Points de Vue, the International Review of Ophthalmic Optics created by Essilor in 1979, is committed to providing prescribers (all eye care professional involved in prescription throughout the world) with forward-looking and useful information for their practices and effective patient care.

Points de Vue is an expert-to-expert publication, sharing the latest knowledge on scientific evidence, clinical practice, market insights, patient needs and innovative solutions.

This 72nd issue welcomes 25 experts sharing their perspectives on “Digital Vision”.

If you have comments or questions, contact us at: PointsDevue@Essilor.com

We strive to answer within 24 hours. We are at GMT+01 summer (Paris / France)
DIGITAL VISION

Between the time spent drafting an editorial on your tablet, looking at your smartphone, checking traffic on your GPS, then arriving at the office and answering e-mails on your laptop, reading a few e-documents, attending e-conferences via hangouts, always with your eyes riveted to the screen - then returning home and checking the news and social media on your PC or leafing through your e-book, you can spend several hours a day in front of screens of various sizes. These days it’s perfectly common to live in this ultra-connected and multi-screen environment.

If we’re to believe the latest research, nearly 61% of Americans spend more than five hours a day in front of a screen*. On average we use four different screens per person, either simultaneously or in succession**. That’s certainly a widespread practice, but it’s poorly suited to how our vision system operates. Human eyes aren’t biologically designed for near vision, which is supposed to be limited to a brief accommodation reflex. Staring wide-eyed into digital devices while maintaining a rigid and largely unnatural posture is bound to have physiological repercussions. Digital asthenopia affects up to 90% of all users**, and reports of physical pain, ophthalmic disorders and endocrine disruption affecting melatonin or cortisol secretion*** - all potentially the result of overexposure to displays - are multiplying. These findings underscore the paradox between a digital society and physiological reality, and prompt the question: can we live (well) in a connected world?

The vision health sector is offering a wide range of solutions for tackling that question: new diagnostic tools, personalized protocols and treatments, advances in ophthalmic optics and lens technology, patient education and awareness, and so on. The new technology itself is making a contribution, thanks to mobile apps, connected devices, big data, professional networks and sites that publish scientific studies and help in education, coordination and collaboration between stakeholders. And since the ophthalmic optics industry is first and foremost a field of innovation, there is a continuing focus on research and development, both to design innovative devices and to conduct clinical studies that will help us identify risks and outline new preventive or curative strategies.

In this 72nd issue of Points de Vue, we try to make sense of these latest trends and developments by once again calling on experts from around the world as well as digital artists, to give us a multi-faceted perspective on digital technology and its implications.

Our multi-screen existence is opening up a host of technical, cultural, social and entertainment possibilities that are changing the way we view the world and redefining our societies... and their relationship with vision health. It’s our role to anticipate needs and face up to the major challenges posed by the digital world, to live well while being Zen and connected!

*2015 report from The Vision Council, USA; see article on page 14
** 2014 international Ipsos study; see article on page 38
*** Experts’ voice; see article on page 06
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WE THANK ALL AUTHORS AND CO-AUTHORS FOR THEIR VALUABLE AND VOLUNTARY (UNPAID) CONTRIBUTION TO POINTS DE VUE. TO ENSURE BOTH CREDIBILITY AND IMPARTIALITY OF THE CONTENT, WE DO NOT FUND SIGNED ARTICLES, AND IN THE SAME WAY WE OFFER THE MAGAZINE FOR FREE TO READERS, BOTH THROUGH PRINT AND ONLINE.
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In this new digital era, there are new risks for user eyes and new challenges for vision care professionals. Ten experts, optometrists, ophthalmologists and researchers have addressed this broad topic and offer us their experience and thoughts in the form of verbatim comments. This overview has been divided into three main thematic areas: risks and prevention, professional practices, and projections and expectations.

1. RISKS AND PREVENTION

What effects do digital displays have on health? The main risks, whether they are known, suspected or potential, primarily concern vision, but may also affect other functions. Experts are reassuring however: good visual hygiene, regular eye exams by professionals, appropriate optical solutions and enhanced public awareness provide effective prevention.

Impact of digital displays on vision

“Our visual system is biologically designed for distance vision. Near vision is only an accommodation reflex that helps us quickly identify objects close at hand. Our eyes are not designed to stare at screens for hours on end.”

José de Jesús Espinosa Galaviz

KEYWORDS
digital devices, connected vision, multi-screen environment, computer, smartphone, tablet, video games, blue light, ametropia, emmetropia, digital displays, posture, digital tools, connected life, eye strain, vision health, prevention, visual hygiene, accommodative effort, asthenopia, headaches, sensitivity to the light, diplopia, sleep, cortisol, melatonin, ergonomics, protection, child, myopia.
“No clinical study to date has demonstrated that overexposure to digital displays is the cause of early macular degeneration. However, blue light emissions are a reality and over time we are bound to see a clinical impact. Concerning the increase in cases of myopia, various studies point to the possible influence of digital displays used at ever closer distances. We still need to understand why certain subjects develop myopia and others don’t, even among twins.”

Sebastian Marx

“A reduction in the frequency of blinking during screen use increases the severity of such symptoms as dry eye or irritation and blurred vision. Smartphone users tend to hold their phones very close to the face, thus requiring an intense accommodative effort causing eye strain or headaches.”

Sebastian Marx

“In such rapidly developing cities as Singapore, we see concomitant growth in the number of people working in offices and cases of asthenopia, sensitivity to light, transient diplopia and so on.”

Koh Liang Hwee

“The increase in ophthalmic disorders is linked to the proliferation of screens and the time spent watching them: in the classroom (from primary school to postgraduate courses, including tablets, computers, electronic tables, etc.), but also at all ages via the social networks, television and e-books, which are becoming increasingly popular.”

Helen Summers

“No clinical study to date has demonstrated that overexposure to digital displays is the cause of early macular degeneration. However, blue light emissions are a reality and over time we are bound to see a clinical impact. Concerning the increase in cases of myopia, various studies point to the possible influence of digital displays used at ever closer distances. We still need to understand why certain subjects develop myopia and others don’t, even among twins.”

Sebastian Marx

“The main risk for the younger generation is myopia, perhaps not true myopia, but rather an ‘accommodative spasm’ (i.e. near point stress according to Skeffington), since the human eye and brain were not designed for extended near vision.”

Aravind Srinivasan

“Our visual system is biologically designed for distance vision. Our eyes are not designed to stare at screens for hours on end.”

José de Jesús Espinosa Galaviz
Consequences beyond vision

“In the medium and long term, digital displays affect people in different ways. The impact is not solely ophthalmic. The symptoms are varied, suggesting both physical disorders (neck and back pain, etc.) and psychological disorders (fatigue, irritability, poor concentration, memory problems and so on).”

Aravind Srinivasan

“Overexposure to blue light emitted by screens can disrupt the secretion of melatonin and thus affect the quality of sleep. Eye strain can also have an effect on productivity and lead to other disorders, such as stress, anxiety or mood swings.”

Koh Liang Hwee

“Ever more pervasive video gaming is associated with player immersion and strong screen flicker. These two situations can eventually stimulate systemic and endocrine functions, resulting in elevated cortisol levels. The main repercussions have been found to affect sleep, behavior, mood, motivation and learning.”

Helen Summers

Preventive solutions

“Consumer awareness campaigns are an important means of highlighting the risks and symptoms related to digital displays and offer an opportunity to stress the need for regular eye exams.”

Aravind Srinivasan

“OVEREXPOSURE TO BLUE LIGHT EMITTED BY SCREENS CAN DISRUPT THE SECRETION OF MELATONIN AND THUS AFFECT THE QUALITY OF SLEEP.”

KOH LIANG HWEE
“Every person consulting a vision care professional should be informed of the impact of digital devices and blue light, as well as the importance of good visual hygiene and the availability of optical solutions. A wide range of high-quality solutions are available; it is regrettable, however, that current prices limit their use primarily to adults rather than children.”

Helen Summers

“A new specialty, ergo-optometry, could be created. The ergo-optometrist would counsel patients on how to take better care of their visual health, explain what products to use to treat dry eye and provide personalized information with regard to lenses and frames, even for patients without refractive error. Overweight people can contact Weight Watchers. People with ophthalmic problems should be able to contact Eyes Watchers.”

Joachim Köhler

“Good visual hygiene also includes: an ergonomic work space; good posture, a straight head and back; good lighting, with lower lighting for screens and adequate room lighting; breaks every 20 minutes; alternating between near and far screen distances, and suitable ophthalmic lenses.”

Helen Summers

2. PROFESSIONAL PRACTICES

How are digital devices influencing the everyday lives of vision care professionals? New consultation protocols, near vision refraction and control methods appropriate to digital displays, personalized counseling and more frequent continuing education are the main developments cited by experts. Many professionals are incorporating digital tools into their practices to better assess users’ needs. In the context of overexposure to digital devices, experts are also beginning to take more interest in children and emmetropic people (without refractive error).

Protocols and refraction

“Just a few years ago, protocols were established on the basis of the symptoms one should look for rather than on patients’ needs depending on their environment. This approach is now changing. Currently, in addition to patients’ histories, we are also interested in their concerns, expectations, environment and so on, and we are adapting protocols accordingly.”

Luis Ángel Merino Rojo

“For people who rely heavily on their near vision, I apply a protocol based on behavioral optometry. This approach is important when prescribing the best lenses for a particular type of activity.”

José de Jesús Espinosa Galaviz

“My approach? First I exclude ocular pathology and perform a refraction. Then I evaluate the patient’s visual faculties (accommodation, convergence, ocular mobility and sensory aspects such as stereoscopic vision, etc.). Once all these criteria have been evaluated, the treatment strategy can be defined.”

Elizabeth Casillas

“Far vision refraction is often performed using cyclopegic eye drops with a refractometer. Near vision is examined with trial frames equipped with interchangeable lenses to better evaluate posture, head position and reading distance in relation to a support, computer or digital device. Instruments such as ‘Capture I’ or “Visioffice®” are used to measure frame parameters and such individual parameters as pupillary distance and the eye’s center of rotation.”

Helen Summers

“My staff has slightly modified their refraction methods to adapt to digital technologies. We placed a smartphone and tablet in the consulting room and, after the examination, we ask patients to read what is written on the screen. If they are unable to do so, we orient them towards specific lenses. Otherwise, all is well! By using digital devices to test near vision, we fit in more closely with our patients’ digital lifestyles.”

Joachim Köhler

Prescriptions and counseling

“There are several complementary approaches. The first involves optical correction, with high-tech lenses offering optimal vision quality and protection. The second approach involves training, consisting of various exercises designed to improve visual capabilities. The third approach involves education in visual hygiene (posture, breaks, a good work environment, etc.). The final prescription depends on the age and issues of each patient.”

Elizabeth Casillas
"WE HAVE A REAL ROLE TO PLAY IN THE TREATMENT OF DISORDERS RELATED TO DIGITAL DISPLAYS"
ELIZABETH CASILLAS

“The patient’s age affects the proposed treatment. People with presbyopia will be advised to wear progressive lenses, with a coating (i.e. a filter) suited to the specific issues posed by digital devices. For younger children, with or without a correction, lenses must primarily meet the objective of protecting their vision against the harmful effects of screens.”
Aravind Srinivasan

“We must be attentive to each of our prescriptions, always follow the same consultation protocol, compare feedback from each patient and keep a record of all results.”
Berenice Velázquez

“People working on computers are advised to have regular exams, in order to identify any symptoms of ophthalmic stress. The prevention aspect is particularly stressed for children, especially for children under 10.”
Helen Summers

“We have a real role to play in the treatment of disorders related to digital displays and must devote more time to informing and educating ourselves and to testing new solutions. In this regard, it could be useful to reinforce the sharing of experiences and dissemination of information through forums and professional networks.”
Elizabeth Casillas

“Information provided by researchers, universities, specialized societies, suppliers and the like, helps us stay on top of new developments and provide increasingly personalized solutions. We must make an effort to step out of the ‘comfort zone’ of standardized options and adapt them to individual needs.”
Sebastian Marx

"The patient’s age affects the proposed treatment. People with presbyopia will be advised to wear progressive lenses, with a coating (i.e. a filter) suited to the specific issues posed by digital devices. For younger children, with or without a correction, lenses must primarily meet the objective of protecting their vision against the harmful effects of screens.”
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Elizabeth Casillas
There is a paradox. On the one hand, we have more and more technological tools available to us (auto-refractometers, digital phoropters, photo and video sharing capability to improve diagnosis, etc.), but on the other hand, we have a new generation of professionals who no longer know how to perform an exam without these devices. The right balance must be found between the assimilation of new technologies and basic knowledge.

José de Jesús Espinosa Galaviz

3. PROJECTIONS AND EXPECTATIONS

How do we anticipate future issues and respond to the realities of a multi-screen world? Between increased research efforts and the development of technological innovations that will facilitate customized products and services, the various ideas outlined offer a glimpse of the future of the ophthalmic optics sector, which is in a position to turn the digital challenge into a real growth engine.

Clinical studies and R&D

“Technological progress is making rapid headway, but the ophthalmic optics industry should be further ahead than it is if it is to adequately meet the health challenges associated with digital displays. It is important to invest more in health research in general and vision health in particular.”

José de Jesús Espinosa Galaviz

“New studies on the relationship between blue light and macular degeneration and the connection between the development of myopia and digital displays could provide clinical responses to current hypotheses based solely on interpretation.”

Sebastian Marx

“The place of emmetropes

“My colleagues and I feel that emmetropes (i.e. people without refractive error) have been completely forgotten by our profession. During screen use, they are exposed to the same risks as glasses wearers. So it is important to educate them about the existence of simple solutions and practices to fight against asthenopia and other disorders related to digital devices.”

Luis Ángel Merino Rojo

“It would be useful to mount a major information campaign on the risks of overexposure to digital displays. And explain that vision care professionals have solutions to respond to these issues, even for emmetropes.”

Berenice Velázquez

Digital devices and professional practice

“For vision care professionals, digital technologies make it possible to share cases and experience, to the benefit of patients.”

Jaime Bernal Escalante

“Digital tools and certain applications can be used to take a number of different measurements: asthenopia, the quantity of blue light emitted by screens, etc. They can also be used to disseminate recommendations aimed at optimizing visual comfort and participate in the therapeutic education of users.”

Berenice Velázquez

“We must continue research efforts on myopia and its development, solutions to amblyopia, eye reactions during screen use, night vision, light radiation, etc.”

Luis Ángel Merino Rojo

“EMMETROPES HAVE BEEN COMPLETELY FORGOTTEN BY OUR PROFESSION. DURING SCREEN USE, THEY ARE EXPOSED TO THE SAME RISKS AS GLASSES WEARERS.”

Luis Ángel Merino Rojo
“All studies focusing on the exact relationship between connected life and ophthalmic disorders should prove useful. And in my opinion, the development of shared databases would be a real “plus” for all vision health players.”
Jaime Bernal Escalante

Expected innovations

“More precise measuring equipment. The fact of having 20/20 (10/10) vision reveals nothing about the way patients’ use their eyes while watching a screen.”
Elizabeth Casillas

“Tools to measure the impact of luminous digital displays on the eye.”
Aravind Srinivasan

“New products, particularly ophthalmic lenses capable of protecting the eyes against technological ‘radiation’.”
Jaime Bernal Escalante

“The ideal lens: a product capable of integrating all treatments and filters on demand, based on the individual needs of each patient.”
Koh Liang Hwee

“A completely innovative approach, with ‘flexible’ smart lenses capable of adapting their optical properties to specific situations. A high level of modularity that could involve the use of electronic components.”
Sebastian Marx

Vision health in the future

“The multi-screen environment is part of daily life. This environment can potentially pose certain risks, particularly for the eyes, and it is up to us as vision care professionals to concern ourselves with these risks and provide some answers, either directly or via the Internet.

