Binocular Harmonization Technology
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This course teaches a new technology that manages the way that the two eyes work together in progressives. Called Binocular Harmonization Technology, it optimizes the design of both lenses, no matter the distance Rx, so that the eyes receive equal accommodative support. This is a product spotlight supported by an educational grant from HOYA Vision Care.

HOYA believes that this is the 1st lens technology that addresses the anisometropic prescription with a binocular solution.

Our objectives are:

1. Understand anisometropia and its effects on patients
2. Learn how anisometropia, the need to depress the eyes to read in progressives, affects the way that a progressive delivers its power as the eye moves.
3. Know how the HOYA BHT solution works to manage anisometropia and how it improves the way that progressives work.

First we should describe why a need for binocular harmonization. In eyewear, when there is Anisometropia, the binocularity of the lenses affects vision and the wearer's visual comfort. This is especially true in progressive lenses where the mid-range and reading portions are designed to occur at specified position. However anisometropia causes different prismatic effects in each eye as the eye moves from the lens' optical center.

What is anisometropia?

It's a condition wherein, the refractive error between the two eyes, right and left, is different.

Look at this example. It begins to highlight the problem.

If a patient has a +1.00D lens in one eye and +3.00D in the other, the result is a magnification change as you can see. In addition, when the patient's eyes scan across the lenses, they see different powers and prism everywhere except the optical center.

In progressives unlike SV, where the patient can turn their head to look through or very near to the optical center, in progressives, we force the wearer to use different parts of the lens. And, that downward gaze through different powers in the lenses causes different effects.

Remember, we have been refining the construction of the right and the left progressive lens, requiring significant calculations to reduce distortion and blur. Thinking, in detail about how they work together, in all the possible prescription combinations take more computing power as well as vision research.

So, how different are prescriptions?

While the definition of anisometropia is an Rx with 2 diopters or more of difference, I suggest that in sophisticated surfaces like progressives, smaller differences have an effect on binocular vision.

An Rx difference between the two eyes is the norm. In fact, 73% of the prescription population has a total power difference, sphere plus cylinder value, between the two eyes, of a quarter of a diopter or more.

What's the effect? Anisometropic prescriptions as we said cause size and shape differences that are a product of power and prism. Prism also moves the images we see through them.

In simplest terms, prisms bend light, here the lower letter A, the actual object closer towards the base, is seen as if the A were in a straight line, of course, so moved towards the apex. Wow, prisms can help us see around corners (tongue in cheek).

Now while prism is the reason that ophthalmic lenses have power, their side effect when powers are different in the right and left eye, the eyes can't compensate for the differing prisms. In progressive lenses, as the two eyes look down to read, the power down the corridors are changing at differing rates. The eyes can only move together so the experience is that there is differing accommodative help from the 'Add'.

Let's go over some details about prism.

Look at the illustrations in slide 10 with me – 1 shows that prisms are wedges that can break white light up into its component colors. The spread or size of the rainbow is dependent on the Abbe value of the material the prism is made from. Lower Abbe creates a wider spread of colors, higher Abbe, narrower. 2 Is an image of an ophthalmic prism in the size and ring of a trial lens; see that it is wedge shaped with a thicker base and thinner apex. 3. Is the prism straight on; it is base up so the image of the line is displaced towards the apex. Number 4 is the prism as we've already described its effect on viewing and object, here the number 4.

You can see the thickness of the prism; the thick part is the Base, that's here at the top. And, the thin part is at the bottom.

Now, watch what happens when I put the thin part, the Apex down; look what happens to that line. It gets broken and the prism moves the image and where does it end up, it moves it towards the Apex.

If I rotate the prism, eventually I get the prism along the same axis as the line and it will be continuous but if the prism is opposite, perpendicular to the axis, then I get the full amount of the effect of that prism.

Now back to what prisms do to light rays away from the optical axis or optical center… they bend light towards the base of the prism. This is what gives us converging lenses in plus and diverging lenses in minus. And, because we don't see the actual bending of the light we see the results of which is that the image moves towards the apex. That's why plus lenses magnify and minus lenses minify.

Let's place a plus lens in a frame; it therefore makes sense to align the optical axis of the lenses with the visual axis of the eyes. The distance between those is called the PD, as you know.

