Varilux® XR series™

White Paper

essilor

Preface

Our near vision requirements have changed dramatically over the last 20 years. Today, modern lifestyles result in people's eyes moving 100,000 times a day to process all the visual information they are exposed to. We switch our attention and gaze back and forth between various tasks and from one object to another. Examples include people multitasking between different screens or multitasking in motion.

Due to the increased use of digital devices the visual system is constantly confronted with an overflowing quantity of information.

To keep up with these dynamic vision needs, and high-speed processes, we need to offer people new solutions that are adapted to their lifestyles.

For today's presbyopes, progressive lenses need to allow the navigation of the eyes through the lenses easier and more natural when going from one object to another and at the same time provide optimal binocular vision in this highly complex 3D environment.

EssilorLuxottica has launched a new approach to progressive lenses which showcases the next generation of Varilux® lenses.

With digital twinning technology, we can now establish a visual behavior profile for every single prescription.

The Varilux® XR series™ lenses are the first eye-responsive progressive lens that respects the natural behavior of the eye and instant sharpness even in motion, powered by behavioral artificial intelligence.

This paper will review the main aspects of the Varilux® XR series™ lens including the innovative Varilux® XR motion™ technology, the science behind the lens, features and benefits and real-life wearer test results.

Olga Prenat
Head of Medical and Professional Affairs
and Head of Vision Care Education

Author Biographies

Céline BENOIT
EssilorLuxottica
Presbyopia Category Innovation Manager

Sébastien FRICKER
EssilorLuxottica
Lens Design team manager

Guillaume GIRAUDET
EssilorLuxottica
R&D Study Manager

Mélanie HESLOUIS
EssilorLuxottica
R&D Study Manager

Laurent CALIXTE
EssilorLuxottica
R&D Study Manager

Olga PRENAT
EssilorLuxottica
Head of Medical and Professional Affairs and Head of Vision Care Education

Laetitia ROBILLARD
EssilorLuxottica
Varilux Global Marketing Director

Christophe JAN
EssilorLuxottica
Varilux Global Associate Marketing Director

Meena PUAR
EssilorLuxottica
Medical Advisor

Contents:

Summary

In our modern world, the visual system is constantly confronted with an overflowing quantity of information, particularly in the last 10-15 years with the explosion of the use of mobile digital devices. However, this recent evolution challenges our visual and attentional skills. In this increasingly rich and complex visual environment, our eyes can only capture the details of a scene at the level of the fovea, the central part of the retina, representing only 2° of viewing angle. Our attention is also challenged. Only a subset of sensory inputs can be consciously analyzed and used at a time. As a result, when we undertake multiple tasks at the same time, we don't do them simultaneously, but instead we switch our attention back and forth between the various tasks and move our gaze from one object of interest to the other. Hence, in this highly complex environment, it is crucial to perform accurate ocular navigation and place our fovea as precisely and quickly as possible on all the relevant targets for the best reaction times. This is especially important when the observer is on the move, known as in-motion multitasking. In this situation, ocular navigation will reach the highest levels of complexity as the objects of interest can be located at various distances. In this context, ocular navigation is at its limit. The slightest grain of sand in the gears can have a large impact.

If not properly designed, progressive lenses may become this small "grain of sand". This is why Essilor has designed the new XR-motion™ technology developed for Varilux® XR series™ lenses. Varilux® XR-motion™ technology reflects the natural strategy of ocular navigation and thus minimizes the visual challenges related to the use of progressive lenses in complex situations of multitasking in motion. Research has clearly shown that the effectiveness of ocular navigation is closely related to the quality of the binocular image and the good balance between the images given to each eye. Therefore, the objective of the binocular optimization was to provide the best binocular visual acuity while minimizing the difference in image quality between the right and left eye. This XR-motion™ technology considers each point in a 3D environment associated with a binocular target. Both lenses are then optimized according to these targets. The result is a reduction of power and astigmatism disparities in the central vision for a wide range of gaze directions. Hence, Varilux® XR series™ lenses provide optimal binocular visual acuity and binocular balance for a wide range of gaze directions and ensure the best ocular navigation in challenging situations of multitasking in motion.

1. The new normal: increased demand for near vision and multitasking

In our modern world, the visual system is constantly confronted with an overflowing quantity of information during daily tasks, such as multitasking in motion and switching attention between concurrent visual and cognitive tasks and goals. We have the impression that we are able to efficiently manage this enormous volume of sensory data. However, it is an illusion. According to the bottleneck theory of attention, attention can be allocated to only one task or goal at a time (Figure 1)[1]. Thus, multitasking is a myth; instead, attention switches between tasks and targets. Stimuli arrive at a bottleneck where only one item can be processed at a time[2]. As attentional resources are limited, filtering of stimuli must occur.

Not only does the visual attention system have to filter what is relevant from what is not in a rich visual world, but also, in situations where several tasks are performed simultaneously, it has to divide its resources over several goals and frequently switch from one task to another[1]. These very complex attention mechanisms require processing time and effort, and therefore, multitasking demands come with a performance cost[3]. This is important when undertaking modern everyday multitasking situations, such as walking and messaging on a phone or driving while using a digital navigation system, which requires fast visual attention switches and where a loss in performance could have repercussions[3].

