# EYEZEN™ START

## THE NEW GENERATION OF SINGLE VISION LENSES

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Eyezen™ START

# I. INTRODUCTION

Digital technology has reshaped the way we live. Almost all wearers are exposed to screens either in their personal lives with smartphones, tablets or at work on laptops...

As a result, optical standards such as reading distances and eye declination have evolved. Yet most of single vision lenses are not designed with these new parameters in mind.

While almost all wearers increasingly use their screens at close distance, their single vision lenses are optimized for far vision only. This means when wearers look at close-distance objects through the bottom of their lenses, they experience some optical aberrations, caused by deviation from their optimum prescription value that can lead to visual fatigue.

For the first time, we can provide optimized vision no matter what they look at. Thanks to our exclusive Eyezen DualOptim™ technology, the calculation of the Eyezen™ Start lens takes into consideration the gaze direction and object distance at each point of the lens. This ensures to maintain the wearer's prescription in the whole lens according to the optical standard adapted to our increasingly online lives. Ultimately, it means wearers enjoy better vision and relaxed eyes all day long.


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# II. WEARERS' NEEDS

## » 1. USE OF DIGITAL DEVICES: IMPACT ON POSTURE AND VISION

The use of digital devices leads to specific postural behavior when compared to reading on paper, and this is particularly the case when it comes to handheld ones. [1] [2]

To explore this issue in depth, Essilor conducted an internal study on 22 subjects aged between 24 and 51 to record postural data when using devices in natural conditions.

Before each experiment, the subjects were equipped with a helmet on which optical markers were placed. Some markers were also placed on their torsos to record trunk movements.

While using a smartphone, tablet and eBook reader, the subjects were asked to perform seven different tasks:

- Searching for the weather forecast
- Reading an email
- Writing an email
- Playing a video game
- Watching a video
- Searching for information on the internet
- Reading a text

The subjects were in three different postures: standing, sitting on a couch and lying on a bed.

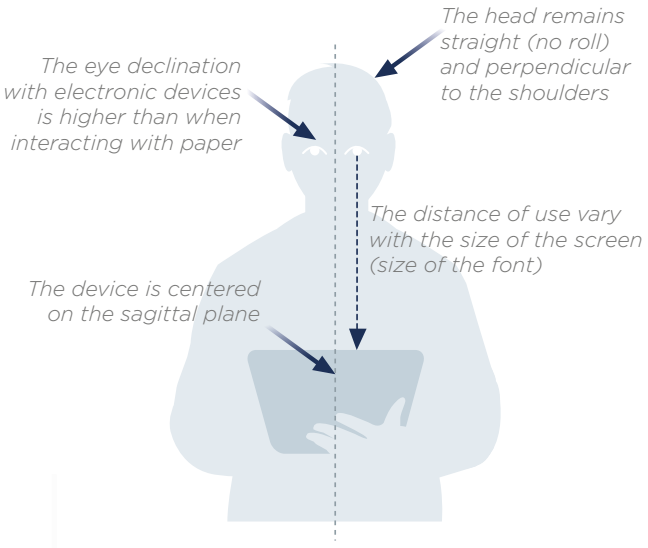
During these activities data were recorded:

- Eye-Device distance
- Head declination
- Eye declination
- Head Roll (rotation of the head around an antero-posterior axis.

These new postures have an impact on the visual system, forcing the eyes to look at the new object: the vergence state of the eyes changes, and there is convergence.

