Light – Medicine of the Future and the Future is here

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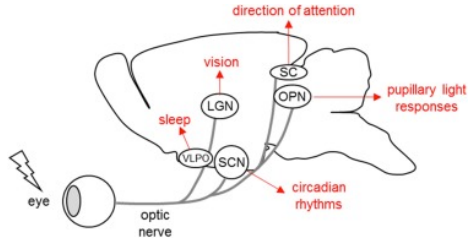
Healing With Light

3 Biological Pathways of Light

1. Vision
2. NonVisual Optic Pathway
3. Photobiomodulation



Summary of mouse visual and non-visual responses to light
1. Retina to LGN to visual cortex to mediate visual responses
2. Projections via the retinohypothalamic tract to the suprachiasmatic nuclei (SCN) mediate entrainment of circadian rhythms to light.
3. Projections from melanopsin pRGCs to the olivary pretectal nucleus (OPN) mediate PLR
4. Projections to the ventrolateral preoptic nuclei (VLPO) modulate sleep.
5. The superior colliculus (SC) receives input from both visual and non-visual pathways to direct attention to visual stimuli. Figure based upon (Hattar et al., 2006)

The influence of light on circadian rhythm and hence its effects on health

The blue light plays a major role in influencing circadian rhythm through stimulation of the ipRGCs.

Newer sources of artificial lighting such as LEDs have substantial amounts of blue in their emission spectra and therefore pose an increased risk of interfering with circadian rhythm

- There exist at least 5 subtypes of ipRGCs each having a different action spectrum and a different network of dendrites (Ecker et al. 2010)
- The reaction speed of these ipRGCs varies
  Complex temporal dynamics take place within the retinal neuronal matrix (Gooley et al. 2012), leading to nonvisual effects that are dependent on the duration of light exposure
- It may be that ipRGCs project their connections beyond the hypothalamus and toward all the major areas of the visual cortex thereby influencing aspects of visual perception (Lucas 2013)

- The light action spectrum that controls the circadian rhythm was first measured by Brainard et al. in 2001 but newer models (Rea et al. 2012) take into account nonlinear antagonistic interactions between the various photoreceptors and this leads to variations of around 500 nanometers (torquoise)

Photobiomodulation

Photobiomodulation therapy is defined as a form of light therapy that utilizes non-ionizing light sources, including lasers, light emitting diodes, and/or broadband light, in the visible (400 – 700 nm) and near-infrared (700 – 1100 nm) electromagnetic spectrum

Used to be called Low Level Laser Therapy (LLLT)

Phototherapy Considerations

- Light Sources for Photobiomodulation
- Light placement
- Light Color
- Light Dosage and Exposure Parameters

Laser Light

- Endre Mester, a Hungarian physician, wanted to use lasers to destroy tumors.
- Early lasers were not powerful enough to destroy tumors but he noticed that laser incisions healed more quickly than expected – his ruby laser had a biostimulatory effect
- Tiina Karu, a biophysicist, looked at the effects of light on cellular metabolism with 300-900nm light sources and established detailed action spectra with clear effects at specific frequencies
- Ultimately this led to the finding that biostimulation ocurred in the mitochondria – specifically the enzyme cyrochrome C oxidase

  Cytochrome C oxidase can exist in multiple states in which it absorbs photons of the various peak frequencies of the action spectrum

What light can reach our cells

- Light biostimulates living cells — if it can reach them.
- Light can penetrate our skin and irradiate deeper parts of our body depending on its color

Longer wavelengths penetrate more deeply

- Blue light 0.5mm or just beyond the epidermis
- Red light can reach down several millimeters
- Near Infrared (650-940nm) penetrates the most
- Penetration gets less as you reach Far Infrared

What light sources work

- Laser light is coherent and monochromatic
- For biostimulation, the monochromatic nature of the light is necessary so LEDs are now widely used for light therapy

We are still on the threshold of fully understanding the complex relationship between light and life, but we can now say, emphatically, that the function of our entire metabolism is dependent on light.

