EnergizeMe Lenses by ZEISS

A Novel Lens Addressing Contact Lens Wearers Needs for Relaxation and Comfort in the Digital World

Contact lenses are a preferred method of vision correction for many people. The motivation to wear contact lenses is driven by both cosmetic and visual factors. Although it is no surprise to individual eye care professionals, the majority of contact lens wearers also use spectacles. Yet the literature on contact lens wearers widely overlooks their concomitant use of eyeglasses, and one might conclude that the two modalities are not intended to overlap, as if patients must choose one or the other. Until now, nobody has made a product specifically for the spectacle lens requirements of contact lens wearers. ZEISS EnergizeMe spectacle lenses were specifically created for their needs.

Characteristics of Contact Lens Wearers

The number of contact lens wearers worldwide is commonly stated to be 140 million, although the original source of this estimate is surprisingly elusive. More detail is known about types of contact lenses dispensed and the characteristics of wearers than the actual number of wearers. Contact Lens Spectrum recently reported that two thirds of contact lens wearers worldwide are women. Although the average age is 31 years, the age by country ranges from about 25 years in countries with large, young populations to nearly 40 years in countries with older demographics. Soft contact lenses (SCL) account for 90% of all fittings but only 9% of contact lenses are for extended wear.[1]

In a 2011 study reporting on more than 100,000 contact lens fittings in 38 countries, 17% of contact lenses were for presbyopic patients; multifocal soft contact lenses (MFSCL) comprised 65% of presbyopic contact lens corrections. But the prevalence of presbyopic patients among soft contact lens wearers varies widely around the world. In Italy and the USA the proportion is more than 60%. In Australia, Germany and the United Kingdom the proportion is about one third. In Japan they account for about 15% and in China only 1%.[2]

Contact lens wearers around the world frequently complain of discomfort after wearing them for a period of time. This phenomenon is called "contact lens discomfort (CLD)". It is defined as a condition characterized by episodic or persistent adverse ocular sensations related to contact lens wear, resulting from reduced compatibility between the lens and the ocular environment. CLD occurs while a contact lens is worn, and the removal of contact lenses mitigates the condition.[3] One of the methods to manage CLD is to wear spectacles after contact lens removal.

Contact Lens Wearers Frequently Use Spectacles

A review by ZEISS of many research papers reporting contact lens studies found that very few address the use of spectacles by individuals who also wear contact lenses. A major review of contact lens discomfort (CLD) described spectacles as a disappointing alternative to contact lenses, something necessary on occasion as an alternative to give the eyes a break.[4] Clearly the attitude among many contact lens experts is that spectacle lenses are something to be ignored except when absolutely necessary.

Yet ZEISS market research conducted in 2015, among more than 2,400 contact lens wearers in China, Germany, Italy and the United States, revealed that at least 65% of contact lens wearers use spectacles every day. Those using spectacles wear them on average more than six hours per day. Another study conducted in 2012 estimated that 80% or more of contact lens wearers in the United Kingdom, Germany and Italy also use spectacles. Contact lenses are most likely to be worn for social occasions, at work or when traveling; they were least likely to be used for relaxing at home.[5] In one cross-sectional study, contact lens wearers were more than five times as likely as spectacle lens wearers to report dry eyes.[6] One factor driving this problem is the use of visual display devices. A study of contact lens and non-contact lens wearers found that the former group is more likely to report adverse symptoms at the end of a workday and the number of hours spent using visual displays correlated with the incidence of scratchy, burning eyes.[7]

The implications of switching between contact lenses and spectacles are complex and this paper will address the visual differences between the two. But it is clear that spectacles provide essential vision correction for contact lens wearers when they do not require the cosmetic or visual benefits of contact lenses, and when they need to give their eyes a rest.

The challenge of digital media devices

Even though contact lens wearers experience significant discomfort when using display devices at work, these patients still enjoy modern media forms of relaxation after work when contact lenses have been removed. And that means using even more display devices.

