THE 'A-B-Cs' OF UV AND SUNWEAR – PART 2

By Andrew S. Bruce, LDO, ABOM, NCLEC

[1 CE CREDIT]

Welcome back to the exciting sequel of this two-part program, creatively entitled, part 2! As I'm sure you recall, part 1 stimulated those neurons by establishing a foundation for what will be presented here. Included was the assertion that today's society presents as being poorly informed about the effects ultraviolet radiation has on short and long-term eye health. Also, the science of light and electromagnetic radiation was presented. It concluded leaving everyone on the edge of their seats, discussing the topic of glare and its effects on the visual system. Now, the anticipation is over... It's time for part 2, which will commence with a discussion of the plethora of sunwear options available to our patients.

LEARNING OBJECTIVES:

Upon completion of this program, the participant should be able to:

1. Have an increased knowledge of the different sunglass options available with their pros and cons.
2. Have an increased knowledge of the effects specific tints have on a patient's vision.
3. Know the benefits of AR and mirror coatings on sunglasses and the importance of appropriate frame selection.

Credit: This course is approved for one (1) hour of CE credit by the American Board of Opticianry (ABO). General Knowledge Course ?

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SUNWEAR OPTIONS

There are a variety of ways to provide eye protection from both UVR and high luminance levels. These include tinted, polarized, photochromic and polarized photochromic lenses. Regarding its ability to reduce luminance levels, the darkness of a lens can be measured, or described, by either its visible light transmission or absorption levels. For example, the "ideal" clear lens would have a transmission value of 100 percent and an absorption value of 0 percent. As we all know, this doesn't exist. A standard CR39 uncoated lens reduces light transmission by approximately 8 percent. This would be referred to as having an absorption value of 8 percent and a visible light transmission value of 92 percent.

Although a tinted lens will reduce the transmission level of visible light, it has no effect on attenuation of invisible UV rays. For this reason, a tinted lens does not necessarily indicate it is providing UV protection. Some materials inherently provide the recommended UV protection of 100 percent up to 380 nm, such as polycarbonate, trivex, high-index plastic and lenses where the UV dyes are added during casting. In fixed tint lenses that do not have complete UV protection, the application of a clear UV protective coating is a requirement. Without such, the mydriatic effect of wearing a tinted lens can be more detrimental to eye health than a clear lens. Why may you ask? Answer your question, I will. The involuntary pupillary response to reduced light transmission is mydriasis, or dilation, which increases light transmission. Hence, the increase in UVR transmission to the inner eye in the absence of full UV protection in a tinted lens. The impermanence of the UV protective coating provided by "Value Mart" sunglasses poses a potential eye health risk because UV protection levels diminish with the age of the coating. There is a false assumption, on the part of the consumer, regarding sunglasses marked "UV protective": the assumption that the level of protection will not decline over the life of the eyewear. Perspiration and cleaning can gradually reduce their UV protective properties.

Also, the poor optical quality of "Value Mart" lenses can cause eyestrain and fatigue for an otherwise emmetropic patient. We must do our part in educating our patients and their parents of these very important FACTS, to help preserve their long-term eye health and visual comfort.

NOTE: Polycarbonate and some high-index plastic materials can be difficult to tint to an absorption level that will adequately provide the necessary luminance protection. One of the many benefits of Trivex is its ease of tinting. Let's begin our discussion of sunwear options with fixed tints.

FIXED TINTS

Fixed tints produce absorptive lenses of varying colors which selectively transmit specific portions of the visible spectrum according to the absorptive properties of the dyes. They can either be solid, gradient or bi-gradient.

Solid: Provides uniform light absorption across the lens.

Gradient: Provides variable light absorption across the lens—typically darker at the top fading to either a lighter shade or clear.

Bi-Gradient: Similar to a gradient tint, but the lens will be darker at the top and the bottom, fading to a clear, or lighter shade in the center.

