Always in Focus

iD MYSTYLE 2

White paper HOYA iD MyStyle 2

HOYA
Eye for detail

Crystal clear vision in a split second

Abstract

HOYA iD MyStyle 2 is Hoya's best individualized progressive lens that offers crystal clear vision in a split second, putting everything in instant focus. The key success factors of this unique lens design are:
Hoya's patented Binocular Harmonization Technology, an unprecedented level of individualization and lifestyle customization with the Hoya iDentifier, and real life verification according to Hoya's patented Binocular Eye Model.

Correcting visual imbalance

More than 70%[1] of presbyopes could experience better vision, especially in the near and intermediate area. This is related to the fact that this group of presbyopes is prescribed different prescriptions for right and left eyes. A known side effect of progressive lenses in general is the prismatic effect, which depends (amongst others) on the power of the lens. If there is a prescription difference between the right and left eye, there are different prismatic effects for each eye, and each eye will use different areas of the lens.

Because in progressive lenses the power changes in vertical direction (in order to reach the addition), each eye will experience a different accommodation support.

This difference in accommodation support leads to a situation where the image quality is different for each eye. As a consequence the brain will try to equalize the image quality of both eyes. This can lead to asthenopic complaints which are often not directly recognized as being related to the lenses.

Hoya's Binocular Harmonization Technology balances the accommodation support in such a way that both eyes experience the same image quality, which leads to:

- Perfect and effortless focusing
- Constant stability
- Excellent depth of vision

Tailoring to the individual

Research amongst consumers has shown that more than 75% of presbyopes find it important that their lifestyle is taken into account when buying new progressive lenses[2].

The Hoya iDentifier takes this fact into account. The software guides the eye care professional and their patient through a three step lifestyle module, where the lifestyle of the wearer is recorded in detail and each area of the lens (distance, intermediate and near) is independently tailored to the needs of the wearer.

Not only lifestyle, but also the prescription, frame and wearing parameters, as well as wearing history are taken into account in this process.

This unique support system with its virtually unlimited design variations guarantees a fully personalized lens profile for each wearer and can meet the most extreme visual demands.

Binocular Eye Model

Hoya has developed five new patented binocular evaluation methods which form the very basis of the development of Hoya's unique Binocular Harmonization Technology. The Binocular Eye Model considers all elements that are important for a perfect binocular performance of progressive lenses, and includes the patented Binocular Clearness Index, Binocular Accommodation Demand Difference, Binocular Vertical Prismatic Difference, Binocular Convergence Difference and the Binocular Magnification Difference. These unique evaluation methods guarantee that each design is verified under real life circumstances before it goes into production, and ensures unprecedented binocular performance of the lenses, regardless of the prescription difference between the eyes.

[1] *Depending on the country*
[2] *TNS research "Hoya – a multifocal perspective" in UK, Belgium, Germany, France, Spain and Italy in 2012*

HOYA
Eye for detail

Binocular Harmonization Technology

Seventy-three percent[1] of presbyopes have a different prescription for the right and left eye. Even the smallest prescription difference means that the light rays pass through the lens at different positions for the right and left eye. This results in a visual imbalance that can cause asthenopic complaints, such as tired and burning eyes and headaches. Symptoms of this type are often vague, not directly noticed by the wearer, or considered to be linked to their glasses.

This problem is caused by the prismatic side-effect of an ophthalmic lens that cannot be compensated by the wearer. The result of different prescriptions for the right and left eye is that each eye uses a different area of the lens, as illustrated by Figure 2. While this is not a major problem when wearing single vision lenses, it does become more serious when progressive lenses are used. We can gain a good understanding of this phenomenon by using ray tracing for an initial rough assessment and by considering a pair of single vision lenses with an object at infinity, and with an object 4 meters (approx. 13 ft) away at an angle of 30 degrees to the right.

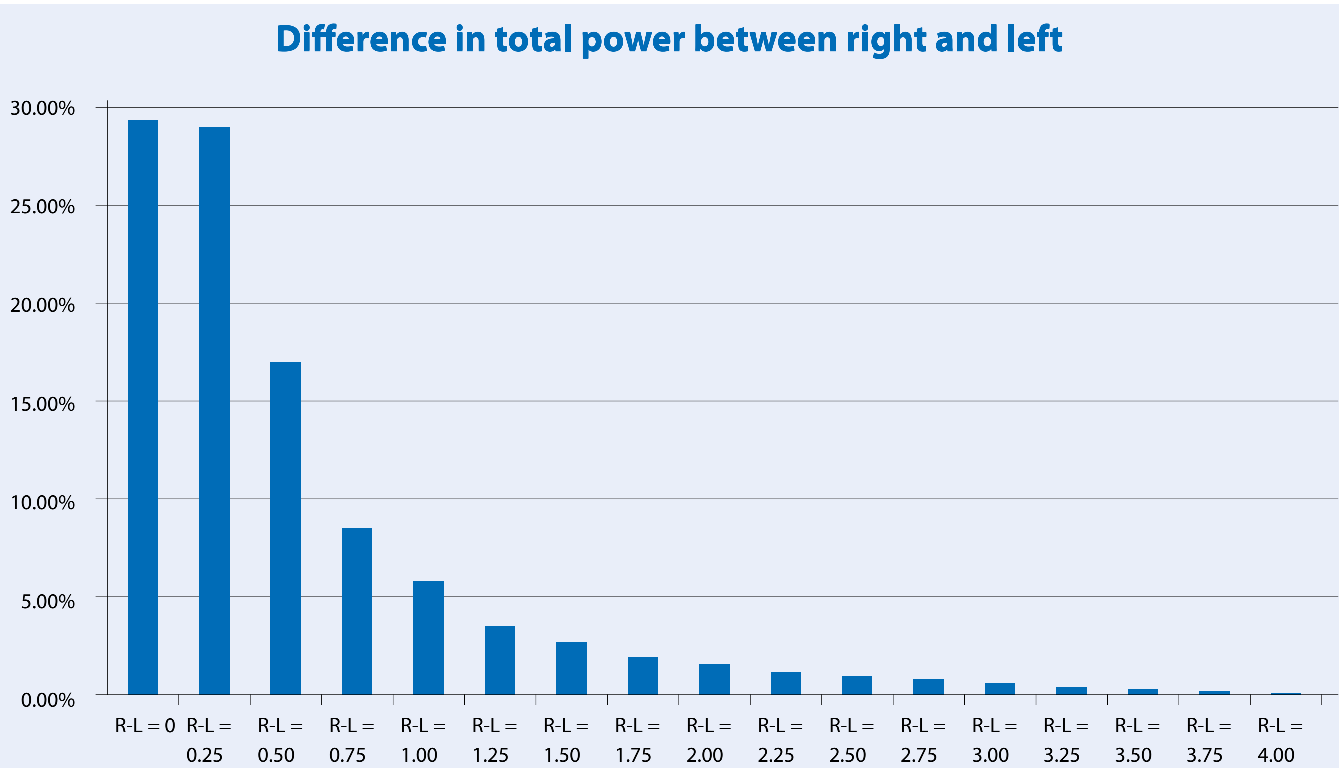


Figure 1: Difference in total power between the right and left eye [3]

[3] Hoya data: European progressive lenses 2007-2013

Visual imbalance can cause asthenopic complaints

Light rays pass through the lens at different positions

Many people have a different prescription for the right and left eye. Even the smallest prescription difference means that the light rays pass through the lens at different positions for the right and left eye.