The worldwide use of digital entertainment media has been publicized extensively in recent years. Perhaps the greatest level of detail is available for the US market. The Nielsen Company reports quarterly on the viewing habits of US adults. In 2016 adults age 20 and over spent more than 50 hours per week viewing televisions, game consoles, computer displays and handheld digital devices. Perhaps surprisingly this trend increases with age, so that maximum usage is among those aged 50–64 (see figure 1). Younger users tend to spend more time on handheld devices and game consoles, while older users spend more time using television displays. The greatest use of computer displays is among adults aged 25 to 64.[8] This high level of use is correlated with increasing symptoms of Digital Eye Strain (DES); 65% percent of adults report symptoms of DES.[9]

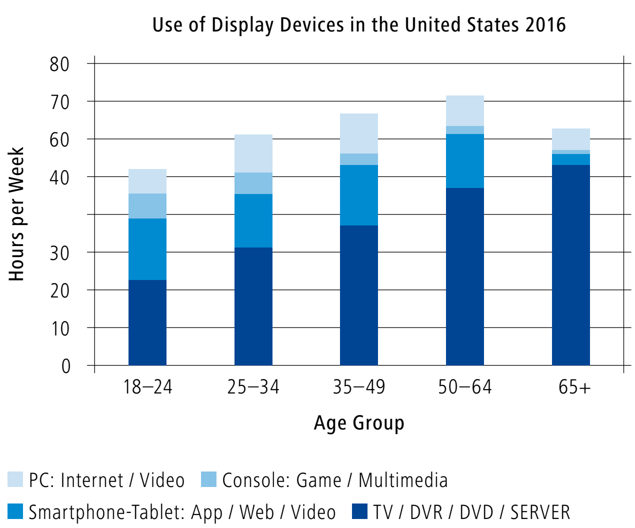

Figure 1. Weekly media viewing habits in the United States during 2016

This heavy use of visual display technology has led to concerns about the high level of blue light emitted by the digital screen's trichromatic light sources. Virtually all displays emit large quantities of High Energy Visible (HEV) light; typically the peak of the blue source in these displays peaks at about 440 to 450 nm. Some experts believe this trend is responsible for an increasing prevalence of sleep disorders[10]. A further consideration is that peripheral glare spectral sensitivity has a strong peak at 440 nm (shown in figure 2) – compared to the photopic light sensitivity curve, and glare sensitivity is significantly shifted toward short wavelengths.[11] This may be one reason why attenuation of blue wavelengths reduces symptoms of eye fatigue when using computer displays.[12] To address these concerns, ZEISS invented Duravision BlueProtect, the antireflection coating specifically tuned to reduce the adverse effects of HEV while preserving the wavelengths that are essential for normal diurnal physiology.

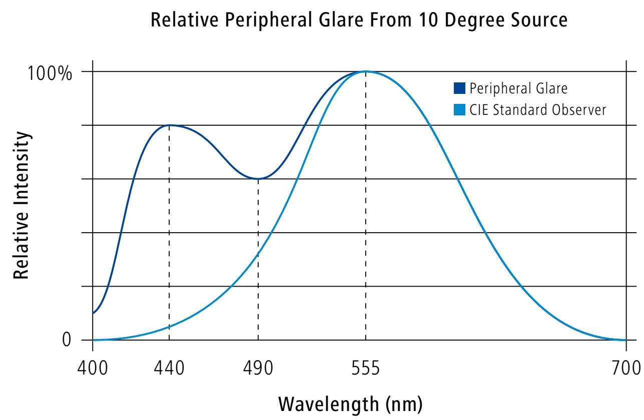

Figure 2. Blue light at 440 nm has enhanced glare potential

Differences between contact lenses and spectacle lenses

A contact lens wearer experiences several visual changes when putting on spectacles. The most obvious change is the presence of a spectacle frame that limits the peripheral extent of corrected vision. Perhaps more important is the change in dynamic vision during eye movements. Spectacle lenses remain stationary whereas a contact lens moves with the eye. Because of this, spectacle lenses present a more variable experience compared to contact lenses. In particular, spectacles provide variable prismatic effects and peripheral distortions during eye movements. In addition, the effect of vertex distance in spectacles produces optical differences that depend on the sign of the dioptric power. Negative power spectacle lenses produce smaller images and present a reduced accommodative demand compared to contact lenses, while the opposite effects are found with positive powers.[13] This means that when wearers switch between contact lenses and spectacles there may be changes in discernibility of near objects as well as changes to accommodation.

