task at hands.

3. Usability of in-car interfaces

Most of the solutions for integrated control of the vehicles’ comfort functions rely on vision and touch, not improving much relatively to the traditional ones. A consequence of such reliance is distraction. Distraction was discussed in [Por06] and relates to the human inability to do two things at the same time. According to Bengtsson et al in [BGI03], a driver can do two simultaneous tasks if one of them is done in an automatic way while the other is done in a controlled way, e.g., talking to passengers (automatic) while driving (controlled task, on which the driver is completely focused). Certain complex tasks, like searching for a specific track on a CD, demand significant mental load and are not automatic, inducing distraction to the driver [Ozk05]. Alternatives to vision in interfaces for comfort systems include the use of haptic feedback and voice control.

The use of haptic switches to control and receive feedback from in-vehicle equipments has been studied for a while. Bengtsson et al, in [BGI03] performed a comparative simulator study between the traditional knobs-and-switches interface of a vehicle and a proposed interface for the same functions (audio and climate control) using a haptic switch, concluding that “the participants’ degree of task completion improved with the haptic/graphic interface” for more complex tasks but task completion was however “slightly slower with the haptic/graphic interface”. They concluded that none of the systems is preferable: while the traditional interface appears to be safer, the haptic/graphic is regarded as imposing less mental workload.

A follow-up work [GB05] by Grane and Bengtsson compared 3 types of feedback from an integrated interface: graphic only (G), haptic only (H) and mixed haptic /graphic (HG). The results point at type H provoking a greater number of errors and higher mental workload, and type HG yielding lower mental workloads and best results.

Voice control has been an alternative for a while, with solutions such as the Ford Voice to Control (V2C) system or the BMW Voice Recognition System. Before it became a trend in production vehicles, Graham and Carter made a comparison study (in [GC99]) between speech control and manual control both on a mobile phone and using the ICE application (Jaguar S-Type comfort functions control). They observed that speech input caused less driving errors than manual control while using a mobile phone, and
also that manual control required greater mental workload, but still task performance was worse when using voice input, which they attributed to the automatic speech recognition technologies, which have improved dramatically since then.

The consensus nowadays appears to be towards steering away from touch and vision in automobile interfaces to reduce the time drivers spend not looking at the road and to lower the mental workload. It is yet important to mention that not having to look means very little. Özkurt in [Ozk05] remembers that when drivers search for a specific button on the dashboard while avoiding looking at it they are distracted in the same way, because the brain is focused on the searching task rather than on driving – experiencing something he called “looking without seeing”.

4. Comfort systems and interfaces

Electronics in automobiles have become generalized in recent years, and are used for driving efficiency and safety (fuel injection, ABS, traction control, drive-by-wire and brake-by-wire and even self diagnosis) and to provide a more pleasant experience to the driver through entertainment and comfort. Equipments like radio or sound systems, air conditioning, ambient thermometers, navigation systems, video entertainment systems and interfaces for electronic devices like MP3 players, game consoles and cell phones come with almost every car sold and make up the comfort equipment of a vehicle. Their presence carries the need to control and interact with them; as the number and complexity of functions increase, the amount of time and concentration needed to operate them increases too.

We have already distinguished between traditional and integrated interfaces. As the number of functions available increased, so did the number of buttons, switches and knobs on the dashboard. Burnett and Porter [BP01] consider “there is a danger that drivers of the future will be overwhelmed by all the functionality on offer within their vehicles” putting the drivers’ ability to control their vehicles at stake. This problem is yet compounded by the fact that these interfaces rely mostly on vision.

Integrated interfaces were the industry’s answer to this problem. They attempt to provide a single interface for almost all devices. Most of them are based in menu navigation with visualization on a screen and control using buttons, rotary switches or dials. The most important ones are the iDrive by BMW, the COMAND by Mercedes-Benz and the MMI by Audi.

iDrive was the pioneer in the current paradigm of integrated interfaces and was developed by BMW with the goal of reducing the amount of buttons available in automobiles. Appearing in 2002, it uses a rotary switch with haptic feedback, a few auxiliary buttons and an LCD screen (see figure 1). The first iDrive version was not well accepted, and the main reason for that was the excessive concentration of functionalities and the variety of ways the Controller (rotary switch) could be manipulated, leading to a learning curve that could go to weeks or months. Subsequent versions adopted some shortcut menus and limited the number of ways to operate the Controller with better results.

