BY **MIKE WOOD**

Our ageing eyes – Part 2

IN THE LAST ISSUE of *Protocol*, I wrote about the natural hardening and yellowing of the lenses in our eyes that sometimes lead to cataracts. That yellowing happens whether we eventually get cataracts or not, and must have an effect on our color vision. I'm particularly interested in how that shift has altered as our industry increasingly moves towards additive color mixing using narrow band LED sources, and away from broad band sources and broad subtractive filters.

"Claude Monet, the French Impressionist painter, did something very similar 100 years ago, albeit with very different technology."

I received some interesting comments to that article, and I thought it was worth revisiting it immediately and discussing those comments. Let me first show you again the magnitude of the change that we all expect to see as we age. This isn't a small inconsequential discoloration of the lens, it's a very significant issue but it happens so slowly, over a period of many years, that we aren't aware that it is happening. **Figure 1** shows the range of that discoloration. As a result of the orderly, geometrical arrangement of its protein fibers, the lens of the human eye is normally transparent, surprisingly so for a natural organic material. Light passes through relatively unimpeded on its way to the retina. (Image from *Radiant Energy and the Eye*, MacMillan Publishers, Sidney Lerman 1980)

The upper left panel of the figure shows a lens taken from a very young eye (its owner was just six-months old). That lens is so transparent that it is virtually invisible against the light gray background. Compare that with that of a 60-year-old in the second row and the shift is obvious. Not all eyes are the same of course and not all lenses from, for example, a 47-year-old eye as shown in the middle of the figure, will have exactly the same degree of transparency as shown here. The loss of transparency depends upon genetics and light exposure, as well as age. The eye contains several antioxidant molecules, including melanin, ascorbic acid, and superoxide dismutase which have some capacity for neutralizing phototoxic reactions. Cells also have some ability to repair themselves. But there are limits to the effectiveness of these defenses, and the ability to repair damage usually diminishes with age. Ironically the yellowing of the lens may be part of our natural defenses, the yellowing reduces the amount of damaging short wavelength light that reaches the retina. That gives us some protection as we get older and our retinal cells are less able to repair themselves. Without that yellowing, our vision may be affected even more.

In the last issue I mused on how noticeable this change was and whether we, as users of colored lighting and lighting designers, might find our work affected. Does a younger lighting designer mix different colors than an older one, for example?

Keny Whitright (the well-known past owner of Wybron, the gel scroller company) saw my article in *Protocol* and sent me some interesting information. Keny had cataract surgery in both eyes in early 2019 and, as is usual in these cases, he had one eye repaired at a

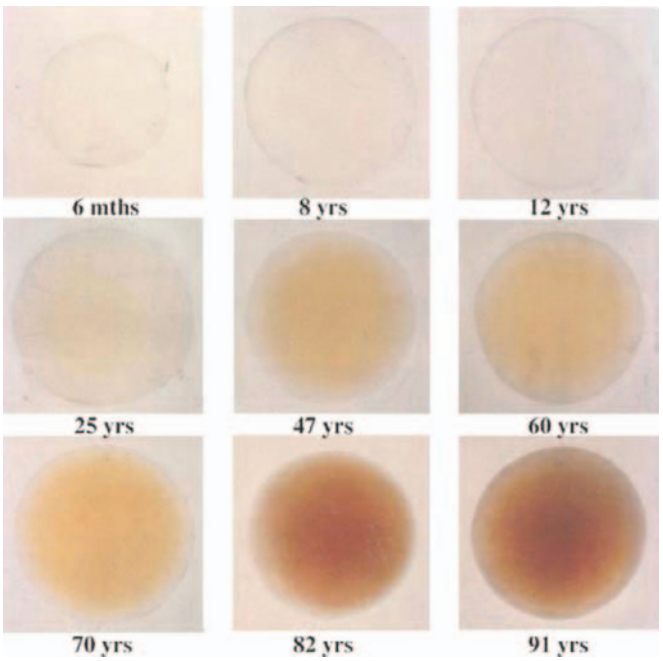

IMAGE COURTESY *RADIANT ENERGY AND THE EYE*, MACMILLAN PUBLISHERS, SIDNEY LERMAN 1980

Figure 1 – Yellowing of lens with age

time with a gap of a few days in between. This meant that, for those few days, Keny was in the privileged position of actually being able to see and judge that change for himself by comparing what his two eyes were seeing. Keny is also the publisher of an app for phones called "Gel Swatch Library" which allowed him to take photographs and superimpose various colored gels over the image. He did this and tried to mimic exactly what he saw with his untreated eye. **Figure 2** is the control image, and **Figure 3** is Keny's result mimicking what he could see with each eye.