Fritz Albert Popp

Light Color

Medical LEDs

Different colors are used for different purposes

- infrared and red for photobiomodulation
- amber for aesthetics
- green and blue for acne and chronobiology
- ultraviolet in dentistry and for sterilization

White 5500K Fluorescent lamps – SAD, depression

Applications of Light Medicine for Optometry

- Migraine Headache
- Retinal Conditions
- Inflammation
- Non-24 disorder
- ADHD
- TBI
- Athletic Performance and Recovery
- Anti-Aging Medicine

Migraine Headache

A study done by researchers at Beth Israel Deaconess Medical Center (BIDMC) in Boston and published in 2016 found that exposing migraine sufferers to a narrow band of green light can reduce light sensitivity/ photophobia and headache severity

"Although photophobia is not usually as incapacitating as headache pain itself, the inability to endure light can be disabling," said Rai Burstein, the HMS John-Hedley-Whyte professor of anesthesia at BIDMC and lead author

Migraine photophobia originating in cone-driven retinal pathways - *Brain*, Volume 139, Issue 7, July 2016, Pages 1971–1986

Migraine photophobia originating in cone-driven retinal pathways

Eight years ago, Burstein and colleagues made the surprising discovery that blue light hurts migraine patients who are blind. They then considered that abnormal sensitivity to light during migraine could be alleviated by blocking blue

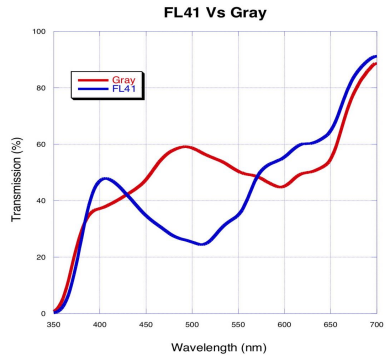
They found that green light exacerbates migraine headache significantly less than white, blue, amber or red

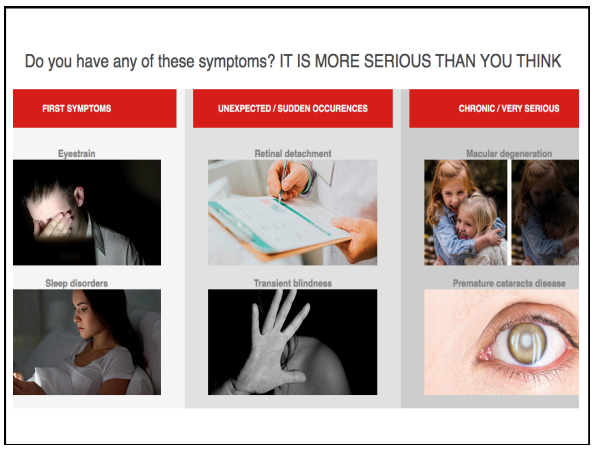
They used ERG and VEP recording to show that green activates cone-driven retinal pathways to a lesser extent than white, blue and red.

Soothing effects of green light

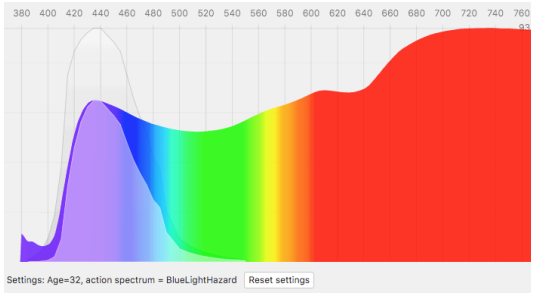
- Thalamic neurons were most responsive to blue and least responsive to green
- Cortical responses to green are significantly smaller than those generated by blue, amber and red lights
- These findings suggest that patients' experience with color and migraine photophobia could originate in cone-driven retinal pathways, fine-tuned in relay thalamic neurons outside the main visual pathway, and preserved by the cortex. Additionally, the findings provide substrate for the soothing effects of green light

