

## VISUAL PERCEPTION From Photon to Neuron

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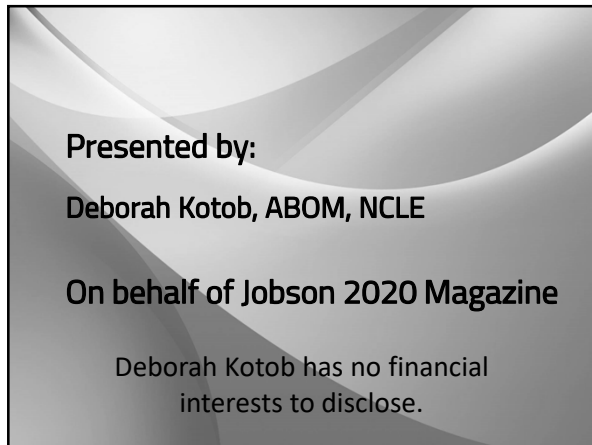
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Presented by:

Deborah Kotob, ABOM, NCLE

On behalf of Jobson 2020 Magazine

Deborah Kotob has no financial  
interests to disclose.

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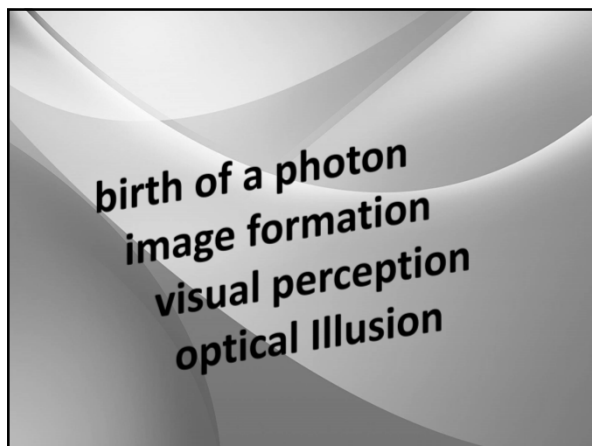
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birth of a photon  
image formation  
visual perception  
optical Illusion

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things  
needed for  
visual  
perception

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eyeballs

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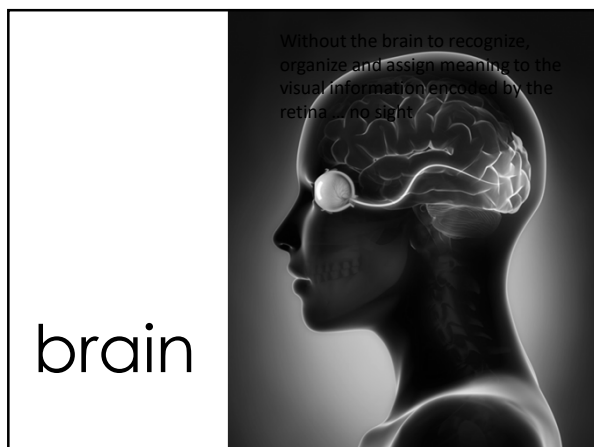
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Without the brain to recognize, organize and assign meaning to the visual information encoded by the retina... no sight.

brain

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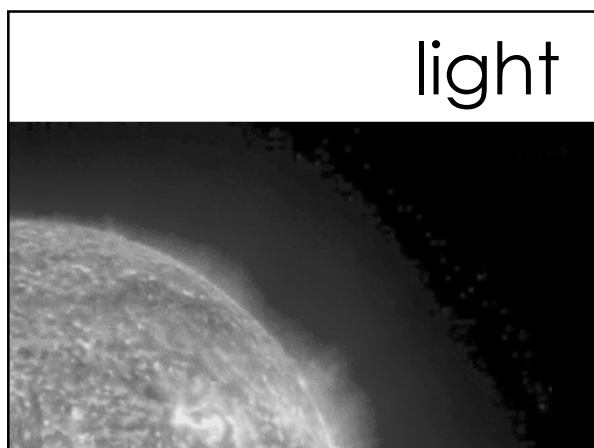
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light

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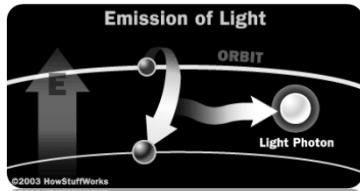
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**Light is a form of energy released by an atom.**



Light is made up of photons; packets of sub-microscopic particles that have energy, momentum but no mass.