Indeed, technological and societal developments are opening up new fields of practice that offer our industry an opportunity to evolve! Personally, however, I prefer direct contact with patients, to show them that I am indispensable as a specialist.”
Joachim Köhler

“New visual needs concern a large number of everyday activities; therefore growth opportunities for the vision health sector can only increase. The solutions developed must provide added value: filters to prevent eye strain or blue light-related risks, lenses capable of stimulating peripheral areas of the retina to fight against myopia or stimulate amblyopic eyes and improve their performance. There are still many little exploited or untapped areas that will undoubtedly drive development in the future. The response to digital issues is part of this.”
Luis Ángel Merino Rojo
Conclusion

The new digital era is witnessing new societal, sensorial and behavioral transformations. This brief survey of the situation worldwide highlights the increased overall level of awareness of the ophthalmic optics sector confronted with the rapid, wide-scale changes driven by the emergence of digital technology and, more particularly, its impact on users’ vision and posture. From stronger prevention efforts to personalized treatment options, without forgetting projections for the future, the vision health sector is joining forces to adapt to developments, anticipate upcoming challenges and provide better performing solutions for ametropic and emmetropic patients of all ages.

Insights collected by Oliver Vachey, science journalist.

KEY TAKEAWAYS

- The human eye is not designed for near vision over a long period. Spending too much time in front of screens results in asthenopia, dry eyes, red or irritated eyes and other ophthalmic symptoms.
- The medium-term impact on users’ general physical condition and behavior is correlated with overexposure to blue light and screen flicker.
- Preventive solutions exist for each situation, but public awareness needs to be improved.
- Professional practices are evolving and adapting with the goal of providing increasingly personalized treatment options designed specifically for users of multiple screens.
- Efforts are still needed in the area of clinical studies, R&D and innovation, to enhance the already substantial offer, provide new solutions and anticipate upcoming issues.
- The satisfactory integration of digital vision issues is a major factor affecting the growth and development of the ophthalmic optics sector.
With its annual survey, *Hindsight is 20/20/20: Protect Your Eyes from Digital Devices*¹, The Vision Council monitors usage trends related to digital displays and their impact, as regards both eye strain and exposure to blue light. The report’s 2015 edition highlights the growing pervasiveness of digital displays in the United States and the stakes in raising awareness of the actors involved in the visual health sector like the general public.

**DIGITAL EYE STRAIN IN THE USA: OVERVIEW BY THE VISION COUNCIL**

Mike Daley began his optical career as an instructor with Ferris State University in 1975. He joined Essilor in 1976. With consolidated skills in sales, marketing, technical services, laboratory operations, he served as the President of Varilux Corporation (1989-1995). After 32 years with Essilor, he retired in 2008 as the President and CEO of the Lens Division of Essilor of America. Throughout his career, he has been recognized by his peers and has served in a leadership position for an impressive number of optical organizations including National Academy of Opticianry (NAO) Hall of Fame; Prevent Blindness America, Board of Directors; AOA Optometric Charity Board; SoloHealth Board of Directors; The Vision Council of America, Board of Directors, and past Vice Chairman. He holds Ferris State University Honorary Doctorate (2006).

Dr. Adamopolous graduated as a Doctor of Optometry from the New England College of Optometry in 1998. During her last few academic years, she had the opportunity to sharpen her clinical skills through a series of rotations in different types of medical settings on the East Coast. After graduation she worked in the private practice arena, treating and managing ocular pathology in a geriatric population. Today, she devotes her expertise to welcome and treat patients suffering from dry eyes, allergies, diabetes, cataracts and glaucoma. Involved in the development of visual health in the United States, she collaborates with the Vision Council as medical advisor.

Erin Hildreth has great past experience in communication, marketing and education. She served as the Education Manager for the Health Industry Distributors Association (HIDA), coordinating and providing contents for trainings. She led several editorial projects including advertising, content management and online development. Today, she is responsible for marketing and communication at The Vision Council. She develops and implements programs that educate consumers about eyewear trends, lens technology and health aspects. Keeping strong focus on eye health benefits, she works on UV awareness, protection and prevention necessity (including digital eye strain), aging and low vision.

**KEYWORDS**

* The Vision Council

Serving as the global voice for vision care products and services, The Vision Council represents the manufacturers and suppliers of the optical industry. The Council positions its members to be successful in a competitive marketplace through education, advocacy, consumer outreach, strategic relationship building and industry forums.
Digital eye strain is more than a reality; it is a public health priority in the United States. This is the warning published by The Vision Council**, which has just released its latest survey on this issue: Hindsight is 20/20/20: Protect Your Eyes from Digital Devices’. The document is based on an analysis of 9,749 questionnaires completed by a representative sample of adult U.S. residents. Its aim is to determine the broad outlines of behavioral changes with respect to digital displays, be they smartphones, tablets, computers, laptops or other electronic devices, such as game consoles. This state of play confirms the trend that has emerged in recent years: “From the moment people get up until the time they go to bed again – including when they are eating, exercising and reading – they are using one digital device after another and thus exposing themselves to risks related to prolonged exposure to light emitted by screens,” sums up Mike Daley, chief executive officer of the Vision Council. In concrete terms, more than 95% of American adults spend at least two hours a day in front of a screen and almost three out of ten spend over nine hours. Even though people working on computers are the most concerned by a potential “overdose”, the study stresses that one child out of four is exposed to screens over three hours a day. These constantly increasing figures can be explained by both new societal patterns (i.e. a decrease in physical activity, an increase in passive consumption and paperless contacts, etc.) and options made possible through innovation. “Digital technologies offer ever increasing options and opportunities to simplify consumers’ daily lives. This growing trend is not likely to be reversed any time soon. Nor are the related ophthalmic problems,” Daley predicts.

**EXPERTS’ VOICE**

**M. DALEY**

“**FROM THE MOMENT PEOPLE GET UP UNTIL THE TIME THEY GO TO BED AGAIN – INCLUDING WHEN THEY ARE EATING, EXERCISING AND READING – THEY ARE USING ONE DIGITAL DEVICE AFTER ANOTHER AND THUS EXPOSING THEMSELVES TO RISKS RELATED TO PROLONGED EXPOSURE TO LIGHT EMITTED BY SCREENS**”

Digital eye strain is the physical eye discomfort felt by many individuals. It is a problem of growing importance: “From the moment people get up until the time they go to bed again – including when they are eating, exercising and reading – they are using one digital device after another and thus exposing themselves to risks related to prolonged exposure to light emitted by screens,” sums up Mike Daley, chief executive officer of the Vision Council. This state of play confirms the trend that has emerged in recent years: “From the moment people get up until the time they go to bed again – including when they are eating, exercising and reading – they are using one digital device after another and thus exposing themselves to risks related to prolonged exposure to light emitted by screens,” sums up Mike Daley, chief executive officer of the Vision Council. In concrete terms, more than 95% of American adults spend at least two hours a day in front of a screen and almost three out of ten spend over nine hours. Even though people working on computers are the most concerned by a potential “overdose”, the study stresses that one child out of four is exposed to screens over three hours a day. These constantly increasing figures can be explained by both new societal patterns (i.e. a decrease in physical activity, an increase in passive consumption and paperless contacts, etc.) and options made possible through innovation. “Digital technologies offer ever increasing options and opportunities to simplify consumers’ daily lives. This growing trend is not likely to be reversed any time soon. Nor are the related ophthalmic problems,” Daley predicts.

**Activities Associated with Digital Device Use:**

- **Work**: 44%
- **Waking up**: 38%
- **Travel**: 32%
- **Recreational reading**: 43%
- **Meal preparation**: 26%
and causes photochemical reactions likely to damage retinal cells, with a cumulative effect. The retina cannot be replaced; its alteration therefore leaves the eye vulnerable to harmful light and environmental factors, thereby increasing the risk of early development of ophthalmic disorders, such as AMD.”

However, blue light is not an enemy that must be fought at all costs. The blue-turquoise spectrum participates in the regulation of natural circadian rhythms (i.e. sleep-wake cycles) among other things, and stimulates the pupillary reflex and such cognitive functions as alertness, memory and emotion regulation.

“Blue light is both unavoidable and indispensable. So it is important to understand its repercussions on the organism and vision, and be familiar with the tools and recommendations for minimizing exposure, particularly from digital displays,” the expert advises.

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**EXPERTS’ VOICE**

working all day on a computer could present physiological changes of the lacrimal system similar to those found in dry eye syndrome. “This is not surprising when one considers that the work environment is often characterized by multiple or split screens, small fonts, poor posture and LED or fluorescent lighting.”

**The blue light paradox**

In addition to eye strain, overexposure to digital displays is linked to the issue of blue light. Eye doctor and medical advisor to the Vision Council, Dora Adamopoulos, recalls that “a great deal of research is currently underway to determine its precise impact on the eyes and vision. One thing is certain: the blue-violet spectrum (415-455 nm) is particularly harmful. It penetrates deeply and causes photochemical reactions likely to damage retinal cells, with a cumulative effect. The retina cannot be replaced; its alteration therefore leaves the eye vulnerable to harmful light and environmental factors, thereby increasing the risk of early development of ophthalmic disorders, such as AMD.”

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**A QUESTIONNAIRE HANDED OUT PRIOR TO A CONSULTATION CAN HELP TO CLARIFY AT WHAT DISTANCE EACH SCREEN IS BEING USED, HOW THE OFFICE IS ORGANIZED, THE MOST COMMON POSTURAL POSITIONS ASSUMED AND SO ON, AND THIS INFORMATION CAN THEN SERVE AS A BASIS FOR DISCUSSING PROBLEMS AND POSSIBLE SOLUTIONS**

E. HILDRETH
Digital childhood and myopia

Prevention and protection are equally important for both adults and young people, who now use computers and smartphones in all aspects of their schooling and social life. The latest Digital Eye Strain report points to intensive screen use and a lack of data on the medium-term consequences. “The phenomenon is recent, so it is impossible to foresee the impact of emitted light on children’s eyes. But in our opinion, myopia is one the main risks that must be evaluated,” Erin Hildreth hypothesized. “The causes of myopia are related to a combination of genetic and environmental factors, and since the pervasiveness of digital devices stimulates ocular accommodation at very close reading distance, this could well be part of the problem.”

The Vision Council therefore calls for vigilance and a complete eye exam every year to ensure the best possible development of children’s eyes. “A professional can evaluate symptoms or visual disorders resulting from the use of digital devices and suggest solutions and make recommendations,” she affirms. However, this approach comes up against one of the main findings of the study: the majority of parents are not worried about the effect of the digital environment on their offspring. 15% of respondents place no limits on the amount of time spent in front of screens, and 30% are not concerned about the potentially harmful impact of digital devices on the development of the visual system.

Think and act “awareness”

This finding of disregard for risk highlights one of the major challenges of the Vision Council’s action: public awareness. Its CEO confirmed this focus: “For us, education is the key. The transmission of information about the nature of digital eye strain, including risks related to exposure to digital displays and especially how to fight them, should be a major focus for mobilizing our sector.” To optimally publicize the issue, The Vision Council is diversifying its strategy and seeking to strengthen its communication in schools and during ‘key’ events: film releases, TV marathon broadcasts, new technology launches, or international trade fairs, including the celebrated CES (Consumer Electronics Showcase), an unmissable event for new technology fans. This is a good way to reach a large number of users and instill in them a desire to safeguard their eye health. And to facilitate the assimilation of prevention, the organization is relying on its flagship slogan: “20-20-20”. Every 20 minutes, look 20 feet in front of you (approximately 6 meters) for 20 seconds. This rule is easy for both adults and children to remember and use. The Think About Your Eyes campaign (www.thinkaboutyoureyes.com) is also a great way to inform people about the benefits of an annual ophthalmic examination,” adds Daley, who sees in consumers’ appetite for connected information an excellent opportunity to use these media, including websites and social networks, and connect with other industry players about the importance of eye health in the digital environment.
Preventive recommendations for the users of digital displays

1) Design your work space in such a way as to alleviate external stressors, with ideal lighting, an “eye-gonomic” setting (ergonomics for the eyes) and good posture.

2) Increase character size in relation to the device used.

3) Observe the 20-20-20 rule. Every 20 minutes, look 20 feet in front of you (about 6 meters) for 20 seconds.

4) Consult a health professional on a regular basis to obtain counseling and prescriptions for ophthalmic lenses designed for multiple screen use.

The importance of prevention

Advances in ophthalmic optics have already made possible a wide range of options for lenses capable of reducing glare and filtering out blue light. These two indispensable options to optimize visual comfort while using digital displays should encourage opticians to add them to prescriptions to more...
It is more important than ever to disseminate this message, inasmuch as scientific advances are increasingly confirming the link between digital displays, eye strain, age-related eye diseases and the importance of prevention and protection. “The new digital era is more stressful on our eyes and we must all adapt accordingly, professionals and users alike. The optical/ophthalmic industry has already identified the major issues raised by digital devices and during the last several years, we have witnessed a boom in innovation capable of reducing disorders related to the light emitted by screens. These products and technologies do much more than protect our eyes: they improve the quality and precision of our vision,” Mike Daley concluded. •

Many manufacturers also offer multifocal lenses for people who need to relieve eye strain and correct both near and far vision,” Dora Adamopoulos added. The medical advisor feels that “the optical/ophthalmic industry must continue to engage in research and development for new products, but also educate the community of vision care professionals and the general public. We have a duty to explain to consumers that they do not have to live with discomfort or pain while using digital devices. Custom glasses, with or without corrective lenses, can alleviate or prevent short-term symptoms and protect against long-term damage.”

63% of adults do not know that electronics emit high-energy visible or blue light

SOURCE: The Vision Council reports on digital eye strain, 2012 & 2013
EXPERTS’ VOICE

• Americans (both adults and children) are spending more and more time in front of digital displays on all types of devices.
• 60.8% spend more than five hours a day in front of a screen.
• 31.9% do not make any effort to reduce symptoms of digital eye strain.
• 72.5% are not aware of the potential damage caused by overexposure to blue light and do not know that digital displays emit blue light.
• 22% of parents say that they are concerned by the impact of digital device use on their children’s vision.
• 30.6% of the same parents allow children to use digital devices for over three hours daily despite their concern.

KEY TAKEAWAYS

• Americans (both adults and children) are spending more and more time in front of digital displays on all types of devices.
• Disorders and risks related to light-emitting screens (i.e. eye strain and retinal pathologies) are either unrecognized or underestimated by the general public, the majority of whom neglect prevention and protection.
• Simple solutions exist to fight against digital eye strain and overexposure to blue light.
• The Vision Council recommends following the 20-20-20 rule (every 20 minutes, take a 20 second break while looking 20 feet away) and using ophthalmic lenses designed for screen use.
• Vision care professionals all have a role to play in terms of advocacy, awareness-raising and counseling.

