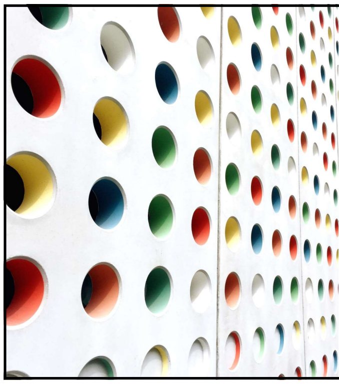

Light Filtering Lenses

Valerie.manso@outlook.com

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Financial disclosure

I Valerie Manso am President of Manso Management Resources, Inc. A consulting company specializing in business and people development in the ophthalmic industry. I currently have an ongoing contracts with PECAA, as Director of Staff Education

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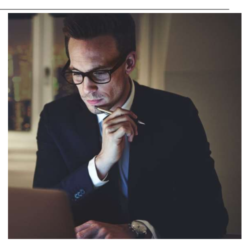
Learning outcomes

By the conclusion of this session the participants will:

1. Understand some of the negative impacts of visible and non-visible light
2. Be exposed to many ophthalmic lens materials and treatments to positively impact patients' sight, health and wellbeing
3. Be provided tips on how to incorporate light filtering lenses into their day-to-day patient discussions



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Background

- Science and research continues to better understand the human eye and the impacts of visible and non-visible light. While light is essential to sight, some components of light can inflict cellular damage: alter our sleep patterns; cause cancer and so much more.

Ophthalmic lens manufacturers and lens coating developers have taken up the gauntlet and developed solutions to filter many of the negative impacts of visible and non-visible light. This session will discuss potential problems caused by light and the ophthalmic lens solutions.

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Agenda

What is light?

- Visible and non-visible light
- How does light impact humans
  - Visible and non-visible light
  - UV Light
  - High Energy Visible Light (blue)
- Dyslexia solutions
- Color blindness solutions
- How to integrate in your business.

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What is light?

- Light is a magnetic field in step with an electric field, traveling through space
- Cosmos: The science of everything says … "At the short end, high-energy gamma rays can have a wavelength much smaller than a hydrogen atom, while at the long end, low-energy radio waves can be as long as the planet Jupiter is wide.
Visible light is a very thin slice of the electromagnetic spectrum, from wavelengths of about 400 to 700 billionths of a meter (nanometer - nm), about the width of an E. coli bacterium or about 1% the width of a human hair."

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What is light?

- Why can we ‘see’ the Visible Spectrum?
- First, “vision” usually involves some kind of chemical reaction triggered by light. The carbon-based chemistry of our cells happens to be kicked off by light of around the visible range. Longer wavelengths don't carry enough pep to set off the reactions, while light of shorter wavelengths carries too much energy, and can damage the delicate chemistry of life (which is why ultraviolet light causes sunburn, for instance).
- Second, the 400 to 700-nanometer range can travel quite far in water before it gets absorbed (which is why a cup of water looks transparent to us – almost all visible light passes through). The first eyes evolved under the sea, and so this range of light held the most evolutionary advantage, compared with other wavelengths

COSMOS – The science of everything https://cosmosmagazine.com/physics/what-is-light

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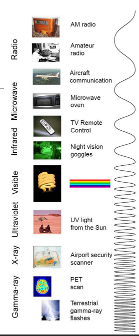
Electromagnetic spectrum

The Electromagnetic Spectrum

- Radio: Your radio captures radio waves emitted by radio stations, bringing your favorite tunes. Radio waves are also emitted by stars and gases in space.
- Microwave: Microwave radiation will cook your popcorn in just a few minutes but is also used by astronomers to learn about the structure of nearby galaxies.
- Infrared: Night vision goggles pick up the infrared light emitted by our skin and objects with heat. In space, infrared light helps us map the dust between stars.



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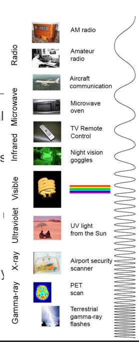
Electromagnetic spectrum

- Visible: Our eyes detect visible light. Fireflies, light bulbs, and stars al
- Ultraviolet: Ultraviolet radiation is emitted by the Sun and are the reas burns. "Hot" objects in space emit UV radiation as well.
- X-ray: A dentist uses X-rays to image your teeth, and airport security through your bag. Hot gases in the Universe also emit X-rays.
- Gamma ray: Doctors use gamma-ray imaging to see inside your body ray generator of all is the Universe.



