Varilux® X series™
Everything you need to know about this new progressive lens.

Bundle of 3 articles:
• Varilux® X series™: the progressive lens with an expanded field of near vision
• Varilux® X series™: ultimate personalization to the wearer’s near-vision behavior
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The vision needs of presbyopes have changed significantly: where once they merely needed the ability to read from a single near distance, presbyopes today are faced with multiple tasks that involve near vision and beyond. Progressive lens design has had to keep pace with those changes and respond more effectively to the needs of a new generation of wearers. The Varilux® X series™ lens has been designed to offer an expanded field of near vision and improved visual comfort for all vision within arm’s reach.¹ This article explains the driving principle behind that innovation and describes how this new generation of progressive lenses was designed.

New vision needs for near vision and beyond

Generation X – those who are born between 1965 and 1980 – have very different vision requirements from their elders. They’re no longer reading at one (single) near distance; instead, they use their entire near space to carry out multiple activities with near vision up to arm’s length. The advent of digital tools like computers, tablets and smartphones has radically transformed their near-vision needs. These presbyopes aren’t just reading; they’re also performing multiple tasks at a near-intermediate distance between 40 and 70 cm: they’re working on a computer screen, reviewing documents, typing on a keyboard, watching videos, answering their mobile phone, writing text messages, sharing data with friends and family, etc. Their vision is dynamic and involves numerous distances. They need to be able to shift smoothly from one task to another, without being held back by their vision.

The Varilux® X series™ lens has been designed to offer these wearers an extended near vision within arm’s reach that meets their needs more effectively than a conventional progressive lens, Fig 1. This article will take a look at the methodology that was used to study these wearers’ needs and describe the features of the new generation of progressive lenses: Varilux® X series™.
A new way of studying wearers’ needs

A multi-disciplinary team came together with the aim of gaining a better understanding of this new generation of wearers. The team’s members studied expectations and behaviour among wearers and developed new research methods for observing their day-to-day experience as closely as possible.

Specialists from a variety of disciplines, including ergonomists, physiologists, sociologists and optics designers, joined forces to learn more about these wearers’ needs, both as presbyopes and consumers.

They drew on a range of new research resources, including:
- a test house, the HouseLab™, where consumers were observed and interviewed while immersed in a natural – but controlled – environment in which they could perform routine daily activities;
- a laboratory for evaluating wearers’ behavior, the Essilor’s Movis Laboratory. This lab is used to capture wearers’ posture and movements in real time as they perform simple tasks such as working on a computer, reading on an e-reader, playing video games, watching videos on a tablet, reading and writing text messages on a smartphone, and so on.

These new techniques provided insights into each wearer’s needs, Figure 2 – insights that were then used to design this new progressive lens.

An extended near vision within arm’s reach

In the past, progressive lens design were merely taking into account the need for distance vision (beyond 3 m), near vision (about 40 cm) and intermediate vision. By observing the new generation of wearers, researchers identified an array of new vision needs in the area up to 70 cm – so-called arm’s-length vision – that falls between near-distance and intermediate vision. While the near vision portion of the lens (where the add power is at least 85%) had already been studied extensively, the portion used for near-intermediate or arm’s-length vision (where the add power is 60% to 85%) has not been as heavily researched, and the researchers gave that area special attention.

Initially the study aimed to define the levels of visual acuity needed for each distance. Researchers found that comfortable reading at a distance of 40 cm required a visual acuity of 0.1 Log MAR (or 0.1 or 20 or 20) or above, while at 70 cm an acuity 0.15 Log MAR (or 0.15 or 60 or 20 ) at least is adequate and between 50 and 70 cm the acuity
requirement gradually changes from 0.10 to 0.15 Log MAR thresholds.

The lens designers then used a sophisticated new calculator that uses an “acuity model”, which can be used to simulate the combined effect of the lens power and astigmatism on the wearer’s visual acuity at any point on the lens, based on the proximity of the objects viewed and the wearer’s remaining amplitude of accommodation. The results were expressed in the form of visual acuity plots like the one shown in Figure 3. It shows how visual acuity is affected by the lens’s optical properties for each gaze direction, ranging from the central portion of the lens, where acuity is at its highest, to the periphery, where it deteriorates. The natural dynamics of head movement obviously allow wearers to maintain their gaze in the centre of that area of acuity. The relationship between add power and astigmatism and the visual acuity used to calculate these maps were determined on the basis of the test measurements performed on a group of wearers.

