VISION AND DRIVING: AN UNDERESTIMATED BUT FUNDAMENTAL RELATIONSHIP FOR PROMOTING ROAD SAFETY WORLDWIDE

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Vision is an indisputable factor in many of the traffic accidents due to human error that happen every day. On 1 April 2020, the United Nations formulated recommendations to governments for enhancing national road safety systems in the framework of its 2030 road safety goals: this included a call to ensure that road users throughout the world have good vision.

This article describes a key reference study conducted in Spain to provide a pioneer country-scale picture of drivers' visual health. More than 3,200 drivers from all over Spain had their vision tested via a specific drivers' eye test protocol* which measured ametropia, visual acuity, visual field and resistance to glare. The study found that some 29.5% of Spanish drivers presented with eyesight issues that needed addressing.

This high level of prevalence of visual issues established in a developed country confirmed the importance of adopting the UN's updated recommendation to ensure good vision in national road safety systems worldwide – in particular by generalising appropriate regular drivers' eye exams and addressing the problems found.

Traffic accidents are one of the major social, economic and health problems faced by modern societies. While such events have many causes, empirical studies find that human error is the main contributor, explaining up to 80% of all crashes (Bryant Walker Smith[13], 2013). Vision is crucial to driving as 90% of the information people need to drive passes through their eyes (David Hyerle[11], 2000).

It was against this this context that ESSILOR started a study in Spain in 2019 with a sample of 3,249 subjects representative of the driving population. The aim was to find out the importance drivers attribute to topics such as the overall role of visual fitness, assessments of their own vision, and the potential implications of any visual deficiencies for road safety. This study will increase the amount of objective information available and promote awareness on the relationship between vision and driving, and in doing so improve road safety for all users.

KEYWORDS:
Vision; Driving; Visual health; Spanish drivers; Road safety.

Context of the problem of traffic accidents in Spain

According to the World Health Organization, nearly 1.3 million people die in traffic accidents every year (WHO[12], 2018), and between 20 and 50 million suffer injuries ranging from mild to serious. At the same time, most countries have introduced a range of measures in their policies and strategies to improve road safety and deal with the persistent issue of traffic accidents. In Spain, the measures applied during the last 20 years have made it possible to drastically reduce the number of victims involved in road accidents. Furthermore, over the decade 2001-2010, Spain fulfilled an objective to reduce the number of traffic deaths by 50% (WHO[8], 2010), as established in the European Road Safety Strategy (European Commission[2], 2017). In fact, Spain decreased traffic-related fatalities from 9,344 deaths a year in 1989 to only 1,800 in 2019, even though those 20 years saw 17 million more vehicles added to Spanish roads (Lijarcio, Useche, Llamazares & Montoro[4], 2020).

Nevertheless, to achieve the objectives proposed in the Sustainable Development Goals (SDGs; WHO[9], 2019), it is necessary to continue both developing and strengthening innovative measures and strategies in road safety in a range of different areas, while focusing cross-cutting efforts on the main contributors of traffic accidents, especially those related to human error.

The importance of visual fitness for safe driving in Spain

Eyesight is highly involved in driving as approximately 90% of the decisions made by drivers are based on visual input (David Hyerle[11], 2000). At the same time, a considerable proportion of the driving population is unaware of the importance of visual health to maintaining a fluid relationship with the road environment and, therefore, to making the safest and most correct decisions. Any inadequate or inaccurate visual input can increase the likelihood of suffering a serious incident while driving.

The WHO calculates that around 1.3 billion people in the world live with some form of vision impairment (WHO[12], 2018). Many of these people routinely drive motor vehicles, representing serious risk to themselves and others. In fact, in 2017 the International Automobile Federation incorporated vision screening as one of its 'golden rules' for driving safety, considering it a key aspect for the strengthening of overall road safety.

According to the Spanish General Council of Opticians-Optometrists (CGCOO[3], 2019), 67% of the Spanish population admitted suffering a visual impairment. The most common problem is myopia (28% of population), a refractive defect that begins in school age, followed by astigmatism (24%) and presbyopia (16%).