Although the visual effect of spectacle lenses differs from contact lenses, it is not necessarily worse. A study of myopic young adults who used both single vision soft contact lenses and spectacles interchangeably showed that they had poorer accommodative and vergence function with contact lenses compared to glasses. In particular there was a tendency toward increased accommodative lag with contacts. Also negative relative accommodation was significantly greater when wearing SCLs, which may suggest a preference for the reduced accommodative demand provided by spectacle lenses.[14]

Presbyopes who require multifocal lenses face different challenges. Soft contact lens correction of presbyopia, whether multifocal or monovision, results in worse high contrast and low contrast acuity than can be obtained from progressive addition lenses.[15] The reduction of acuity is likely due to the presence of multiple overlapping images on the retina caused by the different focal power zones of the multifocal soft contact lens.[16] In a study conducted among presbyopes without prior experience of multifocal contact lenses or progressive addition lenses, progressive lenses allowed quicker identification of street signs during night driving; multifocal contact lenses required closer viewing distances and longer fixation times.[17] In contrast, the same investigators in another study reported on driving tasks requiring identification of targets in the peripheral visual field. Progressive lens wearers needed to make larger saccadic eye movements than multifocal contact lens wearers in order to identify targets. The path length of eye and head movements for progressive lenses was significantly longer than for multifocal contact lenses, indicating that multifocal contact lens wearers were able to rely on peripheral vision more than progressive addition spectacle lens wearers.[18]

Although contact lenses in theory should be able to produce vision as clear as spectacles, the prevalent type of contact lens is manufactured of hydrogel material that suffers from increased light scatter. In a study of patients requiring single vision correction, researchers found that soft contact lenses create significantly more noticeable halos compared to clean spectacle lenses.[19]

Summarizing the problem and goal

Although each individual wearer will have unique experiences, we can draw some general conclusions about the problem of concomitant use of contact lenses and spectacles. Contact lenses present a consistent, natural visual experience with superior peripheral vision. Spectacle lenses provide sharper, higher contrast vision that is free from peripheral halos. Wearers who remove contact lenses and put on spectacles may experience changes in image size and accommodative demand that should be mitigated as much as possible. Wearers of all ages are viewing an extraordinary amount of digital media content displayed on a variety of devices that present unique spectra compared to natural objects. This is especially likely in the evening, at home when contact lens wearers change to spectacles. It is especially important to provide the clearest and cleanest possible lens surfaces to offset the enhanced glare potential of blue light in visual display devices. Contact lens wearers suffering from contact lens discomfort already have tired, burning eyes and should benefit from reduced light-induced stress, particularly in the evening.

The goal in providing spectacles for the contact lens wearer is to provide comfortable and easy vision that will be enjoyed as they give their eyes a rest. Spectacle lenses for contact lens wearers should therefore be designed to require minimal adaptation.

The ZEISS Solution

The ZEISS solution for contact lens wearers is founded on a triad of technologies. Every EnergizeMe lens incorporates ZEISS Digital Inside technology with DuraVision BlueProtect antireflection coating. In addition, three new EnergizeMe multifocal designs have been created specifically for the different challenges faced by young adult, pre-presbyopic and presbyopic contact lens wearers.

Digital Inside® Technology

Intensive use of handheld digital devices frequently requires holding them closer than printed media; in young subjects the viewing distance for handheld devices may approach 20 cm (mean=32cm).[20] In part this is because such devices are small and often must be held in two hands for a more comfortable and stable body posture. ZEISS Digital Inside Technology was created to optimize visual performance for this closer range of viewing and oblique gaze orientation through the lens.[21]

DuraVision® BlueProtect

To protect spectacle wearers from the potential adverse effects of HEV light, ZEISS created DuraVision BlueProtect. This superior antireflection coating is designed to reduce the potentially harmful effects of artificial light at night. Because transmission is reduced in the shortest blue-violet wavelengths, this may also help reduce the peripheral glare peak at 440 nm. The top layers of the DuraVision BlueProtect coating achieve superior scratch resistance and very high wetting angles with antistatic properties, making it easier to clean lenses and keep them clean.[22]

ZEISS EnergizeMe lens designs

The three EnergizeMe lens designs, EnergizeMe Single Vision, EnergizeMe Digital and EnergizeMe Progressive, are all created using proprietary methods for individual optimization of multifocal lenses.

EnergizeMe Single Vision

The EnergizeMe Single Vision design provides up to 0.40 diopters of addition power in the lower field of each lens. The slight addition power helps to relieve accommodative stress in young contact lens wearers, and the corresponding increase in magnification helps offset the spectacle minification of minus power spectacle lenses. It also reduces the near vision prismatic effect for myopes. Because single vision contact lens wearers are accustomed to a constant visual experience, EnergizeMe Single Vision has been optimized to minimize contribution to peripheral blur, relegating its subtle effect only to the extreme infero-temporal and infero-nasal regions. Figure 3 shows a plot of the RMS power error[23] contributed by the EnergizeMe single vision design for an extreme eye rotation field of 90 degrees spanning the maximum possible range of eye rotation. The dashed lines represent eye rotation angles in increments of ten degrees from straight ahead; the curved gray contours represent 0.25 diopters. For most wearers this is at the limits of detectability. Within the 90° field the maximum error associated with this design does not reach 0.50 diopters.

