Wavefront Management Supports Enhanced Vision in Xperio UV™ Polarized Lenses

In normal eyes, pupils constrict in two conditions: when light is bright, and when the eyes are focused on a near object. Conversely, pupils dilate in opposite conditions: when light is dim, and when the gaze is directed toward a distant target.[1] In low light conditions, increased pupil size can improve optical resolution by admitting more light. However, the beam of light entering through a large pupil must traverse a correspondingly larger area of the cornea, where minute aberrations can distort the wavefront and affect vision quality.[2] When a spectacle lens is worn in front of the eye, a large pupil means that the beam of light entering the eye passes through a larger area of the spectacle lens, and aberrations inherent in the spectacle lens can further decrease visual performance. Tinted or polarized spectacle lenses reduce overall light transmission, causing pupils to dilate. This dilation enlarges the area of the spectacle lens used, increasing the aberrations in the wavefront of light that reaches the retina. To counter this effect, and to maximize the glare-reducing and contrast-enhancing benefits of polarized lenses, requires a lens designed to minimize wavefront aberrations.

Visual Performance

In every eye, minute irregularities in the cornea distort the wavefront of light reaching the retina; the larger the area of cornea through which the beam passes, the more aberrated it becomes. Pupil size determines the diameter of this beam, so it is not surprising that visual performance and contrast acuity are best when the beam is smallest—that is, when pupils are maximally constricted.[3,4] Conversely, a larger pupil allows a larger (and therefore more aberrated) beam of light into the eye, reducing quality of vision.

For spectacle lens wearers, the area of the spectacle lens surface traversed by the beam of light entering the eye is similarly determined by pupil size. Lens designers have defined a term, "projected pupil," that corresponds to the area on the lens surface through which the beam of light passes on its way into the eye (Figure 1). As with the cornea, higher order aberrations inherent in the spectacle lens can produce wavefront distortions in the beam. Thus, when the pupil dilates, the projected pupil size increases and the quality of the wavefront deteriorates.

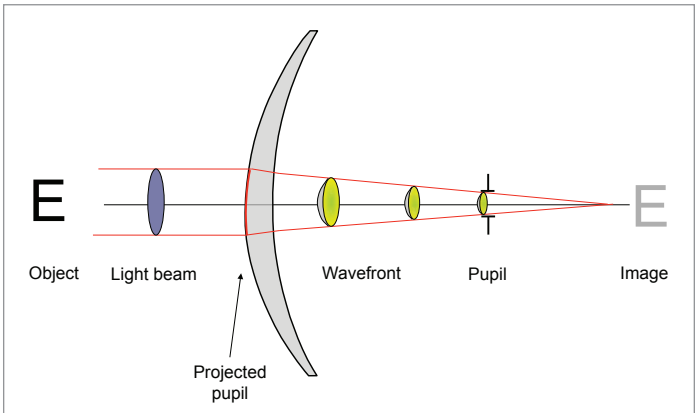

FIGURE 1. The projected pupil: that area on the lens' front surface through which a pupil-delimited beam of light passes on its way to the retina.

Aberration Management

Using wavefront analysis and a sophisticated model that accounts for the factors that influence pupil size, Essilor's patented W.A.V.E. Technology: Wavefront Advanced Vision Enhancement™ manages lens aberrations to minimize distortion in the wavefront passing through the lens at any given point. The W.A.V.E. Technology 2™ platform combines pupil size data from thousands of eyes with mathematical models that relate pupil size to light levels and object proximities across a range of visual tasks.

This modeling allows lens designers to predict the range of projected pupil sizes and create lenses optimized for the largest projected pupil at each gaze direction. This ensures the highest levels of aberration reduction where they are most needed. The benefit is confirmed by both optical bench tests and real-world wearer studies, in which Varilux Physio Enhanced™ lenses—created with W.A.V.E Technology 2™—were preferred to high-quality comparator lenses, especially in low-light conditions.

Xperio UV™ Polarized Lenses

Polarized lenses enhance retinal image clarity by eliminating visual glare; but because polarized lenses cut down on overall light transmission, they cause pupils to dilate. This was demonstrated in a recent study in which the pupils of 13 spectacles-wearing subjects were measured with an infrared camera behind their habitual clear and then Xperio UV™ polarized lenses. An average 0.6-mm increase in pupil diameter was found when subjects wore the polarized lenses, which concurs with published data.[5,6]

The increase in pupil diameter when polarized lenses are worn increases the projected pupil area and, as a result, the level of aberrations in the wavefront that reaches the retina. Fortunately, these aberrations can be managed with W.A.V.E. Technology 2™, which works specifically to minimize the wavefront error generated when pupil size increases.

With Xperio UV lenses, the image enhancement made possible by polarization is improved and safeguarded by the aberration control of W.A.V.E. Technology 2™. When W.A.V.E. Technology 2™ (found in Varilux Physio Enhanced™ and Essilor 360°™ lenses) is paired with Xperio UV polarization, wearers enjoy the best outdoor vision possible.

REFERENCES

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