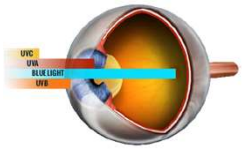
The Science of Blue Light
Unlocking the impacts on our health

1

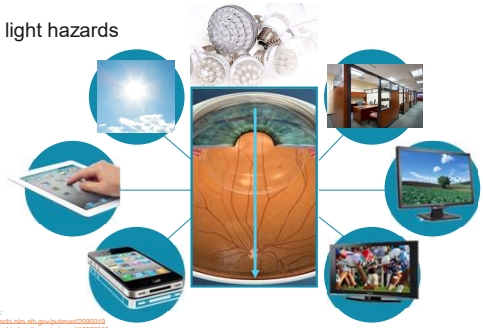
Objectives

- Provide you with an understanding of light
- Explore the impact of blue light
- Today's blue light solutions



2

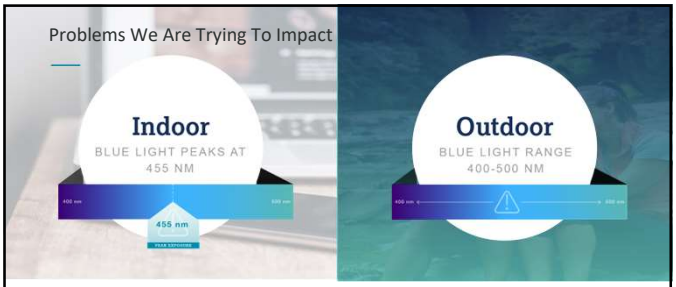
Blue light hazards



References:
https://www.ncbi.nlm.nih.gov/pubmed/20950191
https://www.ncbi.nlm.nih.gov/pubmed/12970330
https://www.ncbi.nlm.nih.gov/pubmed/29065349

3

Problems We Are Trying To Impact



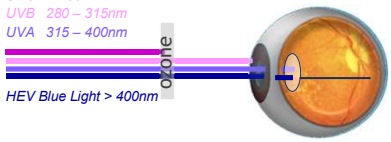
1. Improve Sleep & Sleep Quality
2. Alleviate headache & Migraine symptoms
3. Reduce Eye Fatigue & Strain

1. Reduce Glare
2. Enhance Color
3. Protect from harmful light rays

4

High Energy Visible (HEV) Blue Light and UV Light

- Ultraviolet Light
  - » *UVC < 280nm*
  - » *UVB 280 – 315nm*
  - » *UVA 315 – 400nm*
  - » *HEV Blue Light > 400nm*



- HEV blue light is linked to macula cellular damage and MD (Macular Degeneration).
- SHORT WAVE blue light is myopic, falls short of the retina and scatters in the eye:
  - Contributing factor responsible for Sleep/Wake Cycle.
  - Can trigger debilitating migraines
  - Creates scatter, haze & interferes with visual clarity.

Courtesy of the Vision Council.

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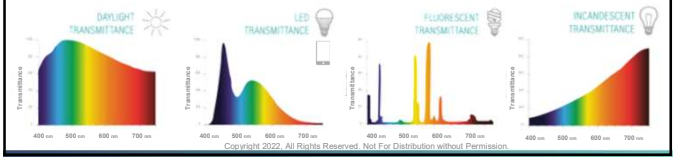
Light Source Comparison

- **Blue light** is a part of the visible light spectrum, between **400 nm & 500 nm**
- The **SUN** is the strongest source of blue light, up to **100x more** energy than artificial lighting, that decreases visual clarity and can **potentially** harm your retina.
- **LED & CFL** lighting, digital devices and artificial lights bathe us in rich blue light that can lead to visual blur, eyestrain, sleep disruption and headaches.
- **Incandescent** lighting transmits low blue, low green with high amounts of amber and red, which is similar to the sun during sunset hours.