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**How are photons formed?**



**Electrons orbit the nucleus of an atom.**

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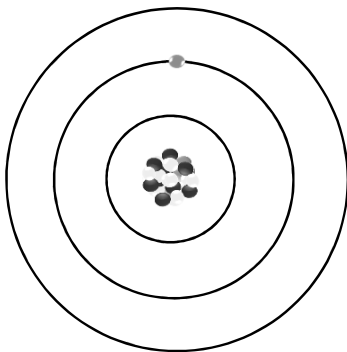
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**electrons are comfy in their orbital**



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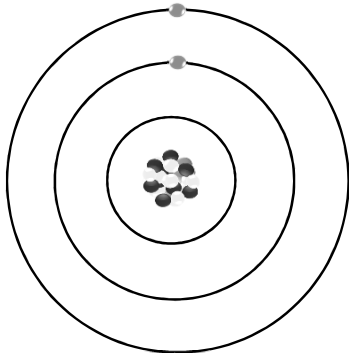
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electron absorbs energy and is forced to a higher orbital




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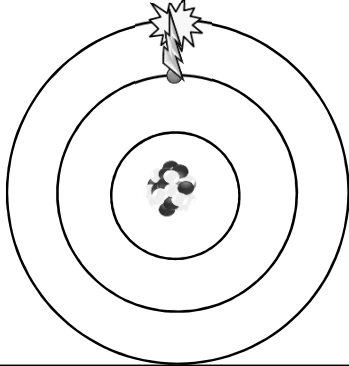
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Electron releases the absorbed energy and falls back to its original orbital and a photon is formed




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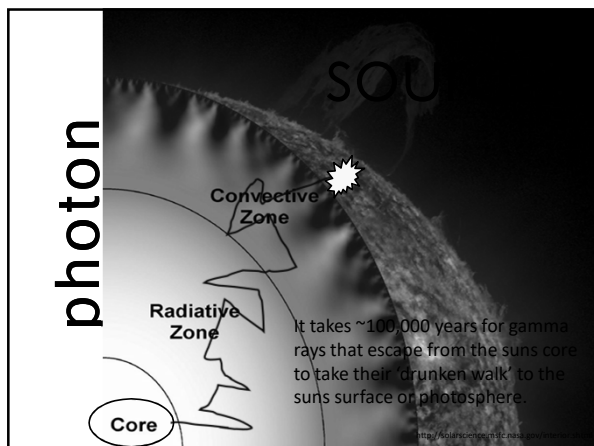
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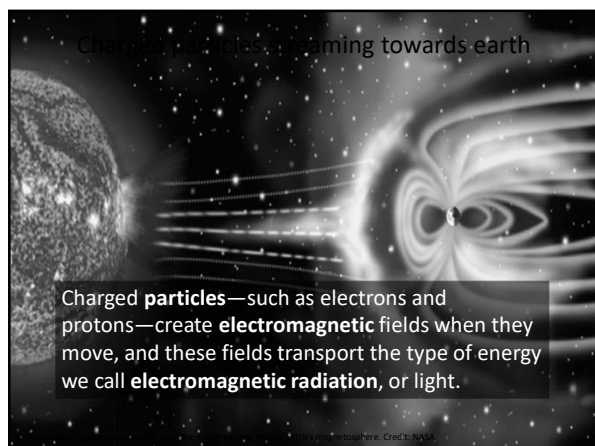
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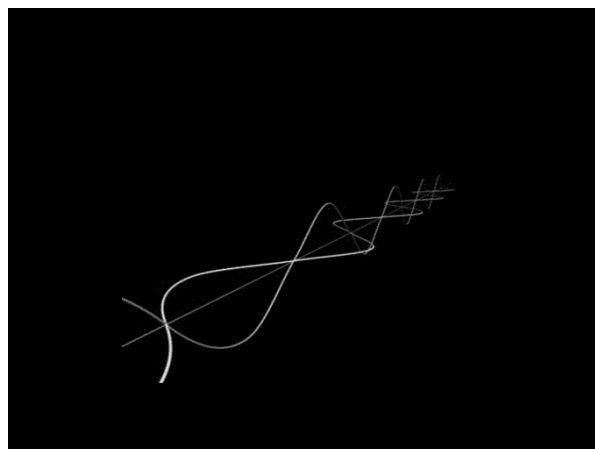
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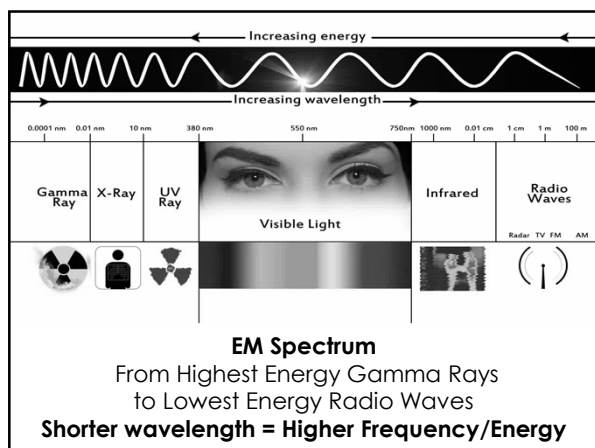
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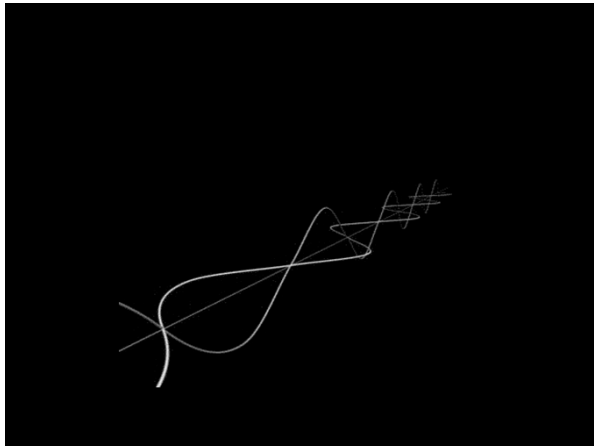
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*photons escape from sun's surface.  
they hurtle through the vacuum of space at  
186,282mps, the speed of light.  
they reach the earth in a little over 8  
minutes after traveling 93,205,678 miles  
have energy & momentum but no mass*