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How light impacts humans

- Encyclopedia Britannica says,

"Life on earth could not exist without visible light, which represents the peak of the Sun's spectrum and close to one-half of its radiant energy. Visible light is essential for photosynthesis, which enables plants to produce the carbohydrates and proteins that are the food sources for animals." – including mankind!

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UV Radiation

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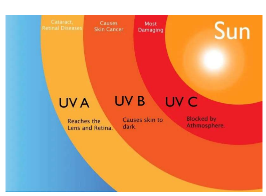
UV Radiation

- UV Radiation is produced by the sun and a few artificial sources like solariums.
- UV Radiation spans from 100nm to 400nm. The UV Spectrum is comprised of UVA , UVB and UVC.
- UVA 100nm – 280nm
  - Accounts for 95% of the UV that reaches the earth
  - Contributes to eye diseases and eye disorders
- UVB 280nm – 315nm
  - Causes skin burns. Prolonged exposure increases the risk of cancer
- UVC 315nm to 400nm
  - Absorbed by the ozone layer



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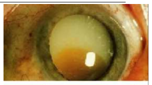
UV Radiation and Eyes

- UV Radiation contributes to the formation of:
  - Cancers of the ocular adnexa
  - Pterygia
  - Pinguecula
  - Photokeratitis
  - Cataract formation



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Measuring and responding to UV Radiation

UV Index	Risk Level	Recommendations
2 or less	Low	1. Wear sunglasses. 2. If you burn easily, use sunscreen with an SPF* of 15+.
3 - 5	Moderate	1. Wear sunglasses. 2. Cover up and use sunscreen. 3. Stay in the shade near midday, when the sun is strongest.
6 - 7	High	1. Wear a hat and sunglasses. 2. Cover up and use sunscreen. 3. Reduce time in the sun between 10 a.m. and 4 p.m.
8 - 10	Very high	1. Wear a hat and sunglasses. 2. Cover up and use sunscreen. 3. Minimize sun exposure between 10 a.m. and 4 p.m.
11+	Extreme	1. Wear a hat and sunglasses. 2. Apply sunscreen (SPF 15+) liberally every two hours. 3. Try to avoid sun exposure between 10 a.m. and 4 p.m.
*SPF = sun protection factor Information based on U.S. Environmental Protection Agency standards.		

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Outdoor risk factors

- Anyone who spends time outdoors is at risk for eye problems from UV radiation. Risks of eye damage from UV and HEV exposure change from day to day and depend on a number of factors, including:
  - **Geographic location.** UV levels are greater in tropical areas near the earth's equator. The farther you are from the equator, the smaller your risk.
  - **Medications.** Certain medications, such as tetracycline, sulfa drugs, birth control pills, diuretics and tranquilizers, can increase your body's sensitivity to UV and HEV radiation.

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Outdoor risk factors

- **Elevation.** UV levels are greater at higher altitudes
- **Time of day.** UV and HEV levels are greater when the sun is high in the sky, typically from 10 a.m. to 2 p.m. (Varies depending on the season and location)
- **Environment.** UV and HEV levels are greater in wide open spaces, especially when highly reflective surfaces are present, like snow and sand.
- In fact, UV exposure can nearly double when UV rays are reflected from the snow.
- UV exposure is less likely in urban settings, where tall buildings shade the streets.