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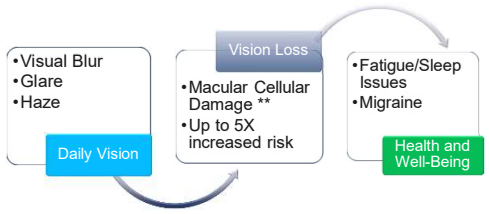
Blue Light Affects us in Three Ways



**References:
https://www.ncbi.nlm.nih.gov/pubmed/20955019
https://www.ncbi.nlm.nih.gov/pubmed/12970330
https://www.ncbi.nlm.nih.gov/pubmed/26065349

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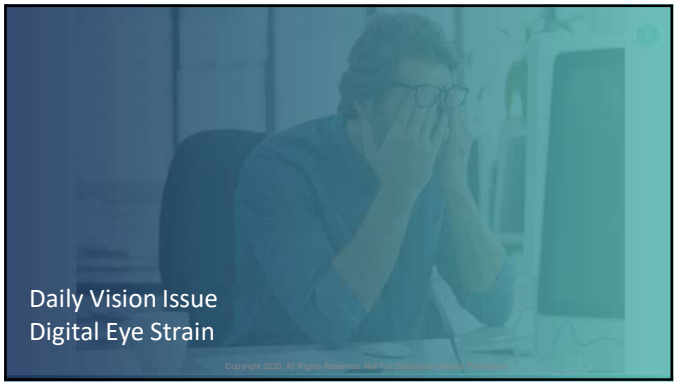

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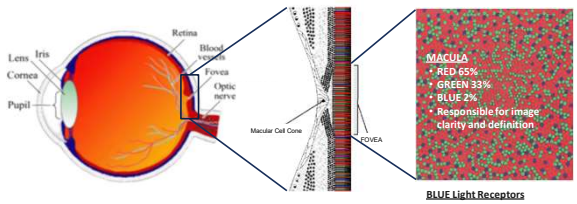
Daily Vision - Fovea is Devoid of Blue Photoreceptors



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How The Eye Processes Light

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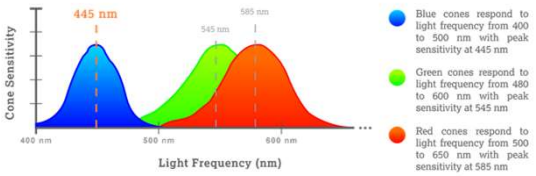
- The retina consists of three color sensing receptors called 'cones' that are stimulated by either blue, green or red frequencies with peak response sensitivities for each.



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Scatter, Haze & Eyestrain

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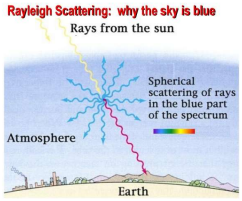
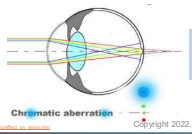
- Scatter and haze is a well known phenomenon, also known as the **Rayleigh scattering** … Light scatters when passing through a medium
- The blue color of the sky is from blue light scattering as it passes through our atmosphere.





Blue light also scatters when entering the eye, which leads to **eye strain** and **visual blur**.

11

What is Digital Eyestrain?

12

- The American Optometric Association says – "**Digital Eye Strain,** describes a group of eye and vision-related problems that result from prolonged computer, tablet, e-reader and cell phone use…"
- ***ALL* Digital** devices get their brightness and efficiency from LED technology. The same tech used in today's LED bulbs and lighting.
- When you think and say "**DIGITAL**", then you must think **LED**.

