SOARING Rx

BY DR. DANIEL L. JOHNSON

Why Wear Sunglasses?

Recognition of the light pathways involved with foci at stem cell niches has directed our investigations into inflammatory and matrix metalloproteinase-related pathophysiologic mechanisms.
- Dr. Minas Coroneo

Frankly, I hope that we can stay somewhere north of this lovely, poetic bit of scientific jargon by Dr. Coroneo, so rich with meaning to his colleagues, and so incomprehensible to us. (While I have your attention, surely you want to know that the damages light can cause the eye are *ophthalmohelioses.* OK, enough fun with jargon.)

The reason that most of us wear sunglasses is that bright light *hurts* (called *photophobia* by Dr. Coroneo and our medical ilk). That's just the truth. Only in recent decades has it become clear that ultraviolet (UV) light causes eye damage. Ironically, wearing dark glasses that don't block UV increases the risk of damage: we're more comfortable, so we don't squint, and more UV light hits the eye.

First, it's quite clear that we can sunburn our corneas (the clear bubble thingy out front, on which contact lenses ride). After a day in the sun, you'll wake up at about 3:00 am with your eyeballs frying under their lids, not able to function well enough to take yourself to the nearest ER for the $1500 medical frustration.

Second, it's true that years of low-level UV exposure can cause corneal scarring, and possibly retinal damage, but probably doesn't contribute to cataract formation.

After reviewing a vast pile of articles on the damaging effects of ultraviolet light on the eye, I can confidently say that we, as a sentient species, really don't know anything *specific* about how much low-level, chronic actinic exposure is tolerable.

On one hand, it's clear that people who live and work outdoors in bright light may be blinded by years of this. UV corneal damage is the most common cause of blindness in the Dahlak Islands in the Red Sea, and troubles "water workers" on the Chesapeake Bay, and outdoor workers in Labrador. In fact, the condition is sometimes called *Labrador keratopathy.*

On the other hand, it's all but impossible to separate the effects of low-level ultraviolet exposure across decades of life from the other causes of ocular degeneration. So, like mother hens, we recommend that everyone protect our eyes against needless exposure to UV light. ☛

The Bottom Line

The British have published formal recommendations on sunglasses for aviators. Translated (with my asides) they are:

• They're a good idea. But not at night. ... (Wait, we don't go a'gliderin' at night!)

• They shouldn't be too dark – 20+% transmissivity, maximum 80% absorption. (You *do* want to see other aircraft, right?)

• Colored tints are bad. (They distort color vision, especially for color-deficient pilots.)

• Don't bother with photo chromic (self-darkening) lenses. (They're activated by UV light, and you *do* have a UV-absorbing canopy, don't you?)

• Don't use polarized lenses. (Strain areas in the canopy plastic form annoying rainbows, LCD displays become unreadable, and waterways don't shine properly for navigation.) Having said that, there is every reason to use polarized lenses while boating or driving, as they remove most of the annoying brightness and glare from specular reflections (light glancing brilliantly off smooth surfaces).

• Don't use clip-ons. (The Brits don't explain why; my experience is that they get dirty and scratched. And you *do* plan to see other aircraft, right?)

• Carry a spare. (But, where to store it?)

Specific recommendations

You're going to have to do your own shopping. Mr. Google can help. Search for site:faa.gov sunglasses.pdf. This is very good. Search for a technical string like "ultraviolet transmission sunglass lenses." Cheap is often not good; vastly expensive is also often not good – the UV doesn't inspect the brand name on the way through.

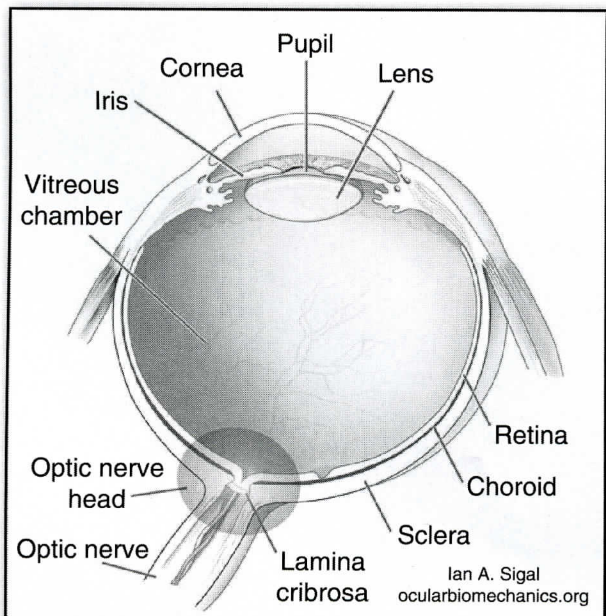
Some tips:

• **Contact lenses** do not filter out UV light, except for some newer brands specifically designed for complete corneal protection. Ask your oculist. The point is that you *can* purchase contact lenses with outstanding UV filtration that protects the entire cornea and its edges. Just don't expect any protection from the randomly bought usual types.