The area of the lens corresponding to arm’s-length vision, located between the near vision zone and intermediate vision zone, was defined as the area of the lens where the power varies between 60% and 85%. To improve that area in particular, the lens designers used a new technique known as Xtend™ technology (an innovation covered by 15 pending patents), as illustrated in Figure 4. It involves applying “acuity buffers” that locally curb vertical and horizontal variations in power so as to maximize field depth and expand the field of vision. In other words, the technique locally corrects aberrations in the lens in order to improve the wearer’s local field of visual acuity in terms of both depth and width. This technique uses the
Researchers introduced a new concept: the “volume of acuity” needed for comfortable vision. That refers to the volume of space that a wearer can perceive through the lens with the necessary visual acuity to perform typical tasks at each distance.

FROM CURRENT OPTIMIZATION...

- Until now, each Nanoptix® element was optimized to manage 1 target object for 1 gaze direction and eliminate swim effect.
- Nanoptix® elements were managed 1 by 1.

...TO XTEND™ TECHNOLOGY OPTIMIZATION

- New Xtend™ technology optimization improves visual performance and delivers extended vision within arm’s reach, allowing wearers to see MULTIPLE TARGETS FOR 1 GAZE DIRECTION.
- Nanoptix® elements are managed by CLUSTERS OF 7 in order to combine their power and multiply their effects.

FIG. 4 | Xtend™ technology: management of multiple targets for the same gaze direction.
Nanoptix™ technology to apply this correction to seven adjacent micro-components simultaneously, taking into account the specific acuity levels to be maintained for each of those micro-components (Figure 5). This task is first performed along the meridian of progression on the lens and then in the area surrounding that meridian. Thus, by moving from one spot to the next, the performance and acuity of the lens progression zone can be greatly improved, while the near vision/intermediate vision zone is specially enhanced for arm’s-length vision.

**Evaluating lens performance using “volume of acuity”**

To evaluate the performance of the Varilux® X series™ progressive lens, researchers introduced a new concept: the “volume of acuity” needed for comfortable vision. That refers to the volume of space that a wearer can perceive through the lens with the necessary visual acuity to perform typical tasks at each distance: reading with near vision, looking at a computer screen with arm’s-length vision, deciphering text with intermediate vision, etc. That volume, which had only rarely been identified in the past, indicates the wearer’s three-dimensional area of clear vision, with specific attention to the depth of the wearer’s field of vision.

Thus, if we compare the volume of acuity obtained with the Varilux® X series™ lens with that of an earlier progressive lens, we see (as shown in Figure 6) that the volume of vision is considerably enlarged both in width and depth, especially in the area of so-called arm’s-length vision. The Xtend™ technology makes it possible to maintain visual acuity at a higher level than the threshold previously defined (0.15 Log MAR at 70 cm), with the result that wearers enjoy a significantly larger area of clear vision.
Using that process, the Varilux® X series™ lens was found to satisfy 75% of the wearer’s needs for arm’s-length vision, compared to an average of 59% for other progressive lenses – an unprecedented level of performance (calculations performed by Essilor’s R&D, based on the standard design of the Varilux X Series in comparison with several progressive lenses available on the market).

Wearers have expressed a high level of satisfaction. As with all new progressive lenses from Essilor, the Varilux® X series™ lens was tested on a large group of wearers before it was commercialized. One of the following studies was conducted in accordance with an established, certified protocol that uses randomization and double-blindness. As can be seen from the results shown in Figure 7, wearers reported superior vision quality, which they...
considered better than that of a previous-generation progressive lens (Figure 7a). They also expressed a high level of satisfaction in using their new lenses for arm’s length activities (Figure 7b). These studies provide evidence that this next-generation lens is a true advance over previous lenses, particularly for improving the area of near and intermediate vision.

**KEY TAKEAWAYS**

- Gen X is a highly active generation, their modern life impacts vision needs.
- Current PALs do not keep up with their new needs in near and intermediate vision.
- In 2017, Varilux® X series™ reinvents near vision, with Xtend™ technology, offering extended vision at arm’s length.
- Wearers can seamlessly capture every detail within arm’s reach, and beyond. No need to hunt for the sweet spot in the lens.
- 95% wearers are satisfied while multi-tasking at arm’s length.

**Conclusion**

With the Varilux® X series™ lens – the eighth generation of progressive lenses – Essilor is once again innovating to push the limits of progressive lenses and more effectively address the multiple near-vision needs of today’s presbyopes – especially those from Generation X, for whom this new Varilux lens is named.

Note from authors: this article is an adaptation from a White Paper published by Essilor’s R&D.

**REFERENCES**

Properly positioning the near-vision zone on a progressive lens is critical to ensuring that presbyopic wearers enjoy optimal near-vision comfort. If you know the wearer’s posture and behavior while reading, it is possible to personalize the design of the progressive lens in accordance with the wearer’s needs. The Varilux® X series™ lens offers precisely that: not only has this new progressive lens been designed to provide an expanded field of “arm’s-length” near vision, but it also – for the first time – offers the potential for personalized positioning of the near-vision zone, based on how the wearer makes use of the lens. This article outlines the principle behind that innovation, describes the measurements to be performed by the optician and highlights the benefits of this new lens for wearers.