Background of the 2018 campaign and study

Essilor Spain is aware of the importance of the problem that impaired vision represents for road safety and, as its motto states, committed to 'improve lives by improving vision'. It saw an opportunity to promote an extensive set of applied scientific studies as a necessary step to learning more about the visual fitness of Spanish drivers, disseminating useful and well-founded information and promoting large-scale actions to raise awareness of the importance of visual healthcare and safe driving.

Essilor Spain first launched a campaign on eyesight and driving in 2018 with the support of the International Automobile Federation (FIA) and in partnership with RACE (the Royal Automobile Club of Spain) and CEPSA (the Spanish Petroleum Company). The first element was an opinion survey entitled 'Vision and driving: habits and perceptions about the relationship between vision and driving' which looked at 3,026 Spanish drivers as a sample. This made it possible to formulate an initial campaign on visual health which was promoted across CEPSA's 1,500 service stations nationwide.

Figure 1: Max, the dummy used as the image of the 'Vision and driving' campaign.

1,800 people die each year from traffic accidents in Spain and 120,000 people suffer major injuries (Lijarcio[4] , Useche, Llamazares & Montoro 2020). Worldwide, 1.3 million people die in traffic accidents every year, and 20 to 50 million are injured. According to the WHO, 1.3 billion people live with some form of vision impairment.

We have been working on the continuity every year. The completion of this 'in vivo' macro-study has meant that 2019 was a key year. However, we are still busy: we reached a collaboration agreement with the United Nations to improve eyesight on the road, putting at your disposal our extensive knowledge and commitment in the field of vision. 'Vision and driving' has become a success story at an international level, and the company is studying how to replicate this initiative in other countries.

Pedro Cascales, Country VP, Essilor Spain

Methodology and development of the new (2019) study

The rich data provided by the first macro-study led to broad acceptance of Essilor's further campaign. There was a clear need and interest to continue researching and promoting the awareness of drivers about the importance of visual testing for driving safety. For this reason, Essilor Spain performed a new and comprehensive study in 2019 called 'The visual health of Spanish drivers and its implication for road safety' (Lijarcio[4], Useche, Llamazares & Montoro, 2020), together with the Spanish Foundation for Road Safety (FESVIAL) and the University of Valencia, and with the collaboration of institutions such as CEPSA, the CNAE Foundation and RACE.

This new R&D project had two main parts. The first was a comprehensive survey of 3,249 drivers who were asked about topics like their habits, beliefs and attitudes regarding vision, their self-perception of the quality of their own eyesight, the use of correction systems, frequency of vision checks, previous visual problems, and opinions on the relationship between visual fitness and traffic accidents. The data retrieved through this survey provided useful information to understand the importance that drivers attribute to questions of eyesight.

The second element of the project was a free visual examination that drivers underwent after taking the survey to find out the state of their eyesight. Specifically, drivers took tests to determine their visual health through the Visiosmart® device, developed by ESSILOR, which measured essential variables for safe driving such as visual acuity, visual field campimetry and full-visual recovery after a luminous glare.

Both the sociological study and the visual testing were carried out at CEPSA service stations on a proportional sample corresponding to the population of Spain's 17 autonomous communities (regions).

The results obtained were analysed through descriptive statistical tests in order to obtain an overall assessment of the incidence of each vision-related study variable in both absolute and relative terms. At the same time, a set of multivariate analyses (which simultaneously evaluated several factors) were carried out to obtain further understanding of these relationships. Finally, a specific visual review protocol was developed for drivers and provided free of charge as a promotional action to hundreds of drivers nationwide across the many opticians' shops in Spain involved with the project.

Figure 2: Visiosmart(R) instrument used in the study 'The visual health of Spanish drivers and its implication for road safety', in which visual acuity, campimetry and glare recovery were tested among 3,249 individuals

Most relevant outcomes

This research generated many useful and interesting results. Firstly, the sociological study showed that Spanish drivers understand the importance of eyesight for driving: some eight out of ten felt that a driver with impaired vision was very likely to cause an accident. They considered this risk to be higher than that of other hazardous situations such as 'driving after drinking two beers', or 'using a mobile phone while driving'.