DIGITAL = LED

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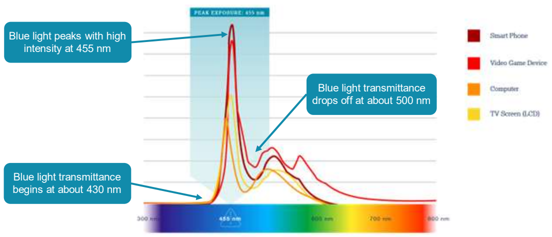
Transmittance Curve from Digital Devices



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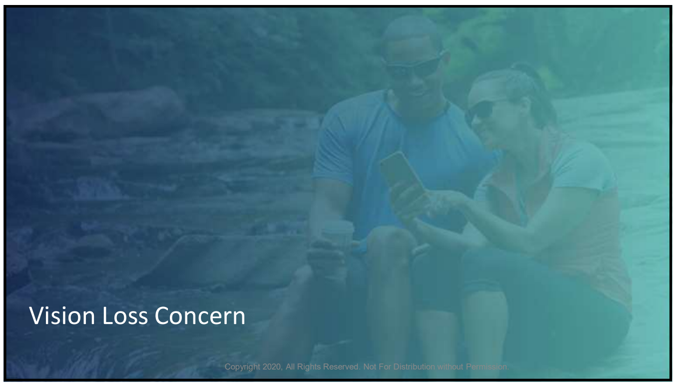

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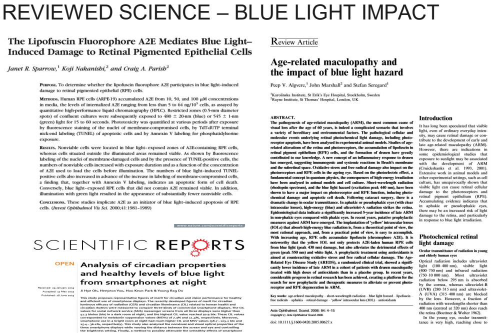
PEER REVIEWED SCIENCE – BLUE LIGHT IMPACT



The Lipofuscin Fluorophore A2E Mediates Blue Light–Induced Damage to Retinal Pigmented Epithelial Cells

Janet R. Sparrow, Koji Nakanishi, and Craig A. Parish

Review Article

Age-related maculopathy and the impact of blue light hazard

SCIENTIFIC REPORTS

OPEN

Analysis of circadian properties and healthy levels of blue light from smartphones at night

15

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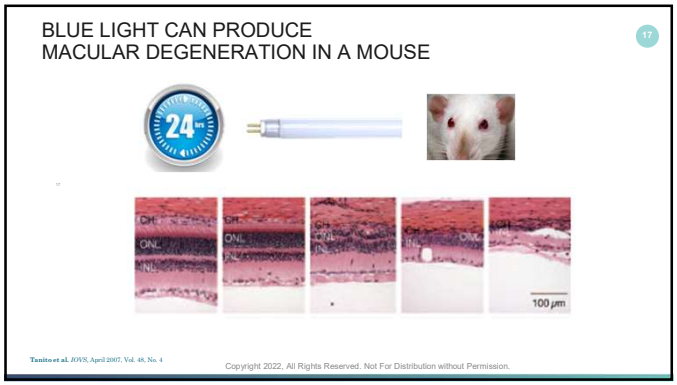
BLUE LIGHT CAN PRODUCE
MACULAR DEGENERATION IN A MOUSE
17
24h
ONL
100 µm
Tanito et al. IOVS, April 2007, Vol. 48, No. 4
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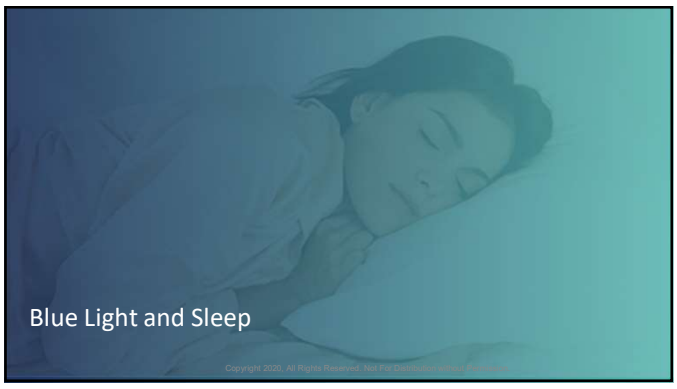
17