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Blocking UV light - Solutions

- Myth – common lens materials block all UV and some blue light
- Fact – majority of lens materials do not block up to 400nm
- Fact – blue light begins at 400nm
- Apply UV treatment or select 100% UV blocking lens materials

MATERIAL	INDEX	100 – 400nm	% UV
CR39	1.498	350nm	83.3
Trivex	1.523	395nm	98.3
Polycarbonate	1.586	385nm	95.0
Mid-index	1.56	395nm	98.3
High-index	1.74	400nm	100
UV420	Various	400nm	100
BluTech	Various	400nm	100

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High energy visible light (Blue)

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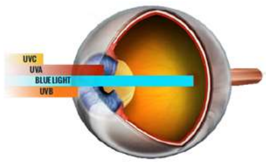
High energy visible blue light

- Blue light is the highest energy portion of the visible spectrum
- Blue light is emitted between 400nm and 500nm
- Blue light passes through the cornea, aqueous, lens and vitreous and had the potential to damage the retina
- Blue light is emitted by the sun, and artificial light sources, as well as digital devices



**The young human lens transmits a small window of UV-B light (320 nm) to the retina*

REFERENCE: Albert R. Wielgus, Joan E. Roberts. Retinal Photodamage by Endogenous and Xenobiotic Agents Photochemistry and Photobiology, 2012, 88: 1320–1345

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Blue light hazard

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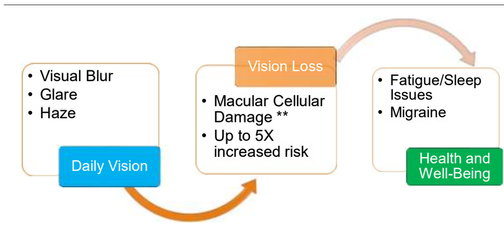
Blue light affects us in 3 ways



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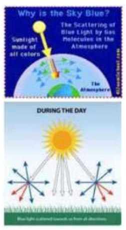
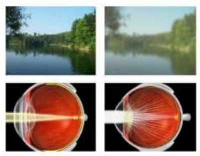
Blue light affects our daily vision





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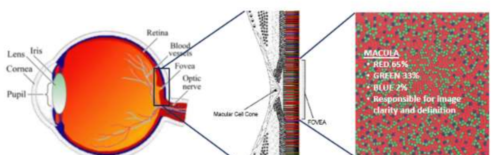
Fovea is devoid of blue photoreceptors



BLUE Light Receptors
- More abundant in periphery
- Provide object recognition vs high visual acuity

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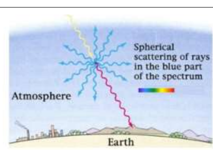
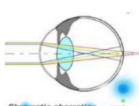
Chromatic aberration – scatter and haze

- 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**.

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Peer reviewed science

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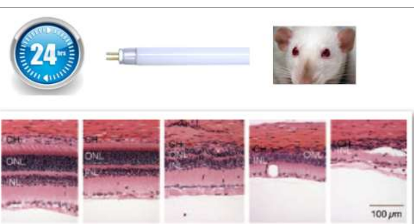
Blue light produces macular degeneration in mice



Tanito et al. *IOVS*, April 2007, Vol. 48, No. 4

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LED lights impact our circadian rhythm

- 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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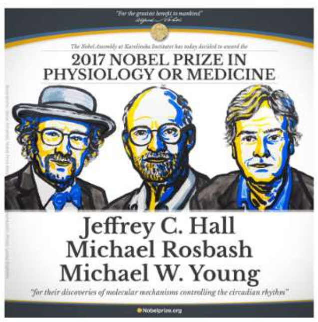
Circadian Rhythm (Biological Clock)

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



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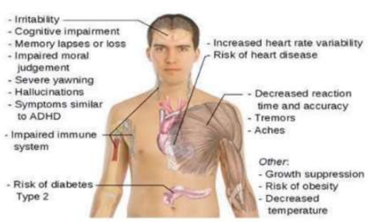
Affects of poor sleep



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

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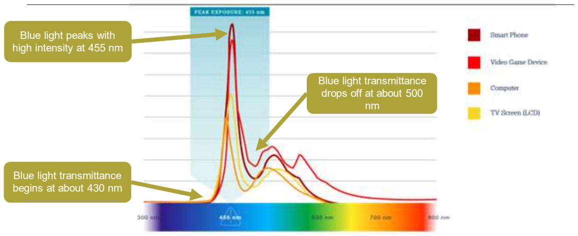
Indoor blue light