***Figure 1***

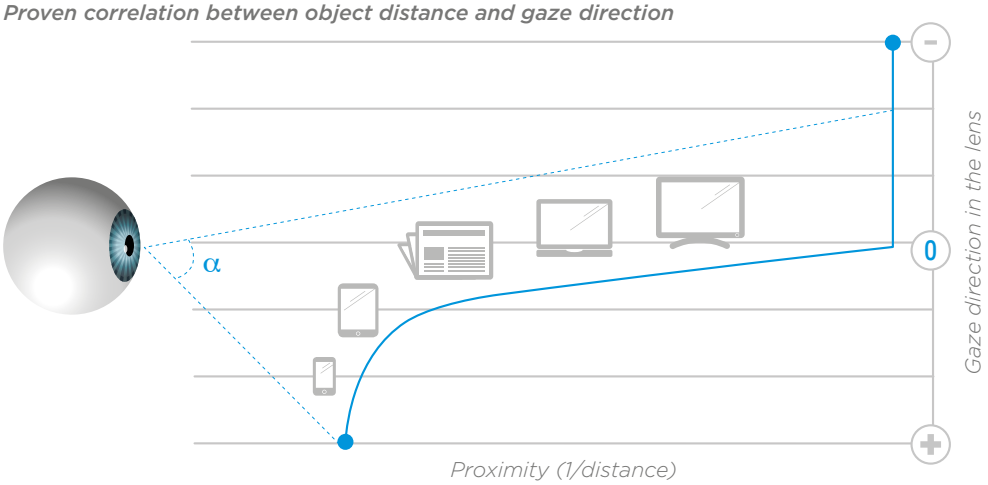
***Differences in terms of postural behaviors between newspaper and digital devices***



**THE INTERNAL STUDY SHOWED USERS ADOPT RIGID POSTURES IN FRONT OF THEIR DEVICES. WHEN COMPARED TO READING ON PAPER, THE DISTANCE FROM THE DEVICE IS SHORTER AND EYE DECLINATION IS HIGHER.**

*Figure 2*

*Proven correlation between object distance and gaze direction*




## » 2. VISUAL FATIGUE

Switching from one device to another and prolonged near and intermediate tasks are highly demanding for the visual system. They can easily lead to visual fatigue during the day.

The Computer Vision Syndrome (CVS), which we call visual fatigue, has been defined by the American Optometric Association (AOA) as a combination of eye and vision-related problems due to prolonged use of computers. [3]

Several studies have emphasized the fact that both digital screens and unperfected correction can lead to visual fatigue. [4] [5] [6] [7]

- The combination of too much screen time and vision issues such as myopia, hyperopia and astigmatism can put extra strain on the eye. Fatigue can set in as the eyes strain to correct for vision issues while focusing on complex digital content (Vision Council 2015, 2016). [8]
- In 2012, Rosenfied *et al.* studied the effect of induced astigmatism on Computer Vision Syndrome [9]. They recorded the symptoms after a 10-minute period of reading from a computer monitor, with astigmatism added in lenses worn by 12 young subjects with normal vision. A significant change in symptoms was reported, and the median total symptom scores when astigmatism was induced were recorded. They concluded the correction of small astigmatic refractive errors may be important in optimizing patient comfort during computer operation.

These scientific findings show not only the importance of refraction accuracy but also the need for good vision correction throughout the lens.

## » 3. BLUE LIGHT

A study conducted in 2014 by the Ipsos institute on four thousand people in France, the United States, Brazil and China revealed over one out of two people are bothered by the strong brightness of their screens. It showed the level of discomfort varies depending on the user's age, and for younger users the main discomfort is screen brightness.

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. A prime example is light emitting diodes (LEDs). Cool white LEDs in particular present an emission peak in the harmful blue-violet band and have a more elevated luminance/brightness than traditional sources. Despite this LEDs are now present in most modern lighting systems and in a large number of screens, especially in computers, tablets and smartphones.

Essilor has developed the technologies Light Scan™, Blue UV Capture™ and Eye Protect System™ to protect the eyes against the potential dangers of blue-violet light. Each of these technologies eliminate at least 20% of harmful blue-violet light up to 455 nm. Furthermore, some of these technologies can be combined to further reinforce the protection against potentially harmful blue-violet light up to 35%.

To satisfy users' needs, an Eyezen™ lens must be ordered with at least one of these technologies.