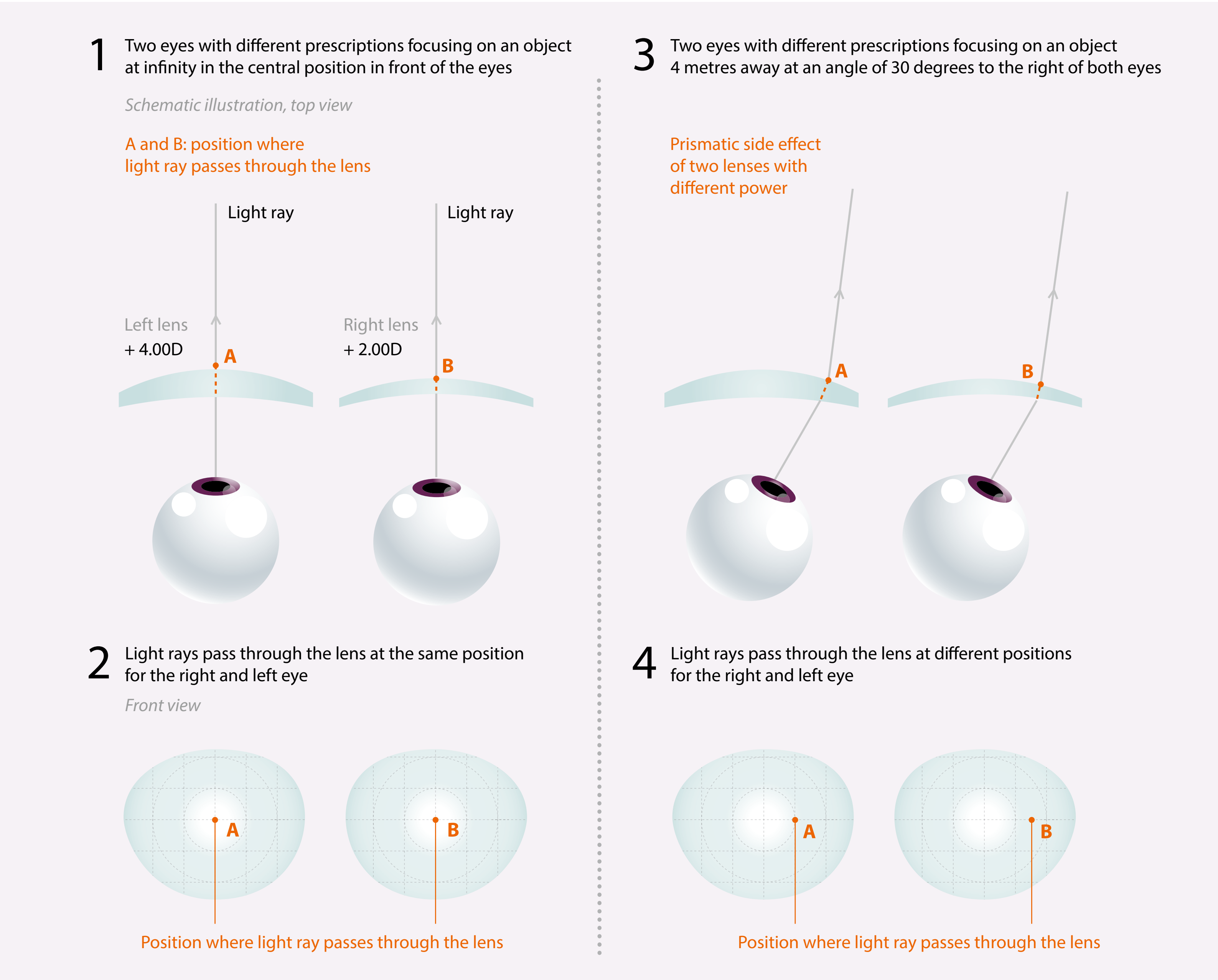


Figure 2: Light rays pass through the lens at different positions

73% of presbyopes have a different prescription for the left and right eye

Example:

This example is based on a pair of single vision lenses with +4.00D for the left eye and +2.00D for the right eye. It assumes that the lenses are properly centered according to the center of rotation of the eye without horizontal or vertical tilt. A general rear vertex distance (RVD) of 13mm where the center of rotation of the eye is located 13.5mm behind the cornea was also used. The lenses are assumed to be simple spherical single vision lenses with a refractive index of 1.50.

Spherical single vision data

Power	R1 [mm]	R2 [mm]	CT [mm]
+2.0D	82.947	-121.898	3.0
+4.0D	71.165	-156.075	5.2

Table 1: Lens data for ray tracing

When the wearer of this prescription focuses on an object 4 meters away at an angle of 30 degrees (or 2.31 meters to the right or left), both eyes need to perform a different vergence if binocular single vision is assumed (without consideration of the Panum areas to be used). The difference in vergence behind the lenses is about 2 degrees between the two eyes in order to focus on the same point in object space. This is caused by the different prismatic effects of the lenses. Due to the different eye movement behind the lenses and the different prismatic side-effects of the lenses, the light rays exit the back surface of the lens at different points. In this example, the difference is about 1.8 mm.

Note that in calculating this example, a simplified ray tracing logic was used (ynu ray tracing), which is generally only applicable to paraxial optics. This limitation has been ignored in order to simplify calculation for this example. As an initial attempt however, this simplified procedure adequately illustrates the challenges that are faced when prescribing a pair of lenses for a patient with anisometropia[4]. The greater the difference in power, the greater the described problem will be, however the basic principle continues to apply even in the case of small prescription differences.

This situation also explains the general rule that myopes experience wider fields of vision with the same frame in comparison to hyperopes.

Let us now apply this principle to a second example with progressive lenses. In this example, our subject with a prescription of +4.00D for the left eye and +2.00D for the right eye is wearing progressive lenses with a standard corridor of 14 mm according to HOYA's definition[5]. We will analyze the problem separately for the horizontal and vertical directions.

We will consider the horizontal direction first. In the past, it was generally assumed that the same design could be used regardless of the prescription. This statement is not related to the inset calculation but to the horizontal direction based on the umbilical line. However, when we analyze actual anisometropic prescriptions, it is obvious that using the same design would result in visual (object space) fields that do not overlap. One visual field will be wider and the other visual field will be narrower. HOYA iD MyStyle 2 is designed to achieve perfect binocular vision. Therefore the visual fields for the right and the left eye are configured in a way that considers the prescription for the right and the left eye in order to produce a single common target design (which defines the binocular visual field in object space). Based on this target design, both progressive power distributions will be defined uniquely for the combined prescription of the right and left eye. The intention is for both eyes to perceive the same visual field in object space. The final result is two different lens designs. The more positive power will become slightly wider and the more negative power will become slightly narrower in order to accurately match the size of the visual fields for both combinations of eye/lens in object space.

Let us now consider the vertical direction. Due to the difference in power, the main light rays pass through the back surface of the lens at different points when focusing on a nearby object. This difference is 1.4 mm in our example. This is presented

[4] In this document, anisometropia refers to any difference in prescription (difference in total power between right and left eye).
[5] 14mm measured from the fitting point to the upper part of the near measurement marking.

in Figure 3: Illustration showing Binocular Harmonization Technology at work. Due to the nature of progressive lenses, both eyes experience a different addition. A difference of 1.4 mm can easily result in an addition difference of 0.10D or more.

The actual effect depends on the difference in power between the right and the left in the vertical direction (the greater the difference, the greater the effect), the absolute power (the stronger the absolute power, the greater the effect), the corridor length (the longer the corridor, the greater the effect) and finally the prescribed addition (the greater the addition, the greater the effect).

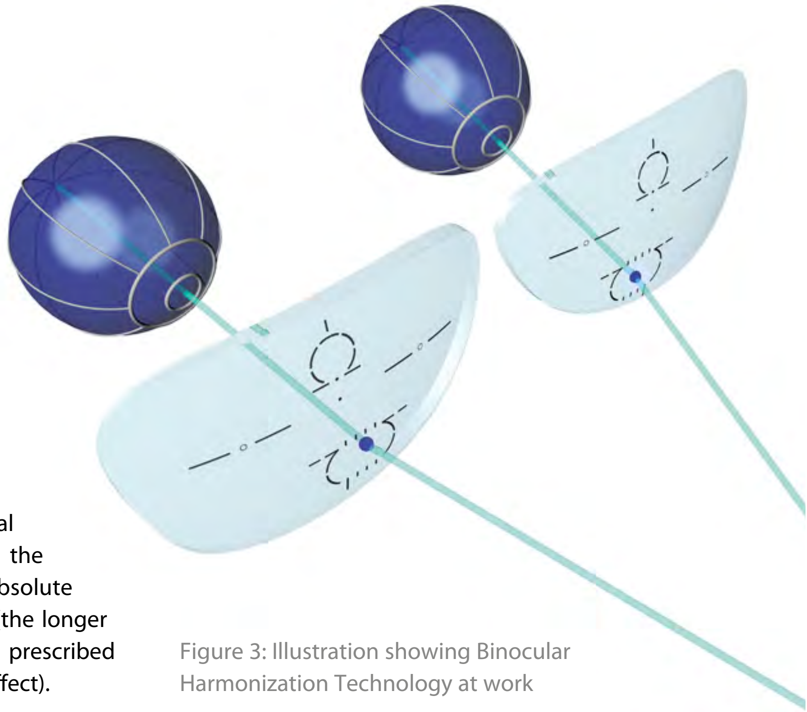


Figure 3: Illustration showing Binocular Harmonization Technology at work

The difference between the actual addition for the right and the left can cause an imbalance as both eyes will experience different additions. In the case of zero amplitude of accommodation, one eye will perceive a clear image (depending on the reading distance) and the other eye will be subjected to an addition that is either too high or too low, causing the eye to perceive a blurred image. In the case of remaining amplitude of accommodation (low prescribed addition power), the resulting mismatch in image quality will lead to a mismatch in accommodation. The issue here is that accommodation innervation is controlled centrally by the parasympathetic pathway (known as Hering's law of equal innervation), meaning that the accommodation response for both eyes is equal. In this case, rivalry arises between the eyes because the brain tries to compensate by increasing or decreasing the accommodation when one eye continuously perceives a blurred image. In turn, this causes blurring in the other eye and results in further effort to compensate. In short, this can cause asthenopic complaints such as tired and burning eyes and headaches.

With the introduction of HOYA iD MyStyle 2, Hoya is the world's first lens supplier to offer a solution for binocular disharmony. HOYA iD MyStyle 2 incorporates patented Binocular Harmonization Technology to balance the accommodation support as well as the visual fields for anisometropic prescriptions. This ensures that both eyes experience the same addition power for each passing point of the lens in the vertical direction as well as the same visual acuity for both eyes in horizontal gaze directions.