• **Regular glasses** *do* filter UV light pretty well. This is true for both glass and plastic (polycarbonate) lenses. Even so, do ask for the transmissivity data on the lenses you buy. The vendor may blanch and protest, but it can be obtained from the optical house by asking.

• **Sunglasses** nowadays usually do filter UV light, but if they don't, they're worse than none: Your pupils will dilate behind the dark lenses, letting more UV light onto the retinas, and you will fail to squint, which is nature's protection against ocular actinic injury. (It's a nicely alliterative phrase, isn't it? Even jargon can be poetic.)

• **Tinted lenses** such as "blue-blockers" distort color vision; on the other hand, a light pink or yellow tint filters deep blue light, which is also capable of doing some damage. Some tinted lenses are sold as "improving depth perception" but what they really do is improve sharpness by reducing the optical circle of confusion due to chromatic aberration at the retina. (It's optically difficult to focus all colors at once; some tinted lenses reduce the number of colors passing into the eye, improving focus.)



OK, that's about it for recommendations, my friends. Unless you're a bit of a geek like me, and want to know more about how this works, you can stop here and go on to the next scintillating *Soaring* article.

Actinic Ocular Harm = How light hurts your eyes.

We've included an anatomical cross-section of the eye for your navigational assistance. We'll take this from bottom to top, retina to cornea, because there's so much less to be said about the retina and lens, and we don't want to be anticlimactic. Even though the light goes in the other direction, except for really, really interested people. ("Her eyes sparkled when she saw her brother's new baby." "His eyes lit up when he saw his new glider.")

The Retina

The retina is normally protected from actinic injury by the fact that the cornea and lens absorb about 99% of the UV light that hits the eye. On the other hand, 1% of way too much is still way too much – such as arc welding without a shield, being hit by a laser, or looking at the sun. These things can cause permanent burns, destroying the spot on which the light is focused.

As you may have read in this space last year, the macula, where central vision is sharpest, is only about 1% of the retinal surface, and any hit to this is a personal tragedy.

A study in rodents showed that chronic low-level UVA causes retinal damage, and it's felt that chronic lower-level UV retinal exposure probably contributes to macular degeneration, especially over the age of 40. Macular degeneration is now the leading cause of blindness in the Western world, and slowly devours our ability to read and to recognize faces.

Commonly used drugs, such as certain antibiotics, nonsteroidal anti-inflammatory drugs, psychotherapeutic agents, and even herbal medicines, may act as photosensitizers that promote retinal UV damage. Having said this, I haven't found a list of specific drugs.

About 20 years ago, a study showed that smoking almost doubles the risk of macular degeneration, and eating large amounts of vegetables high in the retinal pigments lutein and xeathantin about halved the risk. Subsequent research has confirmed and extended the relationship of diet and retinal health, but it's not yet been shown through research whether taking these as supplements actually treats or prevents macular degeneration.

The National Eye Institute's Age-Related Eye Disease Study (AREDS) found that a formulation of vitamins C and E, beta-carotene, zinc, and copper reduced the risk of macular degeneration by 25% for those at high risk. (Google site:nei.nih.gov AREDS summary for much information.) The AREDS2 study, begun in October 2006, is evaluating whether there's extra benefit from adding lutein and zeaxanthin and the omega-3 fatty acids DHA and EPA (derived from fish oils).

The Lens

There is little evidence that the lens is damaged by UV light, above and beyond other influences such as diabetes or smoking. There is clear laboratory evidence that UV light can be used to promote cataracts in animals, but epidemiological studies in humans have contradicted each other.

These studies have shown that use of Vitamin C supplements cuts cataract risk in half. Cataract risk is about doubled by cooking smoke and cigarette smoke, oral or inhaled corticosteroids, laborers, and nearsightedness (myopia). Use of calcium-channel-blocker blood-pressure medication triples the risk of cataracts. (Diltiazem, amlodipine, and verapamil are the commonest Ca++-channel blockers.)

The Cornea

The cornea protects the eye in many ways, one of which is the absorption of most the UV light falling on the eye. Ultraviolet light is high-energy light, which damages cell nuclei and DNA. The cornea can also be damaged by infrared light. (Sunglasses that block both UV, and IR have a greenish or greenish-grey tint.)