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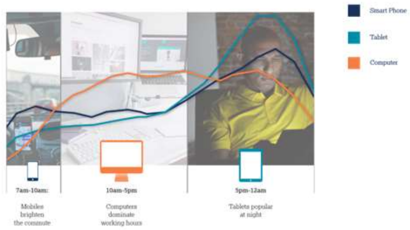
Indoor blue light



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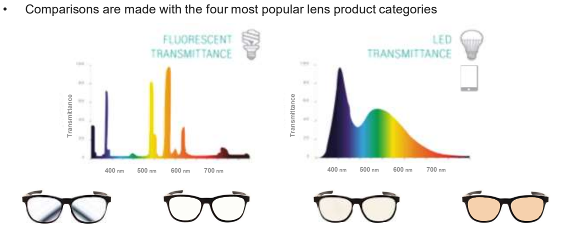
Indoor solutions

- 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



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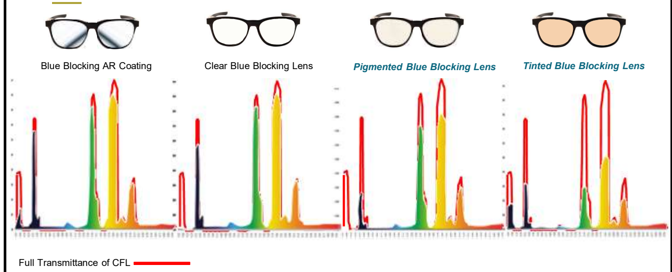
Indoor solutions; CFL/Florescent lighting



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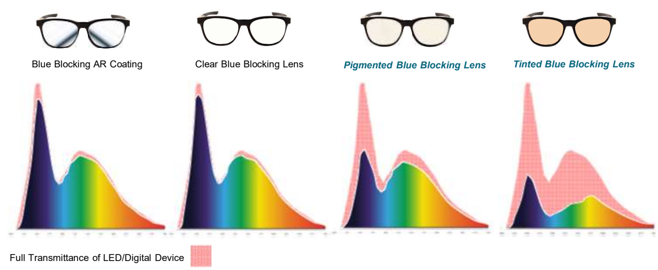
Indoor solutions; LED lighting and digital devices



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Outdoor blue light

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Science Indicates Outdoor Blue Light Causes Damage

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

Janet R. Sparrow,[1] Koji Nakanishi,[2] and Craig A. Parish[2]

Purpose. To determine whether the lipofuscin fluorophore A2E participates in blue light–induced damage to retinal pigmented epithelial (RPE) cells.

Methods. Human RPE cells (ARPE-19) accumulated A2E from 10, 50, and 100 μM concentrations in media, the levels of internalized A2E ranging from less than 5 to 64 ng/10^5 cells, as assayed by quantitative high-performance liquid chromatography (HPLC). Restricted zones (0.5-mm diameter spots) of confluent cultures were subsequently exposed to 480 ± 20-nm (blue) or 545 ± 1-nm (green) light for 15 to 60 seconds. Phototoxicity was quantified at various periods after exposure by fluorescence staining of the nuclei of membrane-compromised cells, by TdT-dUTP terminal nick-end labeling (TUNEL) of apoptotic cells and by Annexin V labeling for phosphatidylserine exposure.

Results. Nonviable cells were located in blue light–exposed zones of A2E-containing RPE cells, whereas cells situated outside the illuminated areas remained viable. As shown by fluorescence labeling of the nuclei of membrane-damaged cells and by the presence of TUNEL-positive cells, the numbers of nonviable cells increased with exposure duration and as a function of the concentration of A2E used to load the cells before illumination. The numbers of blue light–induced TUNEL-positive cells also increased in advance of the increase in labeling of membrane-compromised cells, a finding that, together with Annexin V labeling, indicates an apoptotic form of cell death. Conversely, blue light–exposed RPE cells that did not contain A2E remained viable. In addition, illumination with green light resulted in the appearance of substantially fewer nonviable cells.