The positioning of the near-vision zone: a critical factor
Reading is one of the most important near-vision activities. Every person will adopt a distinct body, head and eye posture and will explore the field of near vision with gaze dynamics that are unique to that person. All of this is governed by a complex coordination of eye movements, including a lowering of the gaze, fixations and saccades, designed to bring the image of the words into the fovea so the text can be read.

To ensure proper visual comfort, the near-vision zone on a progressive lens must be optimally located at the very spot where the wearer directs his or her gaze and explores the lens during reading. That zone demands maximum visual acuity, and its dimensions must correspond to the eye’s exploration of the zone.

In the past, the near-vision zone was positioned on progressive lenses based on average wearer behavior or in accordance with optical parameters such as add power, ametropia and/or reading distance. Today, with the Varilux® X series™ lens, it is now possible to personalize the position of the near-vision zone on each lens, based on each wearer’s exact behavior in terms of reading posture and overall near-vision behavior.
Measuring each wearer’s Near-Vision Behavior (NVB)

Knowing a wearer’s reading posture and gaze dynamics is certainly very helpful, but obtaining that information is no simple matter. The difficulty comes from measuring the wearer’s natural posture, i.e., the posture that he or she would adopt without optical correction... but it’s precisely that correction that presbyopes need in order to read.

To solve that problem, Essilor’s research teams developed a special vision task that can be performed without correction (for uncorrected ametropia ranging from -10.00D to +7.50D in near-vision power) and that accurately reflects the wearer’s reading posture. That task, called «pseudo-reading», consists of observing and tracking a large-size object – i.e. one that does not require visual acuity. The object is blue against a white background and shown on a tablet. The movement of this target across the screen is similar to the average reading behavior of an adult, with fixations of 233 milliseconds and saccades of 6.3 characters.³

In practice, the wearer grasps the tablet, position it naturally in front of them – as they would with a document they are reading – and follow the target’s horizontal movement with their gaze, line by line. The measurement lasts about 17 to 18 seconds in all, depending on the length of the wearer’s fixations, and the wearer is guided by the target’s movement: he or she can predict the saccade movements that need to be made with the help of gray dots shown on the screen background, which anticipate the target’s movement (Figure 1).

It should be noted that this measurement is not the wearer’s absolute behavior, but rather his or her relative behavior in response to the pseudo-reading task. That behavior correlates exactly with the wearer’s actual behavior, as has been shown in validation studies for the measurement protocol conducted on sizable samples of presbyopes.⁴ That calculation is then used to establish the actual positions of the wearer’s head and eyes.

In the course of this exercise, the horizontal and vertical head movements are measured in real time so as to determine the wearer’s head posture and gaze position at all times. From this, we obtain four critical datapoints:

- Three of these datapoints – the downward gaze angle, the lateral offset and the reading distance – describe the wearer’s posture, which is ultimately measured by the average posture during the pseudo-reading task and is called the NVB Point (Figure 2);
- The fourth datapoint, referred to as the wearer’s NVB Ratio, describes how the wearer adjusts his or her gaze vertically during the entire measurement. That ratio is close to 0 for wearers who have a strong tendency to lower their eyes whenever they move to the next line, and therefore change their head and body posture or the tablet position only slightly; the ratio is close to 1 when wearers maintain a static gaze position, i.e., they have a strong tendency to change their posture and/or the tablet position vertically while reading (Figure 3).
Method for Measuring Near-Vision Behavior (NVB)

In order to create a personalized lens, each wearer’s near-vision behavior needs to be measured. This can be done using a tablet, which can be connected to an electronic measuring column or used on its own. The measurement is taken as follows:

1) The wearer’s frame is positioned in a clip that is used to define the frame’s position in space and, by extension, the wearer’s posture and head movements (shown in Figure 1).
2) The wearer’s baseline far-vision position is measured in primary gaze position, using either a measuring column (such as a Visioffice®) or a tablet, by taking two photos – a front picture and a three-quarter view – that can be used to calculate the primary gaze position.
3) The measuring process is demonstrated and explained to the wearer, so that he or she understands the task to be accomplished.
4) The wearer grasps the tablet and gazes at the blue dot in the centre until detected by the camera; then the movement of the target is activated and the gaze position and movements are continuously recorded (Figure 4).
5) The measurement is validated and the near-vision posture and behavior datapoints are saved.

The Near-Vision Behavior technology

Once the measurements have been taken, the data used to personalize the lens must be forwarded. The data is sent using a seven-digit alphanumeric code that combines two pieces of information:

- The NVB Point, which is the wearer’s average gaze position during the measurement, representing the wearer’s reading posture;
- The NVB Ratio, which is the distribution of measurements around the NVB Point and represents the wearer’s dynamic near-vision behavior.
FIG. 4 Measuring the wearer’s Near-Vision Behavior during a pseudo-reading task.