FIGURE 1 Fixed tint sunglasses

SPECIFIC TINTS

As discussed in part 1, the blue end of the visible spectrum, having the shortest wavelength of the sun's visible light emissions, is dispersed by atmospheric conditions. This "Rayleigh scattering" causes what is commonly referred to as spectral noise, which reduces contrast, color saturation, sharpness and detail. The ability of specialized tints to attenuate specific wavelengths and transmit others, make distant objects easier to see. What follows are a few examples of specific tints and their specialized effects.

Neutral Grey: Absorbs uniformly across the visible spectrum resulting in a lens of grey appearance. Neutral lenses, either fixed, or photochromic, reduce luminance levels evenly across the spectrum and therefore maintain the best color perception in a tinted lens. The finding that all colored tints in lenses alter color vision to some degree makes neutral grey the tint of choice of the U.S. Military. It is often a patient's preference because it doesn't affect their color perception and is the recommended color by the American Optometric Association.

Yellow/Blue Blocker: Increases apparent brightness and contrast by filtering out the shorter blue wavelengths and can be beneficial to glaucomatous patients*, target shooters, clay pigeon shooters and hunters for forest conditions. (*According to the Glaucoma Research Foundation: "Glaucomatous patients suffer from a number of vision problems, one of which is a loss of contrast sensitivity. Also, a class of glaucoma medications called Miotics, constrict the pupil to increase fluid flow; this can also contribute to problems with glare. A yellow tinted lens will increase contrast and enhance clarity by reducing the spectral noise caused by blue light.")

Why increase contrast and what benefit does this provide for our patients? Outside, under a clear blue sky on a sunny day, contrast is at its peak. However, overcast and rainy conditions, together with reduced illumination levels, negatively impact contrast and visual acuity. Accordingly, increasing contrast will ultimately improve visual acuity.

Orange: Improves outdoor viewing for patients with macular degeneration. In a similar way that a yellow lens attenuates blue light, an orange lens also improves contrast, depth perception, detail and visual acuity.

ARE YELLOW COLORED LENSES RECOMMENDED FOR NIGHT DRIVING?

Some patients claim blue-blocking lenses reduce the glare from headlights when driving at night. They are not wrong! The attenuation of blue light sharpens the image and improves contrast. However, patients, especially the elderly who typically already have reduced contrast sensitivity levels, should be advised of the adverse effects of wearing any type of absorptive tint at night. The eye is at its peak sensitivity under high illumination. When illumination levels are lowered, reducing light transmission further should be discouraged, regardless of how minimal the reduction. According to Forensic Aspects of Vision and Highway Safety: "Yellow, 'Night Driving' lenses have been shown to provide no benefit in seeing ability at night. They are even more hazardous because they give the driver a feeling of seeing better..." Furthermore, "Studies have shown that they (yellow lenses) actually impair visual performance and retard glare recovery." Glare recovery refers to our ability to recover from blinding or veiling glare, visually. A delay in glare recovery could present a driving safety hazard due to loss of visual acuity.

Brown or Amber: A popular choice of snow skiers, boaters and pilots. Surroundings appear warmer with brown and amber tints, and the optical benefits are similar to orange and yellow tints.

Green: Filters out the shorter blue wavelengths and the longer red wavelengths, limiting transmission to only the mid-range. The eyes' color sensitivity peaks at 555 nm in the mid-range of the visible spectrum—a yellowish-green color that closely resembles the hue transmitted by a green tint. Accordingly, this selective transmission of a green lens improves clarity and contrast. A lens with a fixed tint will reduce light transmission and internal lenticular glare from direct light; however, a fixed tint will have no effect on eliminating reflected disabling glare. A polarized lens is required to reduce disabling reflected glare.