Conclusions. These studies implicate A2E as an initiator of blue light–induced apoptosis of RPE cells. (*Invest Ophthalmol Vis Sci.* 2000;41:1981–1989)

Review Article

Age-related maculopathy and the impact of blue light hazard

Peep V. Algvere,[1] John Marshall[2] and Stefan Seregard[1]

[1]Karolinska Institute, St Erik's Eye Hospital, Stockholm, Sweden
[2]Rayne Institute, St Thomas' Hospital, London, UK

ABSTRACT.
The pathogenesis of age-related maculopathy (ARM), the most common cause of visual loss after the age of 60 years, is indeed a complicated scenario that involves a variety of hereditary and environmental factors. The pathological cellular and molecular events underlying retinal photochemical light damage, including photoreceptor apoptosis, have been analysed in experimental animal models. Studies of age-related alterations of the retina and photoreceptors, the accumulation of lipofuscin in retinal pigment epithelium (RPE) cells, and the formation of drusen have greatly contributed to our knowledge. A new concept of an inflammatory response to drusen has emerged, suggesting immunogenic and systemic reactions in Bruch's membrane and the subretinal space. Oxidative stress and free radical damage also impact on the photoreceptors and RPE cells in the ageing eye. Based on the photoelectric effect, a fundamental concept in quantum physics, the consequences of high-energy irradiation have been analysed in animal models and cell culture. Short-wavelength radiation (rhodopsin spectrum), and the blue light hazard (excitation peak 440 nm), have been shown to have a major impact on photoreceptor and RPE function, inducing photochemical damage and apoptotic cell death. Following cataract surgery, there is a dramatic change in ocular transmittance. In aphakic or pseudophakic eyes (with clear intraocular lenses), high-energy (blue) and ultraviolet-A radiation strikes the retina. Epidemiological data indicate a significantly increased 5-year incidence of late ARM in non-phakic eyes compared with phakic eyes. In recent years, putative prophylactic measures against ARM have emerged. The implantation of 'yellow' intraocular lenses (IOLs) that absorb high-energy blue radiation is, from a theoretical point of view, the most rational approach, and, from a practical point of view, is easy to accomplish. With increasing age, RPE cells accumulate lipofuscin (chromophore A2E). It is noteworthy that the yellow IOL not only protects A2E-laden human RPE cells from blue light (peak 430 nm) damage, but also alleviates the detrimental effects of green (peak 550 nm) and white light. A prophylactic treatment using antioxidants is aimed at counteracting oxidative stress and free radical cellular damage. The Age-Related Eye Disease Study (AREDS), a randomized clinical trial, showed a significantly lower incidence of late ARM in a cohort of patients with drusen maculopathy treated with high doses of antioxidants than in a placebo group. In recent years, considerable progress in retinal research has been achieved, creating a platform for the search for new prophylactic and therapeutic measures to alleviate or prevent photoreceptor and RPE degeneration in ARM.

Key words: age-related maculopathy – short-wavelength radiation – blue light hazard – lipofuscin – free radicals – aphakia – retinal damage – 'yellow' intraocular lens (IOL) – antioxidants

Acta Ophthalmol. Scand. 2006: 84: 4–15

doi: 10.1111/j.1600-0420.2005.00627.x

Introduction

It has long been speculated that visible light, even of ordinary everyday intensity, may cause retinal damage or contribute to the development of early and late age-related maculopathy (ARM). However, there are indications in some epidemiological studies that exposure to sunlight may be associated with the development of ARM (Cruickshanks et al. 1993, 2001). Extensive work in animal models and other experimental settings, such as cell culture, has unequivocally shown that visible light can cause retinal cellular damage to the photoreceptors and retinal pigment epithelium (RPE). Accumulating evidence indicates that in aphakic or pseudophakic eyes, there may be an increased risk of light damage to the retina, and particularly in response to blue light irradiation.

Photochemical retinal light damage

Ocular transmittance of radiation in young and elderly human eyes

Optical radiation includes ultraviolet light (100–400 nm), visible light (400–750 nm) and infrared radiation (750–10 000 nm). Most ultraviolet radiation below 295 nm is absorbed by the cornea, whereas ultraviolet-B (UVB) (280–315 nm) and ultraviolet-A (UVA) (315–400 nm) are blocked by the lens. However, a fraction of radiation with wavelengths shorter than 400 nm (centred at 320 nm) does reach the retina (Boettner & Wolter 1962).