# III. EYEZEN™ START SETS NEW STANDARDS FOR SINGLE VISION LENSES

## » 1. EYEZEN™ START

Usually, single vision lenses are calculated to compensate visual defects of ametropic wearers by only considering prescription in far vision and objects at an infinite distance. Indeed, during the eye exam the refraction is set up with an acuity target located at an far distance (around 5m)*.

This way to calculating single vision lenses is not relevant if we take in consideration the time we spend at close distances on digital devices. Today, even non-presbyope wearers use their single vision lenses to see at any distance.

That's why with Eyezen™ Start we developed a new way of imagining single vision lenses by introducing two reference points in far and near vision for the lens calculation.

For the first time in our single vision lenses, we optimized the whole lens surface for both far and near vision to improve acuity and reduce deviation from the prescription according to object location.

Indeed, for standard single vision lenses, quality of vision can be degraded due to the presence of aberrations, which cause blurry vision. The two primary aberrations found in single vision lenses are power error and unwanted astigmatism.

Power error corresponds to a deviation from the prescribed mean sphere value. Power error either generates blur (for a positive power error) or induces accommodation effort (for a negative power error). For example, a level of power error of 0.18 D causes an acuity loss of approximately 0.05 logMAR, which corresponds to a half-line on a logMAR acuity chart (Fauquier *et al.*, 1995).

* Single vision lenses prescribed in near distance vision are out of the product definition.

Unwanted astigmatism corresponds to a deviation from the prescribed cylinder value and/or axis, reducing sharpness of vision. For example, a level of unwanted astigmatism of 0.25 D causes an acuity loss of approximately 0.05 logMAR, which again corresponds to a half-line on a logMAR acuity chart (Fauquier *et al.*, 1995).

Maintaining power error under 0.18 D and unwanted astigmatism under 0.25 D guarantees maximum visual acuity.

## » 2. EYEZEN™ DUALOPTIM™: HOW IT WORKS

In everyday life, distance objects are usually seen through the upper part of the lens, whereas near objects are usually seen through the lower part of the lens. This lens use becomes even more and more meaningful when the wearer is in front of digital devices.

The actual power and astigmatism of a lens depend on the gaze direction, but also on the object distance. Usually when a lens is designed, it is assumed that all objects are located at infinite. In reality, they are not. That's why the lens power and astigmatism are incorrect.

Thanks to our R&D study on postural data on the use of digital devices, we can determine the object distance for a given gaze direction.

Thus we take into account the distance to objects in our power and astigmatism computation. Therefore we are able to precisely maintain the prescribed power, and reduce unwanted astigmatism.

To design the Eyezen™ Start lenses, Essilor drew on its latest lens calculation software, which was first used for the Varilux® X series™ lenses launch.

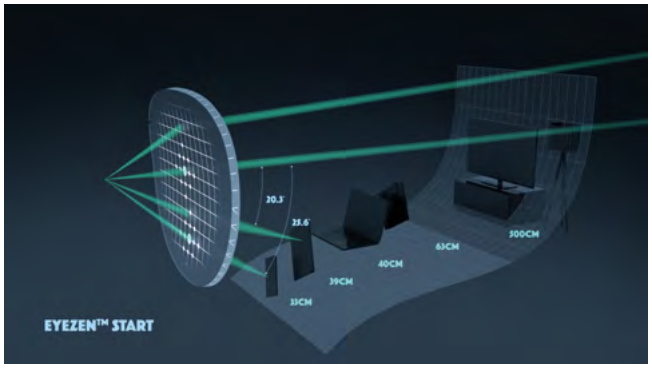
# IV. EYEZEN™ START LENSES PERFORMANCE

Lens calculation now takes into consideration the gaze direction and the object distance at each point of the lens. This calculation ensures the optical power for the wearer remains unchanged from the prescription values. The wearer benefits from the same wearer power and low unwanted astigmatism in the whole lens.