REFERENCES

Some key figures

• In 2015, 69% of American adults use a smartphone and 42.5% a tablet or e-book reader on a daily basis, versus 45% and 26% respectively in 2012.
• 60.8% spend more than five hours a day in front of a screen.
• 31.9% do not make any effort to reduce symptoms of digital eye strain.
• 72.5% are not aware of the potential damage caused by overexposure to blue light and do not know that digital displays emit blue light.
• 22% of parents say that they are concerned by the impact of digital device use on their children’s vision.
• 30.6% of the same parents allow children to use digital devices for over three hours daily despite their concern.
Science is focusing greater attention on how new digital technology is affecting the vision health and motor and postural behaviour of its users. Analysis of postural data could spur innovations in the field of ophthalmic optics.
New technologies and the use of digital media are undeniably changing the postural and behavioural patterns of users. However, there is still little data on the scientific characterization of these new postural habits. Recently, Essilor International’s R&D teams have developed a specific experimental setup that has delivered original results. Through the analysis of postural data measured in this context, they were able to establish a specification for the design of a new class of ophthalmic lenses.

1 Introduction
During the last decade, we have seen an explosion in smartphones, tablets, e-readers and other hybrid devices that concentrate the functions of a computer in a portable device. In France, smartphone purchases increased by 7% in one year, reaching 46% in 2014. Three out of ten people state that they are equipped with a touch tablet, a statistic that nearly doubled in one year, from 17% in 2013 to 29% in 2014. Moreover, most users do not seem particularly attached to a single device, but move easily from one device to another (using a tablet at home, a smartphone while commuting, a computer at work and so on) (Fig. 1).

All these devices represent a great step forward, since they dramatically increase possibilities for exchange, interaction and cooperation, and facilitate access to knowledge. The information dispensed by these devices is much the same, in content, as that of traditional books, but is presented in a very different form. While books require a linear reading mode punctuated by pages, electronic text can be navigated freely by the reader, using hyperlinks; moreover, the ability to scroll text on the screen, using a keyboard or touch screens, eliminates the notion of page.
Electronic reading requires the reader to interact with his or her device. Furthermore, the vast majority of these devices are “mobile” or “handheld” devices and can be used in a wide range of everyday situations: while standing in public transport, sitting on a sofa, or lying in a bed. These new habits are revolutionizing the way we interact with traditional media and we can expect our postures to differ from those we adopt with paper media. Since ophthalmic lenses are traditionally designed to respond to the constraints of paper media, it is critically important to take an interest in these new behaviours. With this in mind, we undertook a study in 2013 to collect data on posture during the use of these new devices.

2 Experimentation for the collection of postural data
Before starting our experimentation, we reviewed the literature on the postural data of users while viewing various types of screens.

2.1 Literature review
2.1.1 Data on computers
In a study on visual fatigue, Jaschinski (2002) asked forty subjects to position themselves at a comfortable distance from their computer and then measured the eye-screen distance for each of them. He obtained a mean distance of 63 cm (standard deviation 13 cm, CI95%[38; 88]). The act of lowering one’s eyes when viewing a computer screen has been the subject of numerous studies in recent years and has led to sometimes contradictory ergonomic recommendations. Indeed, a group of researchers believe that a downward viewing angle of 40° is more suitable than an angle of 15° (Ankrum, 1997), because the former would be preferred for intensive tasks (Ankrum et al., 1995). It also seems that a significant lowering of the eyes reduces the risk of dry eye by decreasing the exposed ocular surface (Jainta & Jaschinski, 2002). However, numerous studies have sought to test the relevance of a lowered screen. An angle of view of 40° below the horizontal causes one to incline the head more sharply, resulting in increased muscle activity in the neck, shoulders and back than an angle of 15° (Turville et al., 1998; Straker & Mekhora, 2000). Furthermore, it seems that operators prefer a screen positioned so that the axis of

**FIG. 1**
Device Preferences Throughout the Day in Europe
Most Weekend Tablet Usage Peaks at 9pm

*Source: comScore Device Essentials, Sunday, 17th February 2013, Europe*
gaze is horizontal or slightly inclined (Bauer & Wittig, 1998)\(^\text{12}\). In the current state of research, the preferred viewing angle can be considered to fall within a range of 8-16° (Seghers, Jochem & Spaepen, 2003)\(^\text{13}\). For a review of the literature on this topic, see Cail & Aptel (2006)\(^\text{14}\).

Given the uncertainty of ergonomic recommendations, we decided to conduct an internal campaign to measure eye declination (i.e. lowering of the eyes), intended to serve as the basis for the development of our range of occupational lenses. Our measurements show an eye declination of 4° (SD 1.53°) during computer use. We noted a wide variability between individuals in their way of positioning themselves relative to a computer screen, and we therefore recommend that this parameter be taken into account when developing occupational lens designs.

### 2.1.2 Data on television screens

It is very difficult to find postural data in the literature on television screen viewing postures. We know, however, that the average size of LCD television screens sold worldwide in 2013 is between 36 and 37 inches measured diagonally. For this size screen, the recommended distance from the screen is about 1.90 m (between 1.40 and 2.40 m). Since the television set may be placed flat on the floor, on a low cabinet, a dresser or wall-mounted, it is not easy to find data on viewing angles. We nonetheless recommend a zero-degree gaze angle for our occupational lenses inasmuch as the television set is most often located at eye level.

### 2.1.3 Data on new technologies

Through a review of the literature in this area, we determined that there is a real lack of postural data related to the use of recent digital devices, hence the need to undertake a measurement campaign.

### 2.2 Review of surveys

Before starting the measurement campaign, we reviewed a number of opinion surveys on the use of digital technologies for the purpose of defining the age group of our population, selecting the devices to be tested and to ensure that we cover as completely as possible the conditions under which these devices are likely to be used in everyday life.

#### 2.2.1 Who accesses the Internet?

If we look at the age of people accessing the Internet, according to the results of the Ipsos Tech Tracker study in the third quarter of 2013, we can see that all age groups are represented and, even though the percentage of Internet users is lower in the over-65 age group (55.5% on average), this percentage remains very high in the other categories (> 80%) (Fig. 2). Moreover, we can easily assume that the percentage of people over 65 years accessing the Internet will increase in coming years, in view of the fact that digital technologies are playing an increasingly important role in our everyday lives. So we did not set an age limit for the recruitment of our subjects.

#### 2.2.2 Equipment in the home

Regarding electronic devices, according to the same study, in 2013, the percentage of laptop owners in the household remained stagnant at about 63%, and the number of connected TVs stood at 14%. It is noteworthy that the number of latest-generation consoles fell slightly, from 40% to 37% in one year, presumably in favour of smartphones, which grew strongly, moving up from 37% to 55%. Similarly, there was a sharp rise in the number of tablets (11 to 30% in one year) and e-book readers (12 to 17% in one year) (Fig. 3). We chose to focus on the latter three devices in our study.
EQUIPMENT IN THE HOME

WHICH OF THE FOLLOWING DO YOU OWN/HAVE IN YOUR HOUSEHOLD?:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>TABLET OWNERS</th>
<th>NON-TABLET OWNERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laptop</td>
<td>64%</td>
<td>62%</td>
</tr>
<tr>
<td>Digital TV via aerial/Freeview</td>
<td>53%</td>
<td>51%</td>
</tr>
<tr>
<td>TV with internet built in</td>
<td>14%</td>
<td>14%</td>
</tr>
<tr>
<td>Latest generation games console</td>
<td>37%</td>
<td>40%</td>
</tr>
<tr>
<td>Smartphone</td>
<td>14%</td>
<td>11%</td>
</tr>
<tr>
<td>Tablet computer</td>
<td>55%</td>
<td>37%</td>
</tr>
<tr>
<td>ebook reader</td>
<td>17%</td>
<td>12%</td>
</tr>
</tbody>
</table>

**FIG. 3** Progression of digital equipment. Source: Adapted from Tech Tracker quarterly release Q3 2013 IPSOS Media CT (data on 1,000 adults in the United Kingdom over 15 years of age)

TABLET USAGE – WHAT FOR?

WHAT DO / WOULD YOU USE A TABLET FOR? (%)

**FIG. 4** Main activities on tablets. Source: Tech Tracker quarterly release Q3 2012 IPSOS Media CT (data on 98 adult tablet owners and 909 adults not owning tablets in the United Kingdom over 15 years of age)
2.2.3 Use of equipment

In 2012, according to the Ipsos Tech Tracker study, tablets were used for relatively traditional activities, which have not changed substantially to date. These activities include: consulting emails and social networking, looking up information, watching videos, reading newspapers, playing video games, checking the weather forecast, etc. (Fig. 4). These are nearly the same activities practiced on mobile phones. We selected seven of the most representative activities for our study.

2.2.4 Location of digital device usage

According to the same study, in 2012, the three main locations in which tablets are used are: the living room (92%), the bedroom (65%) and the kitchen (47%) (Fig. 5). We can assume that in the living room, people tend to be sitting, in the bedroom they are probably lying down, and in the kitchen, they are usually standing. The same assumptions can be made for smartphones. We therefore decided to focus on these three positions (standing, seated and lying down).

2.3 Experimental setup and procedure

Twenty-two subjects participated in the study. The average age was 36.2 (with a range of 22 to 51). Since the goal was to collect reference data, only three subjects with presbyopia were included in the study, since it has been shown that progressive lenses influence natural posture (Mateo B, Porcar-Seder R, Solaz JS & Dürsteler JC., 2010)

The subjects all wore their usual prescription lenses and were all familiar with the digital device being tested (questionnaire).

2.3.1 Experimental setup and calibration

In order to record data on the posture of people in movement, Essilor acquired a technical platform called MoViS (Motion and Vision Science) equipped with a motion capture system (VICON®) comprising eight synchronized infrared cameras.
infrared cameras that can capture the coordinates (X, Y, Z) of retro-reflective markers in real time (Fig. 6).

Each subject was first fitted with a headset equipped with four markers, and we placed four other markers on the upper part of his or her body to mark the position of the trunk (Fig 7).

Before starting the experiment, we took a series of photographs of the subject’s head, which were used to calculate the position of the axis of rotation of each eye\textsuperscript{15} in the headset’s reference point. Then, to be able to measure head and eye movements, we needed a reference position looking straight ahead. For this, the subject had to stand about 2 m in front of a mirror and look at the root of his or her nose in the mirror (Fig. 8). Once the subject was in this position, we proceeded with the acquisition of the markers’ coordinates.

The three devices used by the subjects were also equipped with markers. As a result, during the course of the experiment, we were able to calculate the exact position, in real time, of the subject’s head, and the centers of rotation of their eyes and trunk, as well as the exact position of the object being manipulated.

2.3.2 Procedure
Once the calibration phase was completed, the subject had to follow a specific scenario in which he or she performed fourteen activities one after the other, on three different devices, in three different positions (Tab. 1):

For each of the fourteen activities, we processed the data on the positions of the axis of rotation of the eyes, the device and the trunk so as to extract such data as: eye-screen distance, eye declination, rotation of the head relative to the trunk and rolling of the head.

2.4 Results
During the experiment, the data acquisition frequency of the VICON\textsuperscript{®} system was set at 100 Hz. For each subject, we measured the mean and standard deviation data (eye-
screen distance, eye declination, rotation of the head relative to the trunk and rolling of the head) over the duration of the activity. The standard deviation provided information on the subject’s stability during the activity. We then processed the data via analysis of variance (repeated measures ANOVA). And to delve further, we conducted planned comparisons to identify differences between groups: comparisons by device (smartphone, tablet, e-book reader) or by position (standing, sitting, lying down).

### 2.4.1 Eye-screen distance

The mean distance from the screen was 33.8 cm for the smartphone (SD 5.1 cm) Fig. 9; 38 cm for the e-book reader (SD 6.5 cm) and 39.7 cm for the tablet (SD 6 cm). Analysis of variance shows that there are significant differences between activities (F(14.294)=11.662 and p<0.05). Planned comparison analysis showed a significant difference (t(21)=7.358; MSE= 0.727; P=3.06E-7 < 0.05; d=1.56 ; CI95% [3.9; 6.8]) between small screens (4 inches for the smartphone) versus large screens (6 inches and 9.7 inches respectively for the e-book reader and the tablet). The smaller the screen, the closer the distance of use. These results were subsequently confirmed by Maniwa et al. (2013)\(^6\). Ko et al. (2012)\(^7\) show that users reduce their viewing distance when the...
font size is smaller. But the font size of our devices was also related to their size: 1.5 mm for the smartphone, 2 mm for the e-book reader and 3 mm for the tablet. Our results were thus consistent with their work. (Fig. 9a and Fig. 9b)

By comparison, a study conducted internally on forty subjects shows that the mean distance for reading on paper is 41.8 cm (SD 9.6 cm) and for writing on paper is 41.8 cm (SD 11.4 cm) or approximately 8 cm more than for smartphone use.

2.4.2 Eye declination
The mean eye declination angle was 25.6° for the smartphone (SD 7.2°) (Fig. 10); 20.2° for the e-book reader (SD 7.2°) and 20.3° for the tablet (SD 7.7°). Analysis of variance shows that there are significant differences between activities (F(14.280)=15.641 and p<0.05).

Planned comparison analysis showed a significant difference (t(20)=5.872; MSE= 0.920; P=4.96E-7 < 0.05; d=1.58 ; CI95%[4.9; 8.5]) between standing and seated positions. But since the device most frequently used standing is the smartphone, we also found a significant difference between the smartphone and the two other devices (t(20)=6.942; MSE= 0.773; P=9.67E-7 < 0.05; d=1.51; CI95%[3.8; 6.9]). (Fig. 10a and Fig. 10b)

By comparison, a study conducted internally on forty subjects showed that the mean eye declination angle for reading on paper is 18.7° (SD 6.1°) and for writing on paper is 13.8° (SD 8.8°). Eye declination in the use of recent digital devices is thus much more pronounced than is the case during use of paper media.

2.4.3 Other data
2.4.3.1 Head rotation relative to the trunk
We measured the angle in a horizontal plane between the head and the trunk. Analysis of variance shows that there are no significant differences between activities: F(14.266)=1.7223 and p=0.051. The mean angle between the head and the trunk is -0.3° (SD 5°) where a negative angle indicates head rotation to the left. Since the mean angle is very small, we can conclude that when using digital devices, the head remains perpendicular to the trunk (Fig. 11).

2.4.3.2 Roll angle of the head
We also measured the roll angle of the head. Analysis of variance shows that there are significant differences between activities: F(14.238)=2.4875 and p=0.026 < 0.05. However, planned comparison analysis shows no difference between devices or positions. The mean roll angle for all activities combined is -2.9° (SD 3.6°) where a negative angle indicates head rotation to the left. Since the mean angle is very small, we can conclude that when using digital devices, the head remains vertical.

2.4.3.3 Standard deviation of data during each activity
Since the data acquisition frequency of the VICON® system is set at 100 Hz, a datum is received every 10 ms. The standard deviation of each datum gives us an idea of

“Eye declination in the use of recent digital devices is much more pronounced than is the case during use of paper media”
Factors, 44, pp443-450.

2. Quarterly worldwide FPD shipments and forecast, displaysearch/hs.xsl/quarterly_worldwide_fpd_forecast_report.asp


Vision care professionals are observing higher rates of asthenopia during examinations. The main culprit is: the increasingly wide-ranging and intensive use of digital displays.
THE DIGITAL ENVIRONMENT AND ASTHENOPIA

The incidence of asthenopia is steadily increasing. The main culprit is the increasingly varied and intensive use of digital displays. This dual trend, however, is far from being a foregone conclusion. The observations and ideas for preventive solutions presented below were expressed during an interview with Dr. Marcus Safady, an ophthalmologist practicing in Rio de Janeiro and the 2013-14 president of the SBO - Sociedade Brasileira de Oftalmologia (Brazilian ophthalmology society).

Points de vue: What are Brazilian ophthalmologists seeing during consultations?