FIG. 5 Example of a near-vision zone on a Varilux® X series™ progressive lens that optimally reflects the wearer’s near-vision behavior.

NB: Distance vision is in dark blue above a 15% add, intermediate vision in light blue between a 15% and 60% add, intermediate near vision in beige between a 60% and 85% add and near vision in purple below an 85% add.
The lens can then be personalized in a three-step process:
- The first step is to use the wearer’s data (prescriptions, interpupillary distance, position of the eye’s centre of rotation) and the conditions in which the lenses are worn (shape and size of the frame, lens-eye distance, pantoscopic tilt and wrap angle) combined with the characteristics of the lenses to be produced (front surface, geometry and refractive index).
- The second step is to identify the optimal position of the near-vision zone on the progressive lens, based on the wearer’s posture (as indicated by the NVB Point). Information on ametropia, prismatic effects and binocular vision is taken into account during this stage of the process.
- The third step is to enhance the progression profile based on the wearer’s gaze dynamics, in light of the NVB Ratio. The objective is to adjust the size and shape of the progressive lenses’ near-vision zone in accordance with the wearer’s vertical exploration of that zone.

Figure 5 shows an example of an optimal near-vision zone position and shape on a Varilux® X series™ lens, based on a wearer’s near-vision behavior. We see how, as a result of this optimization, the position of the near-vision zone on the lens (the point where the add power is at 100%, shown by a blue cross) has been modified, and the size of the so-called arm’s-length vision zone (from 85% to 60% of the add power) has been adjusted.

The exact values for progression length and inset for the near-vision zone can only be defined and forwarded to the optician once this lens calculation has been performed.

Mapping near-vision behavior
In order to show these findings in simple graphic form, Essilor’s Research & Development specialists designed a way to map each wearer’s results on a graph of possible behaviors (see Figure 6). On this graph:
- the horizontal axis shows the wearer’s average posture while reading, expressed as a downward gaze angle (from 12 to 30 degrees);
- the vertical axis shows near-vision behavior, i.e., the dispersion of the gaze direction (between 0 and 1).

Thus, a wearer who adopts a sharp downward gaze while reading and primarily uses his eyes to explore his near-vision vertically will fall at the bottom-right portion of the graph. By contrast, a wearer who lowers eyes only slightly to read and primarily changes posture or moves the tablet while reading will fall at the upper left of the graph. Every kind of behavior between these two extremes can be located on the graph.

Moreover, this mapping process includes a colour code; there is a significant effect on the optical design of the lens only if the colour codes for two measurements can be differentiated by the eye. This offers an immediate way to verify that the measurements are reproducible.

Thanks to multiple measurements performed on numerous presbyopes, we were able to show that each wearer’s behavior is reproducible and represents an appropriate datapoint for customization, since it is both specific to each individual and differentiating.

Once the measurement has been taken, the optician provides Essilor with the alphanumeric code for the wearer, so that a corresponding custom-designed Varilux® X series™ lens can be manufactured. We should note that the alphanumeric code generated for each measurement is encrypted and can be deciphered only by Essilor’s computer systems. Two codes that are very different may
FIG. 7  Illustrations of the wearer’s near-vision behavior profile: 1) Lowered gaze, 2) Reading distance, 3) Lateral offset, 4) Vertical movements.

FIG. 8  Vision quality as assessed by the wearers of Varilux® X series® lenses with NVB option (percentage of wearers with vision clarity or average clarity and width rated from 7 to 10 on a 10-point scale).
represent two very similar vision behaviors; conversely, two codes that are similar may correspond to very different behavior patterns. Whatever the case, each code contains all the information needed to manufacture a lens that corresponds very accurately to the wearer’s needs.

**Some simple illustrations for explaining a near-vision behavior profile to wearers**

A very simple communication tool has been designed to give wearers an easy explanation of the principle behind the NVB customization process. It consists of four very simple illustrated scales that show the four aspects of wearer behavior: lowered gaze, reading distance, lateral offset and vertical movements during reading. These illustrated graphics appear on the tablet screen after the measurements have been taken; cursors automatically indicate where the wearer’s behavior falls on the scales (Figure 7). This gives opticians an easy way to tell each customer about his or her specific near-vision behavior and explain how that behavior will be taken into account in designing the customer’s personalized progressive lens. Because the near-vision behavior measurement is important, what’s even more important is its value to the wearer!

**An innovation hailed by wearers**

To attest to the performance of the new Varilux® X series™ lens with NVB personalization, Essilor conducted a multi-site study with a large sample group of wearers to evaluate the lens’s overall performance and key benefits. The wearers were asked to score their vision quality under a range of circumstances on a scale of 1 to 10. Figure 8 presents the results of this study, showing that wearers enjoy the quality of their vision in all circumstances, to an impressive degree.