POLARIZED LENSES

Ambient light emitted from the sun is scattered and random and in all directions. When light is reflected from a horizontal flat surface, it is partially or completely polarized in the horizontal plane. This polarized light is concentrated, and bombards the eye and can be blinding to the viewer (blinding glare). Polarized lenses work on the same principle as a vertical blind: for optimal viewing, blocking horizontally polarized light while transmitting vertical light rays. This selective transmission eliminates horizontally reflected glare, minimizes eye fatigue and strain, improves color saturation and increases contrast. Also, a polarized lens inherently attenuates 100 percent of UV-A and UV-B rays.

However, despite their many benefits, polarized lenses are not for everyone. The FAA advises pilots against wearing polarized sunglasses for several reasons: First, they reduce visibility through aircraft windshields from visual noise, in this case from the colorful rainbow effect of birefringence in the windshield glass, which becomes apparent to the wearer of polarized lenses. Second, they can impair the pilot's ability to spot reflections from other aircrafts in high traffic situations during takeoff and before landing. Also, they can reduce the visibility of instruments because the LCD panels are equipped with partial polarizer filters to reduce glare from instrument panels. Unfortunately, these polarized anti-glare filters are set with their axes at different angles than the axes of the polarized sun lens. (We all know what happens when we look through two stacked polarized lenses with their axes at a 90-degree angle to each other… no light transmits. One lens blocks vertical rays while the other blocks horizontal rays.) Finally, they can interfere with the pilot's ability to evaluate their altitude over water due to the elimination of surface reflections.

FIGURE 2 Polarized view – clear color and detail

As eyecare professionals, we must be well informed about these limitations. Suggesting a polarized lens to a patient who just shared that he/she is a pilot can instantly damage your credibility. However, pilots may have other needs and interests that would justify also purchasing a separate pair of polarized sunglasses; for example, driving, water sports and fishing—all activities for which polarized sunglasses would be beneficial.

A study on the reaction time of drivers showed a 15 percent quicker reaction time for drivers wearing polarized versus non-polarized lenses. The same study revealed that drivers wearing a tinted non-polarized lens was actually impairing their safety and performed better with a clear lens.

ACTIVITIES AND POLARIZED LENSES

There are certain activities for which polarized lenses are preferred and those for which they are not.

Fishing: Ask any serious fishing enthusiast, and they will tell you how polarized lenses are a must. The ability to eliminate surface reflections off the water surface makes the fish easier to see.

Snow Skiing: Snow is obviously highly reflective and can cause blinding glare, especially under bright sunlight. Polarized sunglasses will eliminate this glare. However, on icy slopes, skiers rely on surface reflections to help them avoid potentially hazardous icy patches. Under these conditions, non-polarized lenses may be the preferred option.

Water Sports: For similar reasons, fishing enthusiasts enjoy polarized lenses, water sports enthusiasts and boaters also benefit from the glare reduction and improved visual comfort.

Golfing: Some die-hard and hard-core golfers dislike polarized lenses for their short game because they eliminate the reflected light off the blades of grass, interfering with their ability to interpret the topography of the green. However, other golfers enjoy the benefits, including how they improve the separation between the ball and the background, especially with a brown lens. Inter-

estingly, a study by Pacific University's College of Optometry of pro-golfers and their short game showed an even 50/50 split between those who enjoy polarized lenses when golfing and those who do not.

Driving: As previously discussed, polarized lenses improve driver safety by improving reaction time. Under bright sunlight, overcast, or rainy conditions, polarized lenses improve contrast and reduce visual discomfort by eliminating glare. Some patients may not care for the tempering pattern visible in the side and rear windows through polarized lenses. Also, if the car has older LCD displays, polarized lenses can make such displays more difficult to read. Device manufacturers have made big improvements in screen readability when wearing a polarized lens. Even with the trade-offs, the added safety, eye comfort and clarity make polarized lenses the preferred choice of the majority of ECPs for their own personal use.

The next category of sunwear options is photochromic lenses.

