Blue Light
Helpful or Harmful

Skeffington Symposium 2021
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Blue Light

Blue light is important to visual processes

- Color perception
- Circadian entrainment
- Pupillary light reflex

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The Hazards of Blue Light

1. Photochemical damage – may be factor AMD

2. Melatonin suppression
   - Interference with the circadian rhythm
   - Breast and prostate cancer

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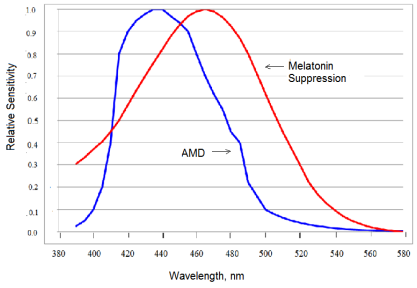
Two Sensitivity Curves



Peak sensitivity for AMD between 435 and 440 nm, for melatonin suppression 465 nm. (Thanks to Michael Morris and Carl Zeiss)

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REMEMBER

Peak sensitivity for **AMD 435-440nm**
(have seen 430nm mentioned)

Peak sensitivity for **melatonin suppression 465nm**
(have seen 460-480 mentioned)

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Light Sources

Incandescent light - little short wavelength light

New light sources richer in blue

- Compact fluorescent lights
- Cell phones
- Tablet computers and E-readers

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The Marketing

Blue light is now called:

High Energy Visible (HEV)

violet/blue band from 400 to 500nm

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Continuing Education

Review of Optometry CE - February 2014

The Lowdown on Blue Light

"…blue light causes damage to the back of the eye (risk of AMD)."

"…there is an increase in the use of …LED lights and …CFL's... most of which emit a high level of blue light.

… by 2020 90% of all our light sources are estimated to be LED lighting."

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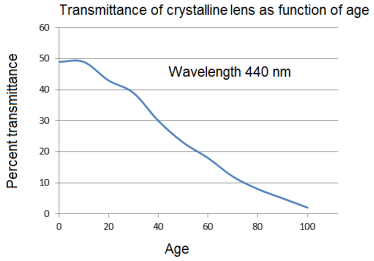
Aging Concerns

Protection by the Crystalline Lens

The transmittance of the crystalline lens declines during life, with the decline maximum in the blue end of the spectrum:



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Age Related Risk

SO as the risk to the retina through lipofuscin accumulation increases, the blue light transmittance via the lens decreases and to a large extent negates the blue light hazard for AMD.

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Aphakia

Blue-blocking IOL's

- increase photoprotection
- eliminate 43-57% of violet and blue light
  - this decreases photoreception including:
    - photopic luminance contrast
    - photopic S-cone foveal threshold
    - mesopic contrast acuity
    - scotopic short-wavelength sensitivity
    - circadian photoreception

Violet-blocking IOL

- better scotopic sensitivity and melanopsin photoreception

Pseudophakia – best with sunglasses

Note: **Most AMD occurs in phakic adults over 60 years of age**

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Another Expert Opinion

Studies suggest that blue light exposure in old age is more important in development of AMD than earlier in life because of the decline in macular pigment density with age. The epidemiological evidence is "equivocal."

Studies suggest that yellow or amber filters would be protective but no epidemiological evidence is available.

Conclusion: it is important to undertake "*…a large scale clinical trial to evaluate the prophylactic effects of blue light filtration in AMD*"

Margrain, TH, Boulton, M, Marshall, J, Sliney, D. ***Do Blue Light Filters Confer Protection against AMD*** ,, Prog in Retinal and Eye Research 2004:23,523-531

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And One Strong Objection

A crucial weakness of the phototoxicity-AMD hypothesis is the absence of convincing epidemiological corroboration despite almost 30 years of careful study: 10 of the 12 major epidemiological studies that examined the hypothesis failed to support it. **Two population-based studies did find an association between AMD and environmental light exposure, but six others found no correlation**, including a study by Taylor who directed the earlier positive Waterman study.

Mainster M, Turner P ***Blue-blocking IOL's Decrease Photoreception Without Providing Significant Photoprotection*** Survey Ophthalmol 2010: 55(3) 272 – 283

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Conclusion on AMD

There is strong evidence that short wavelength visible light *can* produce retinal damage but there is no adequate statistical evidence that real populations suffer from AMD as a result of even very long exposure to environmental light.

If long exposure to outdoor light is not causally related to AMD then indoor light, which is orders of magnitude weaker in blue and UV, cannot be a culprit.

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Blue Light and Circadian Rhythm

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A Fifth Photoreceptor

A retinal cell called intrinsically photoreceptive retinal ganglion cells (ipRGC's) controls the release or suppression of melatonin.

Circadian rhythm – among other things - is thought to be mediated by melatonin which increases at night (in the dark).

ipRGCs are maximally sensitive to blue light

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What Does Blue Light Do?

Blue light acts as a switch, turning off the signals from the ipRGC's

There is no damage to ganglion cells or any retinal structure by the blue light in question.

The effect is to suppress release of melatonin, a hormone that has implications for sleep and, possibly, defense against gondotropic cancers.