In the Eyezen™ Start lens, a near vision point is used as a second reference point so the power of the lens is adapted to an object's distance in near vision tasks. This near vision point is determined according to wearer's prescription, lowering gaze direction and vergence angle. For the wearer, the mean power and astigmatism at this near vision point will be the same as the mean power and astigmatism at the far vision point. This ensures maximum acuity in far and near vision zones.

The Eyezen™ Start lens is locally modified to provide the right prescription to the wearer according to an object's location, no matter which part of the lens he is looking through.

***Figure 3***
***Eyezen™ DualOptim™ technology***



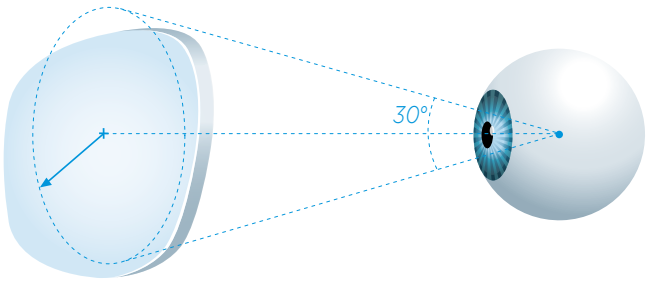

## » 1. OPTICAL PERFORMANCE

### a) In the zone used most

The extended criterion brings up the extended area for which the acuity is preserved across the lens. Acuity loss is due to power errors or unwanted astigmatism.

The evaluation is performed inside a cone of gaze directions whose apex is the center of rotation of the eye and whose axis is the "straight ahead" direction. The half-angle of the cone is equal to 30°. This cone contains the majority of gaze directions that are used during everyday tasks (represented in dashes below for both lenses).

***Figure 4***
***Cone of gaze directions for the computation of the Eyezen™ Start lenses performance factor***




We perform ray tracing for all directions inside the cone to determine lens power and astigmatism taking into account the distance to object.

We evaluate the angular extent of the vision zone, where power deviation is lower than 0.18 D, and astigmatism deviation is lower than 0.25 D. We choose these threshold values because beyond them wearers will suffer an acuity loss equal or greater to one half-line on a logMAR acuity chart.

We evaluate the performance of a lens by calculating the percentage of the vision cone for which prescription is maintained. For example, a performance factor of 100% means it is maintained for all gaze directions.

The evaluation is performed in wearer power mode, which means we take in consideration wearer needs both in far and near vision.

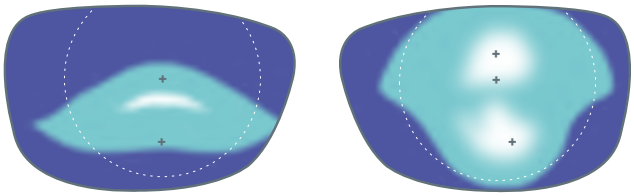
We compute the performance factor for a number of prescriptions, -4.00 D to +4.00 D sphere and from 0.00 D to -2.00 D cylinder.

We compare the performance of Eyezen™ Start lenses to standard single vision lenses by computing a performance gain representing the increase in percent from a standard single vision lens to Eyezen™ Start lenses:

***Figure 5***

***Vision area with power error and unwanted astigmatism combined under their threshold for standard single vision lens (left) and Eyezen™ Start lens (right)***

$$\text{Performance Gain} = 100 \times \frac{\text{Eyezen™ Start performance factor} - \text{standard single vision performance factor}}{\text{standard single vision performance factor}}$$



The prescription is perfectly maintained at the reference points in far and near vision and the average performance factor of Eyezen™ Start is 49% larger than standard lenses.