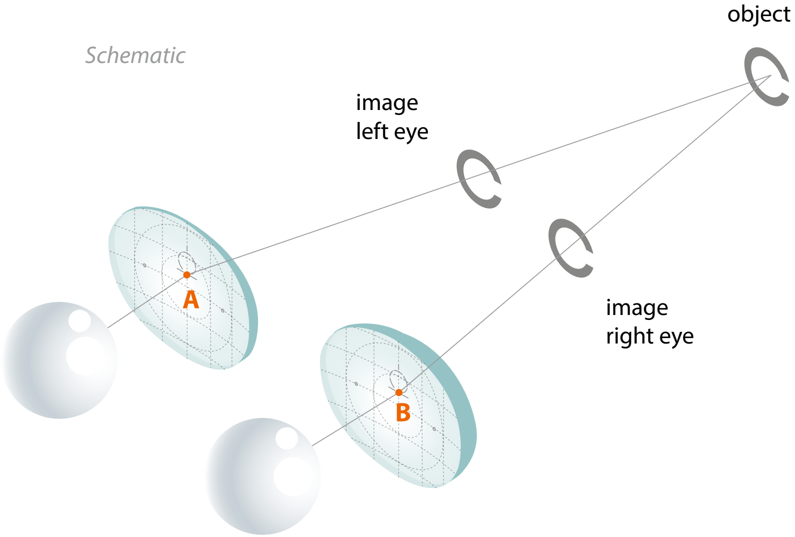
HOYA iD MyStyle 2 allows for the vertical prismatic difference caused by the different prescription values between the right and left lenses; the resulting adjustment to the addition power distributions ensures that both eyes experience the same addition. This applies for the total progressive corridor rather than just a single part of the lens, so the benefits are experienced in the intermediate and reading areas of HOYA iD MyStyle 2. Put simply, this is achieved by expanding the corridor for the more positive power and compressing the corridor for the more negative power. A simplified illustration of this technique is shown in Figure 4: Adjusted object distance for the right and left lens using Binocular Harmonization Technology.

Coming back to the example, the progressive power distribution for the left eye (+4.00D far vision prescription) will be expanded by 0.7 mm to provide an actual addition of +2.50D at a point 14.7 mm below the fitting point. The progressive power distribution for the right eye (+2.00D far vision prescription) will be compressed by 0.7 mm to provide an actual addition of +2.50D at 13.3 mm below the fitting point.

Hoya is the first to offer a solution for binocular disparity

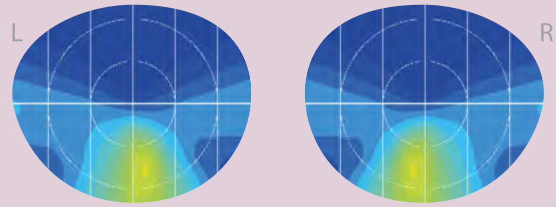
Introduction on progressive lenses

1 Two eyes with different prescriptions focusing on an object in the central position in front of the eyes

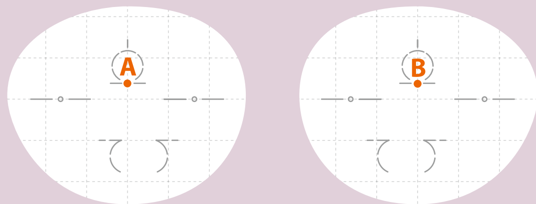


A and B: position where light ray passes through the lens

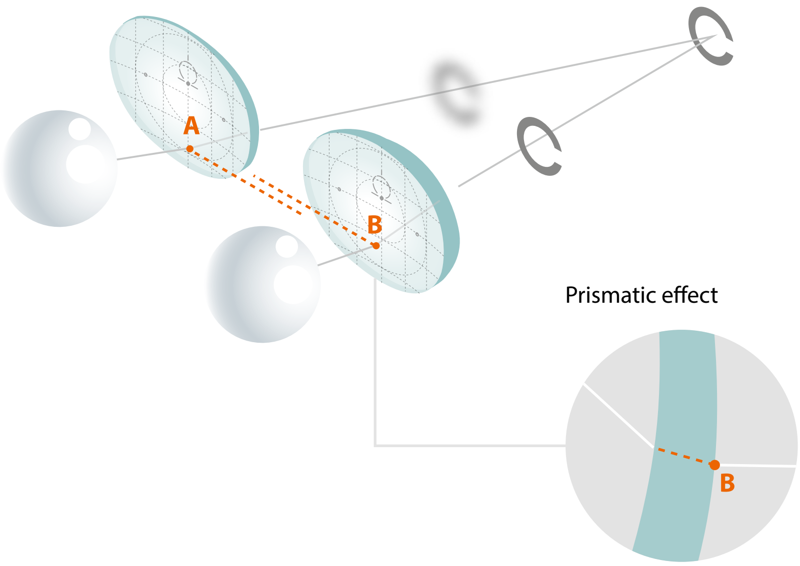
Progressive lenses feature different addition powers in different parts of the lenses.



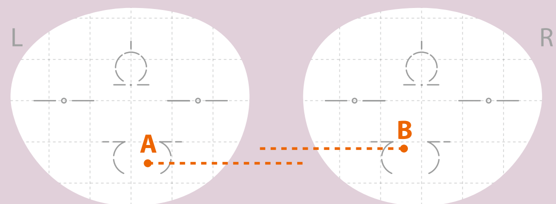
If both eyes are in the central position, light rays pass through the lens at the same point. Therefore, both eyes experience the same addition power.



2 Two eyes with different prescriptions focusing on an object at near



Due to different prismatic effects, the light rays pass through the lens at different positions for the right and left eye.



Therefore the eyes experience different addition powers.

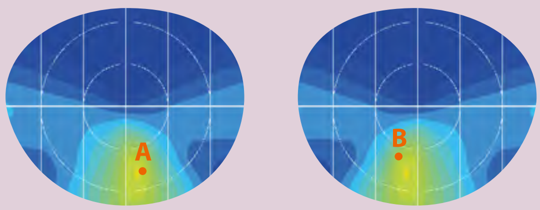


Figure 4: Adjusted object distance (simplified illustration) for the right and left lens using Binocular Harmonization Technology

Even in anisometropic cases, both eyes are using more or less the same point in the upper part of the lens when focusing on an object at infinity, which is illustrated in part 1 of Figure 4. When focusing on an object at near, both eyes are looking through different points in the lens. By adjusting the progressive power distribution according to the actual used positions, both eyes will experience the same accommodation support.

Effortless focusing. Constant stability. Excellent depth of vision.

This adjustment is made for each anisometropic case. For prescriptions where residual amplitude of accommodation is present, the adjustment considers the remaining accommodation to be equal for both eyes. This procedure balances the progressive power distribution between the right and the left lens in order to provide the same accommodation support for both eyes while taking the different prismatic effect of both lenses into account.

HOYA iD MyStyle 2 provides perfect and effortless focusing:
With Binocular Harmonization Technology, the visual acuity in both eyes is the same because both eyes receive the required accommodation support. Equal visual acuity in both eyes means that the binocular visual acuity will exceed the monocular visual acuity and the visual fields will be experienced as wider.

HOYA iD MyStyle 2 provides constant stability:
With Binocular Harmonization Technology, both eyes will provide perfect monocular and binocular vision. The wearer experiences constant vision stability thanks to the perfect degree of visual acuity, especially in the binocular vision situation.

HOYA iD MyStyle 2 provides excellent depth of vision:
With Binocular Harmonization Technology, the accommodation support at each passing point of the lens is equal for both eyes. This does not lead to binocular rivalry due to one image being blurred. Consequently, the eyes do not need to constantly refocus. As a result, HOYA iD MyStyle 2 provides constantly stable binocular vision.

New lifestyle based individualization

HOYA iD MyStyle 2 offers an unprecedented level of individualization. The Hoya iDentifier consultation software and algorithm are used to independently tailor the distance, intermediate and near vision areas to the individual wearer's needs. The objective is to ensure clear and stable vision during the wearer's most common daily activities as those activities are considered to be the most important.

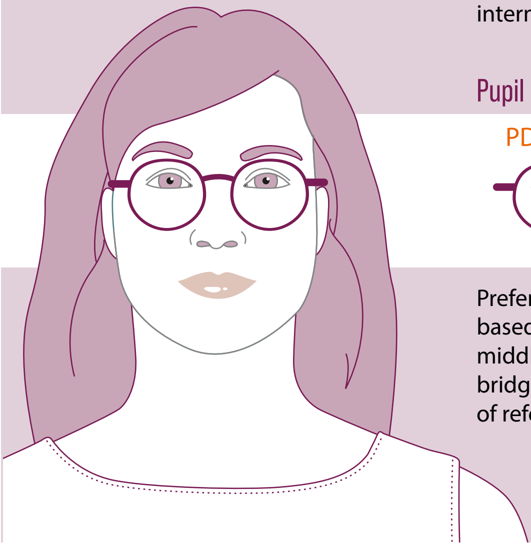
With the Hoya iDentifier, all the elements that potentially influence the choice of the appropriate distance, near and intermediate areas are recorded step by step.

Firstly, the wearing and fitting parameters that are necessary for an individualized progressive lens (PD, Fitting Height, Frame Box Measurements, Vertex, Face Form and Pantoscopic Tilt) should be recorded using the Spectangle Pro measurement system. This data should then be transferred to the Hoya iDentifier software.