The right half of this image shows what Keny could see with his

Figure 2 – Control image

> **"Grey or white hair looks yellow to older eyes, so it needs the extra added blue to look white again."**

treated eye, and the left side shows his approximation, using his app, of what he could see from his untreated eye. As expected, a significant yellowing of the image.

Keny took this a stage further, good scientist that he is, and attempted to find out what color gel he needed to superimpose over the untreated eye to get a result that looked more like reality. A blue gel was needed of course, and the best result possible would be one where the overall light level was reduced, but that the colors matched the good eye. **Figure 4** shows Keny's match where he found a piece of Lee 202, Half CTB, over his untreated eye, on the left, reclaimed the original color balance. I'm actually surprised it was only a half CTB; it could easily be more.

The color being a CTB though, as opposed to another kind of blue, makes perfect sense. If you recall from the last article the yellowing of the lens tends to move the eye's response to a white light directly along the black body line towards the warm end. That is, the yellow lens is behaving very much like a CTO filter. (In Keny's case, again using his Gel Swatch Library App, he matched it close to a Lee 764 "Sun Colour Straw.") Thus, the filter needed to counteract it would naturally be a CTB. It's very pleasing to see that Keny's experiment confirms the hypothesis.

Keny isn't the first to do an experiment like this. Claude Monet, the French Impressionist painter, did something very similar 100 years ago, albeit with very different technology. When he was 82 years old, Claude Monet suffered from such severe cataracts that he agreed to have the lens removed from his right eye. By this point

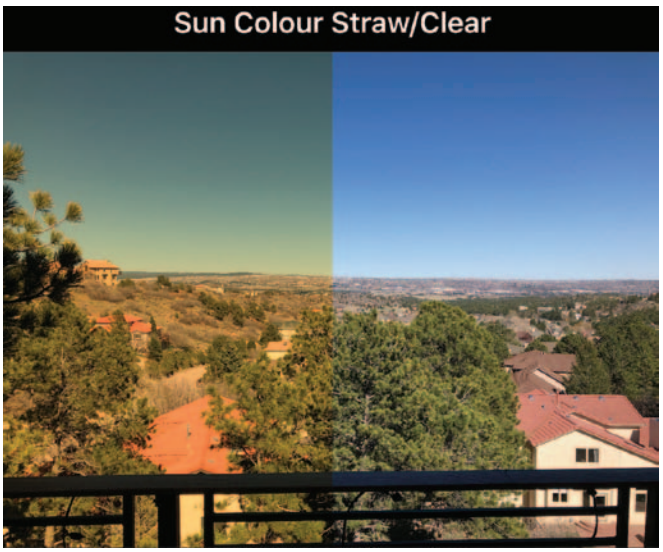

Figure 3 – Untreated vs treated eye

his cataracts were so bad that he was almost blind. He agreed to the operation on his right eye but not his left. After the surgery he used spectacles with a powerful positive lens on that eye to replace the lens he lost to the surgery. This didn't give him perfect sight, but he did regain much of his color vision in that eye. His paintings from after the operation show that items painted using his left eye, the one that still had the cataract, have a dominance towards red and yellow while those using his right eye have a blue cast. By way of

Figure 4 – Lee 202 makes a match

Figure 5 – Monet – The House Seen from the Rose Garden – left eye

Figure 6 – Monet – The House Seen from the Rose Garden – right eye

example, between 1922 and 1924 Monet painted a series of works called "The House Seen from the Rose Garden." He deliberately painted these using one eye or the other, in the same way that Keny Whitright did above with his camera, but in Monet's case with a paintbrush and canvas. Here are two examples from this series, one painted while looking through his left eye, **Figure 5**, and the other of the same scene through the right, **Figure 6**. Interestingly, with no lens at all, his right eye could likely see more into the deep blue and ultraviolet than a normal eye, which may partially account for the deep colors in that painting. Whatever the reasons, these images reflect what Monet could see, and his interpretation of the scene.