PHOTOCHROMIC LENSES

Definition: A reversible, light-induced change in color. As stated in part 1, "light" is a broad term that includes both visible and invisible electromagnetic radiation. Through a chemical reaction, a colorless lens is changed to a colored lens by exposure to invisible UVR. Removing the radiation source will return the colored lens back to its colorless state. The nature of the chemical reaction is the reason photochromic lenses favor their colorless state when subjected to heat and activate to a greater degree when subjected to cold. For example, a photochromic lens on a snow-capped mountain, under a clear blue sky, will achieve its maximum darkness.

PHOTOCHROMIC BENEFITS

The wide availability, regarding lens materials and designs, make photochromic lenses a great choice and recommendation to provide round-the-clock protection from the sun's harmful rays for virtually all patients of all ages. Photochromic lenses are definitely the most practical option for both the elderly and younger patients who cannot, or will not, take the time to switch between different pairs. As previously discussed in part 1, photochromic lenses can also help preserve the visual system's long-term dark adaptation ability.

Photochromic lenses provide variable protection from extreme luminance levels and harmful High Energy Visible light (HEV) depending on UVR levels present and their respective luminance absorption. Despite all the concerns about HEV light emissions from digital technology, the sun is ultimately the greatest source. Sunglasses provide a high degree of protection from visible light, which obviously includes this HEV blue light. The darker the lens, the greater the reduction of visible light; subsequently, the greater the reduction of HEV blue light. A photochromic lens that darkens to a brown or amber shade will attenuate blue light to an even greater degree.

Most photochromic lenses provide 100 percent UVR attenuation. Glass photochromic designs such as Thin & Dark by Corning provide 90 percent to 99 percent UVR attenuation depending on its shaded state.

As with most things, there are, what some would consider, "downsides" to photochromic lenses. The most common complaint I hear from patients is the time photochromic lenses take to return to their clear state after removing the stimulus. Teachers and working professionals, who are frequently inside and outside, typically dislike this delay. Lens manufacturers are always working to improve this "clearing time" with new technology and designs.

The second most common complaint I hear is, "My glasses don't get dark when I'm driving!" As stated earlier, photochromic lenses undergo their chemical reaction when exposed to UVR. Most windshields block a significant percentage of UVR, impeding this chemical reaction. There are photochromic designs that claim to respond more effectively behind the windshield, reacting to both visible and invisible light.

The last and most frequently expressed concern I hear is regarding the lenses' darkened state obscuring the view of the eyes in outdoor photographs. As previously discussed, UVR is always present outdoors, during daylight hours; even out of direct sunlight. This will always cause a photochromic lens to darken to some degree, making outdoor photographs challenging. This is just the nature of the beast. They're going to darken!

There are myriad photochromic options from all the major players in the lens manufacturing industry. How does one possibly decide which to default to? I recommend researching each manufacturer's designs and talking with the respective lens representatives regarding how their design compares to others. If the opportunity presents itself, personally putting them to the test and comparing their performance will enable you to provide first-hand recommendations—always the most effective.

The last category of sunwear options to be discussed in this course is polarized photochromic designs.

POLARIZED PHOTOCHROMIC

We have already discussed the independent benefits of both polarized and photochromic lenses. What if we could combine these? Amazingly, technology has made this possible; lenses are available that adjust the degree of polarization in the lenses based on UVR levels present. As the lenses darken from UVR exposure, they gradually become increasingly more polarized. This UVR dependent polarized variability means that behind the windshield, the lack of UVR exposure will deactivate the photochromic returning the lens to a clear state while removing the polarizing catalyst. Only when directly exposed to UVR and in their darkest state, will they attain their maximum degree of polarization.

ADDITIONAL LENS TREATMENTS

Once the decision has been made as to the best-suited sunglass style for the patient, what other options should be considered?

AR COATS/BACKSIDE AR COATS

AR coats are often only applied to the back surface of a sunglass lens, preventing light from striking the back surface of a lens and reflecting it back into the patient's eyes. As discussed earlier, a polarized lens is the sun lens that attenuates disabling reflected glare but even polarized benefits from a backside AR to prevent light from bouncing off the back of the lens into the eye. Backside AR coats are especially important when front surface mirror coatings are applied to the lens, why you might ask? Keep reading to learn why.