The COMAND system (COckpit MAnagement and Navigation Display) was developed in 2000 to integrate the comfort functions on a single interface. This system consists of a LCD screen for viewing and an extensive set of buttons through which the system is controlled. The sheer volume of buttons available is the major handicap of this system, and it was also more complicated to use than before because of the menu-navigation complexity. The current version of the COMAND system evolved towards more recent versions of iDrive and MMI.

![Figure 2. COMAND (left) and MMI (right) interfaces.](image)

MMI can be considered the balance between the excessive concentration on the original iDrive and the excessive number of button of the original COMAND. In addition to a rotary switch and an LCD screen as found in iDrive, it provides buttons to control some onscreen menu options and
provides keys for direct access to the main functions. Nowadays both iDrive and COMAND are converging to the MMI solution.

Other solutions exist, like the Jaguar touch screen interface used in the S-Type and in current XJ and XK models, or the Porsche system which is very similar to the original COMAND. But the previous 3 solutions are the state-of-the-art for this area and newer solutions tend to be similar to them. There are also several equipments, namely navigation systems/GPS and DVD-Video players that can be added to vehicles a posteriori, which are usually based on touch screen LCD.

Integrated interfaces for comfort systems in automobiles use mostly rotary switches to control some sort of a menu hierarchy on a system providing graphical feedback through a LCD display; devices for a posteriori integration in vehicles are mostly based on LCD touch screens. Voice control is now being introduced to offer further control possibilities for all of these systems and investigation is being made along the line of haptic/tactile feedback. Although not yet dominant, integrated interfaces are maturing, are well installed in the industry and tend to become dominant. Their biggest handicap lies on the necessary training: according to [TJT05], untrained users perform worse using integrated interfaces, but there is little difference when comparing trained users. Their major advantages are the number of functions available, the possibility of integration with other devices and the space saved in the vehicle’s dashboard.

5. Simulators for usability testing

The use of simulators is current practice in these days, and works such as [GB05], [Ozk05], [GC99] and [TB03] use computerized simulators. Simulators can vary in terms of realism depending on budget, availability and objective of the work, and evolved from simple driving footage to very realistic simulators presenting near-real graphics and using audio and force feedback as well as advanced hydraulic systems to simulate the behavior of a vehicle, acceleration and movement, thus preventing a condition known as “simulator sickness”.

Simulators are less costly (if the simulator is already available), offer less safety hazards and provide greater control over the task and better data logging; on the other hand, they can have lower than desired realism, inducing users into not taking them as serious work tools. Some of the simulators available worldwide are presented here. Some parts of this survey are inspired in [Ferr07], which should be consulted for further details.

One basic example of a simulator can be a computer game adapted to a specific task. This way, the game Streets of Simcity can be considered an elementary driving simulator, allowing the production of sceneries through use of the Simcity 2000 game; however, this game has serious flaws in behavior and offers very limited control – it is, nonetheless, a reasonable simulator for some purposes, at a rather low cost.

Simulators used for research purposes have features like the use of real car bodies given away by manufacturers or specifically purchased, and the whole simulator is built inside them, using the car’s own instruments; others use car bodies specifically designed for the simulators, featuring identical levels of detail but were developed specifically for the task. An example of the former is the Wrap-Around Simulator from University of Minnesota (WAS) while the Driving Simulator by the School of Engineering of Cranfield University is an example of the latter. In terms of graphics, two main solutions exist: either video projectors over spherical domes or concave screens or other similar technologies; anyway, the result is that drivers see the simulation through the windshield or rear windows of the car, much like in a real vehicle. Other simpler vehicles use a number of monitors associated with the use of a dashboard, as with the PatrolSim.