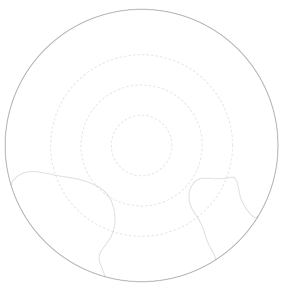

Figure 3. 90° fixation field RMS Power error plot of EnergizeMe Single Vision

EnergizeMe Digital

Like the EnergizeMe Single Vision lens design, EnergizeMe Digital provides addition power in the lower part of the lens. The targeted wearer for this design is a pre-presbyope older than age thirty. The fixed addition power of 0.65 diopters is designed to provide extra accommodative relief for tired eyes. This is especially important for the majority of people who report experiencing symptoms of DES, especially in the evening when contact lens wearers are more likely to be using spectacles. These wearers also are accustomed to single vision contact lenses and have the same changeover issues experienced by younger wearers. The EnergizeMe Digital design also places its very low levels of potential blur in places where it is least likely to be noticed. Figure 4 shows the 90° eye rotation field plot for EnergizeMe Digital. Like EnergizeMe Single Vision, it provides essentially clear vision for almost all eye rotation angles. It only reaches 0.50 diopters of RMS power error at nearly 45 degrees of eye rotation in the inferonasal direction; this is where the wearer's nose and cheeks are located and the low level of blur cannot be perceived at such a close range.

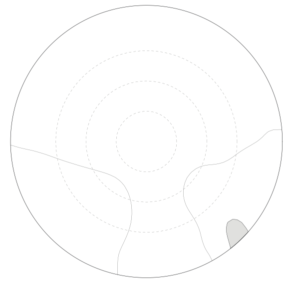

Figure 4. 90° fixation field RMS power error plot for EnergizeMe Digital

EnergizeMe Progressive

The third EnergizeMe lens design is a full-range progressive lens available in all customary addition powers. As already noted, the contact lens literature shows that progressive lenses typically provide superior foveal vision for a range of visual tasks when compared with multifocal contact lenses or monovision. But while presbyopic contact lens wearers get a boost in central acuity simply by switching to progressive addition spectacle lenses, it is important to ensure that they have an easy experience switching between modes of correction. Because multifocal contact lenses outperform ordinary progressive lenses for tasks requiring peripheral vision awareness, it is important to mitigate the blurry effect of progressive addition lenses for the peripheral retina. It is usual when discussing the merits of one progressive lens versus another to explain differences in central acuity experienced by the moving eye; this requires analysis for light rays passing through the center of rotation of the eye. But this would be the incorrect approach for the present problem. Instead, the EnergizeMe Progressive has been designed in a way that it reduces potential blurry vision in the peripheral retina. To demonstrate its effectiveness, calculations must be performed with respect to the entrance pupil of the eye.

Figure 5 shows a comparison of a common +2.00 diopter addition progressive lens design, raytraced to compute RMS power errors for light rays passing through the entrance pupil of the eye referenced with respect to the central dioptric powers required for the fovea. Although the type of contact lens may vary between wearers and the peripheral refraction requirements of each wearer is unknown, this analysis provides a maximum estimate of the potential change in image quality when changing from contact lenses to this ordinary progressive lens. Because the peripheral retina is much less sensitive to blur than the fovea centralis, the plot scale has been set to show the defocus in 0.75 diopter steps. The plots are equivalent to tangent screen visual fields test covering the central 60 degrees of vision. The left plot is calculated at a plane perpendicular to the central line of sight at 1 meter viewing distance for 15° of downward gaze. The right plot is for a plane at 50cm and 30° down gaze. Much of the lower field of view with an ordinary progressive design may be compromised compared to a contact lens correction.