The parameter definitions are described below:

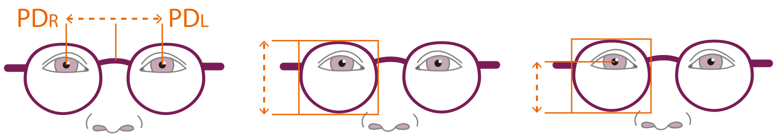
- PD is the pupil distance, measured as the distance from the middle of the frame to the center of the right/left pupil.
- Fitting Height is the distance from the lower boxing line around the frame shape to the center of the pupil for each eye separately. The fitting height must be measured while the patient is wearing the properly adjusted frame in a natural straight ahead gaze position.
- The B-Size is the vertical size of the frame shape, as defined by the boxing system.

PD, Fitting Height and B-Size are illustrated in Figure 5: Pupil Distance, B-Size and Fitting height



Lifestyle based individualization

With the Hoya iDentifier, all the elements that potentially influence the choice of the appropriate distance, near and intermediate areas are recorded step by step.



Pupil distance

Preferred values based on using the middle of the bridge as the point of reference.

B-Size

The B-Size is the vertical size of the frame shape, as defined by the boxing system.

Fitting Height

Fitting Height is the distance from the lower boxing line around the frame shape to the center of the pupil.

Figure 5: Pupil Distance, B-Size and Fitting Height

- Vertex Distance is the distance from the apex of the cornea to the plane of the frame front. It is measured while the patients is in natural straight ahead distance gaze.
- Pantoscopic Tilt is the angle of the frame front relative to the vertical plane in space. It is measured while the patient is in a natural straight ahead distance gaze.

The Vertex and Pantoscopic Tilt are illustrated in Figure 6.

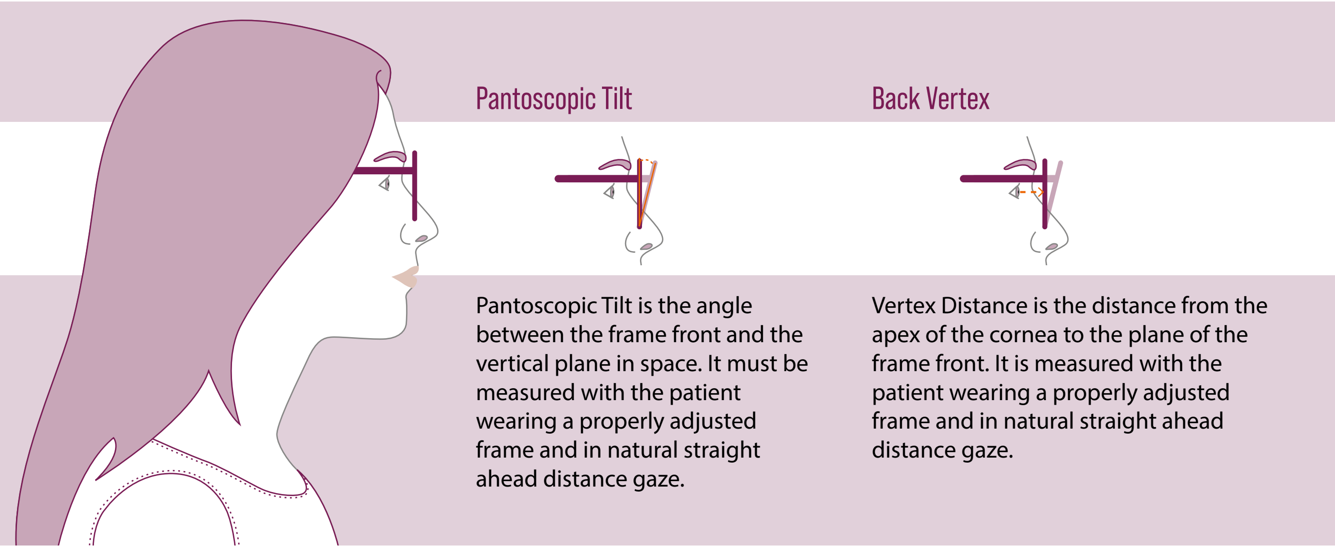


Figure 6: Pantoscopic Tilt and Back Vertex Distance

- Face Form is the angle between the center of the bridge frame front and the horizontal plane in space. It is measured while the patient is wearing a properly adjusted frame.

Face Form is illustrated in Figure 7.

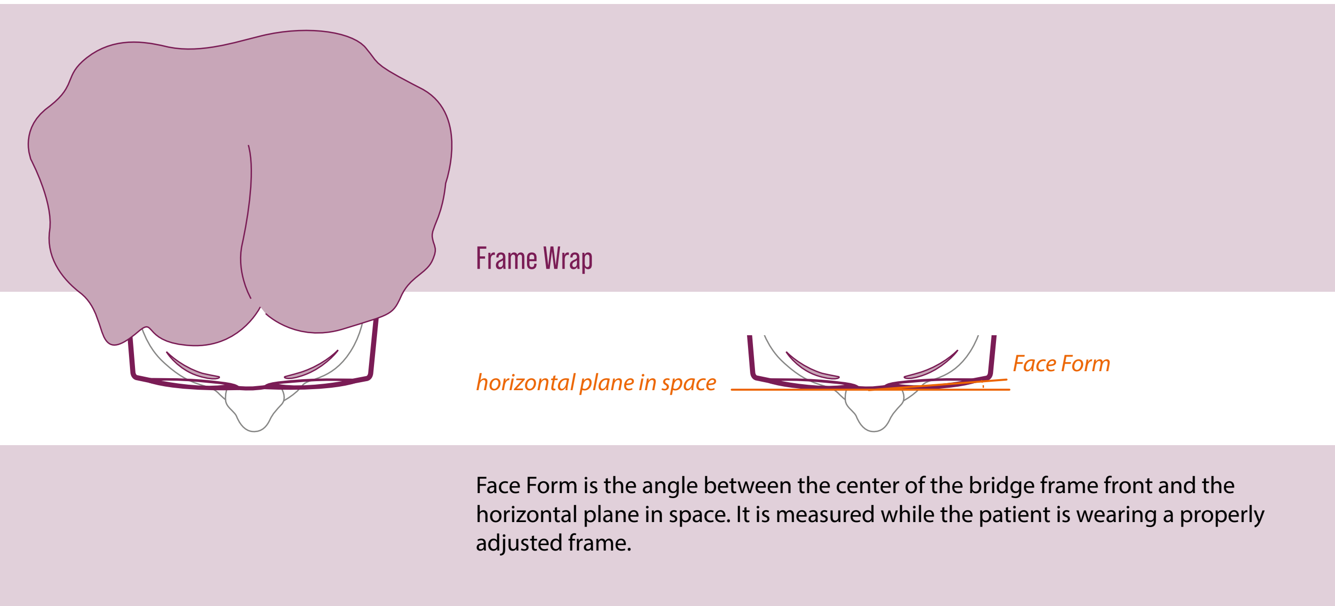


Figure 7: Face Form

Next, a record is made of additional information such as the previous type of lenses worn by the customer (single vision, bifocal, progressive, or none), the manufacturer, the design, the corridor length and the level of satisfaction with these lenses as well as the previous prescription. These elements are considered in order to recommend a best-fit configuration that matches the individual wearer's personal experience.

Finally, the Hoya iDentifier offers an improved way of recording the wearer's lifestyle. The iDentifier algorithm categorizes the percentage of activities that take place outdoors. Based on this information, the iDentifier considers different lifestyle profiles and also makes a detailed analysis of digital media use, reading behavior, driving, sports activity and the professional working environment.

Once all the information has been recorded, the Hoya iDentifier algorithm calculates the optimal design for far and near vision and allocates the appropriate base corridor length before combining them to create the ideal distribution for each individual customer.

It is important to understand that HOYA iD MyStyle 2 offers the possibility of creating a far vision design separately from the near vision design in order to tailor the result to the individual needs of each patient. For the first time, a progressive lens design can combine a very wide far distance area with a narrower near distance area for people who mainly use the far distance area, or the opposite for people who mainly focus on tasks that require a wide near vision area.

All of the elements mentioned above are also considered for the base corridor length recommendation, so each individual patient's lifestyle is taken into account as well as the shape and fitting data.