Dr. Marcus Safady: We are seeing more and more patients suffering from asthenopias in our practice. Nowadays, symptoms such as dry eyes, red eyes, eye strain sensations, blurred near vision, headache, peri-, intra- or retro-ocular pain, and glare sensations are extremely common. The origins of these symptoms may be refractive (uncorrected or poorly corrected), accommodative or muscular, and clinicians must consider their true cause to treat them effectively.


KEYWORDS
Asthenopia, eyestrain, postural fatigue, glare, headache, dry eye, contrast perception, adaptation, comfort, posture, digital displays, ergonomics, e-reading, digital devices, connected life, computer, smartphone, tablet, Essilor® Eyezen™, ophthalmic lenses, protocol, eye examination.
What correlation do you see between asthenopia and digital displays?

If the patient is properly corrected and presents no particular abnormality in binocular vision, asthenopia symptoms are generally related to external causes. Foremost among them is the intensive use of digital devices, now ubiquitous in our daily lives. When we work in front of a screen our eyes blink less often, resulting in dryness of the ocular surface. The effort of accommodation and convergence is also more sustained due to the increased proximity of multiple displays (e.g. the smartphone and tablet are used at closer distances than the computer). Our eyes make an effort to focus and converge on more or less pixelated targets, whose quality and contrast vary, while remaining exposed to high screen brightness levels. The light emitted is characterized by a predominant dazzling white light that peaks in the blue at short wavelengths. An ophthalmic impact is unavoidable.

Does this type of disorder affect some populations more than others?

These displays exacerbate existing visual defects and also affect those who do not wear glasses. Studies show that 60% to 90% of people using digital displays have more or less troublesome symptoms of eye disorders, regardless of their visual correction. Ophthalmic consultations reveal this problem in adults, children and adolescents. In fact, young people, who often keep their eyes glued to video games, cell phones and computers all day long, even at school, are a particularly vulnerable population.

“Asthenopia symptoms are generally related to external causes correlated with the ubiquitous use of digital devices in our daily activities.”
“Displays exacerbate existing visual defects and also affect those who do not wear glasses.”

What are the most common solutions and recommendations?

Patients may not be aware of the causes. When they consult, they usually come in for a refractive problem. They complain of eyestrain and subjective symptoms. Ophthalmologists need to be attentive and play an active role in the fight against this very real scourge. Recommendations are simple: a good visual examination (including visual acuity, binocular vision and accommodation), a refractive correction, ergonomic advice (i.e. best practices for the use of digital devices) and the prescription of a treatment (i.e. eye drops to relieve ocular dryness) or a preventive solution such as appropriate ophthalmic lenses.

How is treatment for this problem handled in Brazil?

In Brazil, as in the other countries, eye problems related to the ubiquity of digital displays are widespread. Vision care professionals are increasingly aware and a "standard" protocol is beginning to emerge. It is organized into four
main points and is potentially very beneficial for the patient. First point: increasingly frequent consultations with age, arriving finally at an annual rate (eye check once a year). Second point: ergonomic advice (on posture, lighting, rest, etc.) to avoid exacerbating the problem. Third point: better lubrication of the ocular surface, simply by blinking more frequently or via artificial tear solutions. Finally, the fourth and central point of the prevention plan for asthenopia related to digital device use involves the prescription of ophthalmic lenses adapted to the specificities and pervasiveness of digital displays.

**What are the desired characteristics for these preventive lenses?**

They are two in number. The first is the provision of additional refractive power at the bottom part of the lens to relieve the eye’s accommodative effort. A few fractions of additional diopter are invaluable when working for hours in front of a digital display. The second is the presence of a filter blocking blue light and the glare effect: a selective anti-reflective treatment reduces screen brightness and blocks harmful blue light.
The perfect ophthalmic lens must combine both features to fight effectively against asthenopia generated by digital device use. These characteristics seem to be consistent with the ophthalmic lens offer called Eyezen and designed by Essilor research centers?

Absolutely!

**KEY TAKEAWAYS**

- Intensive use of digital displays increases the incidence of asthenopia.
- The problem affects all age groups and as many people not wearing glasses as those with visual defects.
- In Brazil, an easy-to-use four-point protocol is helping to fight effectively against this type of disorder.
- Glasses combining additional refractive power in the bottom part of the lens and a blue light filter are the main preventive solution prescribed for asthenopia related to digital device use.

“The central point of the prevention plan for asthenopia related to digital device use is the prescription of ophthalmic lenses adapted to the specificities and pervasiveness of digital displays”
Market research institutes and observatories that study socioeconomic impacts are providing invaluable insights into how people use digital devices and how those devices are affecting the health of users around the world.

P.38 How have multiple screens become the new reality worldwide?

P.45 Is there a link between the digital environment and myopia?
Just a few years after their market introduction, digital devices are abundantly present in people’s everyday lives. We now live in a multiple-screen environment and may use up to ten different devices with screens in a single day (laptop, desktop, tablet, console, digital TV, GPS, e-book reader, digital code device, smartphone or smartwatch).

Users today want to be connected at all times. However, these new media are affecting their vision and posture. To measure this impact, the Ipsos institute conducted a broad survey on four continents with four thousand people. The results show the growing challenges posed by this new digital reality to public health.

**Cross-generational use of digital devices is accelerating**

Today, digital devices have become an accepted part of everyday life, irrespective of age, social class or geographical area. After years of undisputed reign, the supremacy of television and computers has now been challenged by a massive influx of small screens – smartphones, tablets, e-book readers and game consoles – that have truly revolutionized digital practices. In less than ten years – the launch of the iPhone barely dates back to late 2007, and the tablet to 2010 –, these new media devices have emerged as essential everyday tools, generating new habits and new needs.

**SURVEY**

To measure the impact of the use of these new devices on users’ vision and posture, Ipsos conducted a broad survey on an international scale in four countries (Brazil, China, France and the United States), with four thousand people aged 18 to 65.
The use of digital screens is now a daily reality for a very large majority of the population. Young and old alike use them several hours a day, and 29% of smartphone owners have their eyes riveted on their phone screens for more than four hours a day. Opportunities for use are varied and include reading, writing, watching videos, taking photos or videos and much more. Fig. 1.

Multiple-screen use is intensifying

Devices are no longer used just sequentially; they are increasingly used simultaneously. Combined, they exact a heavy toll on the eyes at any distance, whether viewed from afar or close-up: for example, 72% of people surveyed have watched television while using a smaller screen, such as a smartphone, tablet, e-book reader or game console, forcing them to constantly look back and forth from one screen to the other. 69% have used a computer while alternating with a smaller screen(s). This intensified use is reported by users themselves: 89% of them confirm that they seem to spend more time using screens, and 82% say they are watching screens for longer periods than two years ago. Fig. 2.

New digital uses are causing visual and physical discomfort

The increasingly intensive daily use of digital devices, particularly small screens – the smartphone is the most frequently used device on a daily basis –, involves a certain amount of discomfort, and users are well aware of this: 89% have felt discomfort or pain in their eyes, which they associate, at least in part, with their use of screens. But most of the time, their symptoms seem to be temporary and fairly harmless: they complain of eyestrain (74%), itchy eyes (50%), dry eyes (46%), rather than report that their eyes sting (34%) or hurt (35%). Their eye symptoms, especially eyestrain (which 51% describe as moderately or highly bothersome) are considered just as uncomfortable as the bodily pain affecting the neck and shoulders (54%) or back (51%) Fig. 3.

In addition to these visual and physical symptoms, 46% of respondents report they have difficulty sleeping, including 35% for whom this is a real problem.

Even though these symptoms cause little or no concern on the part of users of digital devices, several factors should nonetheless alert healthcare professionals, leading them to monitor their development over time.
**MARKET WATCH**

**Differences in habits with digital screens between now and 2 years ago**

You spend more time on digital devices now than 2 years ago

Whenever you use digital devices, you look at digital devices for a longer period of time now than 2 years ago

You read text more often on digital devices now than 2 years ago

You switch more often from one digital device to another now than 2 years ago

You look at digital devices at close distances more often now than 2 years ago

You look at digital devices at closer distances now than 2 years ago

**Base** All Respondents (n=4034)

Question a: If you had to compare the way you used digital devices 2 years ago to your actual habits, would you say that...

**FIG.2** Intensification of multi-screen use

**Level of discomfort experienced for each symptoms**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Total Experienced the symptom</th>
<th>Total High/Medium level of discomfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tired eyes</td>
<td>51%</td>
<td>74%</td>
</tr>
<tr>
<td>Neck and shoulder pain</td>
<td>54%</td>
<td>70%</td>
</tr>
<tr>
<td>Back pain</td>
<td>51%</td>
<td>66%</td>
</tr>
<tr>
<td>Headache</td>
<td>39%</td>
<td>55%</td>
</tr>
<tr>
<td>Itching eyes</td>
<td>29%</td>
<td>50%</td>
</tr>
<tr>
<td>Dry eyes</td>
<td>31%</td>
<td>46%</td>
</tr>
<tr>
<td>Far blurred vision</td>
<td>32%</td>
<td>46%</td>
</tr>
<tr>
<td>Difficulties to fall asleep</td>
<td>35%</td>
<td>46%</td>
</tr>
<tr>
<td>Teary eyes</td>
<td>25%</td>
<td>44%</td>
</tr>
<tr>
<td>Irritated eyes</td>
<td>25%</td>
<td>41%</td>
</tr>
<tr>
<td>Close up blurred vision</td>
<td>26%</td>
<td>40%</td>
</tr>
<tr>
<td>Red eyes</td>
<td>21%</td>
<td>37%</td>
</tr>
<tr>
<td>Painful eyes</td>
<td>21%</td>
<td>35%</td>
</tr>
<tr>
<td>Burning eyes</td>
<td>20%</td>
<td>34%</td>
</tr>
<tr>
<td>Screen glare</td>
<td>19%</td>
<td>34%</td>
</tr>
<tr>
<td>Dizziness</td>
<td>16%</td>
<td>30%</td>
</tr>
</tbody>
</table>

**Base**: All Respondents

Question a: Have you ever experienced these symptoms, even rarely?

Question b: How would you evaluate the level of discomfort when you experience these symptoms?

**FIG.3** Body and visual discomfort linked to multiscreen uses (including difficulty falling asleep)
- There already seems to be a very strong link between intensity of screen use and the symptoms felt. In other terms, the longer and more frequently one uses digital devices, the more one is affected by ocular or physical symptoms. Small screens, especially those found on smartphones, tablets, or game consoles, seem to cause more problems for the eyes, due in particular to difficulty reading small type: people using these devices heavily (i.e. more than four hours a day) seem to feel that they have dry eyes more often than others (62% had already experienced this symptom, versus 46% for all users) or experience sore eyes more often (46% versus 35%). And as the use of digital devices continues to expand, it is likely that more and more people will face these symptoms in coming years.

- Moreover, more than half of those reporting one of these symptoms feel that their symptom(s) are worsening over time, and becoming increasingly troublesome.

- Users of digital devices also encounter the problem of blurred vision, when viewing them close-up (40%) or from afar (46%), which may be perceived as getting worse over time (31% for distance vision, and 29% for near vision).

- Despite these specific signs, few envisage spending less time viewing screens: over 40% of those surveyed state that they have simply not considered reducing the length of time or frequency they use their digital devices to relieve their symptoms, illustrating by this attitude their increasingly strong dependence on these everyday objects. Most of the time, users opt for quick, simple solutions, such as taking a break, changing position or looking away from the screen from time to time. It is also noteworthy that 60% have already tried to change the brightness of their screen, and that 40% wear dedicated eyewear during screen use.

**Everyone is concerned, particularly young people**

Since they use these devices for longer periods and more intensively than those over fifty, young people are the primary victims of damage related to digital device use, even before they become presbyopes, they now seem to suffer from a greater number of ocular and physical symptoms than their elders. Tired or sore eyes, headaches and blurred distance vision are felt far more frequently by those under forty year of age. These symptoms are also

---

**Solution tried to relieve symptoms**

<table>
<thead>
<tr>
<th>Solution tried to relieve symptoms</th>
<th>% of success of the solution among those who tried it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taking a break</td>
<td>68%</td>
</tr>
<tr>
<td>Changing your posture</td>
<td>47%</td>
</tr>
<tr>
<td>Looking away times to times from the digital devices</td>
<td>47%</td>
</tr>
<tr>
<td>Adapting the environment lighting</td>
<td>37%</td>
</tr>
<tr>
<td>Modifying your work station</td>
<td>36%</td>
</tr>
<tr>
<td>Changing the lighting of the digital devices</td>
<td>37%</td>
</tr>
<tr>
<td>Using digital devices for a shorter period of time</td>
<td>41%</td>
</tr>
<tr>
<td>Using less frequently digital device</td>
<td>37%</td>
</tr>
<tr>
<td>Wearing dedicated eyewear</td>
<td>26%</td>
</tr>
<tr>
<td>Changing your food habits or taking food supplements</td>
<td>18%</td>
</tr>
<tr>
<td>Taking medicines</td>
<td>19%</td>
</tr>
</tbody>
</table>

Base: Think the symptoms are caused by the usage of digital devices (n=3463)

Question: Have you tried the following solutions to relieve your symptoms linked to the usage of digital devices?

**FIG. 4** Solution tried to relieve symptoms
accompanied by a greater awareness by those under forty of the link that may exist between the use of screens and visual discomfort. Everyone is concerned by eye problems, including wearers of corrective lenses, and particularly contact lens wearers. A significant proportion of non-wearers are also affected: 61% of them have the impression that they must make more of an effort to see well when using digital devices (versus 66% of corrective lens wearers).

Finally, countries like Brazil and China, which are experiencing an unprecedented boom in the use of these new digital media, are also particularly exposed to this situation, due to their usage practices: in China, 45% of smartphone users say they use their phone over four hours a day (versus 29% for all countries), and for activities that are often more time-consuming than average (i.e. watching a film or a video, reading for long periods, etc.).

What are the potential risks of digital screen use and what solution(s) are available to prevent them?

Even though they are aware of being "addicted" to screen use, people still seem to be insensitive to the risks inherent in prolonged use of digital devices. For example, the danger to the brain of increased exposure to electromagnetic waves, supported by numerous scientific studies, is a topic that comes up regularly in the news without provoking much of a reaction from the public (in France, ANSES published reports in 2009 and 2013, that were widely reported in the press; and a law governing public exposure to electromagnetic waves was adopted on 29 January 2015). Similarly, users of digital devices do not yet clearly perceive (or do not wish to perceive) the possible link between increased exposure to screens and a potential decline in their eye health. Regardless of the digital device used, those surveyed see the screen more as a source of eyestrain than as a potential danger for their eyes. For example, smartphones are considered by 27% as a device that could damage the eyes, while 39% consider instead that it is simply responsible for visual fatigue. Fig. 5.

Currently, sunlight and exposure to UV radiation are still considered the main risk for the eyes. As for blue light and its potential dangers, this remains an elusive concept for most people: only 47% consider spontaneously that they are familiar with the principle of blue light but, in fact, when it is explained to them, over half realize that they are not familiar with this phenomenon.

Awareness of the potential dangers of the intensive use of screens and the cumulative effect over time is more
important than ever, particularly among young people, who are by far the most intensive users of digital displays. Healthcare professionals have an important support role to play in their education.

Faced with these new uses for digital devices, a dedicated eyewear range, designed to relieve the eyes and protect them would appear to be quite relevant: 77% of those surveyed state that they would consider purchasing this type of eyewear, particularly the most intensive users of small digital displays. And those who do not wear corrective lenses should not be ignored, since 65% of them also state that they are interested.