*Note: The gradient color from dark blue to white is representative of the labeled criterion. Dark blue color means that the criterion in over its threshold value, light blue colors means that the criterion is under the threshold value, White color means that the criterion is close to 0.*

## b) In the near vision zone

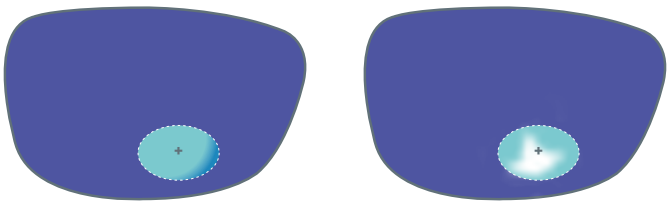
As described above, Eyezen™ Start lenses take into account object distance to provide the wearer with the right prescription when they look at, for example, digital devices.

Therefore, the near vision area is specially adjusted in power to match the prescription.

We evaluate the performance around the near vision point. The performance factor for each lens in this case is the mean value of optical quantities over the near vision area.

***Figure 6***

***Near vision area for prescription evaluation for standard single vision lens (left) and Eyezen™ Start lens (right)***



Considering a core range from sphere -6.00 D to +6.00 D and cylinder from 0.00 D to -4.00 D, the average diminution of optical criteria as mean power and unwanted astigmatism in the near vision area for an Eyezen™ Start lens versus a standard lens is **60%**. Up to an extent this average diminution is equivalent to divide by 2.5 times optical power error and unwanted astigmatism in the near vision area.

These results confirm the strong performance of Eyezen™ Start lenses. The lens not only delivers better acuity in far vision but also in near vision – for the first time in our single vision lenses.

## » 2. IN-LIFE WEARER TEST

Essilor instituted a test to evaluate the Eyezen™ Start lens' overall performance in real life, including in the use of digital devices and their impact on visual fatigue.

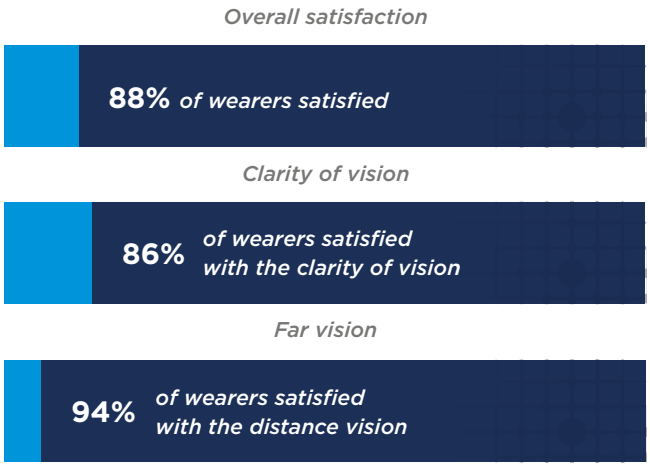
The study was conducted in France in 2018 by eurosyn.

A total of 49 wearers were recruited, all using standard single vision lenses* with anti-reflective coating at the time of the study. Furthermore, the wearers were all regular users of digital devices and were suffering from different levels of visual fatigue symptoms.

During the study, the participants were equipped with Eyezen™ Start lenses and were given no specific instructions other than to wear them daily for two weeks. Wearers were not aware of the lenses' features. After this period, they answered a questionnaire to evaluate the lenses' performance.

- As can be seen in Figure 7, 88% of wearers were satisfied with Eyezen™ Start lenses in general and 86% were satisfied with the clarity of vision through the lenses. Moreover, 94% of wearers were satisfied with the quality of their far vision with Eyezen™ Start lenses.

***Figure 7***
***Overall satisfaction*** (1)



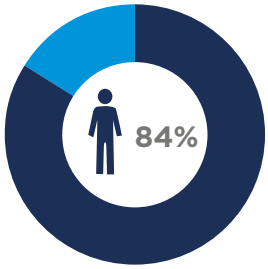

* Clear standard single vision lenses with an anti-reflective coating.