The key variables influencing the three design elements (far vision design, near vision design and corridor length) are:

Far vision variables:

- Far prescription power (monocular and binocular)
- Addition power
- Pantoscopic Angle
- Back Vertex Distance
- B-Size
- Fitting Height
- Previous type of lenses worn by the patient; manufacturer, design, degree of satisfaction
- Lifestyle requirements

Near vision variables:

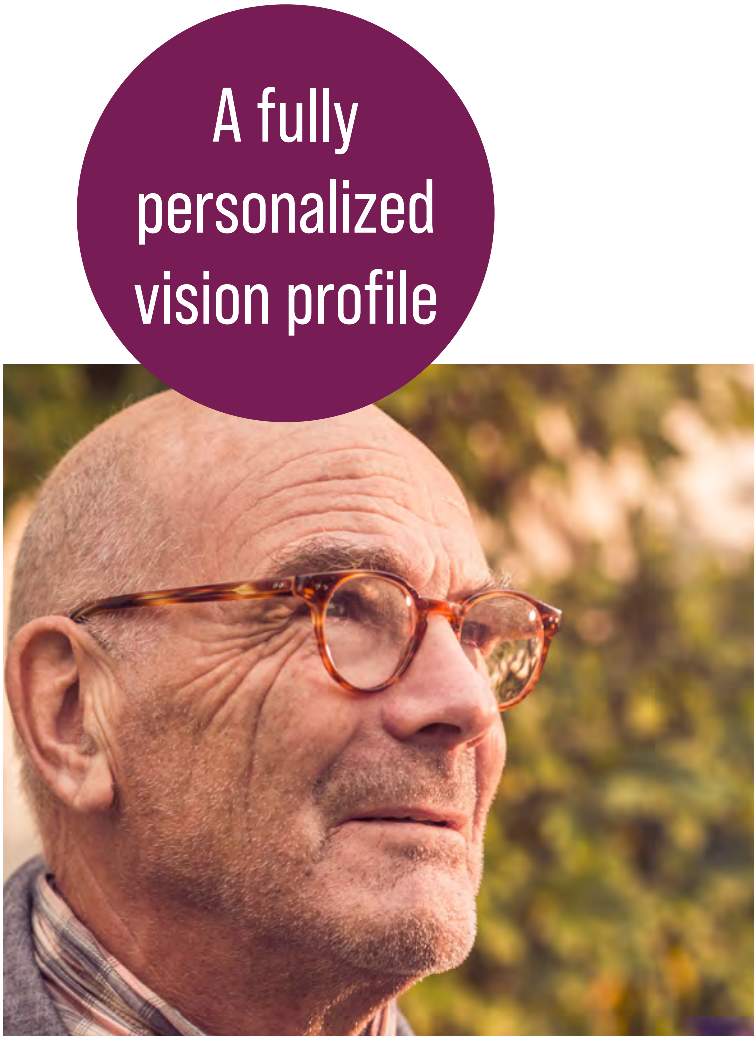
- Far prescription power (monocular and binocular)
- Addition power
- Pantoscopic Angle
- Back Vertex Distance
- Previous type of lenses worn by the patient; manufacturer, design, degree of satisfaction
- Lifestyle requirements

Corridor length variables:

- Far prescription power (monocular and binocular)
- Anisometropia
- Addition power difference compared to the previous prescription
- B-Size
- Fitting Height
- Vertex Distance
- Previous type of lenses worn by the patient; manufacturer, design, degree of satisfaction
- Lifestyle requirements

This unique system with its virtually unlimited design variations guarantees a fully personalized vision profile for even the most extreme visual demands.

HOYA iD MyStyle 2 is a fully personalized progressive lens that exactly matches the visual fields to the patient's needs and considers the position of the spectacles when worn in order to optimize surface geometries. This results in perfect vision regardless of the position of the spectacles when worn.



HOYA iD MyStyle 2 Convenience Options

The iD MyStyle 2 is the most personalized lens on the market. The iD MyStyle2 iDentifier allows you to create endless design possibilities by allowing the patient to be a part of the lens design process – this is a first for progressive lenses. The iD MyStyle 2 also comes in 4 convenience option profiles to allow for a more simplified process in designing the perfect lens for your patient. These four profiles allow the Eye Care Professional (ECP) to choose the best design based off the patient's lifestyle needs without compromising the technologies. The convenience options will still use Integrated Dual Surface Technology (iD), Binocular Harmonization Technology (BHT), as well as Position of Wear Measurements (POW). The four options are: iD MyStyle 2 Modern, Adventure, Detail, & Stable.

Each convenience option uses a unique design to enhance the comfort and vision your patient uses most.

Choosing the correct convenience option is crucial when fitting the MyStyle 2. These four lenses offer incredibly different progressive designs fit for a specific lifestyle. Determining the convenience option that best fits your patient's lifestyle will determine the level of patient satisfaction. Without the iD MyStyle 2 iDentifier we will need to ask questions to uncover the needs of the patient, which will allow us to make informed decisions on which iD MyStyle 2 convenience option will offer the highest patient satisfaction.

iD MyStyle 2 Modern

The iD Mystyle 2 Modern is HOYA's most popular convenience option. This design is the most balanced of the convenience options and works with many different tasks. The iD MyStyle 2 Modern is great for indoor and outdoor use and provides clarity at all distances. It is designed for people who wear their progressives daily and want one pair of glasses that works for all viewing areas.

iD MyStyle 2 Adventure

The iD MyStyle 2 Adventure is designed primarily for outdoor use. The design has a strong emphasis on the distance viewing area – with near perfect edge to edge clarity. The iD MyStyle 2 Adventure is the perfect design option for patients who spend most of their day outdoors. It is a great design for outdoor enthusiasts, mail carriers, truck drivers, pilots, etc. This convenience option is designed with distance viewing in mind.

iD MyStyle 2 Detail

The iD Mystyle 2 Detail is a great option for indoor use. It was designed with an emphasis on the near and intermediate zones. Designed for the person who spends most of their day indoors, focusing on near tasks. The iD MyStyle 2 Detail is ideal for long hours of computer work or hobbies that require a lot of up-close work (i.e. puzzles, crafts, scrapbooking, etc.). The iD MyStyle 2 Detail is a great convenience option for an office setting environment such as an accountant or IT worker, while also allowing them to utilize those same glasses for everyday use.

iD MyStyle 2 Stable

The iD MyStyle 2 Stable is primarily used for indoor use with an increased distance zone. This convenience option has a small and quick intermediate zone. It was designed for the mature presbyopes that read often yet benefit from an increased distance area to move about safely. The iD MyStyle 2 Stable is recommended for experienced wearers, seniors, people who are less active and ST-28 converters.

Hoya has developed five new patented binocular evaluation methods

Binocular Eye Model

Hoya has always used several unique evaluation methods to ensure the highest level of correction. However, a method that uses conventional monocular maps is no longer adequate to evaluate the performance of HOYA iD MyStyle 2.
Hoya has developed five new patented binocular evaluation methods for HOYA iD MyStyle 2, which are summarized in the Binocular Eye Model. These newly developed evaluation methods focus purely on assessing the binocular performance of the different design variations. These new evaluation methods complement the existing evaluation methods used by Hoya, which are:

Monocular evaluation methods:

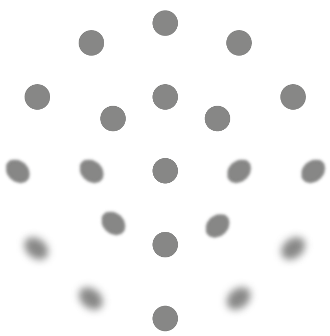
- Astigmatic Error
- Mean Addition Power
- Clearness Index
- Deformation Index
- Skew Deformation Index
- Dynamic Deformation Index

The Binocular Eye Model consists of:

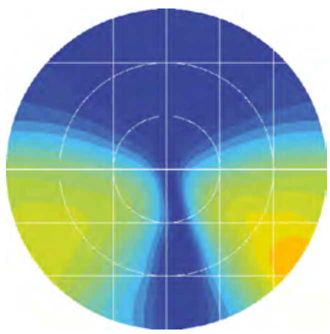
- Binocular Clearness Index
- Convergence Difference between R/L
- Accommodation Demand Difference between R/L
- Magnification Difference between R/L
- Vertical Prismatic Difference between R/L

The maps presented in this paper are based on ray tracing technology. This technology makes it possible to trace the path of an infinitesimally small bundle of light rays through the lens. This tiny bundle of light rays can be seen as a circle in object space and changes in shape and size depending on aberrations in the lens. This document provides a basic explanation of how the different evaluation models should be interpreted.

Monocular Evaluation Methods*



Object observed through different positions of the lens



Unwanted Astigmatism (monocular)

low high

Astigmatic Error

The Astigmatic Error is the key evaluation method for a progressive lens. The map displays the unwanted astigmatism which is induced by the lens. This is not related to the prescribed cylinder power, only to unwanted astigmatism.

Figure 8: Astigmatic Error (monocular)

Dark blue areas are regions in the lens where the unwanted astigmatism (not the prescribed cylinder power) is 0.00D. Orange areas indicate areas where the unwanted astigmatism is higher, the highest value in the scale would be indicated in red.

* All maps illustrating monocular evaluation methods represent a right lens (HOYA iD MyStyle 2 plano Add 2.50 YD308 in default wearing condition) and the view is from an observer position towards the lens. The illustration clearly shows that the near vision area is displaced inwards, which reflects the inset. This presentation allows the use of a system of X, Y and Z coordinates relative to the fixed prism reference point of the lens (0, 0, 0).
The size of the lens is 60mm. Therefore each step in the matrix is 10mm.

Mean Addition Power

The Mean Addition Power can also be seen as the Mean Power Map, but the Power would always be scaled to 0.00D in the far distance area. This method allows us to read the offset from the mean far distance power.