Despite this positive reception in principle, the challenge in marketing this new type of eyewear will be to convince people of its effectiveness and, more importantly, to create a desire for it, particularly when we understand that the populations most concerned are those most averse to wearing glasses on a daily basis (i.e. people under forty and contact lens wearers, in particular).

For this reason, an appropriate educational effort must be made to really convince the different target groups of the tangible benefits of this type of eyewear. In view of the visual and physical discomfort reported by those surveyed, an improvement in visual comfort and a decrease in fatigue and headaches are the benefits expected by digital device users.

“Young people are the primary victims of damage related to digital device use, they now seem to suffer from a greater number of ocular and physical symptoms than their elders”
Conclusion
With rapidly changing digital use practices, everyone is or will be concerned by the potential dangers represented by these screens. But increased awareness of the inherent risks is slow to develop; certainly, physical and ocular discomfort are increasingly felt by digital device users in their daily lives, but the long-term effects remain poorly understood. Healthcare professionals therefore have an important role to play in heightening people’s awareness and helping them protect themselves, in the face of this growing public health challenge.

“Awareness of the potential dangers of the intensive use of screens and the cumulative effect over time is more important than ever”

KEY TAKEAWAYS

- The increasing use of digital devices is a transgenerational, global reality.
- 72% of respondents report that they use a combination of several different screen-based devices.
- The use of digital devices causes visual and physical discomfort (including difficulty falling asleep).
- Half of respondents consider their visual and physical symptoms bothersome.
- Half of respondents are bothered by strong screen brightness.
- Two out three people feel that they must make an additional visual effort when using screens.
- Three out of four people suffer from visual fatigue
- Everyone is affected by this discomfort, particularly young people.
- 77% of users report that they are interested in purchasing dedicated eyewear to relieve this discomfort.
- Healthcare professionals have an important role to play in raising awareness and providing treatment.
WILL “DIGITAL VISION” MEAN A BLURRY FUTURE?

Research points to the growing use of digital devices. In parallel, myopia is at epidemic levels in countries around the globe. Taking the longer view, this epidemic could have a negative impact on the lives of the myopic people, especially as they age, and will increase the economic burden that poor vision creates on the world around us.

Myopia widespread and growing; links to near vision demanding tasks and small digital screens

It’s been reported that of the approximately 7 billion people in the world, more have access to a mobile phone than a toothbrush.

That astonishing statistic speaks to the power and pervasiveness of digital communication and information. Millions of people on this earth can use the technology to text or make a phone call, yet may not have running water and electricity in their residences.

Let’s admit that there is a hypnotic quality to the digital screens that inhabit our lives. Follow someone into an elevator as they are absorbed in what they’re reading on the phone. Stop to watch people on a busy street corner, exiting an office building or on public transportation – it’s a safe bet that a large number will have a smartphone or other digital device in their hands.

We are turning more and more of our daily routine over to our digital devices. From getting the news, to paying for coffee, to receiving directions to reminding us of appointments – digital devices have become the personal assistants for 21st-century lives.

We are living multi-screen lives and are more productive because of it. However, have we stopped to consider how spending so much time squinting at small screens is impacting our vision? Eye health professionals are increa-
According to researchers, rates of myopia have doubled, even tripled, in many eastern Asia countries during the past 40 years. Hong Kong, Singapore and Taiwan have experienced rate increases hovering around 80 percent. Professor Kathryn Rose of the University of Technology Sydney and Ian Morgan with the Australian National University mentioned the prevalence of myopia in East Asia as ranging from 82% to 96% depending on age groups and countries.² Published studies confirm those figures:

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>PERCENTAGE OF MYOPIA</th>
<th>AGE GROUP</th>
<th>YEAR OF THE STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seoul</td>
<td>96.5%</td>
<td>19 yo</td>
<td>2010²</td>
</tr>
<tr>
<td>Taiwan</td>
<td>86.1%</td>
<td>18-24 yo</td>
<td>2010⁴</td>
</tr>
<tr>
<td>Guangzhou, China</td>
<td>84.1%</td>
<td>17 yo</td>
<td>2007³</td>
</tr>
<tr>
<td>Singapore</td>
<td>81.6%</td>
<td>17-29 yo</td>
<td>2009-2010⁴</td>
</tr>
</tbody>
</table>

Since 1963, Chinese students have participated in a daily routine designed to relieve eye fatigue. While seated at their desks, they massage the pressure points around their eyes. It doesn’t seem to be working. Rates of myopia have been soaring in Chinese cities, nearing almost 90 percent in places.²

Myopia is an elongation of the eyeball. While not being able to see distances can be frustrating, even dangerous when driving, it can be corrected with spectacles, contact lenses and refractive surgery. However, high myopia has been associated with a higher risk for ocular disorders, including retinal detachment and glaucoma.

singly worried about “digital vision” and the consequences resulting from spending so much time focused on small screens. In addition to failing eye sight, there are the related health issues and socio-economic impacts to consider. While users aren’t abandoning their digital screens, eye health professionals should be aware how to better advise them to be productive and retain their healthy vision.

Myopia increasing in Asia
In parallel, we observe a rise of myopia in developed and developing nations worldwide. It’s at epidemic levels. Eastern Asia, Europe and the United States have all seen a dramatic increase in the number of people who are experiencing shortsightedness.

Poor Vision’s Effect on Global Productivity

$272b

Potential annual global productivity loss associated with uncorrected refractive errors.

($22 billion United States, $7 billion Japan, $5 billion Germany.)

Source:
Smith et al., “Potential lost productivity resulting from the global burden of uncorrected refractive error,” Bull World Health Organ 2009;87
In a news release about a King’s College London research project, Katie Williams from the university’s Department of Ophthalmology, said, “We knew myopia was becoming more common in certain parts of the world – almost 8 in 10 young people are affected in urban East Asia – but it is very interesting to find that the same pattern is being seen here in Europe. This has major implications for the future burden from this eye disease which can threaten sight in older age, particular in very shortsighted people.”

The same rise in myopia is happening in the United States. The American Academy of Ophthalmology estimates that the current rate of myopia has risen to 40 percent from 25 percent in the 1970s. In a news release about a King’s College London research project, Katie Williams from the university’s Department of Ophthalmology, said, “We knew myopia was becoming more common in certain parts of the world – almost 8 in 10 young people are affected in urban East Asia – but it is very interesting to find that the same pattern is being seen here in Europe. This has major implications for the future burden from this eye disease which can threaten sight in older age, particular in very shortsighted people.”

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**Myopia prevalence in Europe**

European countries have been experiencing the impact of digital vision and myopia as well. The European Eye Epidemiology (E³) Consortium has done an extensive study of meta-data associated with eye health research which estimates that refractive error affects more than half of the continent’s adult population – myopia being the leading type with 227.2 million people based on 2010 population estimates. Based on this study, the prevalence of myopia suggests that about 20.1 million Europeans are therefore at higher risk for associated complications such as retinal detachment.

The E³ study also shows that younger people are more affected by myopia than their parents. According to the study, about one-half of younger Europeans are affected. After analyzing the data, the study uncovered that overall levels of myopia have increased about one-third for adults born after 1940 as compared to those born before that year.

**Link between myopia and education**

Another interesting finding in several research studies is the association between level of education and the incidence of myopia. The research suggests that the more educated the person – regardless of where they live – the more likely they are to suffer from shortsightedness.

“Eye health professionals are increasingly worried about “digital vision” and the consequences resulting from spending so much time focused on small screens”
This is significant because it points to lifestyle factors as having a role in the rise of myopia.

The E³ analysis of studies, which looks at more than 60,000 people, shows that the rate of myopia is about twice as much higher in people with college degrees compared to those whose education stopped with primary school.²

One of the studies included in the E³ analysis was what is known as the Gutenberg Health Study from the University Medical Center in Mainz, Germany. By examining 4,685 people ranging in age from 35-74 without cataracts or refractive surgery, the results show that myopia increases as education increases.³

The question is then natural: Is there a link between myopia development and the use of digital devices? Although no study has shown a direct link, it has been shown that when using handheld video games, children adopt a closer working distance which in turn may favor Myopia onset and progression.⁴ Indeed, near work behavior appears to be highly linked to myopia prevalence. Epidemiological studies showed that higher amount of near work results in a high prevalence of myopia in children.¹⁰,¹¹,¹²

The digital vision “antidote”
This rapid rise in myopia is alarming, especially as it affects younger people the most. Are we raising a global generation that will suffer from poor vision throughout their lives?

There is research that indicates that sunshine can be an antidote to digital vision. An Australian research project from 2003-2005 shows that time spent outdoors in natural light significantly affected the presence of myopia in children.¹³ Longer time of outdoor activity, such as sports and leisure activities, were associated with more hyperopic refractions and lower myopia rates in the 12-year-old students studied. Those who combined longer time of near work with shorter time of outdoor activity

“\textit{In addition to failing eye sight, there are the related health issues and socio-economic impacts to consider}”
had the least hyperopic mean refraction, while the students who combined low levels of near work with high levels of outdoor activity had the most hyperopic mean refraction. The lowest odds for myopia were found in groups reporting the highest levels of outdoor activity.

Chinese schools are testing various methods to improve that country’s myopia epidemic. Some schools are experimenting with transparent classrooms – the walls and ceilings are constructed of see-through material to allow for as much light as possible – to determine if that helps improve the students’ eyesight.

Other schools are forcing children to be outside more during the day and away from near vision demanding tasks including small digital screens. Students are sent outside during lunch and recess with the doors locked to keep them there.14

The role of sunlight in our eye health is not completely understood as of yet. A theory suggests that the healthy wavelengths on the blue light spectrum from the sun (the good blue) releases dopamine in the retina which would prevent the eyeball from elongating, thus preventing from myopia. These wavelengths are also protective to vision and other health functions. And the cumulative effect of the damaging wavelengths of blue-violet light (the bad blue) has been linked to retinal cell death, and possibly to AMD. The sources such as artificial light (cold LED), computer screens and handheld devices are rich in harmful blue-violet light and may source potential risks.

In addition to good old-fashioned outdoor playtime for children, the importance of an annual eye examination by a trained vision professional can’t be over emphasized. With the increased use of digital devices and rising rates of myopia, an annual exam is the best way for parents to have poor vision diagnosed – and then corrected as needed – in their children.

Promising research

Promising researches from specialized centers in Australia and China do offer hope. The Vision Cooperative Research Center (Vision CRC) is a partnership between the Brien Holden Vision Institute at the University of New South Wales and the University of Houston College of Optometry.

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Direct & Indirect Cost of Vision Loss

The direct costs of vision loss worldwide in 2012 were 2.3 trillion dollars. Indirect costs, such as lost productivity, added another 652 billion dollars.

Source:
It has announced a new technology that slows the progression of myopia in children. Vision CRC has been conducting large-scale clinical trials in Australia and China designed to control in participating children the position of the central and peripheral retinal image points. Therefore, corrective lenses can be made to control myopic progression by changing the retinal image position at the periphery without affecting the image at the center of the retina. Professor Brien Holden (1942 - 2015) has been quoted saying, “What we need are treatments that effectively slow the progress of myopia which will significantly reduce the prevalence of high myopia. A reduction in the rate of myopia of 33% could produce a 73% reduction in myopia above 5.00 D.”

To strengthen research on myopia, Essilor International and the Wenzhou Medical University in China, opened in 2013 a joint research laboratory: the Wenzhou Medical University-Essilor International Research Center (WEIRC).

“What makes it all the more important is that the link between the severity of myopia and the risk of associated conditions is exponential. Slowing the development of myopia by only 50% reduces the risk of conditions that can lead to blindness (retinopathy, retinal detachment, etc.) by a factor of 10,” explains Dr. Björn Drobe, Essilor Group Researcher and Associate Director of WEIRC.

The laboratory works on three different approaches. The first is to gain a clearer understanding of the mechanisms that cause children to develop myopia. The second focus for research relates to the predictability of myopia, and more particularly involves a study conducted with a group of 1,000 children from urban and rural environments. Lastly, the laboratory is working to identify new ways of controlling the development of myopia through a clinical trial involving 210 children.

“Ultimately, the new knowledge gained will enable us to make our products more effective in terms of slowing the development of myopia with offerings that are suitable for all children and are attractively designed, as well as enabling the development of innovative solutions to counter the myopia pandemic,” summarizes Dr. Björn Drobe.

**Socio-economic impact of myopia**

Impaired vision is the most common disability in the world, affecting 4.3 billion around the globe. The good news is that 80 percent of those impairments can be avoided or cured. However, that much vision impairment comes with a price tag.

While the global direct socio-economic impact of myopia hasn’t been determined yet, the effect of poor vision on the global economy is well documented. A 2012 review by the Boston Consulting Group and Essilor found that:

- Approximately 33 percent of the world’s working population has uncorrected vision problems that result in a $272 billion loss of productivity to businesses globally.

“Let’s not give up the digital devices, but let’s be sure to take care of users’ eye health while advising both an annual comprehensive eye examination and frequent breaks from “digital vision” to take in a longer view.”
Increasingly rely on them to connect with friends, get our news, make financial transactions, and simply make our lives easier and more productive. As a planet, we spend 3 billion hours a week playing video games. That means that we will spend more time in “digital vision” mode - fixated on small glowing screens using our eyes for near vision more often.

There will be consequences.

Yes, the majority of myopia cases can be corrected with spectacles, contact lenses or refractive surgery. And the research centers such as Vision CRC and WEIRC, as well as the technology development, give us hope for a better-seeing future. However, with so many young people dealing with shortsightedness, as they age the cost and impact of poor vision is likely to increase from such things as loss of productivity, motor vehicle accidents, falls, and social isolation. Add to that the significant increased risk people with high myopia have for related vision diseases.

Let’s not give up the digital devices, but let’s be sure to take care of users’ eye health while advising both an annual comprehensive eye examination and frequent breaks from “digital vision” to take in a longer view.

- Poor vision slows the education of school-aged children, resulting in academic under-achievement and risk of reduced adult literacy. In fact, 30% of children worldwide need vision correction and don’t have it.
- Impaired vision is associated with 60 percent of driving accidents around the world.
- Globally, poor eyesight multiplies by seven the risk of falls and hip fractures in the elderly.

The National Medical Research Council of Singapore commissioned a study on the economic cost of myopia. In 2009, the mean annual direct cost of myopia for school-aged children in Singapore was $148 (U.S. dollars), with the median cost at $83.33 (U.S. dollars) per student. It also showed that the cost of refractive surgery equaled the cost of buying and wearing contact lenses for 10 years. Beyond the cost for children, with a myopia rate of 39% in adults over 40, a 2013 study estimates the total cost of myopia for this population to be approximately SGD$959 (USD$755) million per year in Singapore.

What it means for the future

Research has indicated that myopia is rapidly rising in East Asia, Europe and the United States, especially among younger people. And research points to factors other than genetics, such as behavior and environment, as causing this epidemic. Is the common denominator among these the time spent using digital devices at near? The global use of these devices is only going to grow as we increasingly rely on them to connect with friends, get our news, make financial transactions, and simply make our lives easier and more productive. As a planet, we spend 3 billion hours a week playing video games. That means that we will spend more time in “digital vision” mode - fixated on small glowing screens using our eyes for near vision more often.

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Let’s not give up the digital devices, but let’s be sure to take care of users’ eye health while advising both an annual comprehensive eye examination and frequent breaks from “digital vision” to take in a longer view.
An epidemic of myopia is circling the globe, with Eastern Asia, Europe and the United States seeing rising rates of shortsightedness, especially in young people.

Research shows that there is a link between education level and myopia rates – those with more education are more likely to be myopic.