Blue Light and Sleep
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LED Lights Impact Our Circadian Rhythm

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- Blue light controls our circadian rhythm - our sleep/wake cycle.
- The light sensing cells in the retina (Melanopsin ganglion cell) that control our sleep cycle and melatonin production are activated by blue light between 450 to 500nm.
- Melatonin production begins a few hours before bedtime in the absence of ***intense*** blue light
- In fact, blue light is a more powerful suppressor of melatonin than just about any drug. **Harvard Health Letter 2012**

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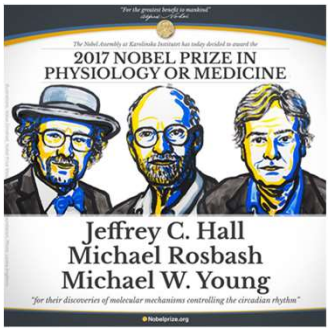
Circadian Rhythm (Biological Clock)

The 2017 Nobel Prize in Medicine was awarded for the study of the **circadian rhythm**



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Light Source Comparison

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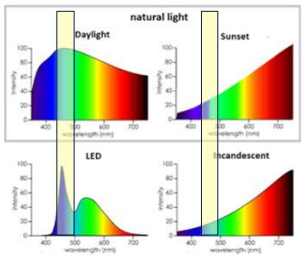

Spectral Power Distributions (SPDs) of different natural and artificial light sources
note that intensities are not the same for each source (sunset is much less intense than daylight)
graphics adapted from: http://www.lightingschool.eu/portfolio/understanding-the-light/

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The Energy Deficit

22

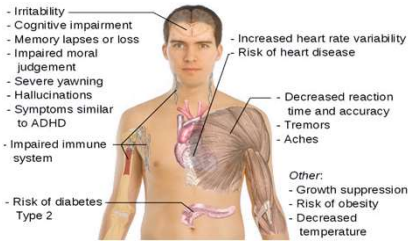
- 1 in 3 adults don't get enough sleep (CDC) (Stats Canada)
- Fatigue from sleep loss can result in:
  - cognitive decline
  - lower productivity
  - Increased safety concerns

Poor Sleep = Low Productivity

22

General Wellbeing - Effects of Poor Sleep

23

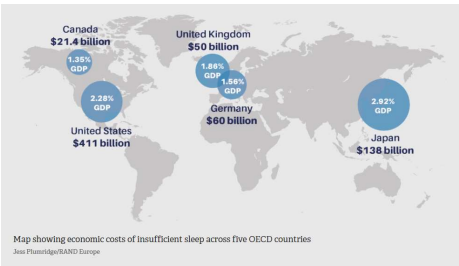


The National Academy of Sciences - Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem: 2006

23

Effects of Insufficient Sleep is a Global Concern

24



Map showing economic costs of insufficient sleep across five OECD countries
Jess Plumridge/RAND Europe

https://www.rand.org/randeurope/research/projects/the-value-of-the-sleep-economy.html

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Sleep Loss in the Workplace

25

HARVARD UNIVERSITY

"Americans are not missing work because of insomnia. They are still going to their jobs but accomplishing less because they're tired. In an information-based economy, it's difficult to find a condition that has a greater effect on productivity."

~Ronald Kessler, professor of health care policy at Harvard Medical School

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Impact of Fatigue in the Workplace

26

Fatigue is a safety hazard in the workplace, and it affects productivity as well.

Fatigue affects employees' ability to think clearly, slows reaction time, and decreases attention, vigilance, short-term memory, judgment and other functions.

Tired employees are less productive (presenteeism) and more likely to miss work (absenteeism).

When employees are not thinking clearly, they are more likely to make mistakes that can be costly or even deadly.