What’s more, wearers expressed a clear preference for the NVB version of the Varilux® X series™ lens over the traditional version without NVB customization. For example:

- The transition from far vision to near vision was easy for 94% of wearers and was very easy for 84% of wearers with the Varilux® X series™ lens with the NVB option, compared to 86% and 76% respectively for the traditional version of the lens (Figure 9).
- The adaptation to their Varilux® X series™ lenses with the NVB option was completed in less than one day for 82% of wearers and even less than 1 hour for 71% of wearers, compared to 75% and 61% respectively for the traditional lenses (Figure 10).

These results demonstrate the extent to which measuring the posture and near-vision behavior of wearers can further improve their comfort and satisfaction with their progressive lenses.
Conclusion
Varilux® X series™ lenses that are personalized for the wearer’s Near-Vision Behavior are pushing the boundaries of a progressive lens to provide even more benefits than their conventional counterpart, including an extended field of near vision. This customization based on near-vision behavior represents the first time that the power progression on a progressive lens has been tailored to the wearer’s precise use of the lens in near vision. The wearer’s posture, lowered gaze, lateral adjustment of the reading plane and vertical movements during near-vision exploration can now be taken into account when designing his or her progressive lenses. That’s a considerable advance, hailed by wearers, and promises even greater visual comfort for presbyopes who wear progressive lenses.

Note from the authors: this article is an adaptation from the White Paper published by Essilor’s R&D.

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The launch of a new generation of progressive lenses is only truly significant if the new lenses give presbyopes better visual comfort and greater satisfaction. And the only people who can make that determination are the wearers themselves! That’s why Essilor always conducts multiple “wearerv studies” prior to launching any new lens. This article describes the principle behind the new Varilux® X series™ lens – the 8th generation of the Varilux® progressive lens – and shares the results of the studies conducted for its launch. It outlines the benefits available from this new lens and describes how wearers experience the lens.

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**VARILUX® X SERIES™: WHAT DO WEARERS THINK?**

**Varilux® X series™: the 8th generation of the Varilux® progressive lens**

The Varilux® progressive lens has been through a great variety of innovations since it was first introduced by Bernard Maitenaz in 1959. Seven generations have already come and gone, and each one – from Varilux® 2 (1973) to Varilux® Comfort (1993), Varilux® Panamic® (2000), Varilux® Physio® (2006) and the Varilux® S series™ (2012) – brought improvements that reflected the accumulated experience of previous years. While this is not the place to describe each of those generations in detail (for that you can refer to the various publications that accompanied each one1), it is undeniably true that the Varilux® lens has always been at the cutting edge of innovation and represents the standard against which other lenses are measured. The 8th generation is no exception and introduces two major innovations: an expanded field of near vision that includes “arm’s-length” vision, and the ability to customize the lens progression based on the wearer’s near-vision behaviour. These innovations have been described in detail in two white papers2,3 published by Essilor’s Research & Development department and summarized in two recently published articles4,5.

**From the research lab to the market, wearers are the centre of attention**

“The wearer is always right!” – that’s the motto of Essilor’s Research & Development team, which has been focusing its attention on wearers for decades. In everything from special studies designed to generate new concepts to our testing of prototype lenses, when they’re used as representative samples of the target population, wearers...
play an integral role in the research process from start to finish. That process, known as the “Dioptric Loop” in the 1990s and as “Live Optics” since 2010, is based on the idea that only wearers can assess the level of progress in lenses, and that research must be conducted with the aim of ensuring enhanced vision and greater satisfaction among wearers. Wearers are used in studies because ultimately they are the best representatives of the patients examined by ophthalmologists and optometrists and the customers fitted with lenses by opticians.

As a result, Essilor has been conducting two types of testing over the past few decades: so-called «wearer studies», performed in accordance with controlled scientific protocols in laboratory or real-life conditions, and «market testing», conducted under actual market conditions. The purpose of wearer studies is to validate improvements to lenses on wearers, while market testing is designed to confirm that customers actually perceive the benefits provided by the new lenses.

For the Varilux® X series™ lens, the “Live Optics” model has been enhanced so as to yield an even better understanding of wearers and to verify that this latest innovation truly addresses the vision needs of patients with presbyopia.

Those enhancements initially related to the lens design phase. Designers began focusing on emerging needs among wearers, especially posture concerns and new practices prompted by a changing society. These include the use of smartphones or tablets or both, with users routinely switching from one to the other – new activities that are generally conducted at arm’s-length distance.

Second, researchers drew on new tools and methodologies to improve their understanding of wearer behaviour and wearers’ expectations. For example, they placed wearers into an experimental laboratory (the Movis Lab™, see Figure 1), where their movements could be measured and their position analysed in real time and 3D. Moreover, wearers were asked to make video selfies showing the most problematic vision situations they encountered with their progressive lenses, so researchers could learn more about their day-to-day needs.