(1) n=49/49 - 10-point scale from 1 to 10 - % of wearers who rated from 7 to 10
(2) n=49/49 - 6-point scale from 'Much worse' to 'Much better' - % T3B: % of wearers who answered from 'Somewhat better ' to 'Much better'
(3) n=29/49 wearers who feel glare from digital device screens with both their current eyeglasses and Eyezen™ Start lenses - 10-point scale from 1 to 10 - % of wearers who rated glare from screen less troublesome with Eyezen™ Start lenses than with their current eyeglasses

- Eyezen™ Start lenses allowed the wearers to enjoy good vision when using digital devices, vision that was clearly better in comparison to their current eyeglasses they were using at the time of the study. Indeed, 84% of wearers experienced improved visual comfort and 80% better contrast with Eyezen™ Start lenses when compared to their current eyeglasses. The impact of Eyezen™ Start lenses was also discernible with respect to glare perception: among wearers who felt glare from digital devices, 76% of them noticed a reduction in glare intensity with Eyezen™ Start lenses when compared to their current eyeglasses.

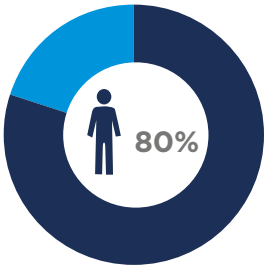
***Figure 8***
***Vision while using digital devices***

*Better visual comfort* (2)



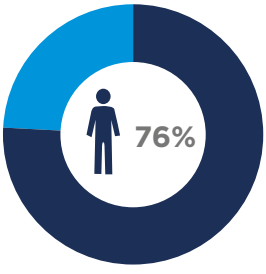

*% of wearers who feel a better visual comfort in comparison to current eyeglasses*

*Better contrast* (2)




*% of wearers who feel a better contrast in comparison to current eyeglasses*

*Lower glare intensity* (3)




*% of wearers who feel a lower glare intensity in comparison to current eyeglasses*

- Eyezen™ Start lenses performed well when it came to using smartphones, tablets or computers: at least 90% of wearers reported comfortable vision when using these digital devices. Eyezen™ Start lenses also performed well in daily activities such as driving or reading a book, with up to 93% of wearers declaring having comfortable vision.

***Figure 9***
***Visual comfort on digital devices (4)***

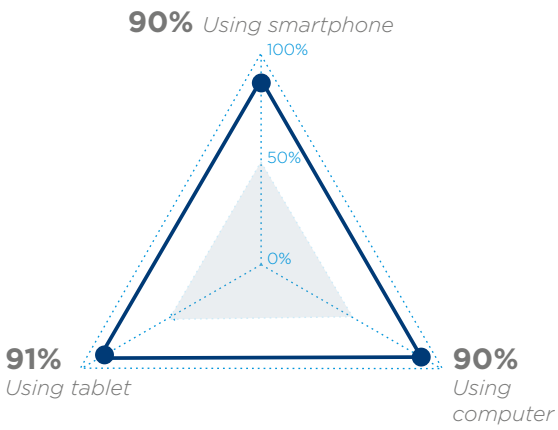
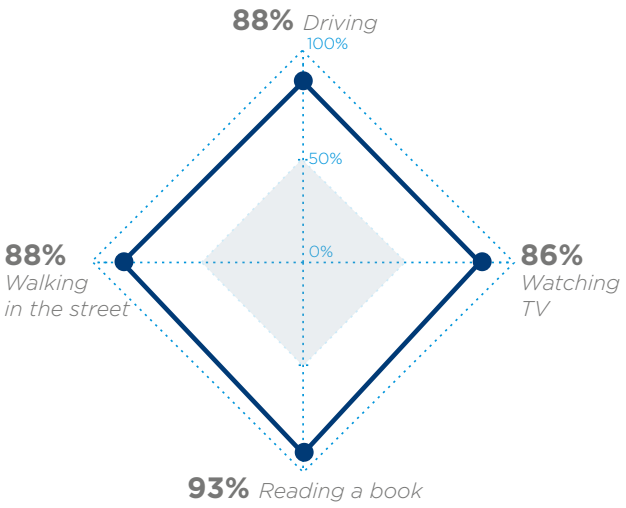