Source: Fatigue in the Workplace. National Safety Council 2018

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Presenteeism

Presenteeism 10X Absenteeism

~57.5 unproductive work days – (~3 working months)

~4 sick days per year

Source: GCC Insights

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Clinically Proven To Double Melatonin

29

Medscape

Coverage from the American Academy of Optometry (AAO) 2017

Blue Light-Blocking Glasses May Help, Study Suggests

Caroline Helwick
October 14, 2017

Key Findings

Wearing Blue Light Blocking lenses for just 5 days, participants demonstrated:

1. Increase in Melatonin levels by 96%
2. Less awakening during sleep, reduced sleep onset latency (fell asleep faster)
3. Improved cognition using pattern comparison test – 47%

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BLUTECH

U PENN Laboratory Study

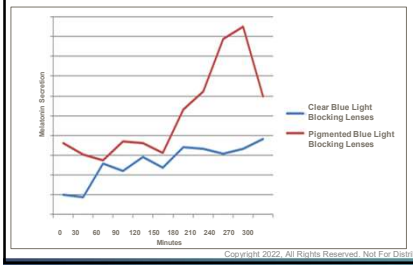
30

Perelman School of Medicine

Effects of Blue Filtering Lenses on Sleep and Melatonin Production in Good Sleepers

Holly Barilla[1], Philip R. Gehrman[1], Indira Gurubhagavatula[1]

[1]Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA, USA



Key Findings

While wearing Blue Light Pigment lenses vs control lenses (Clear Blue Light Blocking lenses), healthy participants with no sleep disorders, demonstrated:

1. Significant increase in melatonin secretion after 3 hours of wear
2. 45 minutes more sleep as indicated in the subjects sleep diary
3. 25 minutes increase in sleep duration as measured using actigraphy device

30


Blue Light and Migraine
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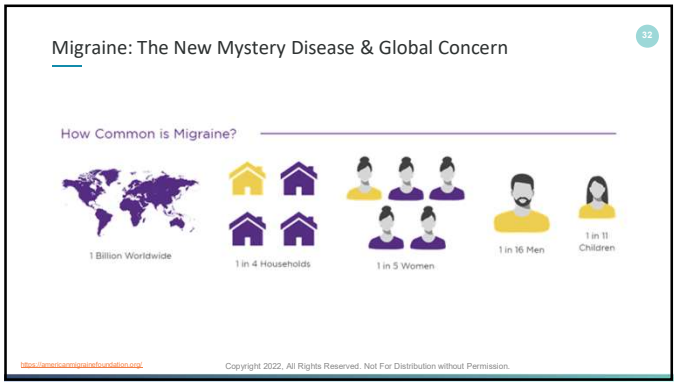
Migraine: The New Mystery Disease & Global Concern
32
How Common is Migraine?
1 Billion Worldwide
1 in 4 Households
1 in 5 Women
1 in 16 Men
1 in 11 Children
https://americanmigrainefoundation.org/
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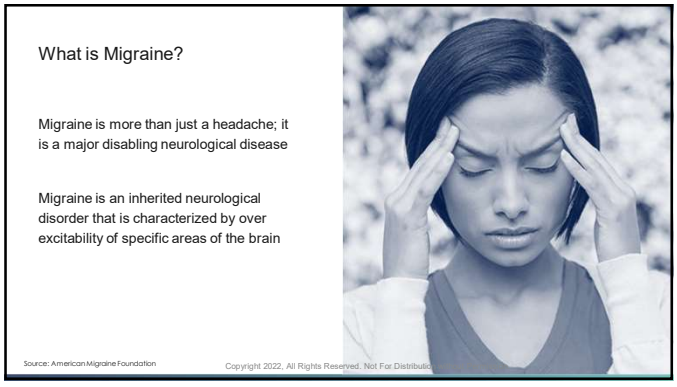
What is Migraine?
Migraine is more than just a headache; it is a major disabling neurological disease
Migraine is an inherited neurological disorder that is characterized by over excitability of specific areas of the brain
Source: American Migraine Foundation
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Migraine Symptoms – 4,000 person study