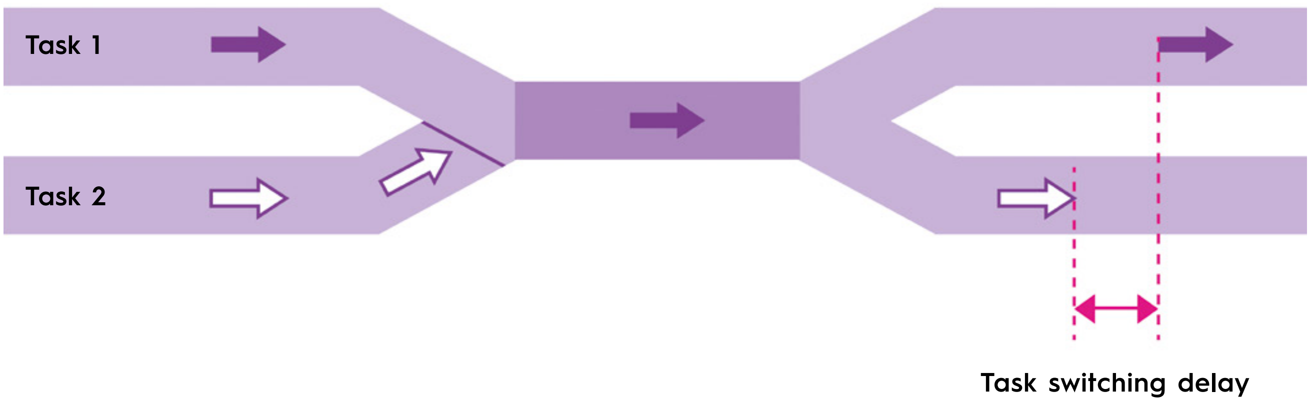

Figure 1: *Illustration of the bottleneck theory of attention*

2. Eye movements and visual attention

In order to successfully undertake multiple tasks simultaneously, we must skillfully switch both our gaze and attention back and forth. To do this, we must be able to move our eyes quickly and efficiently between the various targets and objects supporting the different tasks. This is dependent on the specific structure of our retina and the execution of coordinated movements of our eyes.

Cone photoreceptors in the human eye enable shape and color perception. They are not evenly distributed across the retina, with a sharp peak in density close to the center of the retina called the fovea (Figure 2)[4]. The fovea covers about 2° of visual angle, which roughly corresponds to the size of a thumbnail at arm's length[4]. Only in this tiny part of the visual field can we achieve high acuity. We can move our fovea to objects we want to process by making very precise and fast eye movements, allowing our vision to function with high acuity despite the small fovea[4]. Three pairs of extraocular muscles enable these movements and are attached to our eyeballs for horizontal, vertical, diagonal, and torsional movements[4][5].

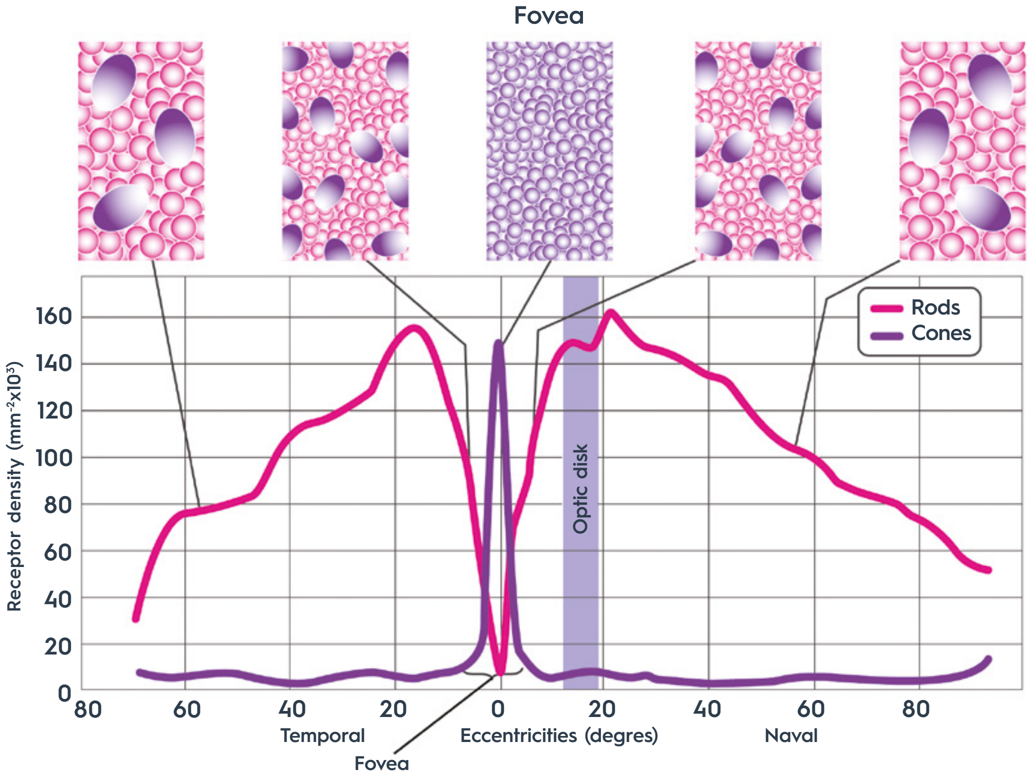

Figure 2: *Distribution of photoreceptors in the eye. Overall, rods outnumber cones by a ratio of 20:1 or greater in the retina. However, in the fovea, the cone density is the highest and is correlated with visual acuity.*

As the highest level of acuity is only available in 2° of the central visual field, we have to shift our gaze at regular intervals, typically 3 or 4 times every second, to bring objects of interest into the fovea and make them available to the attentional system to be processed[5]. This succession of saccades and fixations builds the representation of the surrounding visual environment[4][5].

When viewing objects at a given distance, the saccadic eye movements require both eyes to move conjugately with the same amplitude. When shifting gaze between targets located at different distances along the midline, we employ symmetric eye movements in which the two eyes rotate with equal amplitude in opposite directions[6]. They are called vergence eye movements.

To shift our gaze between targets located at different distances, not along the midline, we generate disjunctive saccades, produced by the two eyes rotating in the same direction but with different amplitudes[6]. Under normal viewing conditions, disjunctive saccades are the most commonly generated eye movements[6].