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photon

100,000 years and 8 minutes later  
we have LIGHT...now what?

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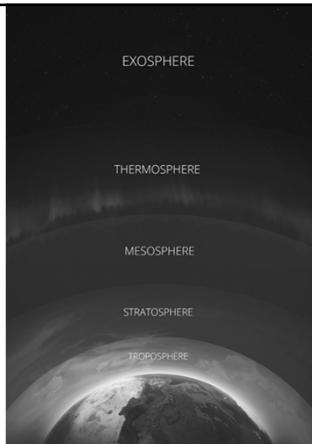
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Some UVR,  
Visible  
Light,  
Infrared  
and Radio  
Waves  
Reach the  
Earth's  
Surface



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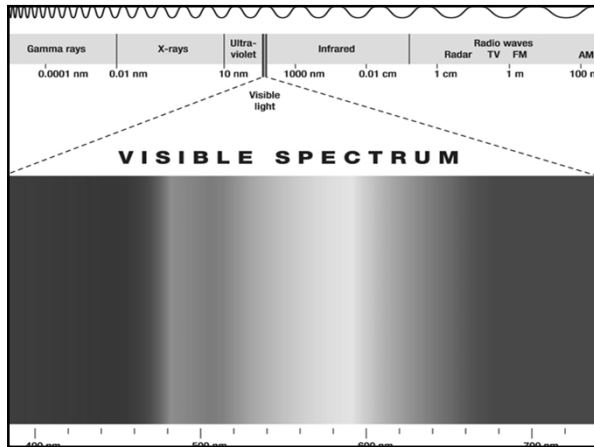
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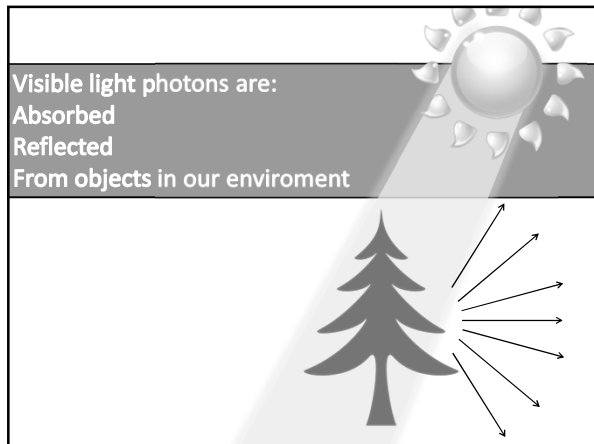
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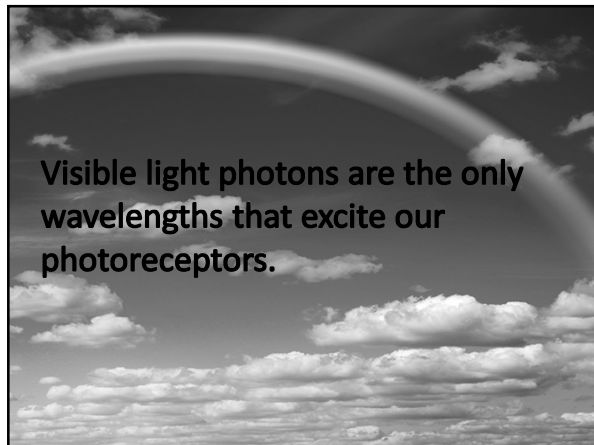