Audio and haptic feedback are also used; while audio usually consists of previously recorded sounds (engine, environment and others), haptics go from using some movement library from steering wheels and joystick APIs to advanced mechanical plataforms using engines to move a platform mounted on a hydraulic support. The UCF Driving Simulator developed at the University of Central Florida is one example of such advanced simulator. Other simulators go further and provide advanced mechanisms to handle simulator sickness, as the National Advanced
Driving Simulator by the (USA) National Highway Traffic Safety Administration, which moves along rails in 2 dimensions, rotates 360° in all 3 axes and is mounted on a hydraulic platform.

Figure 3. Outside and inside of the NADS simulator.

5.1. Partial simulators
All the simulators described so far are “total simulators”, in the sense that they seek to immerse the user in a full driving experience. However, sometimes some tools are developed, seeking to mimic the behavior and functionality of only certain parts of the automobile. The designation of “partial driving simulator” is used to describe these tools. These include tools that simulate some aspects of driving, tools used in combination with other simulators or embedded in real-life cars (such as car-telematics interface simulators, before their insertion in production cars). To exemplify this concept one can look at [BG03], where Bengtsson et al used a simulator with a screen and a rotary switch capable of simulating an integrated interface for comfort systems, or Graham and Carter’s [GC99] who resorted to a steering wheel and a pedal set to keep a moving block on a computer screen in motion, similarly to a driving task.

6. Setup & Procedure
The experiment took place at the Laboratório de Complementos de Visualização at IST, using the simulator developed by [Por06], which was conveniently adapted for this study.

6.1. Participants
Our experiment was conducted on 14 subjects, aged between 21 and 63 years old, with driver’s license time between 1 and 40 years. Two age groups were considered: the young age group (5 males and 3 females, aged 21 thru 32 and having had a driver’s license since 1 to 14 years) and the old age group (3 males and 2 females, aged 42 thru 63 and having had a driver’s license since 24 to 40 years). Gender distribution is almost balanced globally and on both age groups.

Users in this test were considered trained and experienced concerning the driving interface: they all bear a driver’s license and the driving task is simpler than that in real life, at least in Portugal, where cars are equipped with manual gears and the simulator uses automatic transmission. Users are also trained but inexperienced concerning the comfort systems interfaces, because the interfaces used, although similar to the real ones, are not exactly identical; this situation is worse with the integrated interface, because this is not common to find.

6.2. Equipment
The simulator used in this work is shown on figure 4. It consists of a computer with a Pentium 4 3.4Ghz with 2Gb of RAM memory and a nVidia FX Quadra 4000 graphics adapter, using a WACOM Cintiq 21 UX touch screen (viewing and simulating the traditional interface), a Thrustmaster Ferrari GT 2 in 1 Rumble steering wheel and a Logitech Force 3D joystick (simulating a rotary switch of an integrated interface).

Figure 4. The simulator used in this work.

This simulator was adapted from [Por06] to serve the purposes of this work. Adaptations include introduction of a new scenario providing an uneventful monotonous course on which to drive, with two new scenario elements and changes to previously made elements for convenience, and the adoption of a new and more forgiving behavior for steering wheel, accelerator and brake. The latter adaptations were introduced by an expedite two-stage procedure involving 4 persons to adjust steering and pedal sensitivity.

6.3. Procedure
The test consisted of three phases: an introductory phase where users learned how to
use the comfort systems and got used to the vehicle’s behavior; a formal test phase where users drove along the course performing tasks using either interface for the comfort systems, and finally users were required to fill in a quiz about their opinion on the course and the experiment.

In the formal test phase, users were required to drive maintaining a constant speed close to 80 Km/h on a specifically designed monotonous course. While driving, in specific places, drivers were asked by the examiner to perform some tasks and to answer questions about some details in the scenario (like traffic signs, trees, road profile changes), which they were previously warned to pay attention to.