What happens when your eyes turn behind the lenses of a pair of glasses – turn them to the right and each eye looks through only one part of the prism of the lenses.

Now we need a way to describe the position of the prism and we do that by describing the direction of the base relative to the way that the eye looks through the prism in four directions. In if the base is towards the nose, out if towards the ear, up if above the eye, down if below.

Looking down at the eyes from the top, the right eye looks through a base in prism (the blue arrow), the left eye looks through a base out prism (the green arrow). Remember, the eye can look through only one prism portion of a lens at a time. That's how we properly describe the direction of the prism. This is normal when wearing glasses and in most cases causes no discomfort.

When the eyes turn in to read, for example, in plus lenses, then there is base out prism induced for each eye. See that the direction of the base is towards the ear in both the right and left eye?

Let's align a pair of minus lenses now with the eyes. No prism.

When both eye look to the right, the right eye is looking through a Base Out prism (blue arrow), the left eye looks through a Base In prism (green arrow). See it (review slide 17)?

Now, when the eyes turn in to read, what direction is the base? Take a few moments to determine the direction – is it 'In' or 'Out'? If you said Base In You were correct. Now let's think about plus and minus lenses vertically. When you look through the optical center of plus lenses, and the visual axis and the optical axis of the lenses are aligned, there is no deviation of the line of sight. When looking down through a plus lens, light is bent towards the base, but the image is seen towards the apex.

As a result, in plus lenses, the base up prism effect moves the image of the reading material farther down. It's part of the problem that some plus Rx wearers have with the position of the reading portion and why Base Down prism used in prism thinning helps to move the image up to a more convenient spot.

When you look through the optical center of minus lenses, and the visual axis and the optical axis of the lenses are aligned, there is no deviation of the line of sight. But, when a progressive wearer looks down, the base down prism makes the image of the reading material appear to be higher.

Now in both minus and plus lenses, as we've seen in previous slides, the amount of and rate of displacement of that final image, due to the prism, is dependent on the power of the lenses vertically. And, that's when Binocular Harmonization Technology will help to correct.

Look at the video in slide 23. What happens to a pair of glasses with combination of powers, +1 and +3D?

If we move the lenses up and down, much like a patient moving their eyes up and down, we can see the unequal movement of the line viewed through the lenses. That unequal rate of change is a product of the power and resulting prism.

So, to summarize what we've learned so far…

- When patients scan, look down to read, are mobile, moving in their environment, walking down the supermarket aisle…
- Prisms cause a separation of images
- The two separate images cannot be compensated for by the wearer
- In progressives, when looking down, both eyes can experience differing amounts of power and prism, images move at different rates and that makes the power different for each eye
- The result can be problems with binocularity

Let's step back and **define** a few terms.

Binocularity is the ability to focus upon an object with both eyes and create a single stereoscopic image.

There are a number of mechanisms that help to create binocularity. For example, even when the two eyes or the images are close but might not be totally coincident over each other, if the images fall within what is called Panum's Area, the brain will appear to have fused the images into one. In this way, this results in less confusion but can result in fatigue and eyestrain if sustained.

When there is binocularity and vision is made up of two separate images from two eyes, at two different angles, they are successfully combined into one image in the brain and produce a perception of **Depth.** It is in fact this perception of depth that helps with mobility.

Did you ever wear a patch and try to do something that requires good depth perception – pouring a cup of coffee, driving through a toll-booth – yikes! This is an extreme example, but a slight power difference between the 2 eyes can result in adaptation problems, especially for a first time PAL wearer. Why wasn't it a problem when the patient was in a single vision correction? Yes, that's when the SV wearer turns their head – right? Not so in progressives.

It is more difficult for the brain to achieve binocularity when the images don't overlap in the visual cortex. Binocular Harmonization Technology (BHT) help patients adapt more easily to their glasses. Ha, maybe that's why pirates, and their eye patches are angggrrrryyyy pillagers… (see the pirate in slide 29)!

Let's look at what happens when the prescription is the same in both eyes. To read, the eyes depress equally, if the power is the same, the prismatic effects, power and rate of change is the same. Both C's (Landolt C's) are nice and clear (slide 30).