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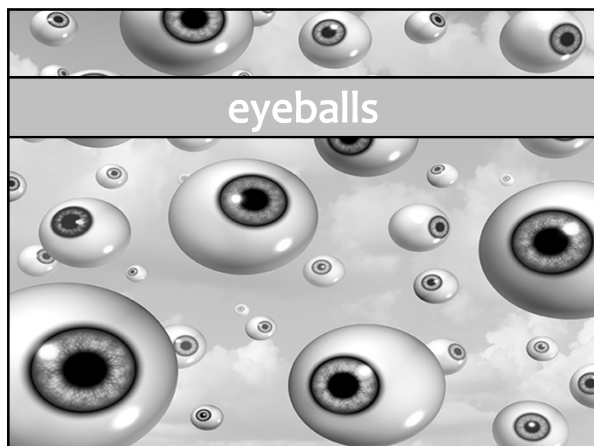
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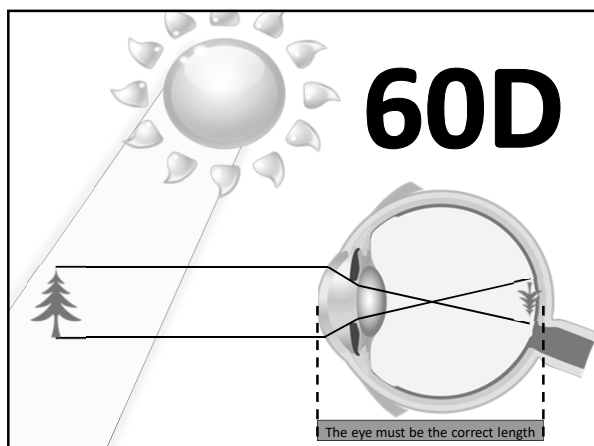
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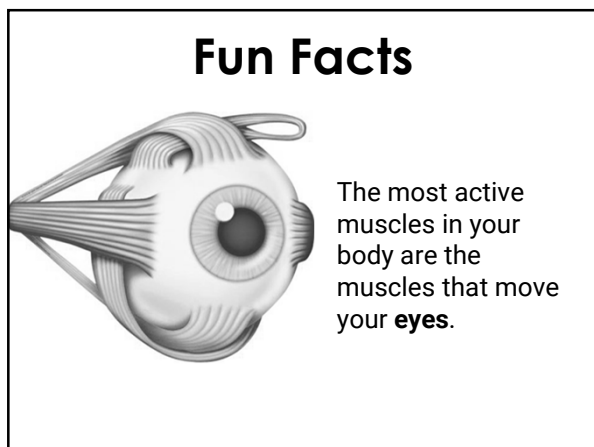
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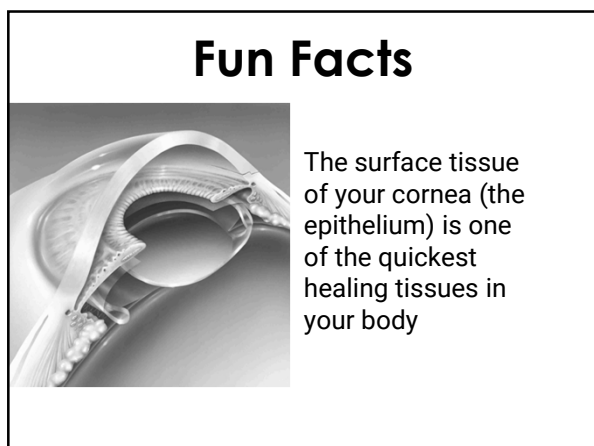
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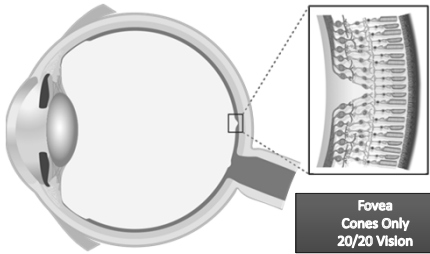
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**The fovea**, comprises less than 1% of the retina, but it takes 50% of the visual cortex of the brain to process foveal signals.