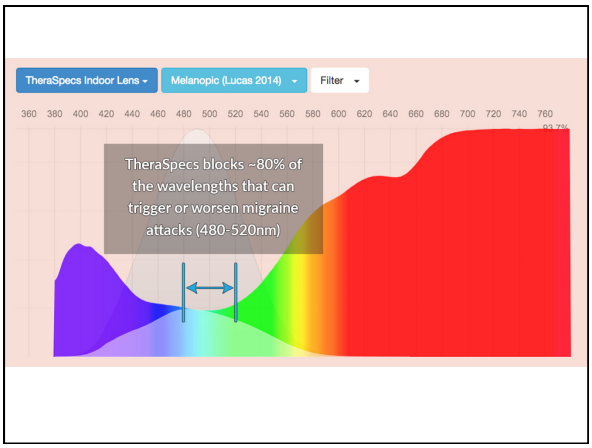
Spectral Characteristics of FL-41



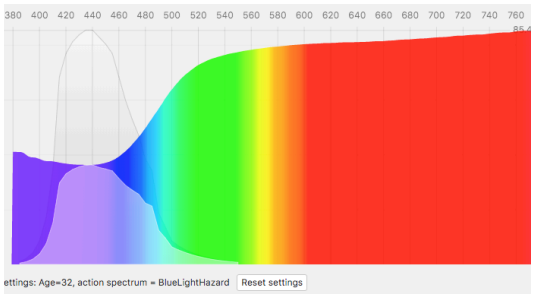


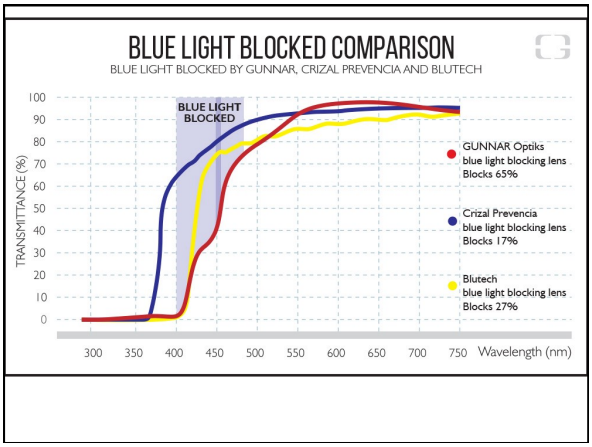
Axon FL-41





Reticare





AMD and photobiomodulation

- Assessments on 42 eyes with dry AMD (age related eye disease study (AREDS) 2–4) were conducted
- Multiwavelength light emitting diode (LED) light comprising of yellow (590 nm), red (670 nm) and near-infrared (790 nm) bandwidths was applied to subjects' eyes for a treatment course of 3 weeks
- Outcome measures were changes in best-corrected visual acuity (BCVA), contrast sensitivity (CS), drusen volume and central drusen thickness.

AMD and photobiomodulation

- Significant improvement in mean BCVA of 5.90 letters ($p < 0.001$) was seen on completion of the 3-week treatment and 5.14 letters ($p < 0.001$) after 3 months
- Contrast sensitivity improved significantly (log unit improvement of 0.11 ($p = 0.02$) at 3 weeks and 3 months (log unit improvement of 0.16 ($p = 0.02$) at three cycles per degree
- Drusen volume decreased by 0.024 mm3 ($p < 0.001$) and central drusen thickness was significantly reduced by a mean of 3.78 μm ($p < 0.001$), while overall central retinal thickness and retinal volume remained stable

Non-24

- *Non-24-Hour Sleep-Wake Disorder (Non-24)* is a neurological sleep disorder in which a person's sleep/wake cycle is longer than 24 hours
- The person is unable to adjust her sleep/wake cycle to the length of the day, and her sleep time progresses around the clock. For example, if she goes to sleep at midnight and sleeps until 8 am one day, she may not be able to fall asleep until 1 or 2 am the next night, and will need to sleep correspondingly later the following morning. The delay continues to get worse every day until he is going to sleep at 4am, 6am, 8am, etc. Eventually she comes around the clock again to her starting point and the process continues on
- Most people with Non-24 are blind

Non 24

Used to be called

Circadian Rhythm Sleep Disorder - Free Running Type

For some people the length of their cycle varies from day to day, and they cannot predict their sleep/wake schedule in advance

Why is Non-24 often misdiagnosed

- Many people try to cope with Non-24 by forcing themselves to keep a normal schedule. This results in a chronic sleep deficit
- Chronic sleep deficit symptoms can mimic depression, attention deficit hyperactivity disorder, chronic fatigue syndrome, fibromyalgia, or just plain fatigue
- A patient who complains about not being able to fall asleep may be misdiagnosed with primary insomnia, and prescribed sleep medication
- A patient who complains about being tired all the time may be misdiagnosed as suffering from depression, and prescribed antidepressant medication

TBI

- Light therapy is an exciting new area of research as a possible treatment for persistent post-concussion symptoms − also called chronic mTBI
- Research in 2019 is also showing that light therapy is a potential treatment for patients diagnosed with possible CTE (chronic traumatic encephalopathy) based on their medical history

TBI and CTE

- In 2019 Dr. Margaret Naeser presented two case studies of light therapy having significant positive effects in two retired, professional football players with possible CTE, based on their medical history
- Clinical tests confirmed the positive effects of the in-clinic light therapy treatments
- In the case of the one football player who agreed to fMRI scans, the scans confirmed the positive results

TBI and CTE

- After the six weeks of in-clinic treatment, the study called for testing at one week, one month, and two months following the end of light therapy treatment
- For the man in case study #1, he found that his symptoms had returned at full force after two months without light therapy treatment, and tests confirmed this
- He then started using the Vielight Neuro Gamma at home, and after 12 weeks, his symptoms abated