Corresponding to the increase of myopia is also an increase in near vision demanding tasks including the use of small digital devices as people rely on them more not only to communicate, but also to access news, information and entertainment.

“Digital vision” will likely have a socio-economic impact on the world, especially as young people with myopia grow older.
Vision care professionals already offer numerous preventive solutions for users of digital displays. Recent technological innovations in the field of ophthalmic lenses provide a host of new benefits for both those who wear eyeglasses and those who don’t.

P.54 What are the latest innovations for people with eyeglasses and those without, using digital devices?
P.68 Is it possible to live a zen lifestyle while staying connected? A study measuring the performance of the Eyezen® lens offer brings proofs.
The advent of digital technology has not only changed methods of communication and information management, but also the visual and postural-motor habits of users. To respond to these emerging needs, the ophthalmic industry has taken the path of innovation in the area of physical chemistry and optical design. This article presents a twofold technological breakthrough, which gave rise to a new category of ophthalmic lenses for a connected life. Designed by Essilor, a world leader in ophthalmic optics, these lenses are dedicated to users of all types of digital devices.

**NEW OPHTHALMIC LENSES FOR A CONNECTED LIFE:**

**EYEZEN™ FOR AMETROPES AND EMMETROPES, AND VARILUX® DIGITIME™ FOR PRESBYOPE**

Céline, holds a French engineering degree from Ecole Centrale Marseille and Paul Cézanne University in Marseille (where she obtained her Master in Optics and Photonics). In 2010 she defended her thesis in optics in collaboration with Essilor International and Charles Fabry laboratory. After working one year as a research engineer at ONERA (a French aerospace research center), she definitively joined Essilor International’s R&D Optics department in 2011. Céline develops designs to meet the emerging needs of wearers.

Marie holds a French engineering degree from Chimie Paris Tech and a Masters in marketing from Essec Business School. She joined Essilor International in the Global Marketing team in 2011. Marie is in charge of projects targeted at lens wearers with specific needs, such as pre and emerging presbyopes. She develops innovative marketing offers, such as the new ophthalmic lenses aimed at users of digital devices.

**KEYWORDS**

Eyezen™, Varilux® Digitime™, mid-distance lenses, Crizal® Prevencia®, power distribution technology, light filtering technology, blue light, blue-violet light, blue-turquoise light, UV, AMD, LED, ametropia, emmetropia, presbyopia, pre-presbyopia, digital screens, posture, digital devices, connected life, eyestrain, photobiology.

*Product availability date may vary depending on the country*
The last ten years were marked by the emergence of digital devices, such as smartphones and tablets. Already indispensable to our daily lives, they are revolutionizing the way we communicate, learn, stay informed, work, entertain ourselves and relax. With an average of four different devices (computer, smartphone, tablet and TV), we tend to switch between them more frequently and at times even use them simultaneously (Fig. 1). The time spent using these devices has increased significantly and continues to grow: indeed, nine out of ten people state that they spend more time using them today than they did two years ago. Our daily lives have been turned upside down by this digital revolution, but everything has also changed for our eyes.

Specific needs
Indeed, the use of these devices creates new visual and postural behaviours and modifies our light environment. Ten years ago, there was only one reading distance: the distance at which we held a book or newspaper. On paper, characters have always been fixed in size and highly contrasted. Today, in addition to reading books, we also read on smartphones, tablets and computers at different distances (some of them quite short) and in various postures, as a study undertaken by the Essilor R&D has shown (page 22). On screens, characters are becoming smaller and more pixelated.
Furthermore, our light environment has changed. Ten years ago, our eyes were exposed to natural light or artificial light emitted by incandescent lamps. Now, our eyes are constantly exposed to the bright light of screens and other light sources, such as LED or CFL bulbs, which strongly emit of diffusing and potentially harmful blue-violet light.

As a result, our eyes must focus more intensely and more often to adjust to the varying distances of use and to small pixelated characters found on screens. This not only causes eyestrain, but also postural aches and pain. In fact, a study conducted in 2014 by the Ipsos institute on four thousand people in France, the United States, Brazil and China revealed that:

- Two out of three people feel that they must make an additional effort in front of screens to see well,
- Three out of four people suffer from eyestrain,
- 70% complain of neck and shoulders pain
- Over one out of two people are bothered by the strong brightness of their screens.

Lastly, the harmful blue-violet light emitted by screens can contribute to premature aging of the eyes.

This study showed that all users of digital devices – regardless of their age, the type of device used and the frequency of use, feel the same discomfort, related to the difficulty of reading small characters and screen brightness. However, the level of discomfort varies depending on the user’s age. In fact, for younger users, the main discomfort is screen brightness, while for older users, it is the effort required to decipher the small characters.

A complete range designed for connected life

To meet these new visual needs, Essilor designed a new category of lenses for a connected life. This all-new range of ophthalmic lenses provides a correction for each reading distance required by digital devices, relaxes users’ eyes and protects them against the potential dangers of blue-violet light:

- Advanced single-vision lenses combined with Crizal® Prevencia® coating, called Eyezen™, for young adults (aged 20-34), pre-presbyopes (aged 35-44) and emerging presbyopes (aged 45-50), available for all prescriptions, and even for emmetropes,
- Mid-distance lenses combined with Crizal® Prevencia® coating Essilor® Digitime™, for presbyopes (aged 45 and over), specifically designed for digital devices use.

Eyezen™ lenses are meant to replace standard single-vision lenses for wear by ametropic patients, but are also intended for occasional wear by emmetropes during their on-screen activities.

There are three different products optimized for three user profiles depending on their age (Fig. 2):

- For young adults (aged 20-34): Eyezen™ 0.4
- For pre-presbyopes (aged 35-44): Eyezen™ 0.6
- For emerging presbyopes (aged 45-50): Eyezen™ 0.85

“Essilor designed Eyezen™, a new category of lenses for a connected life”
THE NEW SINGLE VISION LENSES AS PRIMARY PAIR FOR AMETROPES OR IN PLANO FOR EMMETROPES.
WITH 3 OPTIMIZATIONS DEPENDING ON PROFILES:

**YOUNG ADULTS**
20 - 34 years old

**PRE-PRESBYOPES**
35 - 44 years old

**EMERGING PRESBYOPES**
Without near vision correction
45 - 50 years old

**EYEZEN™ 0.4**

**EYEZEN™ 0.6**

**EYEZEN™ 0.85**

STANDARD CORRECTION

WITH +0.4D TO RELAX EYES OF 20-34 YO FROM DIGITAL STRESS

STANDARD CORRECTION

WITH +0.6D TO RELAX EYES OF 35-44 YO FROM DIGITAL STRESS

STANDARD CORRECTION

WITH +0.85D TO RELAX EYES OF 45-50 YO FROM DIGITAL STRESS

PROTECTION FROM UV & HARMFUL BLUE-VIOLET LIGHT EMITTED BY SCREENS.
REDUCED SCREEN GLARE & IMPROVED CONTRASTS.

THANKS TO CRIZAL® PREVENCIA®

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**Fig. 2** Eyezen™ lens range for 20- to 50-year-olds, segmented by age (advanced single-vision lenses combined with Crizal® Prevencia® coating)
**PRODUCT**

**PRESBYOPES**
With near vision correction 45 - 65 years old

<table>
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![Images of lenses with different settings](Image)

**PROTECTION FROM UV & HARMFUL BLUE-VIOLET LIGHT EMITTED BY SCREENS. REDUCED SCREEN GLARE & IMPROVED CONTRASTS.**

**THANKS TO CRIZAL® PREVENCIA®**

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**FIG. 3** The Varilux® Digitime™ mid-distance lens range for presbyopes aged 45 and over, segmented according to digital device use (occupational lenses, for occasional wear during on-screen activities or other activities requiring near or intermediate vision correction, combined with Crizal® Prevencia® coating)
In addition to providing perfect correction for ametropia, Eyezen™ lenses also provide the necessary accommodative support to relieve eyes from stress while using digital devices, which differs depending on age. On top of that, they protect eyes from the harmful light emitted by screens, reduce glare and improve contrast thanks to their Crizal® Prevencia® coating.

Lastly, the mid-distance lenses are intended for occasional wear by presbyopes during their on-screen activities or during any other activity requiring near or intermediate vision correction.

There are three different products optimized for three different categories of presbyopes, depending on the device they use most frequently (Fig. 3):

- For presbyopes keen on smartphones and tablets: Varilux® Digitime™ Near
- For presbyopes keen on computers: Varilux® Digitime™ Mid
- For presbyopes keen on large screens (TV or video projectors): Varilux® Digitime™ Room

Varilux® Digitime™ Near mid-distance lenses are optimized for smartphone or tablet use with wide near vision fields, but they also provide an intermediate vision field suitable for computer use. The minimum guaranteed depth of field is 80 cm, regardless of the prescription.

Varilux® Digitime™ Mid mid-distance lenses are optimized for computer use with wide intermediate vision fields, while also providing a near vision field suitable for smartphone or tablet use. The minimum guaranteed depth of field is 100 cm, regardless of the prescription.

Finally, Varilux® Digitime™ Room mid-distance lenses are optimized for large screens use with wider extended vision fields (delimited by room size) and offer intermediate vision and near vision fields suitable for computer, smartphone or tablet use respectively. The minimum guaranteed depth of field is 220 cm, regardless of the prescription.

Response to emerging needs in the design of this new range of lenses for a connected life

To respond to the emerging needs of wearers, Essilor brings its expertise in two areas: first, in optical lens design, to provide a perfectly suited correction, and secondly, in the area of protective lens coatings, to protect the eyes against the potential dangers of the blue-violet light emitted by screens. The range originated with a twofold technological breakthrough.

A unique technology of power distribution

Essilor R&D conducted a study on the emerging visual and postural behaviors engendered by the use of digital devices. The study revealed that the average reading distance is nearer on these devices than when reading on traditional paper media (33 cm for smartphones and 39 cm for tablets versus 40 cm for paper). Researchers also noted an average increase in the eye declination angle while reading on a smartphone (25° for smartphones versus 18° for a reading task on paper). These data (Fig. 4) reveal the need for a new Ultra-Near Vision field.

![Comparison of reading distances (D, D') and eye declination angles (Ed, Ed') between a paper medium (newspaper) and a digital screen (smartphone)](image)
A unique power distribution technology was designed to respond to emerging needs. This technology distributes the power over the lens, including additional power in the bottom part of the lens to support the eye’s accommodation effort when using digital devices, according to the physiological needs of each identified group of wearers.

It is important to point out that this additional power respects the physiological functioning of the visual system, without inhibiting the accommodative function of the wearer’s eyes.

How is this technology managed on Eyezen™ lenses?
The additional power values selected are related both to the fact that the objective amplitude of accommodation decreases with age² (Fig. 5), and that accommodative power drops after sustained and prolonged near-vision work³. For example, a drop in accommodative power of 0.4D was observed after 20 minutes of near-vision work for a traditional reading task³. For this reason, the additional refractive power provided is 0.4D for the 20-34 age group, 0.6D for the 35-44 age group, and 0.85D for the 45-50 age group.

How is this technology implemented on Varilux® Digitime™ mid-distance lenses for presbyopes?
Most near-vision exams are performed at a distance of 40 cm for reading tasks. This data is taken into account in the design of the new ophthalmic lenses for presbyopes connected life, so that wearers can effortlessly find their near-vision zone while reading. However, when using their smartphone, they bring it closer and naturally lower their gaze. At that point, their eyes encounter the additional power under the near-vision zone, thus relieving accommodative excess.

This technology creates an additional field of vision: the Ultra-Near Vision zone, which provides additional power. This zone, located under the near-vision zone, allows users to lower than gaze more than when they are reading on paper media. This additional power allows users to use their device at closer distances.

The additional power provided by the lens reflects users’ specific characteristics, as well as their prescriptions and the widths of the fields of view of the target product. So the additional power will not exceed 0.50D depending on the chosen lens and prescription.

Finally, the near-vision zone is not impacted by the additional power. The eye health practitioner’s prescription is therefore always respected.

Since using a smartphone at a distance of less than 40 cm (Fig. 6) is likely to generate a substantial degree of discomfort and difficulty in focusing (i.e. blurred vision), the additional power under the near-vision zone provides support for accommodative effort, giving the wearer’s vision more clarity.

What are the benefits of this technology for the wearer?
The additional power helps to reduce visual fatigue for the wearer, even during prolonged smartphone use. It also improves the readability of small characters. Finally, it allows presbyopes to adopt a more natural posture when using their smartphone.

Ergonomics of visual field positioning on Varilux® Digitime™ mid-distance lenses for presbyopes
Positioning of visual zones on mid-distance Varilux® Digitime™ lenses. The ultra-near, near, intermediate and
FIG. 6 | Benefits of the Ultra-Near Vision zone provided by additional power. Smartphone use without additional power (above). With additional power (below).
extended visual zones are positioned optimally – in view of design constraints (fields of view width, prescription, minimal guaranteed depth of field, etc.) natural gaze lowering of the wearer and average use distances for each specific digital device (Fig. 6). With the exception of the ultra-near vision zone, which includes a progressive zone followed by an area of stable power, all zones are stable in power, therefore improving wearer comfort.

The positioning of these zones is customized to the prescription to follow the wearer’s natural convergence and provide good binocular vision. In this regard, the zones are properly positioned in the lens, vertically and horizontally, to minimize visual fatigue for the wearer.

Characteristics of the intermediate vision zone. Between the near vision zone and the intermediate vision zone, or extended vision zone depending on the case, there is a variation in power known as degression (Fig. 7). This helps to ensure a given minimum depth of field (Fig. 3). The value of this degression is set according to the prescribed addition value, the desired minimum guaranteed depth of field and the wearer’s subjective accommodation.

Customization of intermediate vision on Varilux® Digitime™ mid-distance lenses
The average distance of use for a computer is 63 cm, but a wide variation has been observed: 95% of people use a computer at distances between 38 and 88 cm. It is therefore recommended to customize intermediate vision for each individual.

To customize intermediate vision, Essilor has taken into account a new parameter known as “Screen Distance”, which corresponds to the distance between the eye and the computer screen. When calculating the lens, this
The parameter is used to customize the degression and the horizontal positioning of the intermediate vision zone relatively to the near vision zone. Taking the “Screen Distance” into account does not change the vertical position of the intermediate vision zone in the lens. The length of the degression is therefore fixed. A general illustration of customized degression as a function of “Screen Distance” is given in Fig. 8 for Varilux® Digitime™ Room mid-distance lenses.

The default “Screen Distance” value is set to 63 cm which is the average distance of use for a computer (in the event that the optician do not indicate this parameter when the order is placed). It may range between 35 and 99 cm (as a reminder, 95% of people use their computer at a distance ranging between 38 and 88 cm).

The benefits provided by this parameter are a natural posture in front of the computer and maximum comfort for intermediate vision use.

New light environment
In addition to the optical design of lenses, it is essential to define an appropriate treatment for new light environments and for the spectral characteristics of the light emitted by screens.

The role of light is essential, but can also be harmful at times
Visible light plays a crucial role in our everyday lives. It is essential, in particular, for the perception of colours,
contrast and for visual acuity. Besides vision, certain frequencies of the visible light spectrum are even more important for our health. For example, blue-turquoise light, around 480 nm (465-495 nm) is known as “good blue” light because it is responsible for synchronizing our circadian rhythms (our biological clock) in charge of regulating our waking and sleep cycles, as well as our body temperature and mood, among other things.

Chronic exposure to light also presents some risks for our visual health. Blue light is the highest energetic light to reach the retina, since ultraviolet radiation (UV), which is even higher in frequency, is blocked by the anterior ocular media. There is a rich literature on the harmful effects of blue light on the retina, the first articles dating back over forty years. But it was only recently that the precise spectrum of toxic action of this light on a cellular model of AMD was demonstrated.