MIRROR COATINGS

Mirror coatings can be used for fashion and cosmetic purposes, but also to reduce light transmission by a greater amount than the absorptive properties of the sun lens itself. It is never recommended to tint a polarized lens because of potential delamination; application of a front surface mirror coating is the preferred alternative. Mirror coatings increase the visibility of mirror reflections of the eyes off of the back surface of the lens. Light entering the lens from the back travels into the lens where it bounces off the back surface of the mirror coating internally and is reflected back into the eye. This constitutes the necessity of routinely combining the application of a backside AR coat with front surface mirrors.

Important: Mirror coatings can reduce light transmission by an additional 10 percent to 20 percent. The optician must factor in the transmission level of the lenses before the application of a mirror coat, to ensure that the additional reflectance, provided by the mirror, doesn't reduce light transmission levels to unsafe levels.

Front surface mirror coatings include a FULL mirror coat which is highly reflective, a flash mirror which provides a more subtle effect, a gradient mirror which is more reflective at the top, fading to less at the bottom, and a bi-gradient which is more reflective at the top and bottom, both fading to less at the center.

Offer your patients a wide range of color combinations. Talk with your lab to determine their company of preference and then request a sample kit to demonstrate to your patients. This is a proven and invaluable sales tool.

Frame selection plays an important role in the effectiveness of sunglasses. A larger close-fitting frame provides better coverage for more protection from the sun's harmful rays. Close fit wrap styles provide added protection from sunlight entering from the side or top of the frame. Another benefit of a larger frame is one of physical protection. Many outdoor enthusiasts enjoy activities such as bike riding and hiking; such activities can potentially subject the eyes to physical harm. A larger frame combined with impact resistant sun lenses makes the ideal package.

That being said, close attention must always be given to the prescription and the decentration necessary. Going larger, or using steep base curves with high prescriptions, especially when large amounts of decentration are necessary (narrow anatomical PDs with large frame PDs), will increase lens thickness. Not all prescriptions are suitable for "sporty" wrap frames. High prescriptions in steeply wrapped frames will increase the disorienting "swim" sensation the patient experiences due to induced prism when the visual axis of the eye is not aligned with the lens optical axis.

However, new digital lens designs and surfacing technology, combined with factoring in "positional power effects," applying the relevant compensations for a wrap, vertex and pantoscopic tilt to the prescription, have significantly expanded the range of powers possible with high wrap eyewear. Despite these expanded ranges, certain prescriptions are still better suited for smaller frames with flatter base curves.

FIGURE 3 Mirror coat

CONCLUSION

As we have discussed in this two-part program, UVR is ubiquitous, and it is imperative that we fulfill our responsibilities as eyecare professionals to inform and educate our patients about its harmful effects. In the same way doctors discuss other health issues such as diabetes and glaucoma, lenses are our area of specialty. Patients come to us for our advice. We are the lens experts. We must determine their needs and make the best recommendations to provide for their long-term eye health and protection from the sun's harmful rays. ■

SELF-ASSESSMENT EXAMINATION

1. The darkness of a lens:
a. Determines the level of UVR attenuation provided by the lens
b. Is measured as a percent of visible light transmission or absorption
c. Is variable in a polarized lens
d. Is purely cosmetic with no added benefit

2. Fixed tints:
a. Can be either solid, gradient or bi-gradient
b. Provide protection from reflected glare
c. Always provide adequate UVR protection without additional lens treatments
d. Are only available in a neutral grey

3. Spectral noise:
a. Only affects vision on a rainy day
b. Has no effect on visual acuity
c. Reduces contrast and color saturation
d. Is eliminated by using a blue lens

4. Yellow lenses:
a. Filter blue light and increase brightness and contrast
b. Filter out the longer red wavelengths
c. Are recommended for night driving
d. Is a popular choice for pilots