Just before a saccade, attention is shifted to the location where the eyes are going to land[7]. This pre-saccadic shift of attention enhances the visual performances (acuity, contrast sensitivity, etc.) at the location of the next fixation. It has also been suggested that pre-saccadic attention shifts facilitate the maintenance of perceptual stability and continuity across saccades[8]. This complex mechanism, improving the visual sensitivity at a specific location in space, is called covert attention. Complementary to covert attention, overt attention characterizes the mechanism by which sensory information is selectively extracted and processed at the location where the eyes gaze[5]. Figure 3 is an example of the eye movement dynamics involved in the free viewing of a scene[4]. Hence, eye movements and attention are tightly linked[9].

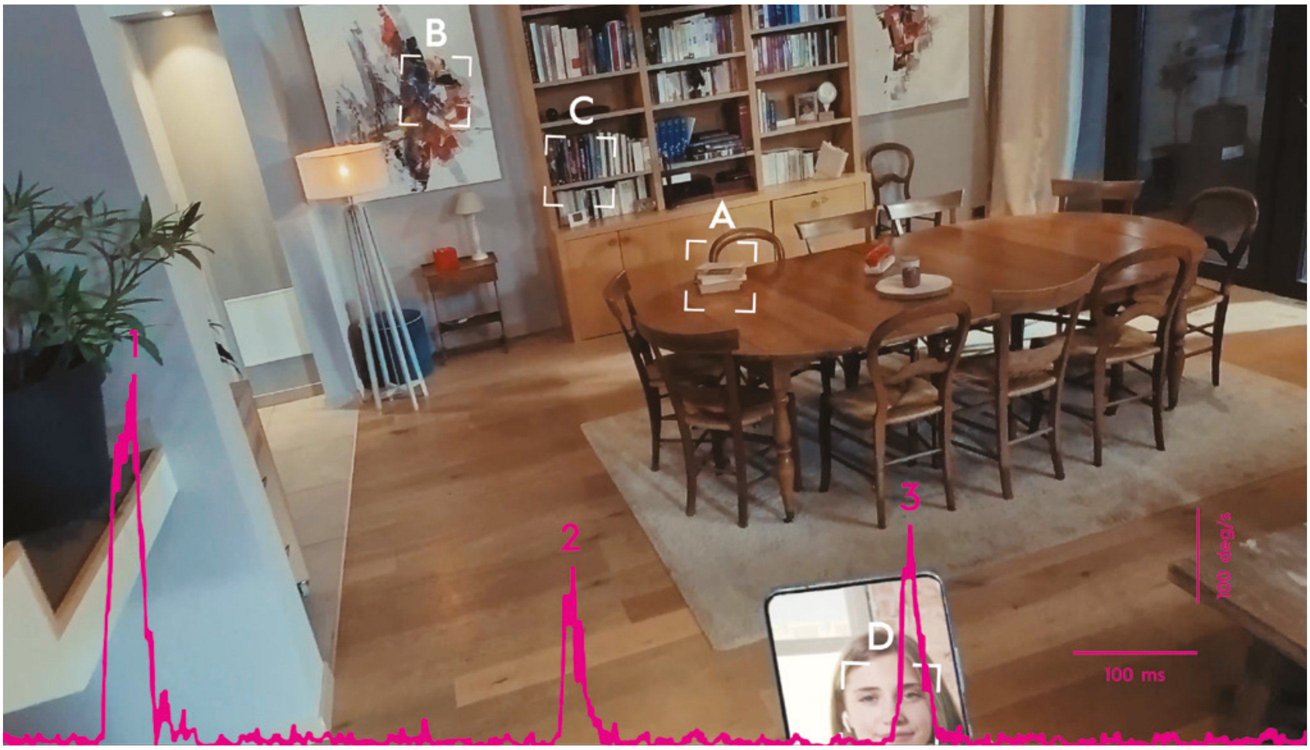

Figure 3: *Example of ocular navigation during free viewing of a scene. When a wearer explores a scene, the gaze moves from one point of the image to another, sequentially, in quick saccades. The squares on the image show zones of interest, while the curve at the bottom illustrates the eye movements, consisting of rapid motions between two consecutive fixation zones.*

3. Ocular navigation and multitasking in dynamic environments

In-motion multitasking will often require attention switches and gaze shifts since the various stimuli of interest will often be located in different areas of the visual scene. Time is crucial when we are involved in multitasking on the move. As expressed earlier, there is an intrinsic time cost of task switching. The ability to efficiently perform several simultaneous tasks on the move will depend on the accuracy of eye movements to jump from one visual target to another. Hence, multitasking in motion requires accurate eye movements[4].

Ocular navigation is key to shifting attention between objects and tasks. Most studies investigating the behavior of ocular navigation address static situations, with objects of interest distributed in azimuth and elevation in a 2D space. However, in our daily dynamic environment, the scene elements are distributed over a 3D space at various distances in motion, relative to each other and the observer. Hence, depth must also be considered and will add another level to the already complex mechanisms underlying smooth and easy ocular navigation in 3D dynamic scenes[10].

To accurately foveate a moving target, the oculomotor system needs to estimate the position of the target at the saccade end, based on information about its position and ongoing movement, while accounting for the neuronal processing delays of the overt and covert attention steps and preparation/execution time of the saccade[11]. This highly complex situation often ends up with errors in the landing position of the eyes, requiring subsequent corrective saccades[11][12]. Beyond this difficulty in ensuring accurate saccade end-points, tracking a moving target object in a dynamic natural scene will often require a combination of saccadic and pursuit eye movements. Moving stimuli typically elicit an initial interceptive saccade, with potential corrective saccades, followed by smooth pursuit[13]. In this highly challenging context, perfect binocular coordination and similarity between the images provided by both eyes are crucial. Any small difference between the image quality conveyed to the right and left eye may lead to serious misperceptions of the dynamic world, affecting the binocular navigation via their impact on stereoacuity and distance perception. Several studies provided clear evidence of the relationship between left/right differences in visual acuity and loss in stereovision[14][15]. Therefore, ocular navigation and multitasking require good binocular vision, summation, and fusion mechanisms[16][17].