During the third stage of the research, in order to assess the performance of the Varilux® X series™ lenses, wearers wore them in real-life conditions during three types of tests. Comparative “wearer studies” were conducted on representative samples of wearers; those studies were supplemented by a new kind of “usage study” in which patients wearing Varilux® X series™ performed routine tasks in a familiar environment (the HouseLab™, see Figure 1).
Figure 2). Lastly, a large-scale “market test” was conducted prior to introduce the lens on the market, to confirm that wearers truly perceived the new lens’s advantages under actual market conditions.

The following chapters briefly summarize the results of the studies conducted for this new lens.

Varilux® X series™ lenses: performance and benefits borne out by wearers

Before to begin the development and deployment phase of a new progressive lens, the lens concept is tested under real-life conditions in accordance with a rigorous scientific protocol. The Varilux® X series™ lens was subjected to this testing just as all its predecessors were. Several studies were conducted to confirm the effectiveness of the Varilux® X design (non-personalized version), validate the benefits for wearers under key use conditions and demonstrate the value of the Varilux® X series™ “NVB” (Near Vision Behaviour personalization).

a) The Varilux® X design was perceived as superior to the Varilux® S® design

An international multi-centre study was conducted under real-life conditions, in accordance with the study protocol used by Essilor (validated by an independent body*). This comparative study was randomized and double-blind; in other words, neither the investigator nor the wearer knew the exact nature of the lenses tested, and the lenses that were worn were issued on a random basis.

Wearers were first given a market lens for their new prescription, to wear for at least three weeks during a special preliminary period called the “wash-out” period; they then wore a test lens and a reference lens for two successive periods of two weeks each.

All three pairs of eyeglasses were identical in every other respect (the same frames, material, coatings, powers and centering), so as to isolate the parameters that were specific to each design tested.

The study consisted of comparing the new Varilux® X design, without the “Near Vision Behaviour” option, with the Varilux® S® design lens from the previous-generation Varilux® S® series, which is the market reference. The wearers wore the two lenses in succession, then were interviewed and asked to fill out detailed, standardized questionnaires, in order to gather their assessments of the lenses.

The results we obtained, which are shown in Figure 3, are worth studying. We find that among the group of 66 wearers who took part in the study (Figure 3a):  
- Quality of vision with the Varilux® X design was rated superior to that of the Varilux® S® design on every criterion (Figure 3b).
- 65% of the wearers who expressed a preference chose the Varilux® X design lens (Figure 3c).
- 82% of the wearers said that adapting to the Varilux® X design was “easy” or “very easy”, versus 76% for the Varilux® S® design (Figure 3d).
- The wearers readily indicated that they were highly satisfied with the lens, as some of their comments make clear (Figure 3e).

These results indicate the degree to which wearers enjoy the new Varilux® X design lens and the marked improvements it provides over the previous generation of lenses.

b) The Varilux® X design lens: proven benefits for “arm’s-length vision”

In addition to the comparison with the Varilux® S® design...
**3a Population**

- 66 PAL wearers (worn for at least 6 months)

  - Ametropia
    - Mean: -0.75
    - Mean: +4.00

  - Age
    - Mean: 55
  - Addition
    - Mean: +2.00

**3b Visual performances**

- Overall Vision
  - 100%

- Distance Vision
  - 88%

- Intermediate Vision
  - 83%

- Near Vision
  - 89%

- Dynamic Vision (weary moving)
  - 91%

- Dynamic Vision (surroundings moving)
  - 89%

**3c Overall preference**

- 65% of wearers prefer Varilux® X design
- 35%
- 41% of them have a large preference

Among wearers who made a choice (n=49/66)

**3d Adaptation easiness**

- Varilux® X design: 82%
- Varilux® S® design: 76%

Easy adaptation rated from 7 to 10 on a 10-point scale (n=66/66)

**3e Verbatims**

- ‘They’ve been brilliant, absolutely brilliant’
- ‘When I first put them on I thought they were great’
- ‘The smoothness of the transition from near to far was excellent’
- ‘These are lovely, I want to keep them’

**Figure 3** Comparison of the Varilux® X design and Varilux® S® design lens among wearers - International multicenter study (n=66)
lens, the quality of arm’s-length vision available with the Varilux® X design was investigated as well, with a specific study of 42 wearers in France (Figure 4a). During that study, wearers who normally use Varilux® S® design lenses were placed in a controlled home environment known as the HouseLab™. In that routine setting, they were asked to perform activities conducted at arm’s length, using the Varilux® X design lenses. The tasks in question were chosen because they are typical of the activities that wearers of progressive lenses find difficult.