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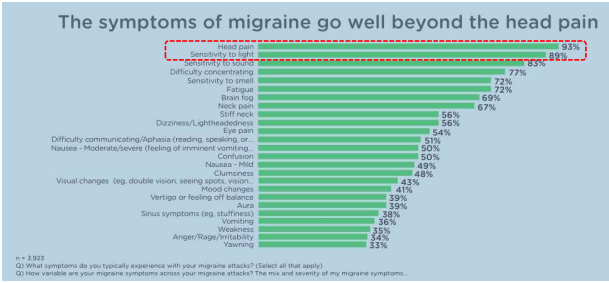

aimovig: Migraine in America 2016

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Common Migraine Triggers

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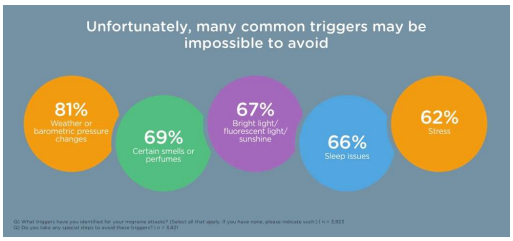

aimovig: Migraine in America 2016

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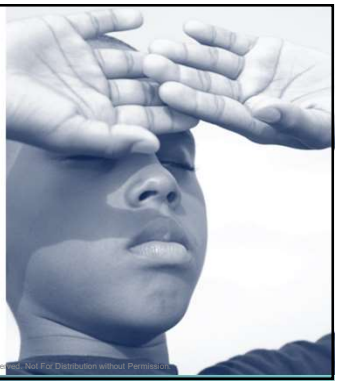
What is Photophobia?

An *extreme and painful sensitivity to light*. It can be caused by an injury, headaches and migraines, medications, diseases, and more.



Source: Photophobic Society of America

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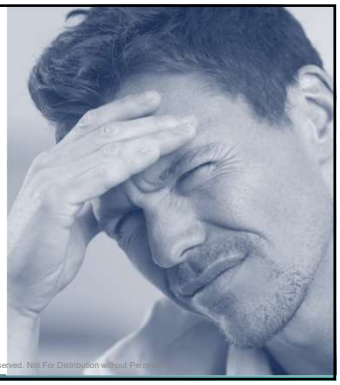
Conditions that may cause Photophobia?

- Cataracts.
- Concussions.
- Corneal abrasion.
- Dry eye.
- Headaches.
- Keratitis which is also caused corneal inflammation.
- Migraine.
- … and more



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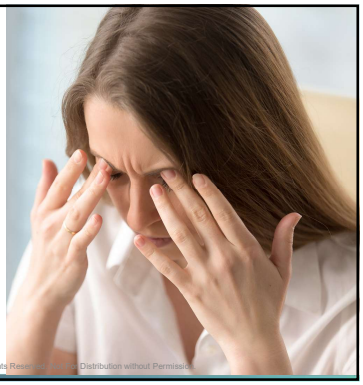
Medications that may cause Photophobia?

- Antihistamines.
- Furosemide.
- Non-steroidal, anti-Inflammatory drugs (NSAIDs)
- Oral and estrogen-based contraceptives.
- Quinine.
- Sulfonamides.
- Tetracycline.
- Tricyclic anti-depressants



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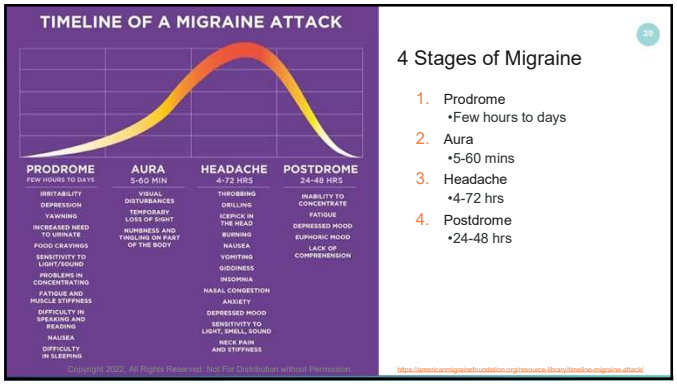