The crucial role of good stereoacuity is especially sensitive in multi-object tracking tasks. Plourde and colleagues (2017) showed that performances were significantly better with good stereo-vision when subjects were instructed to track several objects moving continuously relative to each other, and that can occlude each other at certain moments in the viewing sequence[10]. Therefore, ocular navigation reaches the highest levels of complexity when objects of interest are in motion and located at various distances and can be detrimentally impacted by any small defect of stereoacuity, induced, for instance, by slight binocular imbalance. This is why the goal of the new XR-motion™ technology, developed for Varilux® XR series™ lenses, is to best reflect the natural strategy of ocular navigation and thus minimize the visual challenges related to the use of these lenses in complex situations of multitasking in motion.

4. Behavioral artificial intelligence model

The Essilor digital twin is an artificial intelligence (AI) system providing a realistic indication of spectacle-wearer perception through lenses by simulating the wearer's experience with their lenses in a 3D environment. This tool allows one to replicate the digital twin of any patient, reproduce daily-life situations, and assess the behavior of this humanized digital twin when wearing a specific pair of lenses. It is also integrated with LiveOptics™ processing to understand better wearer appreciation of different kinds of lens optical designs and to simulate complete virtual wearer tests before proceeding to real prototyping and live testing. To achieve this, it considers not only the quality of vision through the lenses but also their impact on visual and postural behaviors. The digital twin of the wearer consists of a body, a head, and two eyes. Each eye can rotate in various gaze directions, as well as the head itself. It also contains perceptual, physiological, and biomechanical models which relate measurements to performance indicators:

- Accommodation efforts as a function of accommodation value,
- Visual acuity as a function of lens aberrations and visual characteristics of the virtual wearer,
- Head and gaze efforts as a function of head and gaze directions.

Essilor has further developed this AI model to more precisely predict wearer behavior, a model that underpins the new XR-motion™ technology. The AI model is based on over 1 million exclusive data points, including real-life wearer data, ordering data, physiological models. For each wearer, their Near Vision Behavior (NVB) measurement allowed the personalization of lenses by modifying the lens near vision location and vertical size. Then, the analysis of more than 160,000 orders of Varilux® X series™ lenses with NVB data facilitated the development of predictive models for the following NVB parameters; gaze lowering, reading distance, lateral offset, and vertical ratio in near vision. The vertical ratio in near vision assesses whether the way one is looking at objects is spread or concentrated. Furthermore, the parametric modelization of gaze lowering is based on the digital twin pseudo reading task, thanks to the Artificial Intelligence model according to mean sphere and addition. Collectively, this NVB data has helped to define visual performance simulations to model real-life situations closely and to mirror accurately the natural behaviors of virtual wearers performing these tasks (Figure 4).

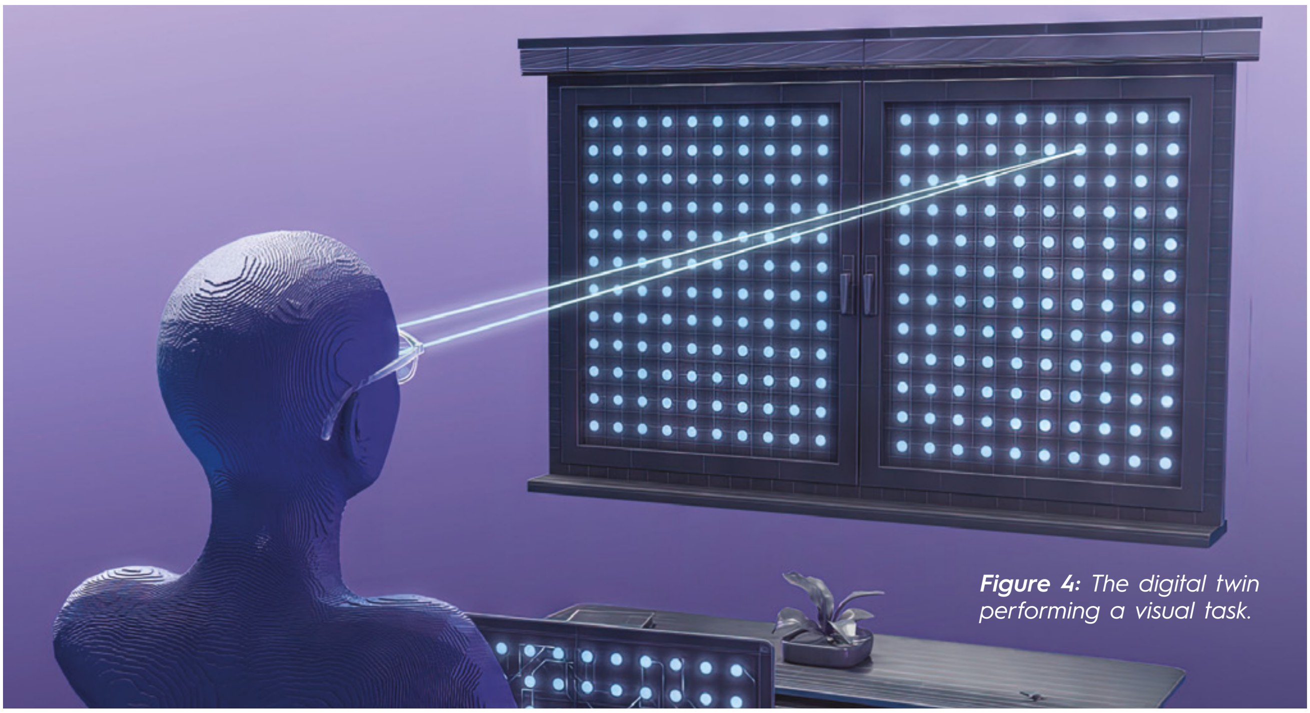

Figure 4: *The digital twin performing a visual task.*

The new modelization of accommodation behavior helped to evaluate the wearer's visual perception better when performing tasks soliciting their accommodation. There is a strong link between the powers through the lenses, the amplitude of accommodation of the wearer, and the distance of objects that can be seen sharply by the wearer. As the amplitude of accommodation of the wearer decreases with presbyopia, this link is even more important to take into account for progressive lens calculation. That is why a realistic modelization of the accommodation behavior of presbyope wearers is very important.