According to the data obtained, Spanish drivers overall rated their own visual health as 'good': only 18.3% of them considered their eyesight 'poor' or 'average'. At the same time, 15.6% acknowledged that they had never had a vision screening, while 26.1% said they had had one more than two years ago. In this regard, it is worth pointing out that it is advisable to have a visual check-up at least once a year. Among the drivers who had periodic

Figure 3: The results of the sociological and diagnostic study were presented to the media at a press conference in Madrid on 3 July 2019, with the participation of David Navarro, VP Global Strategic Projects of the Essilor Group, Pedro Cascales, Country VP of Essilor Spain, Dr Luis Montoro, President of FESVIAL and Professor of Road Safety at the University of Valencia, and Belén Mateo, Director of CEPSA's Network of Service Stations

visual checks, 46.2% did so only when having to renew their driving licence, and 42.8% because they detected a potential vision impairment themselves.

The main incidents of vision-related road risk which Spanish drivers recognise to have been involved in are the following: 32.6% indicate frequently experiencing glare from other vehicles, 9.4% state they frequently experience (uncomfortably) itchy or stinging eyes while driving, and 6.7% say they frequently drive with a blurred vision.

The Visiosmart® tests performed to determine the visual fitness of drivers across three key variables found that the eyesight of Spanish drivers is not as good as they think overall. For instance, 29.5% of participants (an estimated 7 to 8 million) present evident deficiencies in terms of ametropia (e.g., myopia or hyperopia), which can make it difficult to see signs or pedestrians clearly, affect the correct calculation of the safe vehicle-to-vehicle distance, make it harder to correctly detect the speed of other vehicles, and substantially impair reaction times.

Furthermore, 14% of drivers were found to have vision difficulties even in optimal lighting conditions, a percentage that rises to 38% in low-light situations (similar to night driving). This leads to risk for issues like late detection of relevant information, greater effort required to interpret traffic signs, or problems in efficiently reading information shown on the vehicle dashboard.

In addition, it is important to remember that night driving with poor vision is a clear risk: in general, visual acuity at night can be reduced by 70% and depth perception can be seven times lower than usual. In fact, about 42% of fatal crashes occur in conditions of insufficient lighting or poor visibility (RACE[5], 2009) and it is estimated that 15-65% of night-time crashes could be prevented if the road environment were adequately lit (Yannis, Kondyli & Mitzalis[10], 2013; Wanvik[7], 2009; Elvik[1], 1995).

> ***"The early hours of the morning or afternoon, night driving on two-way roads, the entrances and exits of tunnels or situations in which the lighting change is abrupt, can leave our vision blocked for a long time, implying severe safety risks."***
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> **Dr Luis Montoro - President of FESVIAL and Full-Professor of Road Safety.**

In the glare recovery test, 44% of drivers were found to take more than 20 seconds to fully recover their central vision. Specifically, almost 10% were found to have significant visual recovery problems after experiencing glare, needing more than a minute to get back to normal. This is important if we consider that –when driving at 120 km/h – a recovery time of five seconds means travelling almost 170 metres with impaired vision.

In addition to the studies mentioned, and within the campaign 'The visual health of Spanish drivers and its implication for road safety', a vision protocol was designed and offered free of charge to customers who were active drivers in 1,500 opticians' shops throughout Spain. This protocol consisted of a battery of simple tests that an optician-optometrist could carry out in just seven minutes to get a general idea of an individual's visual state in terms of safe driving. The tests carried out were anamnesis, field confrontation, visual acuity in far vision, visual acuity in low vision with low contrast, stereo-acuity, and recovery time after glare.

After underdoing these tests, drivers were given objective data on the state of their vision – naturally, when it comes to aspects vital to safe driving – as well as information on the risks they may face in case of driving with an impaired vision.

Discussion

Traffic accidents are one of the biggest public health problems that threaten people's safety and welfare in today's world. The causality of these accidents – which science shows us are not as accidental as we might think, and are in fact largely preventable – is multidimensional, but some factors, such as vision problems, put both drivers and all other road users at special risk. The actions described in this article have aimed, on the one hand, to gather information on the habits, beliefs and attitudes of Spanish drivers in relation to visual fitness and, on the other, to objectively assess their eyesight through the specialised device Visiosmart®, developed by Essilor.