Monet, a master of color and colored light, was very aware of the

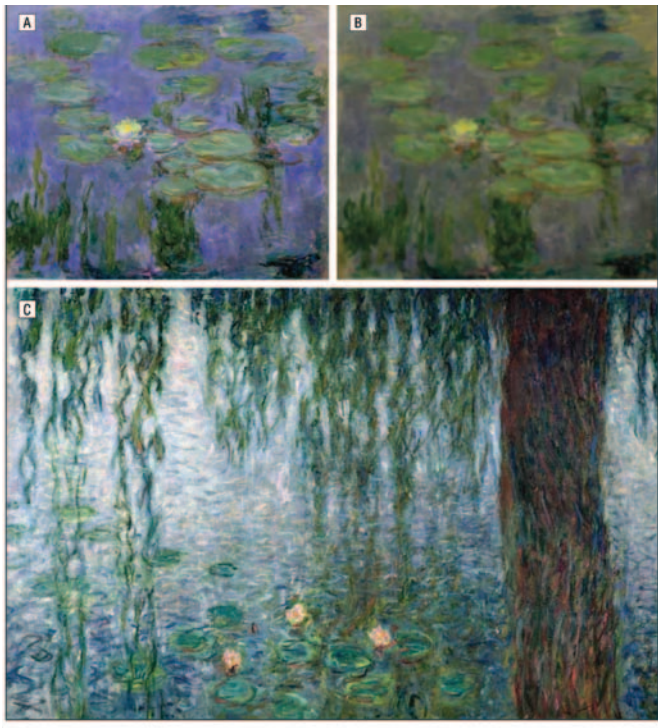

Figure 7 – Monet Waterlilies

yellowing and degradation of his eyesight and memorialized it in these paintings. He went back at this late stage of his life and did more paintings of one of his favored subjects, the lily pond in his garden, and these paintings also show a much-changed blue palette over those done a few years earlier. Michael Marmor published a paper in the AMA's *Journal of Ophthalmology* in December 2006 which discusses this.

Figure 7, from Marmor's paper, shows three examples of Monet's paintings of that pond. The first, **7A**, shows a painting from 1915 when Monet's cataracts were well advanced. **Figure 7B** shows Marmor's estimation of what he was actually seeing at that time, blurry and yellowed. Monet knew his vision was poor and it seems he exaggerated the blues in **7A** to make them look correct as he "knew" they should be. *An artist has two choices in this situation, either paint the world as it appears to them, with a yellowish cast, or to try and compensate for their vision change using their visual memory and add extra blue as compensation. In this case it appears Monet went with the latter.* **Figure 7C** shows a painting from later in his life, done after the cataract was removed from his right eye. The colors in this are much more natural, showing less exaggeration towards the blue. There is no longer a need to compensate and add extra blue. This is precisely what Keny Whitright describes in his photographs.

Finally, I was also asked by a reader what level of blue gel would be needed at what age to correct for the yellowing. In our profession we are fortunate to have such tools readily available! I did some color temperature math using mireds and, very roughly, **Figure 8** is what I came up with, using a 30-year-old eye as our reference. Note, this

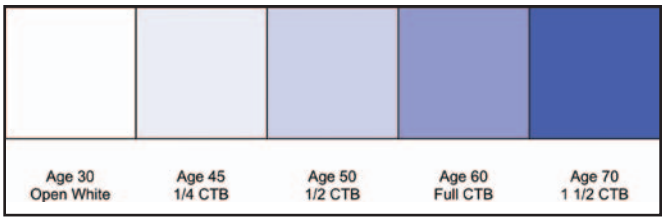

Figure 8 – Color correction with age

is *very* approximate and based on average eyes (whatever they are). Your own eyes could easily differ significantly from these estimates.

I'm 63, so I'm now walking around in a custom pair of Full CTB sunglasses! By the way, this issue is also suggested as a reason for elderly folks getting blue-rinsed hair. Grey or white hair looks yellow to older eyes, so it needs the extra added blue to look white again. ■

Mike Wood runs Mike Wood Consulting LLC, which provides consulting support to companies within the entertainment industry on product design, technology strategy, R&D, standards, and Intellectual Property. A 40-year veteran of the entertainment technology industry, Mike is a past President of ESTA and Co-Chair of the Technical Standards Council. Mike can be reached at mike@mikewoodconsulting.com.