4 Stages of Migraine

1. Prodrome
   - Few hours to days
2. Aura
   - 5-60 mins
3. Headache
   - 4-72 hrs
4. Postdrome
   - 24-48 hrs

https://americanmigrainefoundation.org/resource-library/timeline-migraine-attack/

39

Migraine Aura

40

Visual symptoms of aura are temporary, but they can be disabling. Some examples include:

- Zigzag floating lines or spots
- Vision loss or changes
- Flashes of light
- Blind spots called scotomas

https://migraineagain.com/how-to-know-if-you-have-migraine-with-aura/

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Life Impact of Migraine

41

n=3,444
Q1 (OPTIONAL) If you could describe migraines in ONE WORD, what would that one word be? (Open-ended response data was cleaned for spelling errors and capitalization)

aimovig: Migraine in America 2016

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The Real Impact of Migraine is HUGE!

42

Based on the following:

- 5 migraine attack/episode days per month
- 24 hr duration
- 24 hr recovery
- Missed out time… "didn'ts"
- Occasional medication use

Learn more by using the Migraine Impact Tool

- https://www.speakyourmigraine.com

60	migraine attack/episode days
180	migraine-affected days
60	work, sleep or family time "didn'ts"
30	treatment days

https://www.speakyourmigraine.com/migraine-test/

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Digital Blue Light Is Most Detrimental To Migraine Patients

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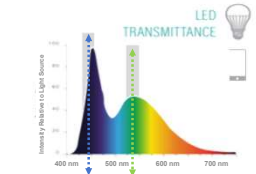
Blue light *(447 nm ± 10) increases migraine intensity*

Green Light *(530 nm ± 10) was shown to soothe migraine intensity*



Blue light 447 nm ± 10	Green light 530 nm ± 10
Exacerbates migraine	Soothes migraine


BRAIN

Migraine photophobia originating in cone-driven retinal pathways

Rodrigo Noseda,[1,2] Carolyn A. Bernstein,[1,3] Rony-Reuven Nir,[1] Alice J. Lee,[4] Anne B. Fulton,[5,6] Suzanne M. Bertisch,[7,8] Alexandra Hovaguimian,[1,9] Dean M. Cestari,[2,8] Rodrigo Saavedra-Walker,[1] David Borsook,[2,3] Bruce L. Doran,[10] Catherine Buettner[2,8] and Rami Burstein[1,2]

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Sleep Quality and Migraine Frequency

44

- Migraine frequency correlates with poor sleep quality and a higher prevalence of poor sleepers.
- Disturbed sleep is a particularly common problem among migraineurs (children or adult), affecting 30% to 50% of migraine patients.
- Greater migraine frequency was associated with a higher prevalence of poor sleep quality

Associations Between Sleep Quality and Migraine Frequency. A Cross-Sectional Case-Control Study, 2016

https://journals.lww.com/md-journal/Fulltext/2016/04260/Associations_Between_Sleep_Quality_and_Migraine.52.aspx#pdf-link

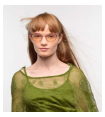
44

Wearer Survey with Blue Light Blocking Lenses

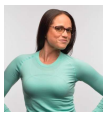
45

99.1%
Of those surveyed
Eyes more relaxed indoors

98.2%
Of those surveyed
Significant sleep improvement



93.8%
Of those surveyed
Absolute "Yes" to wear as everyday glasses



65.1%
Of those surveyed
Significant reduction in headaches/migraines

*BluTech Wearer Survey—2,023 Patients

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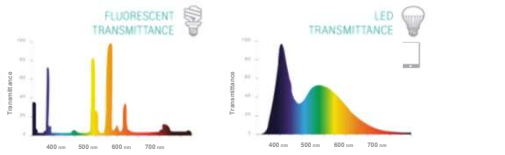
Product Performance