Identification by Essilor and the Paris Vision Institute of the toxicity of blue light on the retina
Joint research conducted by the Paris Vision Institute (see inset) and Essilor International led to the identification of the most dangerous part of the blue light spectrum for retinal cells involved in the development of AMD. The light inducing the highest mortality rate in retinal cells corresponds to a narrow band of 40 nm centred on 435 nm. These wavelengths correspond to the blue-violet light bordering on the blue-turquoise light that is essential to our health (Fig. 9). The research was conducted on retinal pigment epithelium (RPE) cells, the first cells to degenerate in AMD. These cells were photosensitized, to form a model of aging and AMD, and exposed to narrow 10-nm bands of illumination in the blue-green spectral range, between 390 nm and 520 nm, under physiological conditions of solar radiation on the retina (with a control band centred on red at 630 nm).

Protection provided by Crizal® Prevencia®
Photobiological studies demonstrated an average 25% reduction in cell death by apoptosis comparatively between Crizal® Prevencia® lenses and exposure without a filter over the spectral range [400 nm ; 450 nm]. Fig. 10 illustrates the comparative levels of apoptosis between the naked eye (grey) and a Crizal® Prevencia® lens for each blue light bandwidth. This level of protection over the long term would mitigate the risk related to harmful blue light, and therefore the onset of AMD.

Blue-violet light is everywhere
Today, our eyes are confronted with potential new dangers, both at home and at work. Several independent studies conducted by health agencies are now taking an interest in risks related to new sources of artificial light, such as light emitting diodes (LEDs), since the latter, particularly cool white LEDs, present an emission peak in the harmful blue-violet band (Fig. 11) and have a more elevated luminance/brightness than traditional sources. Yet, LEDs are now present in most modern lighting systems and in a large number of screens, especially computer, tablet and smartphone screens.

A unique light filtering technology and wearer benefits
Concerned about the amount of time we spend in front of screens, Essilor has made protection one of its priorities for its new range of lenses designed for a connected life. To protect our eyes, Crizal® Prevencia® coating, the product of a unique light filtering technology, was therefore integrated into the entire range.

This technology selectively filters out harmful blue-violet light, emitted especially by screens, while allowing beneficial light (including blue-turquoise light necessary to the proper regulation of circadian rhythms) to pass through. This technology also provides the best protection against reflected light, smudges, scratches, dust and water for optimal vision and lasting transparency.
The benefits of Eyezen™ lenses and mid-distance lenses combined with Crizal® Prevencia® coating have been confirmed by numerous tests. When evaluated under actual conditions of use, 89% of wearers reported that they experienced reduced glare and better contrast during screen use. In addition, in vitro tests have shown that blocking 20% of blue-violet light would reduce the rate of retinal cell (RPE) death by apoptosis by 25%. This should contribute to longer-term health benefits, and particularly to the prevention of premature aging of the eyes.

**Recommendations concerning the mode of prescription**

For the prescriber, the new lens range stands out for its simplicity of implementation. We have made no changes to the prescriber's usual practices. He or she conducts the eye exam to obtain the prescription in the usual manner.

- For **Eyezen 0.4, 0.6, 0.85** lenses, the only prescription required is for distance vision: the prescriber does not need to worry about selecting additional power.

- For **Varilux® Digitime™ Near, Mid and Room** mid-distance lenses, the distance vision prescription and addition is required: the prescriber does not need to worry about selecting the design.

As for the optician, Essilor can provide a “Screen Distance” measurement tool for in-store use so that the customer can also enjoy the benefits of a customized version of mid-distance lenses. All that the optician need do, when placing the order, is indicating the “Screen Distance” value obtained via this measurement tool in addition to the customer’s prescription.
Conclusion
By continually placing end users at the heart of its innovation process, Essilor closely studied how new digital devices and their use are impacting vision and posture, thus making it possible to identify and characterize new visual needs.

This in-depth understanding of the users of digital devices led to a combination of two cutting-edge technologies of power distribution and light filtering. This patented technology alliance (several patent applications have been filed and are currently under consideration), the basis of both Eyezen™ lenses for ametropes and emmetropes and of Varilux® Digitime™ mid-distance lenses for presbyopes, is a perfect fit with our new connected lifestyles.

These new lenses underwent performance testing under actual conditions of use and prescription before they were placed on the market. This approach was adopted to confirm their benefits and measure wearer satisfaction.
YOUR PATIENTS SPEND A LOT OF TIME LOOKING AT SCREENS.

Smartphones, tablets, computers and TV are now an indispensable part of their lives, to socialize, inform, learn, educate, work, play, relax and see the world.

4 DIFFERENT DIGITAL DEVICES ARE USED ON AVERAGE FOR WORK, EDUCATION AND LEISURE*.

2 OUT OF 3 PEOPLE DAILY USE A SMARTPHONE.

OF PEOPLE SPEND 4 HOURS OR MORE ON A COMPUTER PER DAY.

* Consumer quantitative study conducted in 2014 among 4000 individuals in France, Brazil, China and the US by Ipsos for Essilor.

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KEY TAKEAWAYS
• Connected life has changed our light environment and visual and postural behaviours.
• Essilor internal and external research centers have achieved a detailed comprehension of these needs.
• The new range of lenses for a connected life is the result of this research and was designed to respond to these new needs.
• It is available in several products to specifically meet each user’s needs.
• They are suitable for all users starting at age 20.
• The range was tested and approved by wearers before it was placed on the market.
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THE NEW RANGE OF EYEZEN™ LENSES: WHAT ARE THE BENEFITS PERCEIVED BY WEARERS DURING SCREEN USE?

With recent technological advances, ophthalmic lenses can now offer more than just good everyday vision. They are also aiming to meet emerging needs arising from connected life. Innovations are put to the test by specialized research institutes to measure user satisfaction and the effects of lenses on postural and visual fatigue during screen use. The new Essilor® Eyezen™ lenses were tested in an independent study before they were placed on the market. This article describes the results obtained with a population of ametropic patients wearing single vision lenses.

Essilor® Eyezen™ lenses were defined according to Essilor’s R&D programme: LiveOptics. This programme includes four major steps for the introduction of a new design. Tests conducted with consumers known as “wearer testing” constitute the fourth part of this programme.

Because the best evidence is provided by the wearer, it was essential that this new class of Eyezen™ lenses be tested and approved by the final consumer.

To ensure the impartiality of this type of test and lend credibility to the key role assigned to the wearer in the quality process, testing protocols are validated by independent research institutes. The latter, which hold large consumer databases, are in charge of implementing questionnaires for the purpose of evaluating the objective and subjective performance of Essilor® products.

Brieuc de Larrard
Consumer & Sensory research Director
– Eurosyn, France

As a product testing specialist, Brieuc de Larrard is contributing in large measure to the development of Eurosyn’s Research department and to the introduction of sensory testing in numerous business sectors. Today, he actively participates in the development and validation of innovative product testing methodologies on a national and international scale.

KEYWORDS
Eyestrain, postural fatigue, glare, headaches, dry eye, contrast perception, adaptation, comfort, posture, digital screens, ergonomics, e-reading, digital devices, connected life, computer, smartphone, tablet, Essilor® Eyezen™, Crizal® Prevencia®, ophthalmic lenses, wearer test, protocol.
INTRODUCTION
To focus attention on the consumer benefits of the new class of Eyezen™ ophthalmic lenses, Essilor contacted Eurosyn, a French market research institute specializing in sensorial analysis. In cooperation with this institute, Essilor established a test protocol for the purpose of validating the performance of Essilor® Eyezen™ lenses with a target group of ametropic subjects.

The purpose of this study was to verify whether or not an effortless transition from standard single-vision lenses to Essilor® Eyezen™ lenses was possible for persons with refractive error. More specifically, the goal was to determine the perceived benefits of this new range of lenses during digital device use.

METHODOLOGY
The Essilor® Eyezen™ range comprises three new products: Essilor® Eyezen™ 0.4, Essilor® Eyezen™ 0.6 and Essilor® Eyezen™ 0.85. These three additional refractive powers were all tested during this study.

Thin lenses (n = 1.67) equipped with Crizal® Prevencia® coating were chosen for this study. The lenses were optically centred on the height of the pupil, taking into account the measurement of the pupillary distance for far vision. Before beginning the wear period, each of the testers answered a quantitative questionnaire to assess their general satisfaction and the level of visual fatigue experienced (if any) with their usual eyeglasses (standard single-vision lenses). Each tester was asked to wear Essilor® Eyezen™ lenses instead of their main pair of usual eyeglasses for four weeks. These tests were performed “blind”, i.e. the subjects were given no information on the type of lenses being tested, and the prescription for these lenses was exactly the same as the prescription for their previous pair of glasses, to avoid any bias related to the new refraction.

At the end of the wear period, the consumers evaluated the performance of the Essilor® Eyezen™ lenses by completing an online questionnaire. This questionnaire was used to quantify wearers’ satisfaction in terms of visual comfort during the performance of everyday tasks, and more specifically, during tasks related to the use of digital devices.

POPULATION
Inclusion criteria were: 1/ Be between 20 and 55 years of age. 2/ Be a user of digital devices (for at least 6 hours a day), 3/ Alternate between different screens. 4/ Present symptoms of visual fatigue and/or postural discomfort. 5/ Be ametropic and wear standard single vision lenses to correct distance vision (DV) with or without anti-reflective coating. 6/ Have a prescription less than 1 year old. 7/ Have a correction of: -4<Sphere<+4 / -2<Cylinder<2. 8/ Not be a wearer of progressive lenses. Exclusion criteria were: 1/ Associated strabismus and amblyopia. 2/ Anisometropia greater than 1.5 dioptre. 3/ Diabetes, glaucoma or other eye diseases. Wearers were recruited online by Eurosyn. The institute then contacted each subject to discuss their availability for appointments: the first to select the test frame and take all necessary measurements; and the second, to be fitted with the eyeglasses to be tested. During this appointment, visual acuity testing for distance vision (Monoyer scale) and near vision (Parinaud) was performed. For this wearer test, the sample population was divided into three groups, depending on the wearer’s age: The first group of 25 wearers, aged 20 to 34, were equipped with Essilor®
Figure 1 shows that ametropia distribution is representative of non-presbyopic wearers of single-vision lenses.

Figure 1 shows that ametropia distribution is representative of non-presbyopic wearers of single-vision lenses.

Figure 2 shows that cylinder distribution is representative of non-presbyopic wearers of single-vision lenses.

Figure 2 shows that cylinder distribution is representative of non-presbyopic wearers of single-vision lenses.

Eyezen™ 0.4 lenses; the second group of 31 wearers, aged 35 to 44, were equipped with Essilor® Eyezen™ 0.6 lenses; and the last group of 20 wearers, aged 45 to 55, were equipped with Essilor® Eyezen™ 0.85 lenses. (Figure 1). Cylinder distribution is shown in Figure 2. It indicates a high percentage of low astigmatism values with 75% of the sample having a cylinder of less than 0.5 dioptre.

RESULTS
The results concern the entire Essilor® Eyezen™ range, including all three additional refractive powers (0.4, 0.6 and 0.85). They are consolidated over the complete sample. Seventy-six wearers tested the Essilor® Eyezen™ ophthalmic lenses for four weeks.

In this type of test, the first criterion to be verified is adaptation. The wearers reported that adaptation to these new Essilor® Eyezen™ lenses was easy (“fairly easy” to “very easy”), and 83% were satisfied, all additional refractive powers combined. As regards rapidity of adaptation, 79% rated it as rapid (“fairly rapid” to “very rapid”).

The testers wore the Essilor® Eyezen™ lenses on a continuous basis throughout their activities (including during their use of digital devices). In fact, 94% of them wore the
Essilor® Eyezen™ lenses more than four hours a day and over one out of two testers wore Essilor® Eyezen™ all day long (see Figure 3).

A first observation was made on visual fatigue symptoms and postural pain felt by subjects. All wearers recruited for the test previously experienced ocular or postural discomfort during screen use.

At the end of the wear period, all wearers reported that they felt less visual and postural discomfort while using their digital devices. They stated that this discomfort was less frequent and less intense with the test lenses (Figure 4 and 5).

The remainder of the analysis was aimed at identifying the benefits perceived by the subjects while wearing Essilor® Eyezen™ lenses.

Due to the additional refractive power provided at the bottom of the lens, they are perfectly suited to wearers who make demands on their near vision throughout the day, particularly while using digital devices. Figures 6 and 7 highlight the performance of Eyezen™ lenses: At the end of the day, 90% of wearers state that their eyes are less tired (‘somewhat less tired’ to ‘much less tired’), in comparison with how they felt with their old eyeglasses (standard single-vision lenses).
In addition, 91% of wearers who tested Essilor® Eyezen™ lenses felt that they had less difficulty reading small characters, particularly during smartphone use (see Figure 7: “somewhat better” to ‘significantly better’).

Moreover, 90% of wearers reported that light from screens caused less glare, as indicated in Figure 8.

It is also noteworthy that 89% of wearers had improved perception of contrasts with Essilor® Eyezen™ Crizal® Prevencia®, in comparison with their previous eyeglasses (see Figure 9).

Visual comfort = outcome of benefits

In addition, the study evaluated visual comfort during the use of digital devices, as well as the general satisfaction level.

Indeed, 91% of wearers reported having comfortable vision during screen use with Essilor® Eyezen™ lenses (see Figure 10). 83% of wearers were very satisfied with the level of on-screen comfort provided by these new lenses. On average, 72% of wearers were satisfied with their visual comfort using a computer compared to their previous eyeglasses.

The final result, at the end of four weeks of testing, indicates that 91% of ametropic wearers were satisfied with Essilor® Eyezen™ (see Figure 11), with a satisfaction level ranging from 7-10 on a scale of 10. It is also noteworthy that 78% of wearers reported being very satisfied with the new Essilor® Eyezen™ lenses (with a score of 8-10 on a scale of 10).

This demonstration of performance over the entire Essilor® Eyezen™ range was verified for each of the additional refractive powers (0.4, 0.6 and 0.85). All three ophthalmic lenses provided an equivalent level of satisfaction for the individual testers, as indicated in Figure 12.
Q: What was your general level of satisfaction with this new pair of lenses?
(1= Highly unsatisfactory to 10= Highly satisfactory)

91% from 7 to 10
83% from 8 to 10
91% from 9 to 10
78% from 8 to 10

FIG. 10] Visual comfort while using Essilor Eyezen lenses
(1= Highly uncomfortable to 10= Highly comfortable)

FIG. 11] General satisfaction relative to additional refractive power

Q: What was your general level of satisfaction with this new pair of lenses?
(1= Highly unsatisfactory to 10= Highly satisfactory)

7 to 10
5 and 6
1 to 4

FIG. 12] General satisfaction relative to additional refractive power
CONCLUSION
Essilor® Eyezen™ lenses were tested and approved by ametropic wearers, who previously wore standard single-vision lenses, with very good results. Indeed, 91% of them were satisfied with the new Essilor® Eyezen™ lenses, regardless of their additional refractive power.

Throughout the testing, we observed that wearers preferred Essilor® Eyezen™ lenses to their previous eyeglasses by a wide margin. They reported that their eyes were less tired and that they had less difficulty reading small characters. Finally, during on-screen use, their impression of glare also seemed to have decreased while their perception of contrast increased.

In addition, this new type of lens can completely replace a standard single-vision lens, throughout the day for all types of activity. In fact, 94% of wearers, all prescriptions combined, wore these new ophthalmic lenses for a minimum of four hours a day.