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What is the Sequence?

Illumination of the retinal ganglion cells during the day suppresses the release of melatonin

At night – i.e. in the dark – melatonin is released leading to drowsiness and sleep.

A narrow band of blue light has been identified as suppressing the release of melatonin

Certain common artificial light sources, as well as computer/cell phone and other screens emit blue wavelengths that suppress melatonin

If melatonin is suppressed to a *sufficient degree* the beneficial effects do not occur

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Circadian Rhythm and Sleep

Granting that melatonin affects circadian rhythm which, in turn, can affect sleep we ask: is this the principal controller of sleep?

Obviously not, or else we would all be asleep as soon as it gets dark. We postpone that by turning on the lights – and the TV

Sleep deprivation and disorders long predate the alleged blue light suppression of melatonin

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What About E-Readers?

Fourteen young (avg. age 25) volunteers read for 4 hours before bedtime on E-reader or book

- Reduced evening sleepiness
- Takes longer to fall asleep
- Less REM sleep
- Takes longer to feel alert in the morning

Chang A, Aeschbach, Duffy, Czeizler: ***Evening use of light-emitting eReaders negatively affects sleep, circadian timing and next morning alertness***.2015,pnas.org

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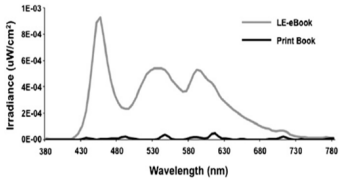
Emission Spectrum of the E-Reader



The measured spectrum of the e-reader has a peak in the blue matching blue LED's

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Summary on Sleep Effect

The two studies involved a very limited population of young adults, all 25 years +/- 1 year, all in "good health."

All were exposed to very long duration of strong blue light or e-reader. No breaks in the exposure were allowed.

Extrapolation of these results to other ages and other groups is a risky undertaking

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Effectiveness of BlueBlockers

Fourteen healthy young (15 – 17) male volunteers viewed LED screens (dominant wavelength 482 nm) for three hours. Some subjects wore clear lenses, others blue blocker lenses.

Melatonin was monitored by salivary tests

Sleepiness was assessed by subjective report every 30 minutes.

Van der Lely et al.*Blue blocker glasses as countermeasure …in male teenagers* Journal of Adolescent Health 2015; 56:113 – 119

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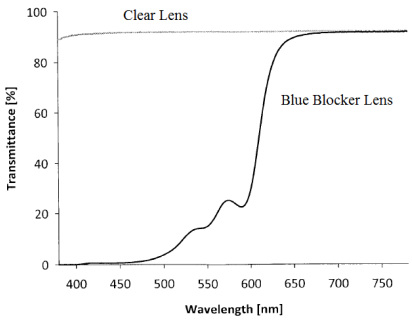

Blue blocker and clear lens transmittance
At 482 nm the attenuation was 98.3%

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Blue Blocker Results

Crossover study: each participant spent time with both glasses on different nights

Melatonin levels were significantly decreased in those wearing clear lenses

Subjective sleepiness was greater during the evening for those using blue blocker glasses

Reaction time on psychomotor tests was shorter for those wearing clear lenses, i.e. they were less sleepy

Morning sleepiness was not different in the two groups in contrast to the study by Chang et al, above

Van der Ley S, et al. Blue Blocker Glasses as a Countermeasure for Alerting Effects of Evening Blue Light ..., J Adolescent Health, 2015 (56) 113-119

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Essilor is Leading the Charge

The claim "Essilor has effectively created a new field in photobiology research" is a little over the top

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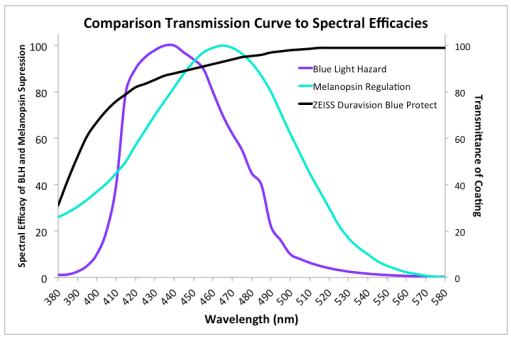
How Much Protection



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What do these Coatings Actually Do?

In the Zeiss graph the transmittance drops to 80% at 410 nm.

This is well away from the peak of both the sensitivity curves.

At the peak of the melatonin sensitivity the transmittance is 90%.

Melatonin reduction is about 3%

Does this represent a worth while effect?

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Conclusions on Blue Light and Melatonin

Experimental evidence shows that blue light can suppress melatonin

Highly controlled experiments with extended blue light exposure show an effect on sleep

The blue light-cancer connection remains speculative

Suppression of blue light by special lens coatings is of questionable value

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Questions

- Is Blue Light Helpful or Harmful
- When is it Helpful and When should it be avoided
- Should we recommend blue blocking lenses
  Eyeglass lenses and/or IOLs
- What About Lighting Recommendations

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Thank You

and Let the Sunshine In!

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