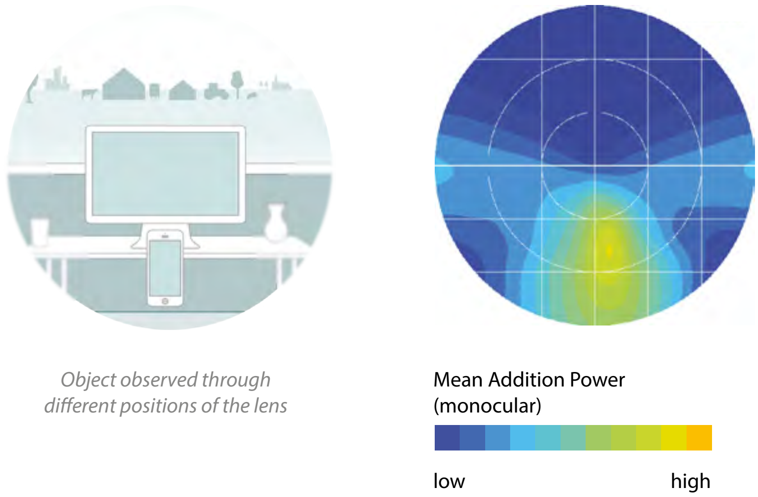
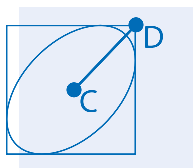


Figure 9: Mean Addition Power (monocular)

Dark blue areas are regions in the lens where the Mean Addition Power is 0.00D, which means that the power present in those areas is the same as the Mean Far Power. Green and orange areas indicate areas where the Mean Addition Power is positive (more plus power compared to the Mean Far Power). If there were any areas with a negative Mean Addition Power, they would be indicated in purple.

Clearness Index

The Clearness Index basically describes how clearly the wearer sees an image through the spectacle lens. It is similar to the visual acuity maps that are often used by other lens suppliers. The Clearness Index map focuses on the light distribution of a circle in object space to the image of the same circle that an ophthalmic lens will create on the retina. This method is based on Point Spread Functions. Ideally, an infinitesimally small circle in object space would be seen by the retina as an infinitesimally small circle, which is expressed as follows:



The Clearness Index is 1.00 if the distance from C to D is 0.

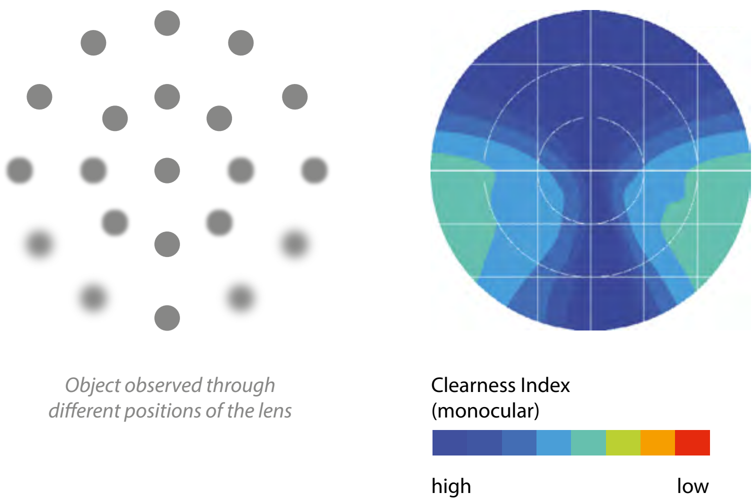


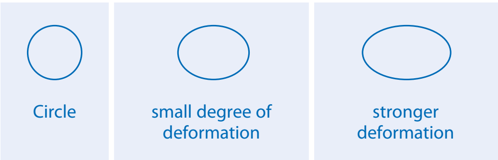
Figure 10: Principle of Clearness Index

Figure 11: Clearness Index (monocular)

Note that a value of 1.0 in the Clearness Index map indicates areas where the wearer has his/her personal maximum visual acuity. These are the dark blue areas in the map; the greener/redder the color, the greater the negative impact on the wearer's visual acuity.

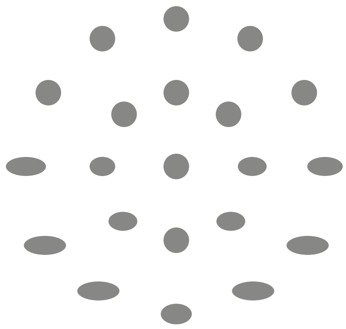
Deformation Index

Generally speaking, deformation occurs due to the nature of a progressive lens. Deformation can be seen as the degree to which a circle transforms into an ellipse when viewed through the lens. The properties of the lens influence the degree of deformation. This deformation basically occurs due to the different spectacle lens magnification in two meridians.

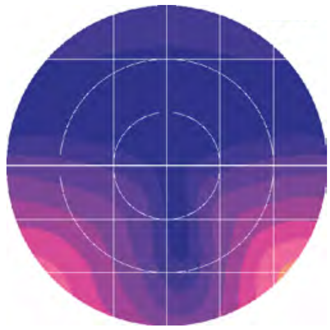


The Deformation Index is calculated as the relationship between the differences in size of the two meridians of the ellipsoid. The greater the difference between the two meridians, the greater the deformation.

Dark blue areas indicate areas in the lens where the deformation value is 0%: i.e. a circle is seen as a circle.
Yellow areas indicate areas where the degree of deformation is high.



Object observed through different positions of the lens



Deformation Index (monocular)

low high

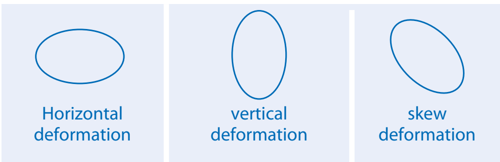
Figure 12: Deformation Index (monocular)

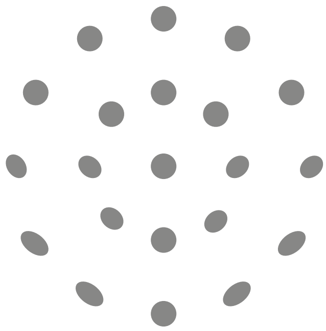
Note that there is a correlation between the degree of astigmatism and the degree of deformation, as deformation of the image is caused by a difference in spectacle lens magnification in a defined area. The Deformation Index only considers unwanted deformation, as the deformation induced by the astigmatic prescription is unavoidable and can therefore be defined as necessary deformation.

Deformation occurs due to the nature of a progressive lens

Skew Deformation Index

Generally speaking the Skew Deformation Index is based on the Deformation Index to a certain extent. However, due to the fact that vertical or horizontal deformation can be fused by our brains more easily than skew deformation, this factor requires careful consideration during the lens design process. Contrary to the Deformation Index, the Skew Deformation Index focuses on the direction of deformation. The map reflects the obliqueness of the deformation; a situation that should be avoided when we consider that the images from both eyes need to be fused by the brain. Skew Deformation Index is often associated with a feeling of swaying.





Object observed through different positions of the lens

Skew Deformation Index (monocular)

Figure 13: Skew Deformation Index (monocular)

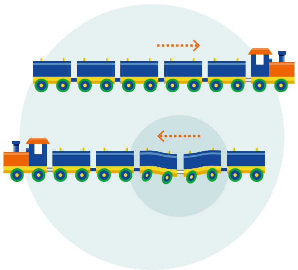
Dark blue areas indicate areas in the lens where there is no skew deformation.

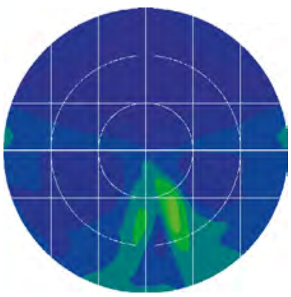
Pink and yellow areas indicate areas where skew deformation is high.

Dynamic Deformation Index

While the Deformation Index and the Skew Deformation Index focus on the deformation that occurs at a single specific point of the lens, the Dynamic Deformation Index considers the change in deformation when moving from one point on the lens to the adjacent point. Both points are situated directly next to each other.

Object observed through different positions of the lens





Dynamic Deformation Index (monocular)

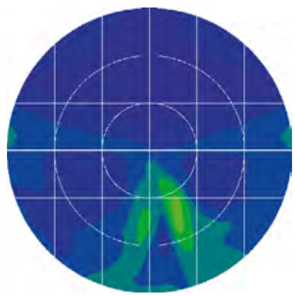
low high

Comparison Dynamic Deformation Index (monocular)

The following comparison shows two HOYA MyStyle 2 design variations. The lens on the left-hand side is a rather “soft” design variation for far and near, whereas the lens on the right-hand side is a rather “hard” design variation for far and near.

It is clear that the harder lens design has more areas in the lens where deformation changes rapidly. On the other hand, the blue region in the near vision area is wider, meaning that there is less change in deformation/astigmatism in that area. However, in areas where a change in deformation does occur, it is clearly more drastic than in the softer design.

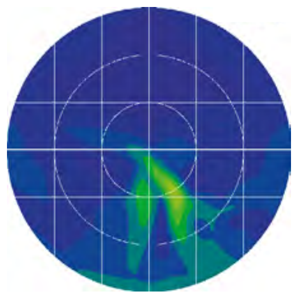
Hoyalux iD MyStyle V+ Corridor 11 YD304



Dynamic Deformation Index (monocular)

low high

Hoyalux iD MyStyle V+ Corridor 11 YD512



Dynamic Deformation Index (monocular)

low high

Figure 14: Dynamic Deformation Index (monocular), and comparison Dynamic Deformation Index (monocular)

Dark blue areas are the parts of the lens where there is no change in deformation between two directly adjacent points, bright green areas are the parts of the lens where the change in deformation between two adjacent points is high.