The results of that study, shown in Figure 4b, bear out the high opinion of the lenses among wearers, regardless of whether they were asked to perform near-vision or mid-distance-vision tasks. That result was corroborated by the fact that 97% of wearers reported having to make “few” or “no” horizontal head movements, and 93% of wearers reported “few” or “no” vertical head movements, to explore their near-vision space (Figure 4c). That latter figure represents a major advance, since the vertical head movements that progressive lenses require for near and mid-distance vision are often a source of complaint among wearers. So these results confirm the new benefit offered by the Varilux® X design lens.

Thus, the design performance of the new Varilux® X design lens was largely borne out.

c) The personalized “NVB” version of the Varilux® X design lens was found to be superior to the Varilux® X design standard lens
Once the performance of the new Varilux® X design had been established, there remained the task of confirming and demonstrating the benefits of the new personalized Varilux® X series™ “NVB”. As a reminder, that option involves measuring each wearer’s near-vision posture and behaviour and designing, calculating and manufacturing a progressive lens that reflects those customized parameters. The principle behind the NVB feature was described in detail in a previous article6.

For that purpose, another comparative wearer study was conducted in accordance with the same strict protocol described above. This study was conducted simultaneously at several research centres with a sample population of 51 wearers (Figure 5a).

---

**FIG. 4**

**4a Population**

- 42 Varilux® S® design wearers (worn for at least 6 months)

<table>
<thead>
<tr>
<th>Ametropia</th>
<th>-6.00</th>
<th>Mean: +0.25</th>
<th>+3.75</th>
</tr>
</thead>
</table>

**4b Satisfaction in activities at arm’s length**

<table>
<thead>
<tr>
<th>Group</th>
<th>Multitasking</th>
<th>Taking care of yourself</th>
<th>Reading a book</th>
<th>Reading in lying position</th>
<th>Doing DIY</th>
<th>Doing precise tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watching movies and sending texts</td>
<td>100%</td>
<td>50%</td>
<td>0%</td>
<td>90%</td>
<td>93%</td>
<td>98%</td>
</tr>
<tr>
<td>Orientating in the street</td>
<td>99%</td>
<td>100%</td>
<td>99%</td>
<td>90%</td>
<td>95%</td>
<td>93%</td>
</tr>
<tr>
<td>Looking dashboard</td>
<td>97%</td>
<td>95%</td>
<td>97%</td>
<td>99%</td>
<td>98%</td>
<td>90%</td>
</tr>
<tr>
<td>Doing precise tasks</td>
<td>93%</td>
<td>95%</td>
<td>93%</td>
<td>98%</td>
<td>98%</td>
<td>90%</td>
</tr>
<tr>
<td>Group discussion</td>
<td>98%</td>
<td>95%</td>
<td>97%</td>
<td>99%</td>
<td>98%</td>
<td>98%</td>
</tr>
<tr>
<td>Multitasking</td>
<td>100%</td>
<td>95%</td>
<td>97%</td>
<td>99%</td>
<td>98%</td>
<td>98%</td>
</tr>
</tbody>
</table>

Satisfaction level rated from 7 to 10 on a 10-point scale (n=19 to 42/42 depending on activities)

**4c Head movements in activities at arm’s length**

Little or no head movements are needed for:

- 97% of wearers
- 93% of wearers

Horizontal and Vertical head movements

Weavers chose among: ‘Not at all’, ‘A little, just right’, ‘Too much’, ‘Far too much’ (n=42/42)
The study’s results can be summarized as follows:
- Vision quality with the Varilux® X series™ “NVB” lens was rated high or very high on every criterion by a very large majority of wearers (Figure 5b).
- 62% of the wearers who expressed a preference chose the Varilux® X series™ “NVB” lens (Figure 5c).
- 90% of the wearers said that adapting to the Varilux® X series™ “NVB” lens was “easy” or “very easy” (Figure 5d).

d) Varilux® X series™: the benefits are perceived by customers under actual market conditions
Having demonstrated the performance of the Varilux® X series™ lens in both the non-personalized and the personalized versions during controlled, protocol-based studies, it was needed to know how the lens was perceived by wearers under real-life market conditions. Therefore, a wide-ranging market test was conducted across Europe, with more than 200 wearers recruited in 22 countries (Figure 6a). Nearly all of the participants (about 93%) were already wearers of progressive lenses and received their new Varilux® X design lenses under typical prescription and adaptation conditions, without any specific protocol. They wore their new lenses for a nominal period of at least two weeks, and then completed an evaluation questionnaire that had previously been translated into their language.