In the young eye, ocular transmittance is very high, reaching close to

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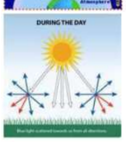
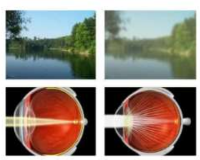
Outdoor blue light





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Outdoor blue light

Goals:

- Reduce glare
- Enhance color
- Improve contrast
- Protect the eyes

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Outdoor solutions

Basic	Better	Best
Photochromic 45% between 400nm – 500nm • Near-clear indoors; darker outdoors; • Not polarized.	**Premium Polarized** Ranges 88% between 400nm-500nm • Blue light filtration • Polarized for excellent glare reduction	**Blue Blocking Polarized** Ranges 92% between 400nm-500m • Blue light filtration • Polarized for excellent glare reduction • Read digital devices outdoors • Superior contrast enhancement due to blue light absorption

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Outdoor solutions - Polarized

Created by NASA to reduce glare

- Polarized filters absorb reflected and scattered light from horizontal surfaces
- Ideal for high glare situations like driving, around water, sand snow and more
- May experience birefringence (blacking out of screen or rainbow effect) when viewing some digital devices; pumping gas or at ATM Screens (Tempered glass)

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Dyslexia

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Lenses for Dyslexia

- Research indicates that some patients with Dyslexia have an imbalance in processing speeds between the Magnocellular (M) and the Parvocellular (P) systems. The M system is significantly slower. ChromaGen filters work by slowing down the processing speed of the (P) system so that they become synchronized.
  The ChromaGen lenses synchronize both eyes so they work together, as a team, which causes the text to become clear and in focus, and effectively stops the words from moving. The lenses modify light's wavelength as it passes into each eye, which dynamically balances the speed of the information travelling along the neurological pathways to the brain.

August 2014 –*Caroline Alencar, Dias Da Costa, et al*
https://www.researchgate.net/publication/270703068_COLOURED_OVERLAYS_IMPROVE_READING_PERFORMANCE_IN_PEOPLE_SUFFERING_FROM_VISUAL_STRESS
June 2002 – Chromagen granted 510K FDA Approval

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Lenses for Dyslexia

Words that move on the page

While reading do you notice...

words are blurry or come in and out of focus
words move up and down and side to side
words appear to "float" on the page
words "scrunch together" or "p u l l a p a r t"
double words or double sentences

Conditions making reading difficult

While reading do you...

get headaches, nausea or fatigue?
re-read the same lines?
lose your place?
lose concentration easily?
get red, irritated or watery eyes?

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System for Dyslexia

- When the ChromaGen lenses are prescribed for each eye, the light is slowed down to the "right" speed for each eye. The result is that both eyes are then working together as a team to send the proper signal to the brain. The signal that is sent from the eyes along the neurological pathways to the brain is now balanced causing the brain to process the information more efficiently or more accurately. The net result is the text is clear and words stop moving.

Each of the 16 different ChromaGen lenses transmits light at different speeds.

August 2014 –*Caroline Alencar, Dias Da Costa, et al*
https://www.researchgate.net/publication/270703068_COLOURED_OVERLAYS_IMPROVE_READING_PERFORMANCE_IN_PEOPLE_SUFFERING_FROM_VISUAL_STRESS
June 2002 – Chromagen granted 510K FDA Approval

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ChromaGen – Recent research

- Published September 9, 2022 - The Use of Chromagen Lenses in Different Ocular and Non-ocular Conditions: A Prospective Cohort Study
- In this study, we aimed to evaluate the efficacy of chromagen lenses and compare the pre- and post-intervention outcomes among individuals with non-ocular conditions such as dyslexia and Irlen syndrome and ocular conditions such as color vision deficiency (CVD) and cone-rod dystrophy (CRD)

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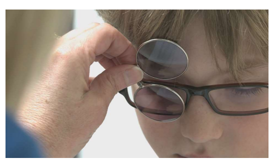
ChromaGen – Recent research