In conclusion, Essilor® Eyezen™ lenses, combined with Crizal® Prevencia® coating, were truly appreciated by wearers. Today, 93% of them continue to wear their new eyeglasses, and 88% would recommend this new type of ophthalmic lens to their families and friends. •

PRODUCT
• Essilor® Eyezen™ ophthalmic lenses combined with Crizal® Prevencia® coating were approved during a wearer test conducted by an independent institute.
• The results showed a reduction in all symptoms of visual and postural fatigue.
• A reduction in glare and improved contrast were demonstrated during the use of digital devices.
• 91% of wearers reported having comfortable vision during screen use, and 91% expressed satisfaction with Essilor® Eyezen™.
• Essilor® Eyezen™ lenses are proving to be an appropriate solution for the emerging constraints arising from connected life. They are a suitable replacement for standard single vision lenses.
Digital art offers a new way of looking at the world. As digital technology continues to evolve, it has been incorporated into new fields of artistic expression. Photography, sculpture, design, dance, painting... digital art is now being embraced in every discipline.

What creative doors have been opened by digital technology? What new challenges does it pose?
DIGITAL ART: A NEW WAY OF LOOKING AT THE WORLD

Diversity of tools and media available, straightforward access and distribution...
As digital technologies continue to evolve, they provide opportunities for new forms of artistic expression, the limitations of which are not yet clear.
Five international digital art experts in photography, sculpture, drawing, dance and painting share their experiences with us, illustrating new creative processes and shining a light on new issues associated with visual perception.

DIGITAL ART: A NEW WAY OF LOOKING AT THE WORLD

ART AND VISION

Liam Fitzpatrick
Editor, photographer (digital photography) - Hong Kong

Murray Kruger
Artist, sculptor (digital sculpture) - South Africa

Francois Lapierre
Artist, screenwriter and digital designer - Canada

Jeremy Sutton
Artist-painter, teacher (digital painting) - US (born in the UK)

Armando Menicacci
Lecturer, creator-choreographer (dance and digital media) – Canada (born in Italy)

Liam Fitzpatrick is a senior editor for TIME magazine. A graduate of Christ Church, Oxford, he has always been a very enthusiastic photographer. He experiments with different techniques and different devices, and is currently looking at the opportunities provided by the iPhone and its various applications. His eye for composition earned him rave reviews and international recognition for his “Kinky Vicious” exhibition – a series of photos showcasing his native Hong Kong. His photos have been published in TIME magazine, as well as on the Roads & Kingdoms website.

Murray Kruger is a fine arts graduate who has been interested in the potential of 3D computer animation right from its beginnings, incorporating it into his art very early on. Now a digital sculptor, he uses computer-assisted design software to create the basis for his works, while at the same time striving to maintain a pictorial approach that is similar to that used in painting. His aim is to create fantastical images that grab the viewer’s attention. His website: www.murraykruger.com

François Lapierre
After studying art and graphic design, François Lapierre spent a number of years working on cartoons, during which he learned how to use a computer. He then embarked on that about which he is passionate: Comics. He’s involved in a number of different areas, working as a designer, screenwriter and colourist on various series, such as Sagah-Nah, Le mangeur d’âmes, and Magasin général. François is currently working on a series of novels for young people: Les guerriers fantômes (the Ghost Warriors). His website: www.flapierre.com.

Armando Menicacci has a Master’s degree in musicology and a PhD in the relationship between contemporary dance and digital technologies. Between 1999 and 2009, he founded and then ran Mediadanse, a research laboratory focusing on the relationships between dance and media. In 2007, he set up the Digital flesh collective which specialises in interactive installations and dance pieces displayed and performed in the UK, Brazil, Spain, France, Italy, the Czech Republic, Tunisia and Turkey. Between 2009 and 2014, he taught in France at the Ecole Media Arts in Chalon-sur-Saone, in Turkey at Bilgi University in Istanbul, in Brazil at the Universidade Federal in Rio de Janeiro and in the UK at the Bartlett School of Architecture in London. He is currently serving as a consultant, lecturer and teacher with the dance department at the University of Québec in Montréal, and is also working on designing movement quality analysis software. Digitalflesh: www.digitalflesh.org

Jeremy Sutton studied drawing, sculpture and engraving while earning a degree in material physics. He became a full-time professional artist in 1994, experimenting with traditional and digital techniques to create works that harness the spontaneity, power and versatility of digital art tools with the beauty, quality and texture of traditional media. He also teaches digital painting, performing live action painting, as well as undertaking commissions. His website: www.jeremysutton.com

KEYWORDS
Digital art, digital creation, painting, sculpture, drawing, dance, digital media, digital photography, iPhone, choreography, digital drawing, music, digital screens, posture, perception, movement, digital tools, connected life, new technologies, computer, smartphone, tablet.
Are touchscreens, smartphone apps and 3D printers all new means of producing art? In this age when digital technologies form part of the very DNA of generations brought up counting Electric Sheep*, the plastic arts are being infused with digital innovations so that they can look upon the modern world through a digital lens. Is this evolution or revolution? The question touches on just how extensive the transformation that creativity and its practices are undergoing is - a transformation driven by digital technologies.

As far as tools are concerned, digital technologies serve first and foremost as an extension of the more traditional techniques. A typical example is photography. "With digital cameras, you can take risks, experiment with different compositions and then start again as many times as you need to until you are satisfied. And then of course you can edit the results - so much more quickly and simply than you could with film", says Liam Fitzpatrick, an enlightened journalist and photographer who gets most of his inspiration from the lights and contrasts of his native Hong Kong. Miniaturization has revolutionised his approach to photography, even more so than its computerisation. "My iPhone has become an extension of my gaze. I "work" in a state of permanent awareness. I can be taking a walk or having a conversation with someone when suddenly a ray of sunlight will caress a wall or a whirlwind of leaves will be whipped up into the air. So I will suddenly drop everything so that I can capture the moment! Something that is only possible with smartphones, which are sufficiently responsive and of good enough quality for my shots".

Dance – the art of movement – has also been able to take advantage of new technologies. "Dance does not need digital technologies to exist. But it can gain from them in order to make it richer and to anchor it in the modern era. It has a great deal to learn from digital technologies: they can provide a new insight into the creative processes involved in it", says Armando Menicacci. The Italian-born teacher-researcher and choreographer – who specialises in the relationships between dance and digital technologies – highlights the benefits of isomorphism that digital technologies provide: "With calculations performed on a computer, all of the processes involved in perception can swap their various forms. A gesture can become an image, an image can become a text, etc. The movements of dancers wearing sensors can, for example, be used to generate sound. So the music is what results from the gesture... the gesture is transformed into music", he adds as an example. The complete opposite of the conventional approach and a means of expression that contemporary dance is only just starting to explore, heralding future pieces that will be utterly captivating.

As well as further extending the areas in which pre-existing art forms can express themselves, digital technologies are also paving the way to new disciplines. Augmented reality, 3D imagery and other robotic arts have all been spawned by computer technologies. South African born digital sculptor Murray Kruger emphasises the opportunity for original creativity with which information technology and its related areas provide him.

"I'm fascinated by phantasmagoric scenes and their power to evoke reactions from viewers. I'm able to use digital tools to create 3D models that would not be possible using more traditional methods. I can check their composition and the lighting from all angles and play around with them as much as I like until I end up with something that most perfectly matches my vision. The same goes for the colouring stages: I can experiment with textures, rendering and sensations, etc." His work combines technology and creativity, infusing each of his works with its own special atmosphere and ambience and meeting one of art's foremost aims: getting the observer to ask themselves questions.

**Pleasures and frustrations of computerisation**

Some artists who experiment with digital media recognize and even regret the limitations of what they do. A stylus and a tablet computer don't feel quite the same in the hand as a hammer and a chisel, or even a real brush. This raises the question "is digital art less enjoyable to create than 'traditional' art? Or, simply, is it more frustrating?" Different, yes. Less enjoyable, no. I love the feel of chalk or charcoal in my hand, but the way in which a digital brush gently slides across a tablet is extremely pleasant", counters Jeremy Sutton. This painter who has made California his home – the spiritual son of artists such as David Hockney and Henri Matisse – appreciates the ever-growing potential afforded by new technologies, such as air painting.

"I've tried painting using leap motion – a motion recognition system. All you have to do is move your hand through the air and you can see its movements transcribed onto a screen. It's so much more than just a gadget – it's a genuine technique which will completely change the way in which we create art in the future", he enthuses.

Could innovation be a way to compensate for the frustration created by computerisation? Immersive technologies (panoramic 3D displays, force feedback, artificial smells, etc.) should gradually bridge the gap between traditional and digital. "But we shouldn't forget that it is just a tool. Let's not forget that a paintbrush at one point in history was high technology. What is important is not so much the interfaces used, but the relationship between the creator and their creation", points out Murray Kruger, who appreciates nonetheless the way in which new technologies – such as the 3D printer – are revolutionising art.

"Fiction is becoming reality and we can now create models of a level of complexity and aestheticism that are on a par with that of traditional works of art". Above all, digital sculptors are delighted that these technological advances are raising the profile of their work and making it more accessible, even helping it to break free of the confines of what is considered purely art. Their work is already being used in jewellery-making, the food industry, architecture and even medicine. And this is just the beginning.

"My iPhone has become an extension of my gaze"

- L. Fitzpatrick
“Dance has a great deal to learn from digital technologies: they can provide a new insight into the creative processes involved in it.” - A. Menicacci

Digital sharing
Art has become more accessible now than ever before thanks to the opportunities afforded by digital technologies and new ways to share it. Nowadays, anybody can share their own art or contemplate that of others on a website, a blog or via social networks. This is a way of sharing that is completely different from traditional channels, which usually require some sort of cultural intermediary or dedicated framework. Jeremy Sutton particularly appreciates “being able to share the creative process and the various stages involved in it, or being able to document them as I work. An educational approach can be considered using physical media, but that is much more complicated to put into practice”. But the flipside to art being so accessible is that it can be misappropriated or reworked. Sometimes in a good way: the process involved is genuinely creative; but sometimes it is reworked in a way that is damaging or intrusive. The painter finds himself up against complicated issues to do with
“There was a time when the brush was the apogee of artistic progress. What is important is not so much the interfaces used, but the relationship between the creator and their creation”
- M. Kruger

Artwork from © Murray Kruger
intellectual property: "We've opened up a Pandora's box. Anything can be recovered, used, changed, etc. A whole new paradigm that brings with it endless legal complexities. It is still probably best to respect everybody's original work and to strive to create and use one's own source of creativity, rather than using something that someone else has made..."

Fortunately, using somebody else's work is not always tantamount to plagiarism. It can even be an artistic approach in its own right: collaborative art, involving the public in the actual creative process. The interaction between the artist, the work of art and the general public results in something ephemeral which is forever being reinvented. In this regard, dance in particular is a field in which many people are innovating. "Participatory art – the idea of co-authoring a piece with the viewer – is helping to foster the emergence of new realities", says Armando Menicacci. But we should not lose sight of the fact that art must first and foremost raise questions in the minds of viewers – it must not simply lead them into its mechanisms so that they become one of its parts. It's all a question of control and how much freedom is granted to contributors so that their own realities can be taken into account without losing sight of the ultimate artistic aim.

An investigation into the ins and outs of participatory art that involves specialists working on computer programmes that can analyse the quality of people's movements and variations in muscular tension so that each person can be identified and the digital response customised (meaning that the result is also customised) so as to reflect their own individual characteristics as closely as possible. Dance of the future?

Multiple screens = multiple limits?
The opportunities afforded by digital technologies seem limitless. But their very nature raises certain questions – particularly regarding the way in which the art is rendered on the flagship digital medium: the screen – be it a tablet screen, a computer screen, a television screen, etc. It could be that there is a debate to be had about the opposition between scattered light and emitted light. Québec-born François Lapierre is a comic designer and colour artist, well-known for the subtlety of his digital colouring techniques. "The image displayed is often magnificent – because of the colorimetric settings. But the result can vary tremendously from one screen to another and – above all – when it is printed out, a key stage in the comic production process". This is something that he finds himself pondering on a daily basis. Although the colour proofs help ensure that the actual prints are a faithful representation of what the artist had in mind, the best solution usually involves modulating densities and contrasts and using as much light as possible. That way, the drawing is not overloaded and there is no risk of colour loss during printing. "Another thing that is very useful is a high-quality screen that is perfectly calibrated with a rendering that is the same as that of the printed image", he adds.

As far as variations from screen to screen are concerned, the easiest solution is for everybody to look at the same one. Another option is simply to accept it, bearing in mind that the actual result is never that different to the one that was intended. "The human visual system is fundamentally very good at adapting", says Jeremy Sutton. "The eye can adjust and appreciate digital art in the way intended by its creator – who is generally aware of the way in which colour..."
can be modulated and is not upset by this. Indeed, they incorporate these modulations into the way in which they conceive their own art*. Liam Fitzpatrick – who is above all interested in the experience – confirms this. As an aficionado of a more retro style, the photographer even uses smartphone apps to give his shots a more vintage look, accentuating certain aspects, giving them more texture, adding a vignetting effect, etc. “As I get older, I am less and less interested in describing reality: instead, I’m adopting a more impressionist approach. The images that I create are light, almost psychedelic. The variations in colour, saturation and contrast that are possible with digital technologies mean that you can play with emotions more easily and more vividly than you can with traditional photography*. 

Digital art, organic fatigue
The question that remains is the one that all ophthalmic optics specialists ask themselves. The question about how to maintain the artist’s most important work tool:
their eyes. What is clear is that this is not their primary concern. Logically, efforts to keep eye fatigue to a minimum should increase in proportion to the amount of time spent in front of the screen. François Lapierre, who spends an average of eight hours in front of a screen every day (twice that during rush periods), has developed his own strategy. “I take breaks every half hour. I regularly glance out of the window, to admire the landscape and rest my eyes. And most importantly, I do my best to display as little white on screen as possible. That is easily the most harmful colour for your eyes. I use a neutral grey background for my drawings and a dominant colour background for my colouring projects”.

All the artists we’ve talked to take regular breaks and experiment with different focal lengths. They also believe that if they have to work in front of a screen, they should adopt relaxing postures and use ergonomically designed equipment. Although these issues cross their mind, they rarely go so far as to protect their eyes or correct any disorders they may have. Liam Fitzpatrick and Jeremy Sutton both confess to being shortsighted, but say that having the world around them appear blurry is actually useful for their art – automatic impressionism! Sutton even “refuses to use glasses for painting or sketching. I simply squint and concentrate on the broad outlines of what I’m painting, instead of focusing on the details”. The precision involved in the task to be carried out seems to be directly correlated to the extent to which the artist takes care of the quality of their vision. François Lapierre always has his contact lenses in and Murray Kruger gets new lenses prescribed every year: “I am shortsighted and I ask my ophthalmologist to work out what lenses I need for carrying out intensive work in front of a screen. But I don’t go so far as to find out about filters and other technologies that can reduce the impact that the light emitted by the screen can have on my eyes…”

It’s up to eye care professionals to focus on their own “art” and develop more appealing solutions, bolstering the link between vision, posture and digital creation.

“And most importantly, I do my best to display as little white on screen as possible. That is easily the most harmful colour for your eyes” - F. Lapierre
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ESSILOR INTERNATIONAL - R.C CRETEIL B 712 049 618

147, rue de Paris – 94227 Charenton Cedex – France
Tel: (+33) 1 4977 4224 - Fax: (+33) 1 4977 4485

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