According to both scientific evidences accumulated over recent decades and the perception of Spanish drivers, eyesight is a factor of great importance for driving performance. While maintaining good visual health is a key first step therefore to preventing traffic accidents, much remains to be done. For instance, around 40% of drivers do not adequately monitor and control their visual health through regular vision checks, most of them being evaluated only when they undergo the compulsory medical fitness assessment needed for the renewal of their driving licences (every ten years for drivers younger than 65).

Figure 4: Sample poster used in the advertising campaign, displayed at opticians' shops to promote our vision protocol

Where visual diagnostic tests are concerned, the results of the study show that there may currently be around eight million drivers with ametropic deficiencies in Spain; furthermore, more than a third of drivers have substantial difficulty seeing in low-light situations (mesopic vision), and about 10% of drivers have serious visual recovery problems after experiencing glare, recovering full vision only after 60 seconds. This data indicates that a significant percentage of people may be at high risk while driving at night.

Unfortunately, there is currently no mechanism to record traffic accidents caused directly or indirectly by drivers' poor visual health. In addition, the fact that many drivers still do not attribute enough importance to vision while driving raises substantial concerns.

In this context, it is essential to continue conducting applied research on the impact of vision on traffic accidents not only in Spain but in every country, since there are considerable psycho-social, economic and cultural differences across regions. Likewise, it is necessary to deploy road safety policies and strategies to increase available information and collective awareness of the importance of good eyesight for safe driving so as to effect significant behavioural change among drivers. In other words, part of our mission consists of emphasising the need to carry out periodic checks of visual fitness in the same way as this is done in most countries with technical vehicle tests, which are widely normalised and enforced by road safety regulations.

This is a challenging mission for Essilor Spain, together with the University of Valencia and FESVIAL. It is essential to be able to count on support and collaboration from other social agents, such as governments and administrations, which have competence in key issues such as health, road safety and mobility, so that eyesight is recognised as a high-impact risk factor in traffic accidents, and legislation and vision control measures are promoted to help reduce accidents.

In line with these initiatives, it is worth highlighting the agreement that Essilor has reached with the United Nations (UNO[6], 2020) to offer its knowledge to globally promote good vision among drivers, as well as donating a million glasses and sunglasses.

Finally, we should not forget to mention that there are other essential stakeholders that might be encouraged to support the task of promoting visual health among drivers: visual healthcare professionals (i.e., opticians, optometrists and ophthalmologists) who help us raise awareness of the importance of maintaining good eyesight to the prevention of traffic accidents among drivers and other road users. Their knowledge and direct contact with drivers make them a fundamental link in this chain, as they can help make people more aware of the importance of the links between vision and driving, which would contribute to saving thousands of lives around the world.

KEY TAKEAWAYS:

- Good eyesight is crucial to safety on the road. During driving, any insufficient, incorrect or inaccurate visual information can lead to a serious traffic accident.
- Studies have shown that, despite understanding the importance of good eyesight to safe driving, a large percentage of Spanish drivers (approximately 30%) do not adequately check their visual health.
- The main vision impairments detected among Spanish drivers were vision problems under low light conditions (mesopic vision), glare recovery and peripheric field campimetry. These were especially common among women and older adults.
- It is essential to continue conducting applied studies on the importance of eyesight in traffic crashes. The actual visual health of drivers should be assessed separately in each country, since psychosocial, economic and cultural differences result in issues that are distinct to each territory.
- As stated in the United Nations recommendation on vision and road safety of 1 April 2020, governments and agencies dealing with health, road safety and mobility issues should include in their agenda actions for addressing eyesight as an essential risk factor for road safety. Also, it is essential to promote measures and strategies that can help reduce crashes related to impaired vision.
- Eyecare professionals have a crucial role in promoting visual health in driving, since they can diagnose any impairments in a timely manner and inform their customers (whether drivers or other road users) about the importance of good eyesight to avoiding preventable accidents.

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