- A total of **156 patients** were included in this study; **110 patients with dyslexia**, 19 with Irlen syndrome, 16 with CVD, and 11 with CRD. The findings showed that the **reading speed and accuracy were improved in 96.34%** of patients with dyslexia and 78.9% of patients with Irlen syndrome. The use of a chromagen lens was significantly associated with visual stress improvement in 89.8% of patients (p = 0.02). Photosensitivity was significantly improved after wearing the chromagen lenses in patients with CVD (87.5%) and CRD (63.6%)



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Lenses for color blindness

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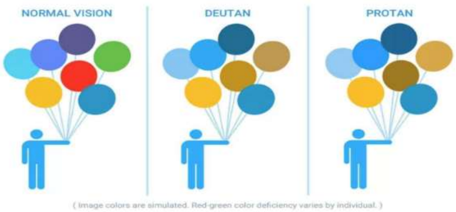
What is color blindness?



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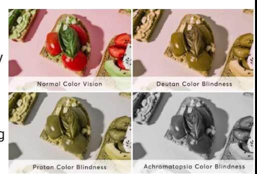
What is color blindness?

- A person with deutan color vision deficiency may experience **confusions between colors such as green and yellow, or blue and purple**. Another common symptom is that green traffic signals appear to be a very pale green or sometimes white.
- A person with protan type color blindness tends to see **greens, yellows, oranges, reds, and browns** as being more similar shades of color than normal, especially in low light. A very common problem is that purple colors look more like blue.



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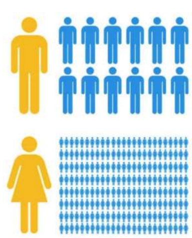
Lenses for color blindness

- Color blindness affects millions of people worldwide. It affects 1 on 12 men, and 1 in 200 women. The condition ranges from a variety of classes, red-green color blindness being the most common.

  Most people who suffer from color blindness are not blind to color but have a reduced ability to see them. Color blindness is also called Color Vision Deficiency (CVD).

  CVD can be acquired, but most are inherited genetically. The genes that influence the colors inside the eyes, called ‘photopigments’ are carried on the ‘X’ chromosome. If these genes are abnormal or damaged, color blindness occurs.



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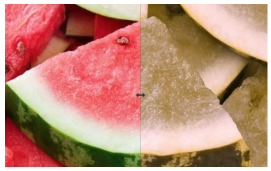
Lenses for color blindness

- Other types of color blindness exist also, such as tritan-type CVD, also called blue-yellow color blindness, which is associated with the inability to see shades of blue, and confusions between blue and green colors.
Blue-yellow color blindness is usually caused by age-related eye conditions such as glaucoma, or exposure to certain chemicals or medical treatments.

In very rare cases, a person can be completely color blind, meaning they see only the intensity of light, but not its color. This is called monochromacy or achromatopsia.

Achromatopsia can be inherited but can also result from progressive eye diseases such as retinitis pigmentosa. In summary, there are many types and degrees of what can be considered "color blindness," ranging from partial to complete lack of color discrimination.



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How the technology works

. Most types of color blindness occur when there is an excessive overlap of the M (green) and L (red) color cones in the eye, causing distinct hues to become indistinguishable. As a result, the number of shades of color a typical color-blind person can see may be reduced by as much as 90%.

EnChroma develops optical lens technology that selectively filters out wavelengths of light at the point where this confusion or excessive overlap of color sensitivity occurs. The M and L cones are altered in such a way that there is a greater amount of difference in color discrimination along the so-called "confusion line" for that individual.

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How to integrate in your business

1. Do the research – understand the problems and potential solutions
2. Invest in samples, demonstration tools, patient literature, etc.
3. If appropriate – wear the lenses
4. Price the lenses – add to website and social media
5. Educate your patients – recommend as appropriate

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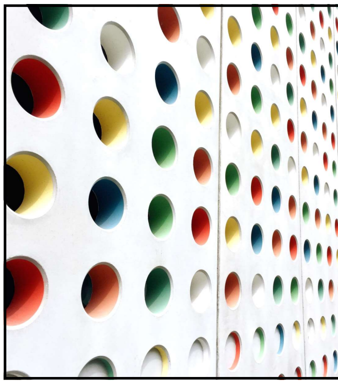

Light Filtering Lenses

Thank you for attending ☺

Valerie.manso@outlook.com

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