A summary of the results from the 172 completed questionnaires received is shown in Figure 6. In particular, we see that:
- Wearers expressed a very high level of both general satisfaction (above 94%) and satisfaction with quality of vision (95%) (Figure 6b). These levels are similar to those expressed under controlled protocol-based study conditions.
- Adaptation was considered “easy” or “very easy” by 82% of the wearers – “less than one day”, according to 87%. It is worth remembering that a new progressive lens always requires a learning period (Figure 6c), and that wearers should always be notified of that beforehand.
- The level of satisfaction during activities that require arm’s-length vision also proved quite high: up to 95% of wearers declared they were “satisfied” or “very satisfied” with their lenses for the multiple activities performed at that distance (Figure 6d).
- It’s important to note that at least 73% of the wearers surveyed said they were “more satisfied” with their new lenses than with their previous ones, both for general use and for tasks performed at arm’s length.
- Lastly, one especially notable point is that a large majority of wearers – 92% – reported having to make “few” or “no” horizontal head movements for clear arm’s-length vision, and 94% of wearers reported “few” or “no” vertical head movements (Figure 6e). This finding deserves
**Population (n=172)**

- **Ametropia**
  - Mean: 0.75
  - Range: -10.25 to +4.25

- **Addition**
  - Mean: +2.00
  - Range: +1.00 to +3.00

- **Age**
  - Mean: 40.44
  - Range: 17 to 76

Data available for at least 140/172 wearers.

**Overall satisfaction**

- 94% of wearers satisfied with Varilux® X design

% of 'Satisfied' or 'Very satisfied' wearers (among respondents: n=172/172)

**Adaptation**

- **Easiness**
  - 82%

% of wearers with 'Easy' or 'Very easy' adaptation (among respondents: n=171/172)

**Satisfaction with visual performances**

- Overall Vision: 95%
- Distance Vision: 96%
- Intermediate Vision: 94%
- Near Vision: 88%
- Dynamic Vision (surroundings moving): 94%
- Dynamic Vision (wearer moving): 96%

% of 'Satisfied' or 'Very satisfied' wearers (among respondents: n=170/172 or 171/172 depending on items)

**Satisfaction in activities at arm's length**

- Multitasking: 90%
- Reading in lying position: 84%
- Taking care of yourself: 89%
- Doing precise tasks: 88%
- Looking dashboard: 95%
- Orientating in the street: 93%
- Group discussion: 95%
- Little or no head movements are needed for:
  - Horizontal head movements: 92%
  - Vertical head movements: 94%

% of 'Satisfied' or 'Very satisfied' wearers (among respondents: n=142/172 to 170/172 depending on items)

**Time**

- 87% Quick (< 1 day)
- 79% Very quick (< 1 hour)

Among respondents: n=172/172

**Head movements in activities at arms's length**

We wearers chose among: 'Not at all', 'A little, just right', 'Too much', 'Far too much' (among respondents: n=172/172 for horizontal, 171/172 for vertical)

**FIG. 6** Evaluation of Varilux® X design lens among wearers in European market testing (n=172)
special emphasis, since it conveys the specific advantage provided by the Varilux® X design lens.

These results, obtained under actual market conditions, confirm those of earlier studies and show the extent to which the benefits found by wearers under controlled, protocol-based study conditions are also observed by clients in daily professional practice.

Moreover, those results were obtained with the non-personalized version of the lens; in other words, they show that the Varilux® X design lens is an excellent product. This suggests an even higher level of performance with the personalized “NVB” version.

Conclusion
Having new lenses tested by wearers is the only way to ensure that they perform effectively and it also helps to ensure their success. Essilor continues to invest a great deal of means and energy in wearer testing, in order to validate and confirm the efficacy of a new lens before introducing it on the market.

Like its predecessors, the Varilux® X series™ lens was subjected to an evaluation by wearers, both during its design phase and before being introduced on the market. As a result, Essilor was able to show that wearers enjoy the high quality of the lens even in its non-personalized version, Varilux® X design; in particular, they see how it represents a major innovation with regard to arm’s-length vision. Moreover, with the Varilux® X series™ “NVB” lens that is personalized to the wearer’s near-vision behaviour, the product ushers in a new era of sophisticated progressive lenses that wearers will especially appreciate. Whether those wearers are patients or clients, they represent the consumers of tomorrow. We hope Eye Care Professionals will be able to capitalize on this new innovation to provide new generations of presbyopes with even greater visual comfort.

KEY TAKEAWAYS
- Wearer studies are the only way to determine the true benefits of any new progressive addition lens.
- Wearers are always the center of the attention of Essilor Research & Development teams.
- Varilux® X series™ was successully submitted to 3 types of wearer tests: performance evaluation in accordance with controled scientific protocols, benefit evaluation of arm’s length vision in HouseLab™ conditions and wearers appreciation in actual market conditions.
- Varilux® X design is perceived as superior to Varilux® S® design.
- Varilux® X design expanded field of vision at arm’s length is confirmed by wearers.
- Varilux® X series™ “NVB” is evaluated as superior to Varilux® X design.

REFERENCES
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