6.4. Performance metrics

While the user drives in the formal test phase, the simulator logs values such as instant speed, position in the scenario (XYZ coordinates), amount of pressure on the accelerator and brake pedals and steering wheel rotation. The examiner registers data on a form including attention flaws during the course and errors in performing the tasks using the comfort systems. The user quiz registers the user’s subjective opinion on his concentration needs and perceived monotony during the course. These data were used to evaluate metrics such as average and minimum speed, side deviation in given stretches, user input on the steering wheel and pedals, attention (or not) to road details, driving errors and task completion performance.

7. Results and discussion

The data collected were used for two distinct purposes: to make sure that users reached a state of monotony and to observe their behavior in such state, noticing the details of the course they were supposed to, and comparing the attention levels when users limited themselves to drive and when they used one of the two comfort systems interface while driving. The driving course in phase 2 is divided in 6 stretches (11, 12, 21, 22, 31 and 32, in this order). Stretches 11, 21 and 31 are monotony control stretches, used to determine if driving has become monotonous; stretches 12, 22 and 32 are where the driver must be aware of changes in the surrounding environment and

where he or she must perform tasks, using the traditional (stretch 22) and integrated (stretch 32) interfaces.

7.1. State of monotony

Determining if users had reached a state of monotony was done considering two indicators: one designated as “speed monotony” and another, “side deviation monotony”. These indicators were based on the log data collected by the simulator in stretches 11, 21 and 31.

“Speed monotony” uses data on instant speed and accelerator pressure, and results in the number of 10-second periods in which drivers let speed increase or decrease too much while keeping the accelerator pressure constant, which it is assumed to be unconscious behavior.

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Table 1. Average number of “speed monotony” periods by age group and by stretch.

The data obtained shows that on average users experiences between 3 to 5 speed monotony periods per stretch, spending an average of 110 seconds, about 18% of the total stretch time, in “speed monotony”. Also 85% of the users experience from 2 to 7 “speed monotony” periods per stretch, spending between 10% and 35% of the total course time in “speed monotony”.

“Side deviation monotony” uses data on side deviation and steering wheel position, counting the number of 10-second periods in which drivers let the vehicle deviate from the center of the lane while keeping the steering wheel steady, followed or not by sudden movements of the steering wheel.

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Table 2. Average number of “side deviation monotony” periods by age group and by stretch.

The data obtained shows that an average user experiences between 5 and 6 of such periods, spending an average of 165 seconds, about 27% of the total stretch time, in “side deviation
monotony”. Also 70% of users experience from 5 to 7 “speed monotony” periods per stretch, spending between 25% and 35% of the total course time in “side deviation monotony”.

### 7.2. Behavior while in monotony

Behavior while in monotony is analyzed by comparing mean and minimum speed between the group of stretches 11, 21 and 31 and each individual stretch 12, 22 and 32, and by analyzing data on attention flaws and task performance on stretches 12, 22 and 32.

The analysis of mean and minimum speeds in the stretches yields interesting results: both values tend to decrease when the cognitive load increases: when just driving, the average and minimum speed are higher, they decrease a little when the user must start paying attention to details in the surrounding environment (stretch 12) and decrease even further when the user starts using the comfort systems (stretches 22 and 32).

Attention flaws are the number of elements or characteristics of the course that the user was unable to see or correctly identify and was expected to take notice of. Examples can be not noticing a given traffic sign, not noticing a different tree on the road shoulder, etc.

Comparing the attention flaws observed in 3 situations (just driving, stretch 12; driving and using the traditional interface, stretch 22; driving and using the integrated interface, stretch 32) yields that a given user tends to behave similarly when just driving or when using the traditional interface while driving; however, when driving and using the integrated interface, users tend to perform better than when either using the traditional interface or when just driving.

This can be explained by the fact that the driver’s awareness of the demanding nature of the task causes the driver to be more alert to the surrounding environment and thus experience less attention flaws. These results are consistent with the perceived attention values from the user quiz, where more than 70% consider their attention levels equal or higher when performing tasks with the comfort systems than when just driving. This behavior is also observed when considering users by age, except for the fact that old users tend to behave similarly when comparing just driving with using the integrated interface, which can be explained by the fact that in this situation they tend to go from “monotony” to “overwhelming” and the concepts of distraction in [Por06] take place.

