PRIMARY eye care
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The Reality of Blue Light and the Eyes

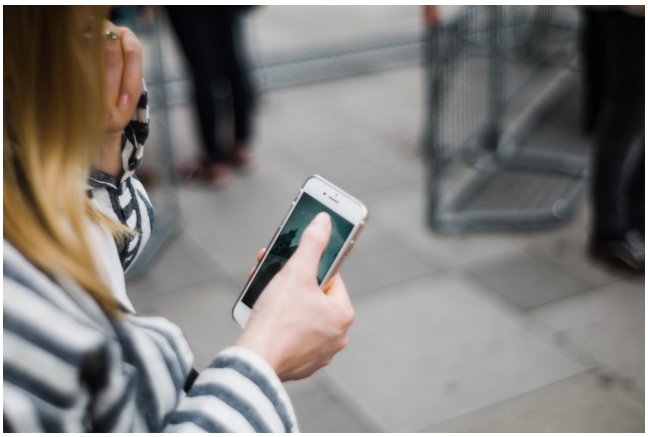
Are blue-light lenses helpful or a marketing farce?

We see wavelengths on the electromagnetic spectrum. This spectrum has differing wavelengths that range from longer wavelengths (radio wave, microwaves and infra-red), through to our visible light spectrum (red to blue) and beyond to much shorter wavelengths (ultra-violet, x-rays, gamma radiation). The wavelengths, both longer and shorter, have the potential to cause harm.

LED lighting produces light that radiates more at the blue end of the spectrum. Incandescent lights like halogen and traditional light bulbs, produce light with more heat, or the longer wavelengths (the red end of the spectrum). LED lighting has become more common as LED technology develops and lights become more powerful and practical for lighting purposes. They are also very energy-efficient and long -lived, so they have economic and practical advantages over the more traditional incandescent lights.

With the usage of LED light sources on device screens, and the increased amount of time spent using these devices, the potential effects of increased exposure to blue light have gained attention. We are all aware of the harm that can come from exposure to ultra-violet (UV) radiation. Where the uncertainty comes in is where the line is drawn from blue light to UV.

UV is recognised to cause ocular damage, particularly with tissues such as eyelids, and the from surface of the eye. The scientific consensus is that these issues are related to UV rather than blue light. UV is broken into two ranges. UVA (320-400nm) and UVB (290-320nm). While the cornea, and the clear fluids in the eye are mostly transparent to wavelengths between 300-400nm, the natural crystalline lens behind the pupil absorbs much of the UVA range and so protects the retina from its potentially toxic effects. UVB can cause damage such as sunburn (on the eye this can be snow-blindness and arc-eye), cataracts and retinal damage.



While most blue light reaches the retina of a young, healthy eye, the natural yellowing of the crystalline lens as it ages creates a blue-blocking filter. But even a clear lens absorbs some wavelengths between 400-420nm*. Also, the pupil, which controls the amount of light passing through to the retina, constricts more to blue light compared to equal amounts of longer wavelengths such as green light.

The photoreceptors within the retina are directly exposed to light. The antioxidative pigments Lutein and Zeaxanthin located in the retina filter out blue light due to their yellow colour. Xanthophylls have a role in protecting against retinal oxidation through the

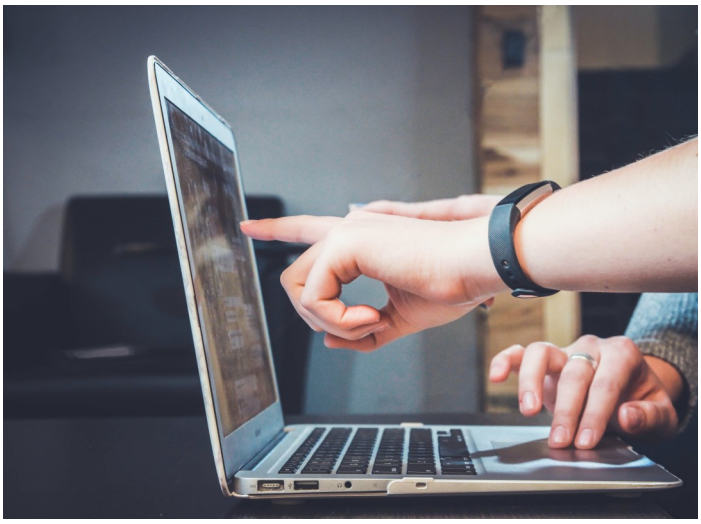
absorption of blue light and the scavenging of free radicals. We obtain these antioxidants though our diets, mostly through eating green leafy vegetables.

Although a number of animal studies show direct evidence of retinal damage following exposure to blue light, almost all of them used radiation far in excess of natural conditions. Given the extremely high levels of radiation necessary to produce retinal damage, natural exposure levels are unlikely to be large enough to cause significant tissue harm.

Electronic devices are now in common usage by almost everybody, to some degree. In the USA 90% of families have at least one computer, smartphone or tablet and the typical family has five or more of these devices. 40-60% of individuals experience ocular or visual symptoms when using electronic displays for prolonged periods. These symptoms include eye fatigue, dryness/burning, redness, headaches and blurred vision. These symptoms are collectively known as **digital eye strain (DES)**. DES are typically transient and usually cease soon after device use ceases. Some individuals, however, may experience sustained symptoms after prolonged use of an electronic screen.