Until now, lenses used to be optimized by considering an average distribution of object localization and distances in the function of gaze directions. However, these new parametric models utilizing NVB data allow to improve simulations performed on ophthalmic lenses by taking into account a more precise average visual behavior in near vision. The consideration of gaze behavior and visual and postural behavior increases the accuracy of the predictive accommodative response and vergence model. The Behavioral Artificial intelligence model has been developed for the new XR-motion™ technology, taking into account the wearer's postural, visual, and accommodative efforts and finding the best balance between them to be as close as possible to natural behaviors.

5. XR-motion™ technology, features, and benefits

The objective of XR-motion™ technology is to make the navigation of the eyes through the lenses easier and more natural when going from one object to another, whatever the distance of these objects and their locations. For this purpose, the ophthalmic equipment has to provide at the same time sharp vision and a perfect combination of images from both eyes.

Accurate positioning of the focus zones

The new XR-motion™ technology starts by modeling the visual behavior of the wearer. Visual behavior defines the combinations of head and eye movements of a given wearer when looking at their environment. The visual behavior is specific to a given wearer. An Artificial Intelligence model has been created based on behavioral data, allowing us to predict the visual behavior of a wearer according to their prescription.

The behavior model of the wearer is used to determine the focal points of the wearer. The focal points are the points looked at by a wearer through the lenses, positioned relative to the wearer's head (Figure 5). The relationship between the behavior profile of the wearer and the focal points is not straightforward. It must account for the prismatic deviations of the lenses, and the wearer's accommodation at different distances.

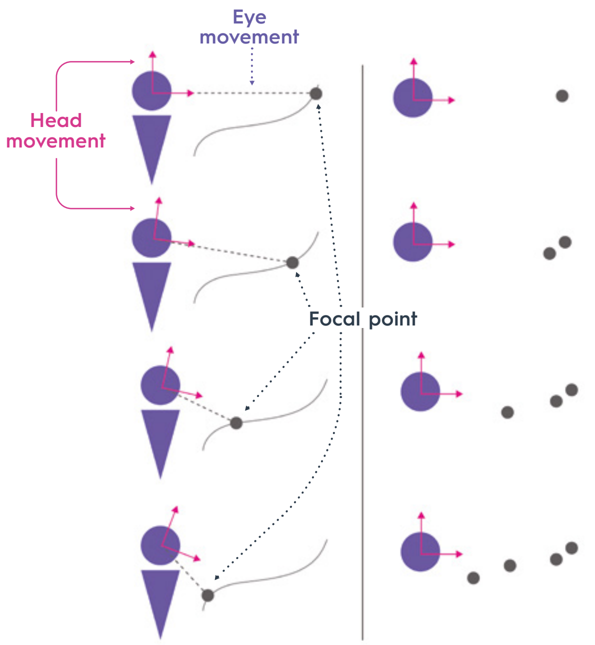

Figure 5: *Construction of behavior model (left) and corresponding focal points relative to the head (right)*

The consistency between the Behavioral Model and the focal points is managed through the behavioral artificial intelligence model that integrates a state-of-the-art accommodation model and accurate ray-tracing

Then, a binocular target design is generated. The target design defines the desired power and astigmatism performances of the lens, for any binocular gaze direction (Figure 6). It manages the variation of power along the meridian line, the dimensions of the vision zones, and the distribution of aberrations. This binocular target depends on ametropia and addition, taking into account the specific visual needs associated with myopes/emmetropes/hyperopes on one hand, or low/medium/high additions on the other. Furthermore, the binocular target can be modulated by other personalization parameters of the wearer.

The binocular target design is then projected onto the focal points. The target is binocular, so the origin of the projection is the cyclopean eye (located in between the two eyes of the wearer). At the end of this step, each focal point is associated with a power and astigmatism target value.

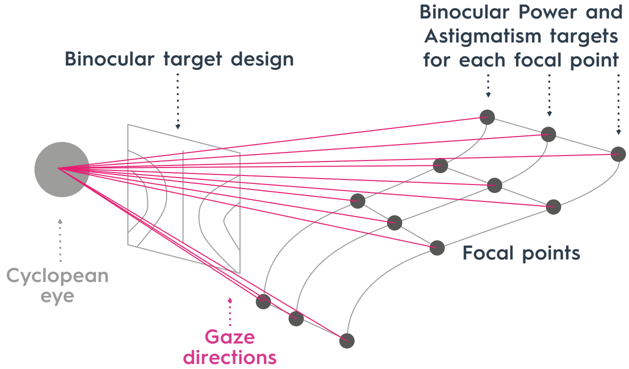

Figure 6: *Mapping of optical target (Power and Astigmatism) on focal points*

Finally, the left and right lenses are optimized. This optimization is an iterative process. It constructs rays originating from the eye rotation center, propagating through the lens, and ending at the focal points. This propagation takes into account the prismatic deviation of the lens. The power and astigmatism are evaluated along the ray, and the lens is optimized until those values correspond to the target values. At the end of the process, the resulting lenses are binocularly paired in the sense that for binocular conjugate points (points of the lenses that correspond to the same focal point), the power and astigmatism values of the two lenses are equal (or very close) (Figure 7). Thus, power and astigmatism disparities are very low.