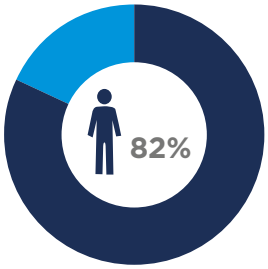

***Figure 10***
***Visual comfort in daily life situations (4)***




- Finally, when wearers were asked to evaluate their visual fatigue, 82% of them declared their visual fatigue level was lower with Eyezen™ Start lenses when compared to their current eyeglasses. It is interesting to note 76% of wearers felt Eyezen™ Start lenses can be beneficial in the long term by relaxing their eyes on a daily basis.

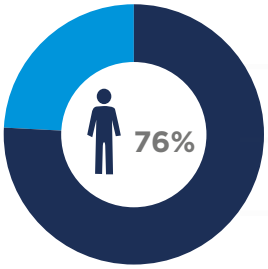
***Figure 11***
***Visual fatigue reduction***

***Visual fatigue reduction already after 2 weeks wearing period (5)***




*% of wearers with less visual fatigue in comparison to current eyeglasses*

***Relaxed vision day after day (6)***




*% of wearers who feel that Eyezen™ Start lenses allow to keep relaxed eyes day after day*

(4) n=33/49 to 49/49 depending on activity - 10-point scale from 1 to 10 - % of wearers who rated from 7 to 10
(5) n=49/49 - 6-point scale from 'Much stronger' to 'Much lower' - % T3B: % of wearers who answered from 'Somewhat lower' to 'Much lower'
(6) n=49/49 - 4-point scale from 'Completely disagree' to 'Completely agree' - % T2B: % of wearers who answered 'Somewhat agree' or 'Completely agree'

## » 3. COMPETITIVE POSITIONING

The comparison was realized based on the extended criteria described below.

The performance for each lens represents the percentage of the vision cone for which prescription is maintained. This cone contains the majority of gaze directions used during everyday tasks.

The prescription is considered maintained when the following is true:

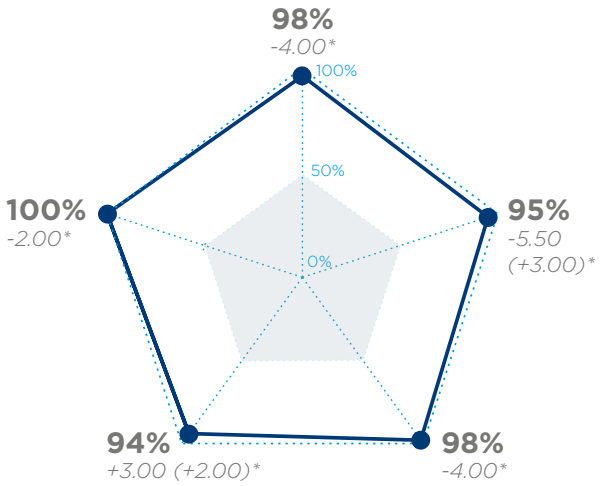
- Unwanted astigmatism < 0.25 D or
- Power errors < 0.18 D

A factor of 100% means the prescription is maintained for all gaze directions in the usage zone. (Cf paragraph dedicated to lens optical perfomance – In the zone used most).