The Dynamic Deformation Index is higher in areas of the lens where the power or astigmatism changes more acutely; i.e. the progressive corridor and the near vision area.

Real life simulation for guaranteed perfection

Binocular Evaluation Methods

Because the X, Y, Z coordinates referred to previously only apply in relation to the surface of individual lenses, a different system of coordinates has to be defined for binocular topological mapping. In fact, binocular properties can only be evaluated properly if use is made of a system of coordinates that is not related to the surface. Consequently, a system has been developed that defines the properties by considering angles in object space. The origin of the coordinate is positioned horizontally in the middle between both pupils and vertically at the prism reference point.

Therefore the near vision area is always displayed below the far vision area and not to the right or to the left as this represents a downward gaze direction.

The size of the map is usually related to a 100 degree viewing angle (unless a different viewing angle is stated) on the object side, so each step in the matrix is 16.6 degrees.

Note that the achievable viewing angle depends on the power of the lenses. Assuming a lens diameter of 60mm per eye, the binocular map expressed in degrees in object space will be smaller for plus power lenses than for minus power lenses. This is due to the different prismatic side-effects of plus and minus power lenses.

In cases where an anisometropic prescription is used, the absolute highest power will define the maximum possible field of vision in object space.

Clearness Index (binocular)

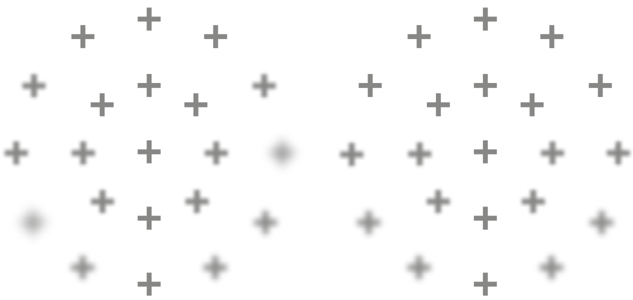
The Clearness Index describes how clearly the wearer sees an image through the spectacle lens.

The Binocular Clearness Index uses the principles that were explained previously in the section on the Monocular Clearness Index. The dark blue regions in the Binocular Clearness Index indicate areas in the lenses (always considered as a pair) where the wearer's visual acuity attains the highest possible value.

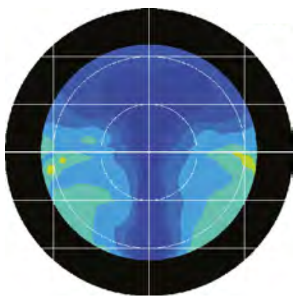
Logically speaking, the Binocular Clearness Index can only be 1.0 if both Monocular Clearness Indices are 1.0, or extremely close to 1.0. However, the Binocular Clearness Index map will generally show slightly wider clear areas compared to the Monocular Clearness Index. This is because small aberrations in one eye/lens combination can be compensated for by the other eye/lens combination.

Similarly, if the visual acuity of both eyes individually, when full correction is applied to the wearer's vision, lies below a value of 1.00, the lens will not be able to provide a visual acuity of 1.00 or higher for the wearer. When considered in this way, the map and the values at each point of the lens can also be seen as a factor to be multiplied by the maximum visual acuity possessed by the individual wearer.

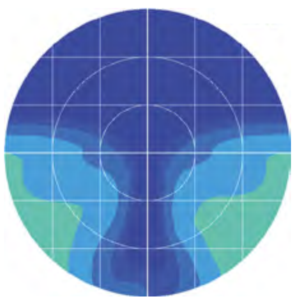
Object observed through different positions of the lens



Hoyalux Summit Pro



Hoyalux iD MyStyle V+ with Binocular Harmonization Technology



Clearness Index (binocular)

The lens pair shown in the comparison is: L: S +2.00D R: S +4.00D Addition 2.50, PD 32+32mm

Figure 15: Comparison Clearness Index (binocular)

Convergence Difference (binocular)

As the Convergence Difference is also a binocular evaluation, we use the same system of coordinates to produce the associated map.

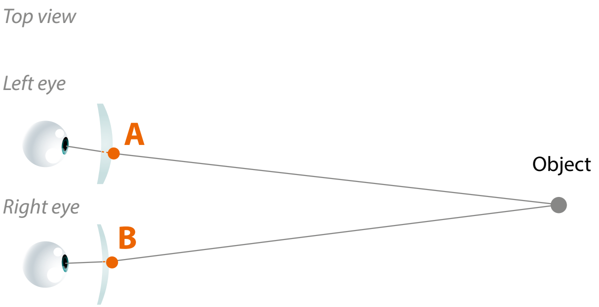
The Convergence Difference shows whether the two lens/eye combinations force the wearer to apply either convergence or divergence as a function of the object distance, the power, the power difference and the prismatic difference (due to the power difference).

That our eyes have a natural ability to converge is a known fact. However, performing the opposite movement, divergence, is either impossible or very difficult.

While convergence is natural when viewing an object nearby, it is rather inconvenient when viewing an object at infinity. This is especially true as there is a strong link between convergence and accommodation. This leads us to conclude that convergence in the near vision area is desirable, necessary and not critical and that both convergence and divergence in the far vision area of the lens may cause complaints. It is also clear however that a difference in vergence is unavoidable, particularly in the case of anisometropic prescriptions, due to different prismatic side-effects of the power for each eye. This effect is magnified if the Wrap Angle increases.

Dark blue in the map indicates areas where no convergence or divergence is necessary.

Cyan and yellow areas indicate where convergence is necessary. Purple areas indicate that divergence would be necessary.



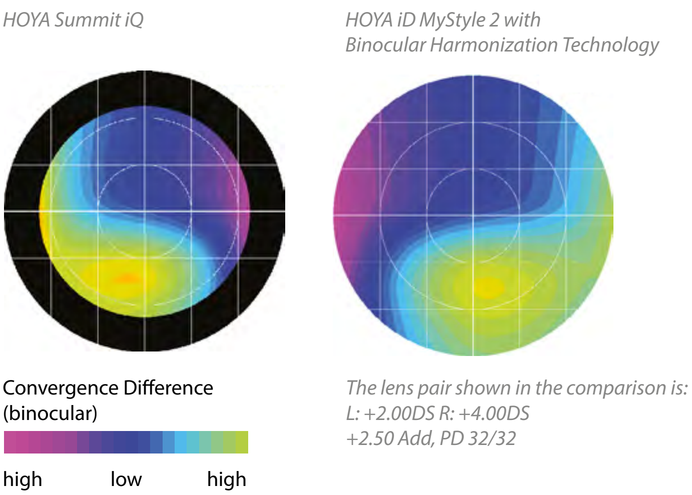


Figure 16: Comparison Convergence Difference (binocular)

With HOYA iD MyStyle 2, the power difference between the right and left eye as well as individual wearing parameters are taken into account during lens optimization, thereby significantly reducing the vergence requirements in the binocular state. Note, however, that controlling the prismatic side-effects that unavoidably arise in anisometropic prescriptions is not the ultimate goal of HOYA iD MyStyle 2.

Always
in Focus

Accommodation Demand Difference (binocular)

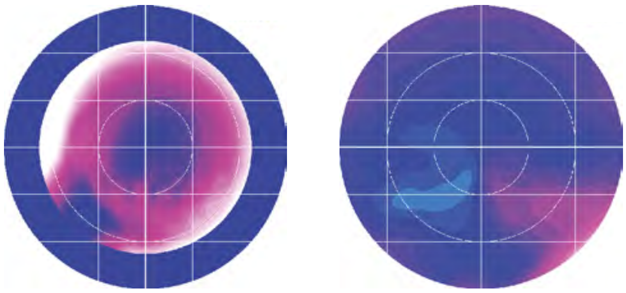
The Accommodation Demand Difference is the most efficient indicator of the effectiveness of Binocular Harmonization Technology. In general, the accommodation demand is the amount of accommodation an eye requires in order to view an object at any distance and is a function of the object distance, the power of the lens at the point where the light rays pass through the lens and the eye's ametropia.

This map uses the difference in mean power between the right and left eye as well as the binocular object distance to define how much each individual eye has to accommodate in order to achieve a sharp, focused image for the relevant object distance. Because a calculation can be made for both eyes, the result can be presented as a difference in accommodation demand between the right and left eye. A difference in accommodation demand of 0.00D can be achieved when the power along the umbilical line (corridor) is matched between the right and left eye. This is possible with Binocular Harmonization Technology. While a number of smaller areas with unequal Accommodation Demand may still remain, those areas are not used often as they are largely located in the peripheral parts of the lens where the Astigmatic Error is higher. In fact, the astigmatic error partly accounts for this remaining difference in the periphery. Because half of the astigmatic error is combined with the spherical power to achieve the mean power, the resulting power can lead to further differences between the left and right, which lead in turn to a difference in the accommodation demand.