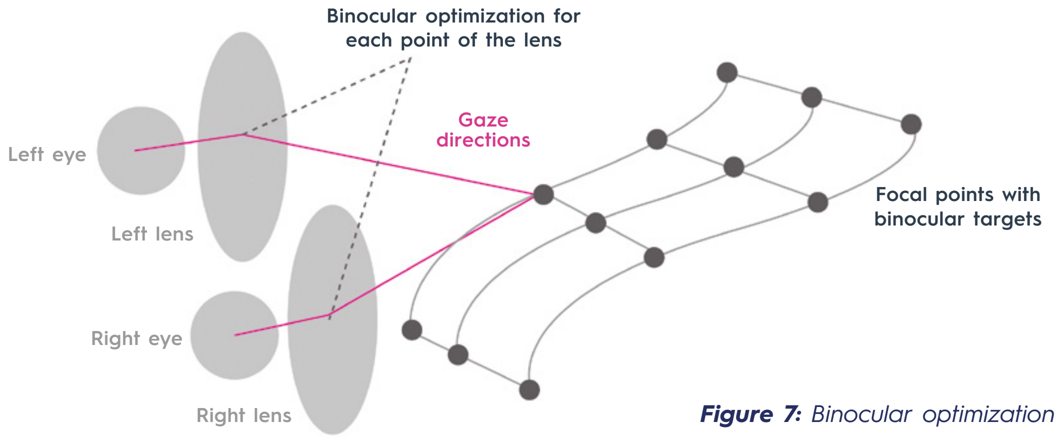

Figure 7: *Binocular optimization*

Another benefit of the process is that the vision zones are positioned in accordance with the visual behavior profile of the wearer. In particular, the progression length is adapted to the gaze-lowering directions defined by the new XR-motion™ technology precisely for each eye. For example, shorter progression lengths are calculated for myopes compared to hyperopes. Moreover, the lower additions also get smaller progression lengths than high additions.

Reduced power and resulting astigmatism disparities

In the case of anisometropia, XR-motion™ technology aims to provide an equal power error and resulting astigmatism for both eyes at the coupled gaze direction used to look at the object points. The power error and resulting astigmatism are calculated to answer to proximity needed at near. The binocular optimization reduced astigmatism and power disparities between the left and right eyes, as seen in Figure 8. Compared to Varilux® X series™ lenses, Varilux® XR series™ lenses deliver reduced astigmatism and power disparities. Therefore, the resulting synchronization of image quality is improved through binocular optimization.

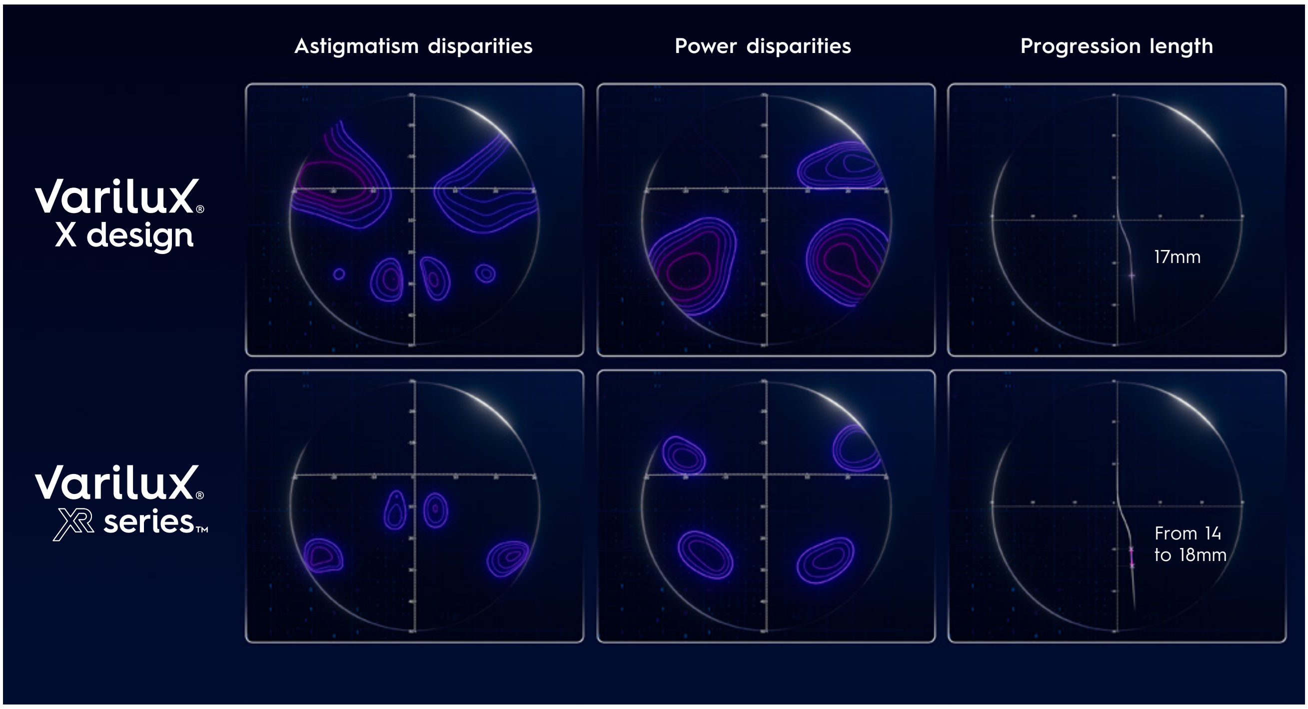

Figure 8: *Comparison of Varilux X design and Varilux XR design optical performances: Reduction of Astigmatism disparities (left), reduction of Power disparities (center) and individualized progression length (right)*

Increased volume of broadband vision

As discussed, multitasking requires precise ocular navigation when moving focus between tasks. To aid this, spectacle lenses must provide sharp vision, easy focus, and an effortless combination of images from both eyes at all distances. To characterize this performance, the volume of broadband vision criteria evaluates the number of object points at distances from near to far seen at the same time with good binocular acuity and minimal differences in image quality through both lenses. An eye-responsive lens predicts wearers' visual behavior (gaze lowering and object distances) and thus responds to how their eyes really move to ensure sharp and fluid vision. The volume of vision is the number of object points between 30cm and infinity, having a binocular acuity loss lower than 0.15logMAR (eq. to a binocular visual acuity of 8/10) and power disparity below 0.15D and resulting astigmatism disparity below 0.25D. As determined by Essilor behavioral artificial intelligence simulation testing, Varilux® XR series™ lenses increase broadband vision volume by 49% compared to Varilux® X series™ lenses (Figure 9), meaning that Varilux® XR series™ lenses provide a larger volume of space in which vision is sharp, and transitions are smooths between near and far.