46

Light Source Comparison with popular Blue Light Blocking Lenses

47

- CFL and LED lighting are the most common light sources in our homes, schools, workplace and just about any establishment we visit.
- Comparisons are made with the four most popular lens product categories



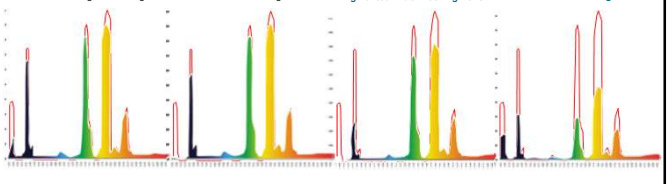
Blue Blocking AR Coating | Clear Blue Blocking Lens | Pigmented Blue Blocking Lens | Tinted Blue Blocking Lens

47

Lens Performance with CFL/Florescent Lighting

48

Blue Blocking AR Coating | Clear Blue Blocking Lens | ***Pigmented Blue Blocking Lens*** | ***Tinted Blue Blocking Lens***



Full Transmittance of CFL

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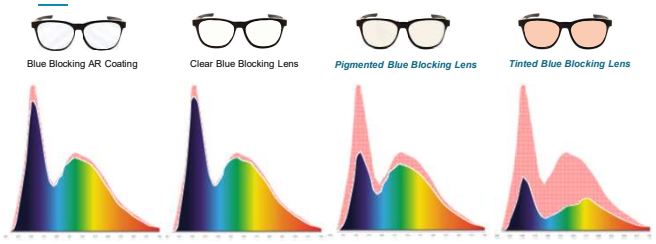
Lens Performance with LED Lighting and Digital Devices



Full Transmittance of LED/Digital Device

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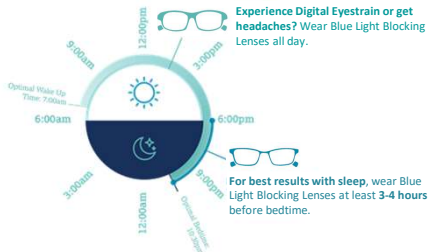
When to Wear Blue Light Blocking Lenses



Experience Digital Eyestrain or get headaches? Wear Blue Light Blocking Lenses all day.

For best results with sleep, wear Blue Light Blocking Lenses at least **3-4 hours** before bedtime.

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Summary

1. Blue light can impede visual clarity, potentially damage the retina, disrupt sleep and exacerbate migraine.
2. Intense blue light in the evening disrupts your patients' sleep cycle leading to increased headaches and migraines.
3. Blue Light Blocking Lenses that effectively block digital/LED light are clinically proven to regulate melatonin production.
4. Blue Light Blocking Lenses that effectively block CFL and digital/LED light, provide optimum protection from detrimental blue light for headache relief associated with photophobia.
5. The **Opportunity** to help your patients is not just with Rx, but also with Plano patients.

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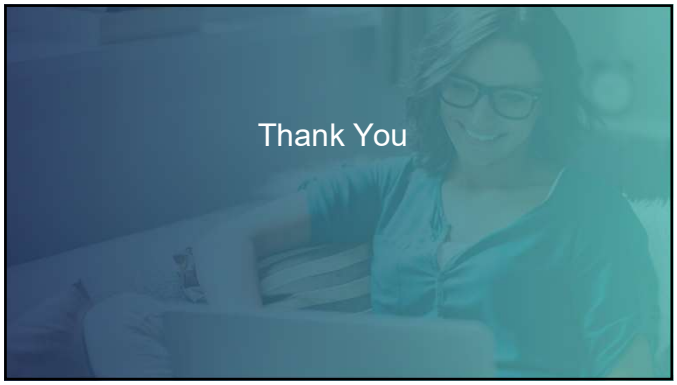

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