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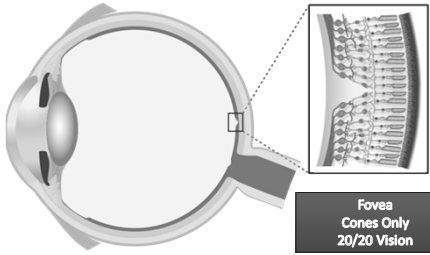
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**The fovea**, was described by Nobel Prize winner Jeremy Nathans as: “the most valuable square millimeter of tissue in the body.”

Visual field of the fovea is twice the width of a thumbnail!

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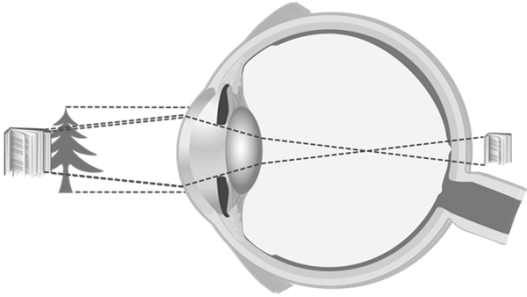
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### Changing Focus




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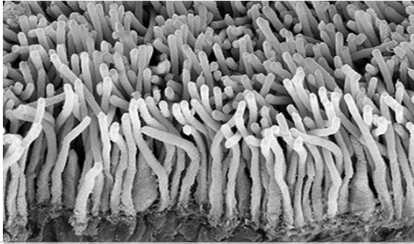
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# retina



The visual information contained in light reaches the retina where its energy will be transduced into electrical nerve impulses by the our light sensitive cells called photoreceptors.

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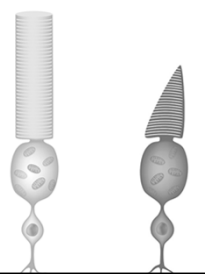
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# photoreceptors

## ROD

120 Million  
Scotopic



## CONE

6 Million  
Photopic

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## Cone Distribution in Retina



- ✓ Red 64%
  - ✓ Green 32%
  - ✓ Blue 2%
- 10 million

*Based on measured response curves*

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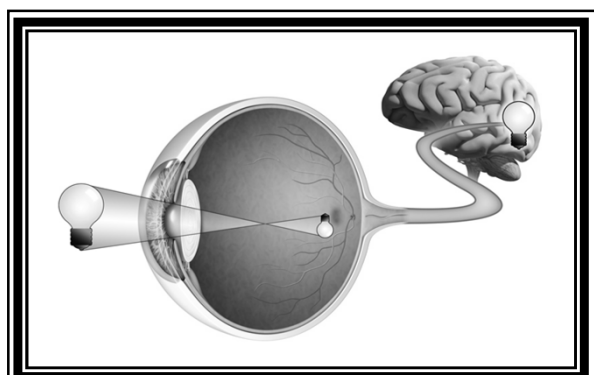
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The visual system is a complex interaction of sensory cells, nerves, and the brain.