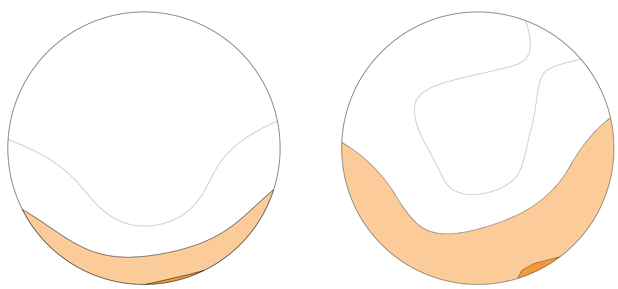

Figure 5. Central 60° peripheral RMS power error plots for a common progressive addition lens

The design of the EnergizeMe Progressive has been modified to reduce the rate of change of mean power and redistribute it throughout the periphery. This reduces potential peripheral blur; Figure 6 shows the results. In comparison to the ordinary progressive, the EnergizeMe Progressive has significantly less potential blur in the central 60° peripheral visual field.

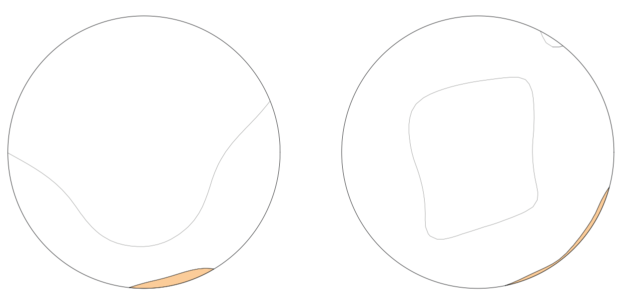

Figure 6. Central 60° peripheral RMS power error plots for the EnergizeMe Progressive

All of the EnergizeMe lens designs have been created to provide visual relief with reduced eye strain while reducing the potential for problems when changing between contact lenses and spectacles.

Performance in practice: the EnergizeMe wearer trial

After the specification of designs for EnergizeMe in 2015, the product performance was verified in an internal wearer trial comprising 60 subjects who habitually wear contact lenses. The consumer acceptance was then tested in practice. In 2016 the three EnergizeMe lens designs were evaluated in a clinical trial among fourteen eyecare professionals in Spain. 130 contact lens wearers who also purchased spectacles were asked to evaluate EnergizeMe. Subjects younger than age 30 were assigned EnergizeMe Single Vision; those over 30 years who had not yet been prescribed an addition for presbyopia received EnergizeMe Digital. The rest of the subjects who had previously received a different progressive lens received the EnergizeMe Progressive.

All three types of EnergizeMe lenses were very well accepted by subjects. There were no statistically significant differences in overall satisfaction with EnergizeMe between the three groups and 93% reported that they were satisfied to extremely satisfied. Fully 87% of subjects reported that they adapted to EnergizeMe within one day. Subjects reported enjoying very wide fields of view (94%) and that they were less dazzled by digital display devices (91%) (see figure 7).

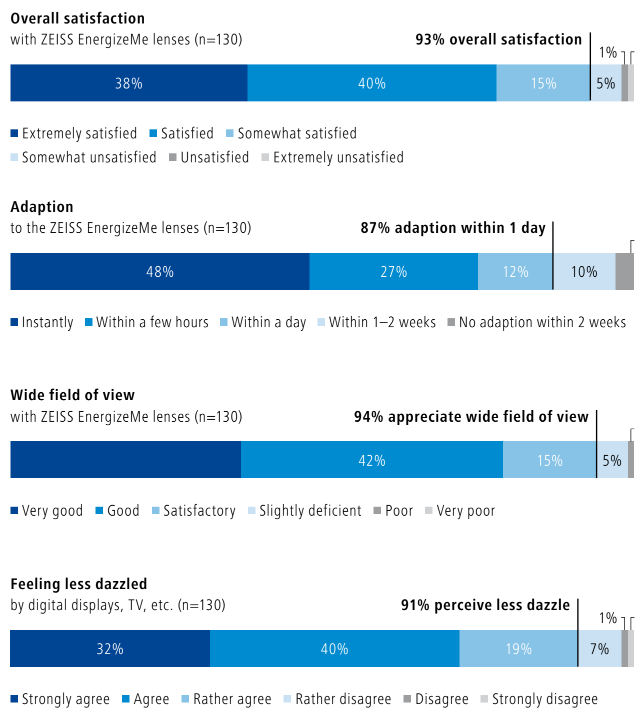

Figure 7. Customer satisfaction results

Summary

ZEISS EnergizeMe lenses have been created for contact lens wearers who also own spectacles and use them to give their eyes a rest. They feature Digital Inside technology to optimize performance for heavy users of digital display devices, especially handheld mobile devices in close proximity to the eyes. They include Duravision BlueProtect to give relief from the HEV blue light emitted from those same displays. And the EnergizeMe lens designs have been specifically created for easy interchange between modalities while providing accommodative relief and excellent peripheral vision.

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