Figure 9: *Varilux® XR series™ lenses increase broadband vision volume by 49% compared to Varilux® X series™ lenses*

Wearer test to evaluate the subjective performance

To validate the digital twin simulation results, an open, comparative, real-life wearer test was conducted measuring the benefits perceived by an experienced panel of progressive lenses wearers in their daily-life with the new Varilux® lens Varilux® XR design (Figure 10). Eurosyn, an independent institute, recruited a panel of 73 experienced PAL wearers, mostly wearing high-end progressive lenses. They were between 45 to 65 years old, with a recent pair of current eyeglasses and a valid prescription matching their current eyeglasses, but they didn't feel the need for an update of their vision correction. They have renewed their progressive lenses at least once. Prescriptions were as follows: myopes 23%, emmetropes 41%, and hyperopes 36%.

Methodology

Study design

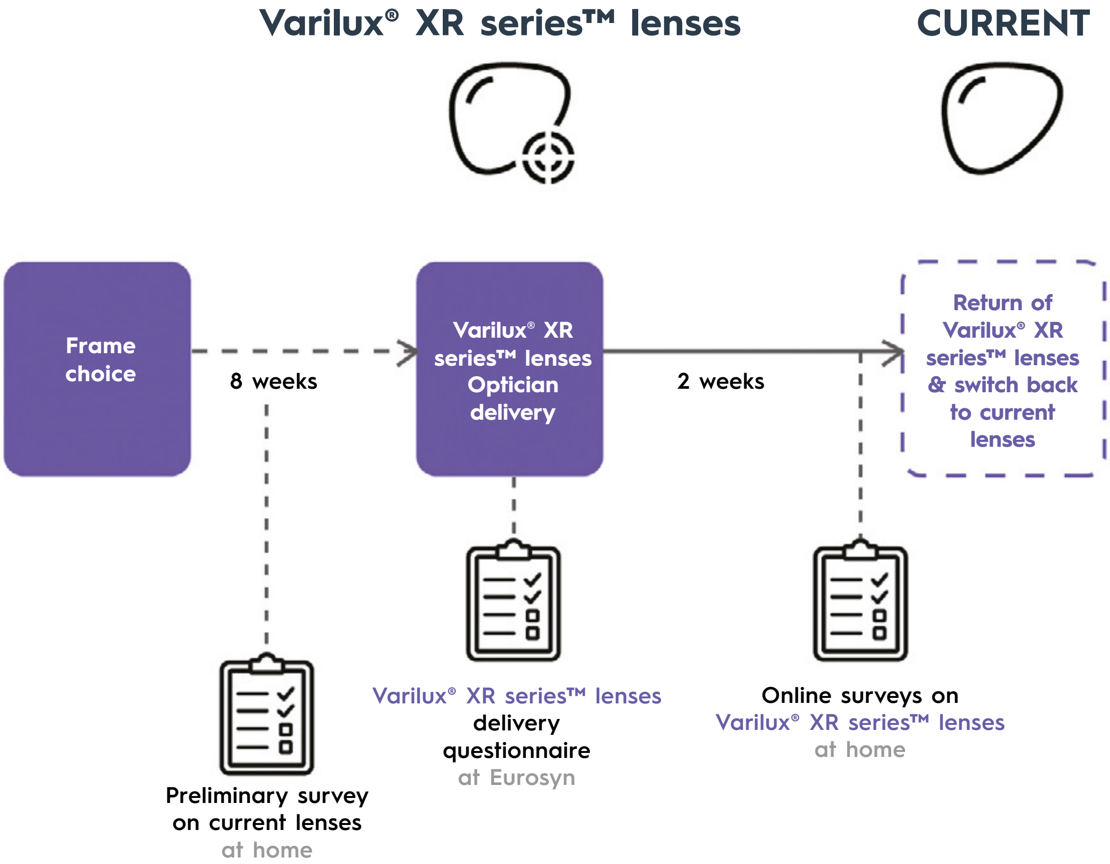

Figure 10. *Wearers test protocol*

Wearer Tests concluded Varilux® XR series™ lenses deliver high performance to progressive lens wearers:

95%
felt adapted from the first day[18]

90%
perceived instant sharpness at all distances even when in motion[18]

95%
felt more confident in motion[19]

Furthermore, Behavioral Artificial intelligence simulation testing of major premium progressive lens competitors concluded that Varilux® XR series™ lens has the highest level of performance overall. The performance of major premium progressive lenses on the market were assessed according to 14 attributes defined by progressive lens wearers through an international survey. A statistical analysis conducted by a third independent party concluded that Varilux® XR series™ was the best progressive lens overall, playing alone in the highest category of performance*.

Sources: Essilor R&D simulations – 2022 – calculation based on lenses measurements weighted by the level of importance of each criteria for progressive lenses declared by users (Quantitative Consumer study - Ipsos - Q1 2022 - BR/FR/IT/UK/US - n=4000 progressive lens wearers) - Simulations done on most relevant competitive brands : brands with good level of awareness among consumers (Consumer Lens Brand Tracking - Ipsos - Q3 2022 - BR/CA/CN/FR/IN/IT/UK/US - n=8000) & offering premium progressive lenses.