The Accommodation Demand Difference is the most efficient indicator of the effectiveness of Binocular Harmonization Technology

HOYA Summit iQ

HOYA iD MyStyle 2 with Binocular Harmonization Technology



Accommodation Demand Difference (binocular)

The lens pair shown in the comparison is: L: +2.00 DS R:+4.00DS +2.50 Add, PD 32/32

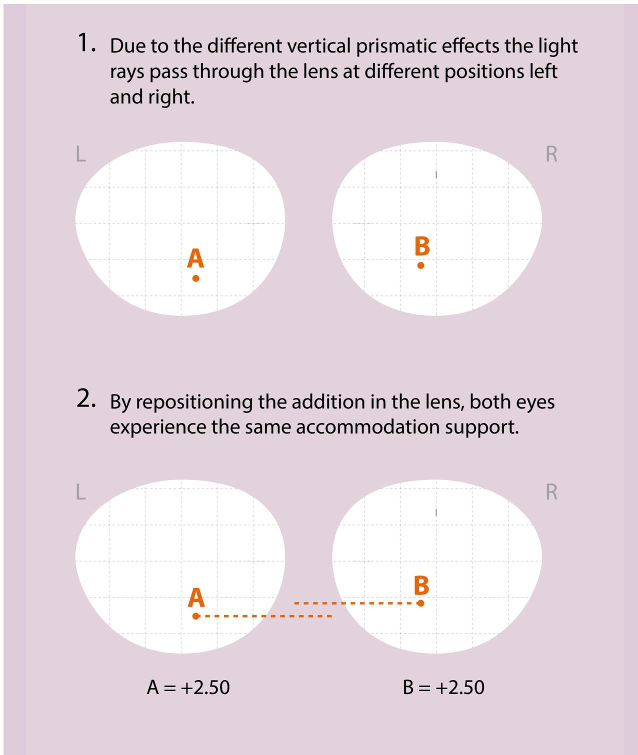


Figure 17: Comparison Accommodation Demand Difference (binocular)

Dark blue indicates areas where the required accommodation difference between the right and left eye would be 0.00D.

Dark purple indicates areas where the accommodation demand for the right eye would be higher.

Cyan indicates areas where the accommodation demand for the left eye would be greater.

One color change step indicates an increase/decrease in the accommodation demand between the right and left eye of 0.0625D

HOYA
Eye for detail

Magnification Difference (binocular)

The Magnification Difference displays the difference in spectacle lens magnification for the right and left eye.

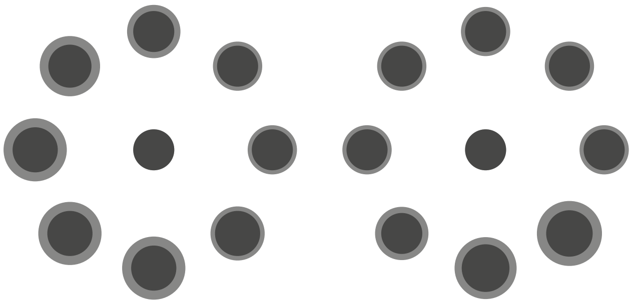
The spectacle lens magnification mainly depends on the power of the lens, its front curvature and its thickness at the center. Because the brain has difficulty in fusing two images of different sizes, a lower magnification difference between the two images results in better and more stable binocular vision.

Even though the overall magnification difference cannot be influenced (due to the difference in prescribed power), improvements can still be achieved in different parts of the lens.

One color change step equates to a 2% increase/decrease in magnification difference. Dark purple indicates a difference of 0%.

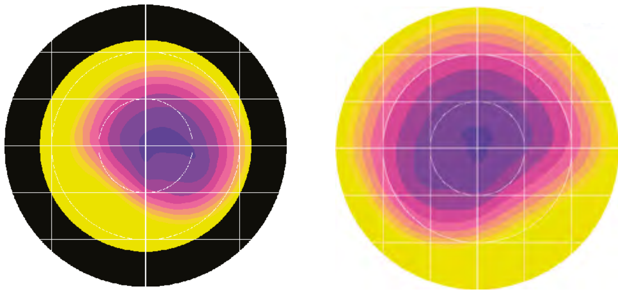
Unsurpassed binocular performance

Object observed through different positions of the lens



HOYA Summit iQ

HOYA MyStyle 2 with Binocular Harmonization Technology



Magnification Difference (binocular)

low high

The lens pair shown in the comparison is:
L: +2.00DS R: +4.00DS
+2.50 Add, PD 32/32

Figure 18: Comparison Magnification Difference (binocular)

Vertical Prismatic Difference (binocular)

In addition to the Convergence Difference map referred to previously (which focuses on horizontal eye movement), the Vertical Prismatic Difference presents the different prismatic effects of the pair of lenses in vertical direction. While the general problem remains in anisometropic cases (the prismatic side-effects of the lens are still different), the Vertical Prismatic Difference can be controlled to a certain extent by adjusting the progressive power distribution for each eye individually based on the known power value for each eye. If the power distribution is changed, the actual power at a single specific point also changes, thereby resulting in a different prismatic side-effect.

Clearly, the only part of the lenses where the Vertical Prismatic Difference is equal is the area around the prism reference point, particularly in cases of anisometropia.

One color change step represents a change in the Vertical Prismatic Difference between the right and left eye of 0.5 prism diopter.

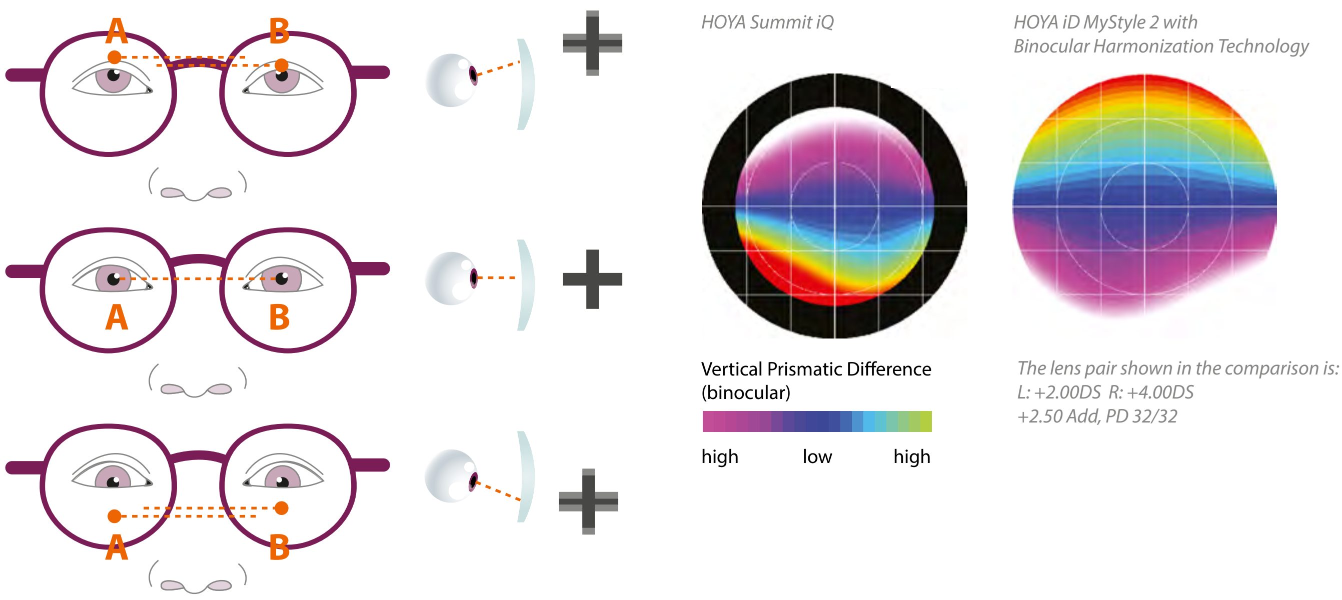


Figure 19: Comparison Vertical Prismatic Difference (binocular)

Hoya iD MyStyle 2
Always in Focus

Innovations in Vision:

HOYA iD MyStyle 2, the third generation of Hoyalux iD designs, is a direct result of the company's InnoVision research and development program.

The first generation of HOYA iD designs deployed Balanced View Control and iD FreeForm Design Technology. These are both revolutionary techniques that resulted in a major reduction in the swim and sway distortion experienced by wearers of progressive lenses.

The second generation, in the form of HOYA iD MyStyle, incorporated our iDEA approach (Intelligent Design by Extensive Analysis) in order to take into account all of the elements that directly influence the image seen by spectacle wearers: their prescription, personal wearing parameters, wearing history and current lifestyle.

The third generation, our BHT designs, are characterised by a strong focus on binocular vision. Each BHT design is evaluated using our revolutionary Binocular Eye Model, a patented binocular performance measurement program which guarantees that each design is verified under real-life circumstances before it goes into production. This ensures unprecedented binocular performance. The BHT designs respond perfectly to the strong demand for natural, stable vision in a dynamic, digital world that requires our visual system to perform at a consistently high level.

Always in Focus

iD MYSTYLE

2

Clarity in a split second. Every time. Everywhere.

- Perfect and effortless focusing
- Excellent depth of vision
- Unprecedented binocular performance
- Natural, stable vision
- In all moments that matter

HOYA

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