Task errors are defined as the inability to complete the task at hand, using the comfort system, or not being able to complete the task before the next task was to be performed. Users were expected to perform a total of 14 tasks, 7 tasks using each system.
Figure 8 shows that the number of users committing errors when performing tasks with the traditional system is much lower than the number of users committing errors when performing tasks with the integrated system. 11 out of 14 users made no mistakes using the traditional interface, while 10 out of 14 users made one or more mistakes using the integrated interface. The distribution is very similar when looking at the sample population as a whole and when looking at any of the age groups.

Comparing the difference between the errors a given user makes using each comfort system interface yields that a little less than half of the users make the same number of mistakes in either interface, the other half makes more errors using the integrated interface; no user makes more mistakes using the traditional interface than using the integrated interface. This behavior is coherent with the perceived behavior by users, as 9 out of 14 considered that using the integrated interface demanded more concentration than using the traditional system to perform the same tasks, thus implying the integrated interface was more error-prone than the traditional one.

7.3. Relating attention flaws & task errors

The results relating to task errors were already expected given [Por06], [BG103] and others, but together with the results from the attention flaws they suggest a new explanation for this phenomenon. It is possible that, as the user is more concerned with the obstacles that might show up on the road while using the integrated system, he or she dedicates more cognitive skills to actually driving and watching the road, sacrificing the accessory task of using the comfort system. This is a strong result that suggests that using the integrated interface has a more intense effect in breaking the monotony than using the traditional interface, as it makes users more attentive to the road environment, even if they can not correctly perform the desired task.

8. Conclusions

Some conclusions can be taken from the results obtained. The first and foremost is that the simulator was able to achieve the proposed goals, because it induced most drivers into a state of monotony during the course. 85% of the users spent from 10% to 35% of the control stretch time in “speed monotony” and 70% of them spent from 25% to 35% of the control stretch time in “side deviation monotony”. Also, 92% of the users found the course to be monotonous and tedious.

When analyzing the behavior while in monotony, it was concluded that as cognitive skills demands increase the mean speed decreases when drivers attempt to compensate for the new demands, and the minimum speed also decreases as users lose trust in their capabilities and attempt to drive safer.

The use of comfort systems interfaces forces users to be more aware to the surrounding environment: drivers’ attention levels are higher when tasks demand greater mental workload, as the number of observed attention flaws increases when going from driving and performing tasks using the integrated interface to driving and using the traditional interface and to simply driving. Users have a perception of this difference, with 70% considering their attention levels equal or higher when driving and performing tasks. However, this translates into less accuracy in performing tasks, as the number of errors and unaccomplished tasks while using the integrated interface is much bigger than that of the traditional interface; once again users have a correct perception of this difference.

When comparing the two age groups, older users drive slower in every situation and are more susceptible to monotony as they spend larger amounts of time in each of the monotony states suggested by the indicators – which is consistent with the results in [SD04]. They also perform worse when using the comfort systems than young drivers, both in terms of attention flaws
and task accuracy, as it is possible that in such situations they go from a “monotony state” to an “overwhelming state”, getting this age group closer to the study in [Por06].

8.1. Future work

The work on this subject should proceed because some of the conclusions stated herein could be stronger if the investigation had been made with other conditions. Improvements in this test procedure could be of 2 distinct natures: one concerning the technical aspects of the simulation, the other the part of the usability tests in this work.

It would be important if tests could be redone in a more realistic simulator, like the NADS simulator presented before. More important than the realism of the simulation is using the actual comfort systems interfaces for the test. The use of a more complex simulator would also provide additional metrics for comparison (like the use of direction lights or awareness to changing lighting conditions) better error determinations and a larger variety of hazards to test with.

In terms of the usability test process, tests should take longer time (1-2 hours each, implying paid volunteers) and involve a larger set of users. Tasks should be more diverse and also carried in cooperation with traffic authorities and traffic safety institutions (which do not exist in Portugal) and in cooperation with medical schools to better deal with the psychomotor aspects of the subject.

References