6. Conclusion

In our modern world, the visual system is constantly confronted with an overflowing quantity of information, particularly over the last 10-15 years with the explosion of mobile digital device use. However, this recent evolution challenges our visual and attentional skills. Only a subset of sensory inputs can be consciously analyzed and used simultaneously. As a result, when we have to do multiple tasks at the same time, we don't do them in parallel. Instead, we switch our attention back and forth between the various tasks and move our gaze from one object of interest to another. Hence, in this highly complex environment, and given our limited skills, it is crucial to perform accurate ocular navigation.

To address this, Essilor has designed the new XR-motion™ technology developed for Varilux® XR series™ lenses. The XR-motion™ technology reflects the natural strategy of ocular navigation and thus minimizes the visual challenges related to the use of progressive lenses in complex situations of multitasking in motion. The continuous optimization of the Behavioral Artificial intelligence enabled the improved simulation of gaze lowering and accommodation behaviors of wearers while assessing the impact of lenses' optical designs on visual and postural behavior. The XR-motion™ technology considers each point in a 3D environment associated with a binocular target. Both lenses are then optimized according to these targets. According to visual behavior determined by Behavioral Artificial intelligence simulation testing, the result is a reduction of power and astigmatism disparities in the central vision for a wide range of gaze directions. The statistical analysis of Behavioral Artificial intelligence simulation testing of major premium progressive lens competitors concluded that Varilux® XR series™ has the highest level of performance overall. Furthermore, comparative real-life Wearers Testing reported that Varilux® XR series™ progressive lenses delivered instant sharpness and better reactivity in motion while keeping a natural posture in daily life.

Varilux® XR series™ is the first eye-responsive progressive lens+ powered by behavioral artificial intelligence*, offering instant sharpness, even in motion**, ensuring the best ocular navigation in challenging situations of multitasking in motion, challenges consumers face every day. Among all premium progressive lenses ranked in performance, the statistical analysis determined that, across all categories, Varilux® XR series™ is the best overall progressive lens***.

Essilor uses Artifical Intelligence to go beyond prescription and eye physiology to understand individuals visual behavior using more than 1 million points of data from real wearers.

***Varilux XR® series™ – in-life consumer study - Eurosyn – 2022–France (n=73 high-end progressive lens wearers). 66/73 perceived instant sharpness at all distances while in motion.*

****Based on achieving the highest composite score among premium Progressive designs of leading U.S. competitors on 14 attributes identified as important by a survey of U.S. consumers. Measurements were the result of Essilor R&D state of the art avatar simulations 2022.*

Eye-responsive defined as the consideration of two parameters in the design of the progressive lens: prescription and visual behavior

References

1. Reimer CB, Strobach T, Frensch PA, Schubert T. Are processing limitations of visual attention and response selection subject to the same bottleneck in dual-tasks?. *Atten Percept Psychophys*. 2015;77(4):1052-1069.
2. Szameitat AJ; Brunel Students. Inter-Individual Differences in Executive Functions Predict Multitasking Performance - Implications for the Central Attentional Bottleneck. *Front Psychol*. 2022;13:778966.
3. Al-Hashimi O, Zanto TP, Gazzaley A. Neural sources of performance decline during continuous multitasking. *Cortex*. 2015;71:49-57.
4. Gegenfurtner KR. The Interaction Between Vision and Eye Movements. *Perception*. 2016;45(12):1333-1357.
5. Findlay, J. M., Gilchrist, I. D. Active vision: The psychology of looking and seeing. *Oxford University Press*. Online Ed. 2003.
6. Quinet, J., Schultz, K., May, P.J., Gamlin, P.D. Neural control of rapid binocular eye movements: Saccade-vergence burst neurons. *PNAS*. 2020;117(46):29123-132
7. Deubel, H., Schneider, W. X. Saccade target selection and object recognition: evidence for a common attentional mechanism. *Vision Research*. 1995;36(12):1827-37
8. Melcher, D. Selective attention and the active remapping of object features in trans-saccadic perception. *Vision Research*. 2009;49(10):1249-1255
9. Palidis DJ, Wyder-Hodge PA, Fooken J, Spering M. Distinct eye movement patterns enhance dynamic visual acuity. *PLoS One*. 2017;12(2):e0172061.
10. Plourde, M., Corbeil, M-E., Faubert, J. Effect of age and stereopsis on a multiple-object tracking task, *PLoS ONE*. 2017;12(12): e0188373
11. Kosovicheva, A.A., Wolfe, B.A., Whitney, D. Visual motion shifts saccade targets. *Atten Percept Psychophys*. 2014;76(6):1778-1788
12. Deubel H, Wolf W, Hauske G. Corrective saccades: effect of shifting the saccade goal. *Vision Res*. 1982;22(3):353-364.
13. Goettker, A., Agtzidis, I., Braun, D.I., Dorr, M., Gegenfurtner, K.R. From Gaussian blobs to naturalistic videos: Comparison of oculomotor behavior across different stimulus complexities. *Journal of Vision*. 2020;20(8):1-16
14. Odell, N.V., Hatt, S.R., Leske, D.A., Adams, W.E., Holmes, J.M. The effect of induced monocular blur on measures of stereoacuity. *Journal of American Association for Pediatric Ophthalmology and Strabismus*. 2009;13(2):136-141
15. Singh, D., Aggarwal, S., Sachdeva, M.M., Saxena, R. Effect of induced monocular blur on monocular and binocular functions. *Indian Journal of Clinical and Experimental Ophthalmology*. 2015;1(4):197-201
16. Opoku-Baah C, Wallace MT. Binocular Enhancement of Multisensory Temporal Perception. *Invest Ophthalmol Vis Sci*. 2021;62(3):7.
17. Ding J, Levi DM. A unified model for binocular fusion and depth perception. *Vision Res*. 2021;180:11-36.
18. Varilux® XR series™ – in-life consumer study – Eurosyn – 2022 – France (n=73 progressive lens wearers). October 2022;1-16
19. ©Essilor – Varilux® XR series – in-life consumer study – Eurosyn – 2022 – France (n=73 progressive lens wearers; 69/73). In motion is defined as driving, walking, and biking.

essilor

essilor.com