TBI and CTE

- The man in case study #2 was unwilling to go without light therapy treatment long enough to be tested at the 2-month point after in-clinic treatment
- He feared that his symptoms would return and didn't want to risk losing the gains that he had made
- He dropped out of the study, and purchased the Vielight Neuro Gamma device for in-home use
- He continues to do in-home light therapy treatments and reports he is doing well

Vielight Neuro Gamma

Vielight Neuro Gamma

- Near infrared (NIR) wearable device suitable for home use
- It is both transcranial and intranasal stimulation
  ideal for comprehensive brain photobiomodulation by simultaneously stimulating the ventral and cortical brain areas
- Vielight Neuro Gamma features microchip-boosted transcranial LED diodes, which generate sufficient power to penetrate the skull

VieLight 810 Infrared (Brain)

- Intranasal channel to reach the deep ventral brain areas
- The nasal cavity is a pathway to the ventral prefrontal cortex. (the distance between the nasal bridge and the ventral prefrontal cortex is relatively short and permeable)
- Note for Users: Near-infrared photons are nearly invisible to the naked eye, making the beam appear much dimmer than it actually is. Additionally, the beam is pulsed at 10 Hz
- Sleepiness is a common side effect of using this device due to the pulse rate correlating with alpha brain waves and neuronal stimulation

Parkinson's disease (PD)

- Sleep disorders are common in Parkinson's disease (PD) and seem to be strongly associated with depression. It has been suggested that sleep disorders and depression are caused by a disturbed circadian rhythm
- Light therapy significantly reduced excessive daytime sleepiness, improved sleep quality, decreased overnight awakenings, shortened sleep latency, enhanced daytime alertness and activity level, and improved motor symptoms in patients with Parkinson's disease

Alzheimer's disease (AD)

Light Therapy Found To Reduce Toxic Brain Proteins

- Gamma oscillation brain waves are important for basic functions like memory retention and attention
- Researchers were able to stimulate gamma oscillations in the brains of mice by exposing them to light flickering at around 40 cycles per second
- Helped eliminate the buildup of amyloid and tau proteins
- When combined with sound tones that are beating in the same frequency of the light, the stimulations went beyond the visual cortex, even extending as far as the hippocampus

Anti-Ageing

- Red LED light therapy is used to reduce fine lines, wrinkles and pigmentation
- LED emits UV-free light rays that can help with our body's own repair process to produce new collagen and elastin (red LED)
- LED is safe for all skin types
- It is non-invasive, painless and requires no recovery time
- From one site: A noticeable improvement in tone and texture is seen immediately after just one session. The recommended treatment for anti-aging is twice a week for four weeks

Chronic Pain

LumiWave

The LumiWave Infrared Light Therapy Device uses the proven science of *photo-biostimulation* to gently warm inflamed muscles, joints and deep tissue areas of the body, including back, shoulders, ankles, wrists, knees and others, through near-infrared (NIR) light waves emitted through specially engineered Light Emitting Diodes (LEDs).

LumiWave also *stimulates cell regeneration and promotes biochemical restorative processes* so that users get better, faster.

LumiWave Single Unit

LumiWave uses the capabilities of light therapy to stimulate the body's own biochemical processes by:

- Inhibiting pain signals by producing endorphins
- Releasing nitric oxide, a naturally occurring chemical in the body that reduces pain
- Reducing inflammation
- Increasing circulation and blood flow to bring fresh oxygen and nutrients to affected areas

LUMIWAVE BY THE NUMBERS

- 1st product to receive FDA clearance in it's product category
- 100% drug-free product that stimulates your body's repair function
- 97% experienced pain relief
- 92% would recommend LumiWave to a friend
- 89% of doctors recommend LumiWave for treating chronic pain

LumiWave PRODUCT SPECS

Therapeutic light emitting diodes (LEDs):

- Type: infrared gallium aluminum arsenide
- Number per pod: 49 infrared and 4 red
- Number per model:
  Single: 196 (4 pods) + 4 red
  Double: 392 (8 pods) + 8 red

Delivered energy:
20 J/cm2 (16.67 mW/cm2) per treatment

Delivered wavelength:
At room temperature: 880
At operating temp: 900 nm

Operating temperature:
106°-108° F (41°- 42° C)

LumiWave Single LED set (4 pods): 7 in x 2 in

Weight: 2lbs
(controller with 4-pod set)


LumiWave