It's important to realize – since the cornea is on the *surface* of the eye – that the light, striking and burning it may come from *any* direction.

This is why normal sunglasses don't protect the cornea well, as light cheerfully comes from all sides. Bright light is most uncomfortable in our visual field, so we tend to be satisfied with any old small dark peepers.

Wrap-around sunglasses were a fad in the early 1960s among skiers, and intermittently since then. Optically perfect wrap-around sunglasses are expensive to produce, so cost is a barrier to quality when you can buy el cheapos for ten bucks at your nearby gas station. However, if you plan to be in a highly actinic environment – sunlit snow, or water, or the beach, or at high altitude – wrap-around sunglasses are the only route to complete cornea protection

Types of UV light

Ultraviolet radiation is divided into three regions, based on effects:

• UVC (200-290 nm), helps create and is absorbed by ozone; UVC is not a concern on the ground. UVC is "germicidal" and is used in ultraviolet sterilizing equipment. This is very damaging to the eye, but most exposures should be extremely brief. We can fly to 60,000 ft. before UVC becomes a concern, and only the Perlan Project is even hoping for that. Obviously, the face shields of space suits are specifically designed to block all damaging radiation, but there are neither thermals nor wave above the ozone layer.

• UVB (290-320 nm), is used to synthesize vitamin D in the skin. However, this only requires about 15 minutes a day of exposure to the face, neck, and arms to sunlight for adequate synthesis. Longer exposure damages the DNA of cells, stimulating "tanning" and causing "sunburn" and potentially leading to various skin cancers. Corneal damage is caused by UVB.

• UVA (320-380 nm) is 98.7% of the UV light that reaches the ground at sea level. It does not directly damage cells, but generates harmful free radicals, so it is indirectly associated with skin cancers. It is absorbed by the lens of the eye, and may damage it. Only 1% of UVA reaches the retina, so damage occurs only from intense light sources or chronic exposure.

What damage is done to the cornea?

A corneal burn – *acute UV keratitis* – is characterized by blurred vision and eye pain between 6 and 12 hours after exposure. (If mild, the eyes feel 'dry'). The superficial layer of corneal cells peels off. This heals in 36-72 hours. Most of the corneal damage, and all the pain and blurring, is due to damage to the outer cells – the epithelial layer – but UV light damages all layers of the cornea.

A wavelength of 270 nm is the most damaging; light of 320 nm is 5000x less damaging. The ozone layer effectively blocks wavelengths shorter than 290 nm, so brief exposure to natural sunlight is not harmful.

This is most likely to occur with altitude, intensity, or time:

• exposure to sunlight at high altitudes, where UV has been less filtered by the atmosphere (pilots soaring wave).

• working or playing on snowy, sunlit terrain.

• working or playing on sunlight, relatively calm water.

The ozone layer is denser in spring, with 23% less transmission of UV light than at the autumnal equinox.

Chronic corneal UV toxicity

With years of persistent exposure to ultraviolet, the cornea may be affected in several ways:

• Small, yellow plaque – *pingueculae* – may form on the white of the eye (the conjunctiva) at the edge of the cornea, usually at the edge nearest the nose. These are not harmful, though they'll annoy the airbrush tech fixing up your photos after your modeling stint. They sometimes make the eye feel continually dry.

• The white of the eye (conjunctiva) sometimes creeps onto the cornea, a *pterygium*. This is unsightly, will blur vision if it's large, may bend the cornea and distort vision, or may feel like a lash under the lid.

• Globules or droplets may form within the cornea, causing permanently blurred vision. In case you care, the globules are called *spheroidal degeneration* and the droplets are called Labrador *keratopathy*; together these conditions comprise *climatic droplet keratopathy*. This is the main cause of blindness in the Dahlak Islands in the Red Sea. It is common in men who work on the water (20% in the Chesapeake Bay).

• Skin cancer of the cornea, *squamous carcinoma*, does rarely occur. I've never seen one, nor known a physician who has seen one.

Thanks to Google, who helped enormously with the research. I know that some readers enjoy discovering the arcane facts I dig out in preparing these columns, and it's for you that I include the geeky details. For me, the main reward of writing this column is the research, for learning is in most ways better than pay. To the reader who has been with me all the way to this paragraph, thank you for your intellectual companionship. If you meet any who didn't make it all the way here, tell them I understand.

Thanks to Dr. Ian Sigal for permission to use his cross-section of the eye – from Sigal et al. Biomech Model Mechanobiol, 8(2):85-98, Apr 2009 (adapted from an illustration from NIH). And thanks to Paul Kram and Ingrid Nelson for critical draft review.