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**Vision** is one of our most important, most complex, and most incredibly designed of all our senses.

Over **70%** of our entire brain has connections to the visual system.

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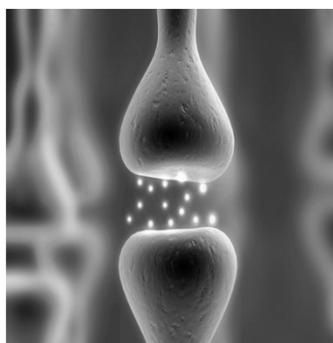
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we see with our

**brain**

Organizes  
Interprets  
Assigns meaning



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Recognition is what gives vision its reality,  
*showing the central role of mind*



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sight is always adapting



Practiced action gamers become 58 percent better at perceiving fine differences in contrast!

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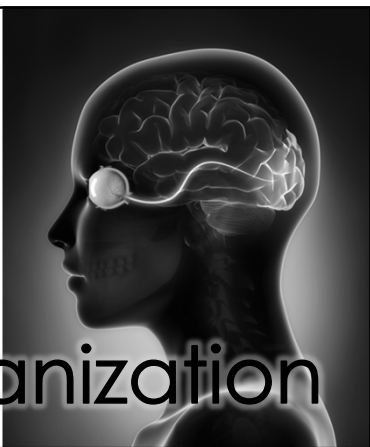
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The brain  
assembles and  
arranges the  
features of visual  
images in a  
meaningful way



# Organization

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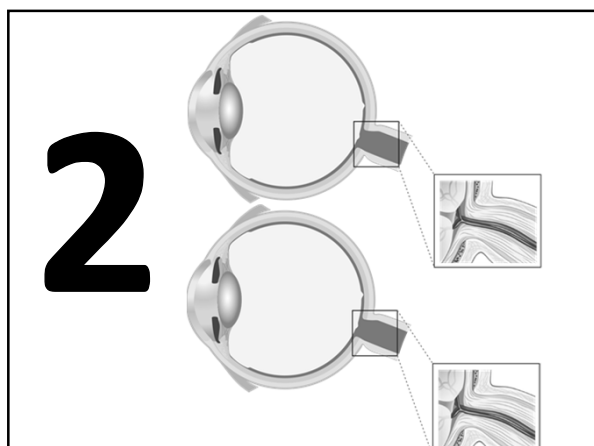
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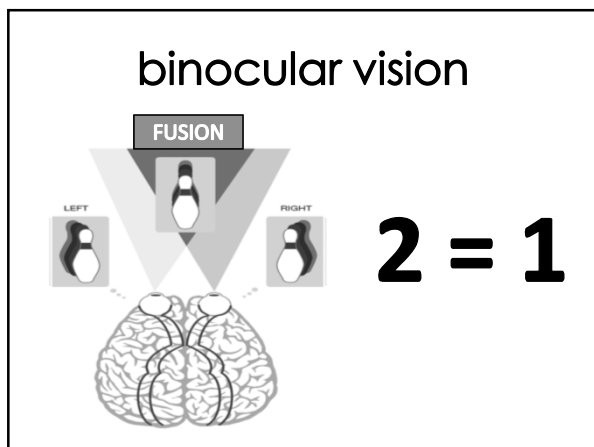
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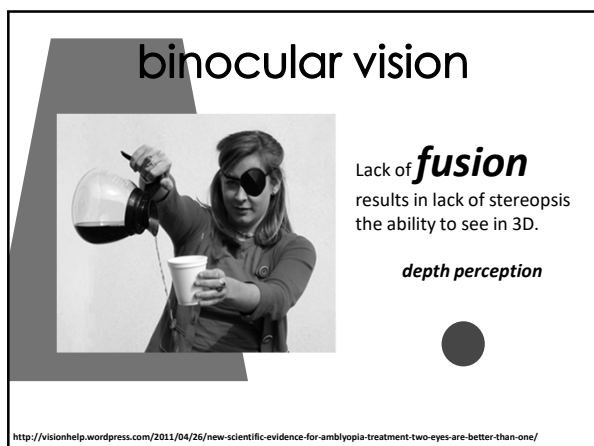
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## distance cues