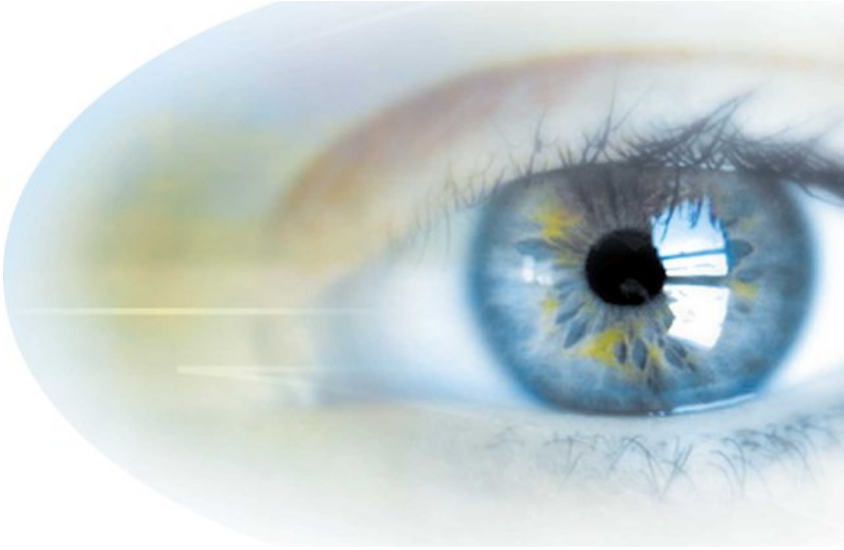
Blue light is a significant contribution to the total light emitted from digital displays. A slightly dated example is that of Apple iPhone displays, where blue light contributed more than one third of the light emitted*. These findings have led to many speculating that blue light emission may be responsible for DES. However, the evidence for this is minimal and many of the studies were poorly designed and could not rule out other causative factors. Studies looking at the effects of blue-blocking filters and the reduction in DES did not allow for confounding factors and the placebo effect. In one double-blind study, the control lenses performed as well as the commercially available blue blocking lenses that were tested*.
Therefore, there is little evidence at this time to support the use of blue blocking filters as a treatment for DES.

Management of other ocular factors (e.g., uncorrected visual error, binocular and focusing abnormalities, anatomical challenges and dry-eye disease), and an appropriate ergonomic environment (e.g., working distance, posture, regular breaks, environmental lighting and screen settings) are more likely to successfully minimise symptoms. For example, most newer phones and tablets have a night setting that reduces the magnitude of blue light emitted from the screen.



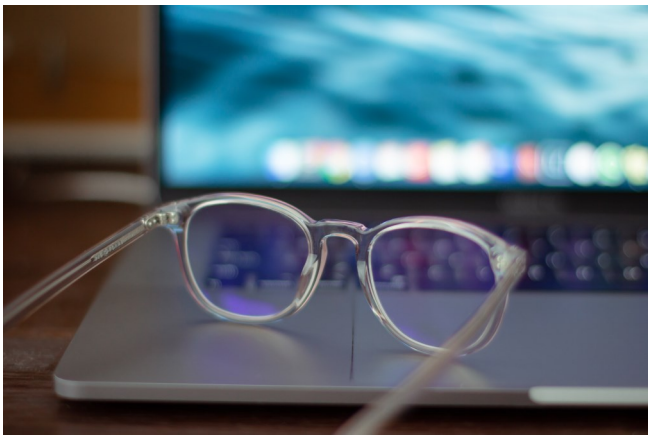
Blue light exposure can affect our natural circadian rhythm. The natural sleep-wake cycle is controlled by the release of a hormone called melatonin from the pineal gland. Melatonin secretion, usually, soon after the onset of darkness, peaks in the middle of the night and falls again during the second half of the night. Exposure to any visible light, but particularly blue light, suppresses the secretion of melatonin. Exposure to blue light sources in the evening will adversely affects one's ability to fall asleep. Not only is there sleep suppression, but there is also reduced morning alertness and shifts in the circadian rhythm. The current expert opinion is to recommend avoiding use of electronic devices two to three hours before bedtime. With the current usage of such digital displays, this length of time may indeed be impractical for most families and individuals.

However, we must remember that blue light exposure is not always bad or harmful. There is evidence that 90 minutes a day of natural outdoor light, can significantly reduce the risk of myopia onset (short-sightedness) in children. There is also evidence that shows that blue-enriched, white fluorescent lighting (17000K) in an office improves alertness, positive



mood, concentration and ability to think clearly when compared with standard white fluorescent lighting (4000K).

There has been some debate that it may be the total exposure to blue light over time that could be harmful to our eyes. The International Commission on Non-Ionising Radiation Protection provided guidelines for levels below which adverse effects were considered unlikely. Interestingly, the range of blue light exposure for digital devices ranged from only 0.43% to 4.09% of this level.



Looking at a clear blue sky on a summer's day or a cloudy mid-winter's day represents about 10.4% and 3.4%, respectively, of this standard. When we compare this to the upper limit of blue light radiation from a smartphone (4.09%), we may conclude that exposure from digital devices does not approach dangerous levels.

The most significant source of short-wavelength radiation comes from the sun. Excessive sun exposure is well-recognised as a risk factor for skin cancers around the eyes, age-related macular degeneration, cataract, corneal sun damage, to name a few ocular conditions. People of all ages need to consider using brimmed headwear and UV-blocking lenses that cover a significant area surrounding the eyes.

There is minimal evidence that blue light-blocking filters are effective in treating digital eyestrain, and current evidence indicates that they are not necessary for the majority of individuals. However, blue light's effect on the body's circadian rhythm can interfere with sleep patterns, and minimising exposure for some time prior to bedtime is strongly recommended, especially for children and teens.

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