5. A green lens:
a. Is recommended for color deficient patients with reduced sensitivity to red light
b. Closely matches the eyes' peak color sensitivity at 555 nm
c. Enhances blue wavelengths
d. Will reduce contrast

6. A polarized lens:
a. Eliminates horizontally reflected glare
b. Reduces color saturation
c. Has no effect on eye fatigue and strain
d. Provides inadequate UV protection

7. Polarized lenses:
a. Are highly recommended for pilots by FAA
b. Have been shown to improve driver safety by shortening reaction time
c. Block vertically polarized light
d. Make the sky a lighter blue

8. Photochromic lenses:
a. Rely on the additional application of a UV protective coating to be effective sunglasses
b. Favor their clear state in the cold
c. Provide variability in light transmission depending on the level of UVR present
d. Are a poor choice for young patients

9. When it comes to HEV light:
a. HEV light transmission in a photochromic lens vary according to visible light transmission levels, less light transmission equals less HEV transmission
b. Photochromic lenses provide no protection from HEV light
c. A grey lens will provide more protection than a brown lens from HEV light
d. Stands for Highly Efficient Visible light

10. Some patients complain that photochromic lenses:
a. Are too dark behind a windshield
b. Take too long to return to clear indoors
c. Provide inadequate UV protection
d. Are only available in glass

11. According to the author, other common complaints about photochromic lenses include:
a. They're too expensive
b. They darken too much when it's dark outside
c. They scratch too easily
d. The darkened tinted state is undesirable in outdoor photos

12. Regarding lens material choice for sunglasses:
a. Polycarbonate is easy to tint
b. CR39 inherently provides 100 percent UV protection
c. All materials require the addition of a clear UV protective coating
d. One of the benefits of Trivex is its ease of tinting

13. Polarized lenses:
a. Are very popular with fishing enthusiasts
b. Help snow skiers avoid hazardous icy patches
c. Are preferred by golfers for their short game
d. Return to their clear state indoors

14. Front surface mirror coatings:
a. Provide a purely cosmetic effect
b. Are not the recommended way to increase light absorption in a polarized lens
c. Are available in solid, flash, gradient and bi-gradient
d. Can potentially reduce light transmission by an additional 40 percent to 50 percent

15. Mirror coatings:
a. Reduce visible light transmission in a lens
b. Have no effect on visible light transmission
c. Increase visible light transmission
d. Are purely a fashion feature of a sunglass

16. Mirror coatings:
a. Are solely applied for fashion purposes
b. Applied to the front surface of a sunglass lens result in an increased need for a backside AR treatment
c. Are applied to both the front and backside of the lens
d. Increase light transmission through a lens

17. When selecting a frame for sunglasses:
a. Frame size has no effect on their performance
b. A smaller frame is always a better choice
c. A larger frame provides better UVR performance and better physical performance
d. Frames should always be high wrap designs, regardless of prescription

18. In the author's opinion:
a. High wrap frames should be used with caution to avoid unsatisfactory results regarding lens thickness
b. High wrap sunglass frames serve no benefit
c. Only high wrap frames should be used for myopes
d. High wrap frames do not impact lens optics

19. Light transmission:
a. In an "ideal lens" would be 100 percent
b. Is the same as light absorption
c. Is unaffected by the application of an AR coat
d. Should be at a maximum for sunglasses

20. When it comes to the topic of sunglasses:
a. They are purely a luxury
b. They are only necessary for adults
c. As ECPS, we have a responsibility and a duty to inform and educate our patients about the importance of protecting their eyes from the sun's harmful UVR
d. It's perfectly fine for the patient to purchase a $12.99 pair from "Value Mart"—there's no difference in quality or the level of protection when compared to premium sunglasses

Examination Answer Sheet

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Directions: Select one answer for each question in the exam and completely darken the appropriate circle. A minimum score of 80% is required to obtain a certificate.

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