When the PAL has unequal refractive powers… and, as the eye moves down for reading… Unequal vertical prism, due to the different rates of change causes the eyes to view through two different lens powers. And, as the eyes continue to depress until the reading position, they are subjected to differing amounts of prism. As the full add power is approached; one C will be in clear focus before the other. Then, full add is reached by both eyes.

The solution is BHT, Binocular Harmonization Technology. It provides the same image clarity for virtually all power differences between the two eyes' prescription.

How is this accomplished?

Using highly technical, patented algorithms, define a surface achieved through sophisticated Free-Form processing. BHT considers the prescription of both the right and left eye and creates the first binocular lens solution. By changing curvature and shortening or lengthening the corridor, the eyes will be in the same add power. What should you know about this solution?

Balanced accommodation support for right and left eye, regardless of a prescription difference. The wearer experiences overlapping visual fields and equal image clarity regardless of a prescription difference. Power and aberrations are being modified in order to create equal image position and therefore, clarity

To develop a model for ensuring binocular harmony, HOYA does 5 analyses and tests to map and reduce error differences. If one thinks about how a clear image is formed when using spectacle lenses, the lens' power, magnification and position alter the effective power and image size and shape. Combine two together and if they are unequal to each other. How is that corrected?

Binocular Maps of the differences of Accommodation, Convergence, Magnification, Vertical Prism and a resultant Clearness Index show how the effectivity of the calculations. The R and L prescription, with the fitting values specified, should suggest an accommodative difference. This is precisely evaluated to predict the variance in accommodative demand caused by the unequal prescriptions of right and left eyes. Then, the difference in accommodative demand is equalized by matching the power along the corridor, for the right and left lens.

Next, what is the expected convergence difference estimated?

The map in slide 39 shows whether the two, lens/eye combinations force the wearer to apply either convergence or divergence for binocularity. Remember, the brain will cause the eyes to turn to look at each image and try to fuse them. Anisometropic Rx's can cause the images to be close and within Panum's Area so it appears to be binocular, but they are not. Images within Panum's Area cause the brain to "see" them as binocular even though they might not be exact. It's the brain's way to reduce confusion and a sense of double vision. However, the result can be digital eyestrain and/or blur, especially during sustained periods of time. Knowing and correcting the differences ensures binocularity.

The resulting change reduces binocular stress when alternating between distance and near viewing.

Another effect of lenses that changes binocularity is magnification, the result of power, front curve, vertex distance and center thickness; but think of this in cylinder lenses, of differing powers and at different axes.

Because the brain has difficulty merging 2 images of different sizes, it's logical that a lower magnification difference between the right and left eye results in better, more stable binocular vision

Last, in progressives, we force wearers to depress their eyes through the lenses vertically. One must therefore understand and correct for the vertical prism difference induced because of the power difference.

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. Reducing this difference to the minimum possible ensures more comfort. If all the differences are adjusted to their minimums, then one can combine the effects and map the clearness of the lens.

The Clearness Index estimates how clearly the wearer sees an image through the spectacle lens. Balancing this enhances binocular clarity throughout the entire lens

To summarize, this binocular eye model is a patented binocular performance measurement program. It was designed to guarantee that each design is verified under a set of algorithms derived from optical science and real-life circumstances. The resulting design is calculated before the lens goes into production so that this ensures unprecedented binocular performance in the resulting two lenses ordered.

Why is BHT better for your practice and your patients?

HOYA believes that this is unique in the market. It's the first design ever to balance corridor length and power distribution according to the prescription difference between right and left prescriptions in the corridor length ordered.

You can adapt the lens to fit the patient's digital use and the lens adapts to provide uncompromised comfort and vision. The only binocular lens solution – as a result, if you need to remake one lens, you need to remake both of them because BHT is a binocular solution.

BHT is the result of an application of iD, integrated Double Surface Designing. Hoya employs patented Integrated Double Surface Technology to separate the functionality and performance of the front and back surfaces, resulting in unsurpassed visual performance. Enable a natural transition between near and distance viewing and widens visual zones at all distances, now with BHT. Binocular harmonization technology optimizes the design of both lenses, no matter the distance prescription; the eyes receive equal accommodative support.

That's It! Congratulations on completing, the Binocular Harmonization course, **VIEW** the end-of-course questions and when ready click on **TAKE EXAM** to complete the 20-question test for ABO credit