

The Benefits and Dangers OF BLUE LIGHT

By Christian Sotty

The blue light region in the visible light spectrum has captured the interest of scientists due to its role in non-visual biological mechanisms such as regulation of the circadian cycle. This part of blue light can have a positive impact on health, and it ranges from 465 to 495 nanometers (nm) (Blue-Turquoise light).¹ However, in the range of 415 to 455 nm (Blue-Violet light), it has been established that light induces a high level of mortality in the retinal pigment epithelium (RPE) cells.² Blue light (also known as high energy visible light) ranges from 380 nm to 500 nm. It is emitted by both natural (sun) and artificial light sources, such as LED lighting.

Synchronizing our biological clock

Light, and in particular “good” blue light, also known as “chronobiological light,” regulates our individual circadian rhythm. We need to reset our biological clocks daily in order to synchronize our biological rhythm. Our clock transmits to a number of parts of the body, such as the liver, muscles, heart, kidneys and other organs. All biological functions need to work at the right moment, and because our biological clock drives this particular rhythm, it ensures particular functions are active at the right time.

“Light acts on the retina through the action of specific cells—melanopsin-containing ganglion cells—which are different from the cones and rods that are the photoreceptors used in vision,” said Claude Gronfier, INSERM (French Institute of Health and Medical Research) chronobiology researcher. “When these ganglion cells are activated by blue light, they transmit a nerve signal that runs along the optic nerve and, rather than activating the visual structures in the brain, activates non-visual structures such as our internal circadian clock. So it’s exposure to light that resets the time on the biological clock.”

Blue light and AMD

Recently, it has been shown that exposure to light contributes to the early occurrence of

age-related macular degeneration (AMD).³ *In-vitro* experiments on porcine cell cultures point specifically to blue light, which is more energy intensive. Macular pigments are natural filters for these wavelengths. Unfortunately, pigments don’t accumulate well in the retina as we age or when disease starts.

“It’s essential to combine several approaches to help explain the pathophysiological impact of light on the retina and the part played by these effects on retinal conditions,” said Serge Picaud, INSERM director of research at the Paris Vision Institute.

“This multidisciplinary aspect was one of the challenges of a recent project in which we tried to determine toxic wavelengths in the visible spectrum. Our main aim was to calculate the relative quantity of light reaching the retina in each wavelength. We measured the toxicity of these relative irradiances using an AMD porcine cell model.

“The work enabled us to define the most phototoxic spectral bands against this cellular model,” he said. “Optics specialists from Essilor took part in the project to help us design optical devices to calculate retinal light irradiances and to manipulate concepts involving light, while researchers from the Paris Vision Institute brought their knowledge of vision and their know-how in experimental biology as applied to the retina. It was important to be able to draw on the results to establish preventive strategies designed to limit the initial development or further progress of visual pathologies.”

10-nm illumination bands

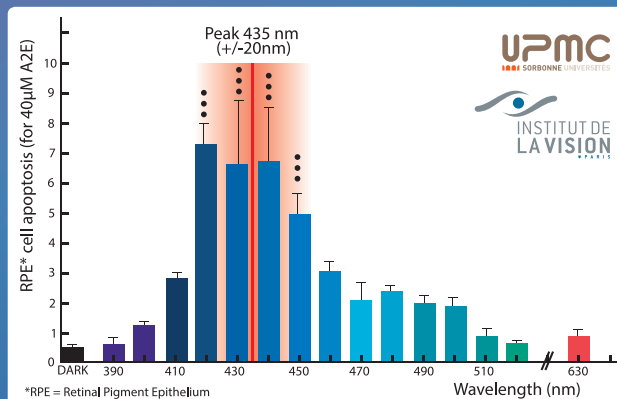
The blue light spectrum is very wide, rang-

ing in broad terms from 380 to 500 nm. It was important to target the blue wavelengths that were most harmful and control the illumination values used to expose the cells to light.

“We produced an illumination device that allowed us to convey light on very restricted, narrow wavelengths—and we split the visible light spectrum into 10-nanometer bands,” said Emilie Arnault, photobiology project manager in the Translational Systemic and Therapeutic Biology of Vision department at the Paris Vision Institute. “Each band was guided by an optic fiber toward a cell incubator. This allowed us to split the visible light spectrum and precisely control the degree of illumination for each wavelength. We were able to produce intensities of illumination in proportion to those of the solar spectrum for each 10 nm band.”

All of these elements confirm the importance of the research currently conducted to accurately describe the wavelengths of blue light: we need to be able to distinguish good from bad clearly so that we can then develop a sophisticated filtering system to address the harmful effects of one while retaining the positive effects of the other.

RPE Cell Death per Wavelength²



References

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