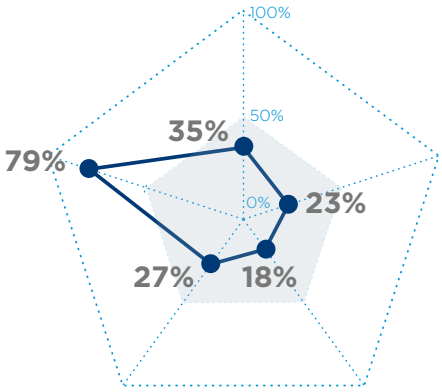
We compared Eyezen™ Start lenses with three main competitors (Competitor A, B and C), based on the percentage of maintained prescription for five different ametropias.

***Figure 12***

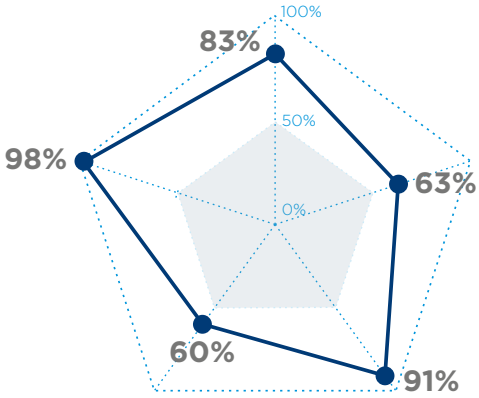
***Percentage of prescription achievement – extent area of the lens where the prescription is maintained*** [1]



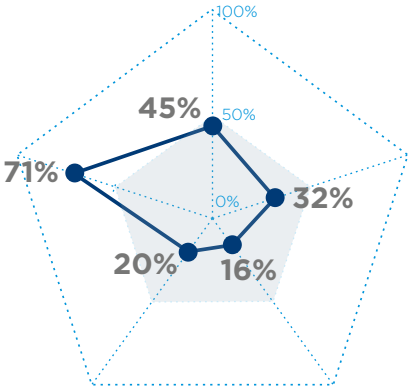

Eyezen™ Start




Competitor B




Competitor A




Competitor C

(1) Based on internal R&D analysis

Eyezen™ Start lenses outperforms in extended criterion when compared to premium single vision competitors' lenses: the prescription is perfectly maintained at the reference points in far and near vision.

The R&D analysis confirmed that none of our main competitors optimize their premium SV designs according to the far and near vision points of reference.

Eyezen™ Start lenses are also the only single vision lenses that take into account convergence, which happens when the wearer looks at objects at close distances. Indeed, the vergence angle increases. This is why Eyezen™ Start lenses are asymetrical lenses.

# CONCLUSION

Essilor decided to keep with its practice of continually placing wearers at the heart of its innovation process by closely studying how digital devices and their use are impacting posture and the visual system, thus making it possible to identify and characterize associated visual needs.

This in-depth understanding of the effect of the use of digital devices on eyeglasses wearers led to a combination of cutting-edge technologies. The Eyezen DualOptim™ technology for the first time provides better acuity in our single vision lenses in both near and far vision. This is extremely significant today when considering that digital devices make us look at closer distances than before.

Secondly, Eyezen™ Start lenses help to protect the eyes from harmful blue-violet light thanks to the most advanced blue light filters.

This innovative combination of technologies used in Eyezen™ Start lenses is what allows them to both relax and help protect wearers' eyes when they are using digital screens.

## KEY TAKEAWAYS

- The use of digital devices leads to specific postural behavior: the reading distance is shorter and eye declination is higher.
- Switching from one device to another and prolonged near and intermediate tasks are highly demanding for the visual system and can lead to visual fatigue.
- With Eyezen™ Start we developed a new way of imagining single vision lenses by introducing two reference points in far and near vision for the lens calculation.
- Thanks to the Eyezen™ Dualoptim™ technology, the whole lens is optimized for both far and near vision. It allows to improve acuity and reduce deviation from the prescription according to object location.
- In-life study carried out by Eurosyn Institute revealed that a high percentage of wearers (88%) are satisfied with Eyezen™ Start lenses. 84% of wearers experienced improved visual comfort and 82% of them declare less visual fatigue compared to their current eyeglasses.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