### binocular cues – 2 eyes

- convergence more = closer
- retinal disparity more = further

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## distance cues

### monocular cues – 1 eye

- Size
- Texture
- Overlap
- Shading
- Height
- Clarity

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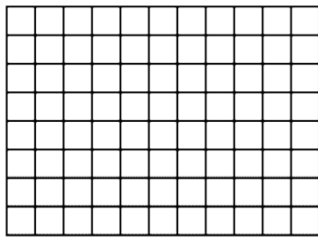
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## Perspective Cues



<http://psych.fullerton.edu/mbirnbaum/psych101/perception/>

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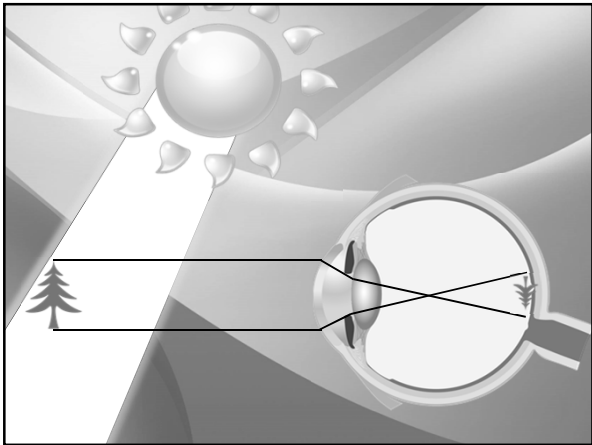
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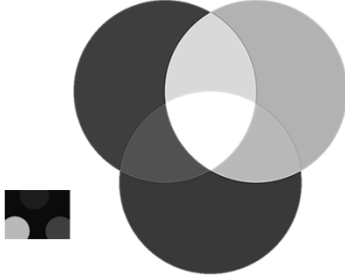
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How do we see color?



Trichromatic **RGB**

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# WHITE

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# BLACK

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## Opponent Theory

Your RED , Opponent is GREEN

- Your stronger RED wins
- Opponent stronger GREEN wins
- Both equally strong no one wins

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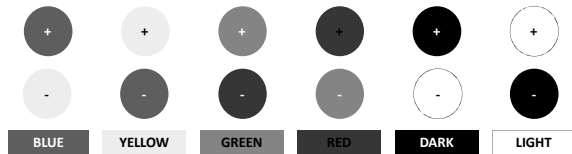
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## Opponent Theory



### opponent neurons

when one of the pair is excited the other is inhibited

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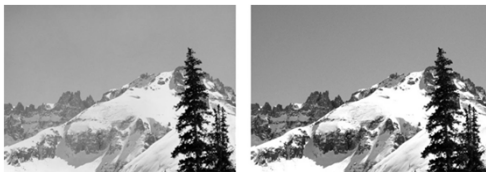
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## Color Enhancement in Lenses Making Colors POP!



Without Captivate CE Tech

Without Captivate CE Tech

### About Color Confusion

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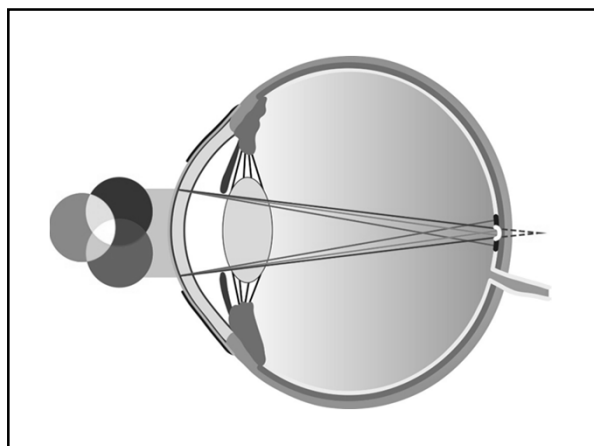
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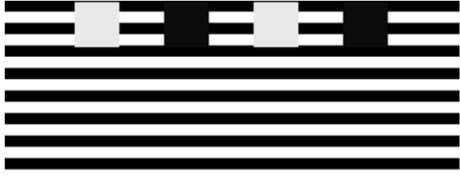
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These four squares are all actually moving at the same speed. Your eye has more trouble distinguishing the blue from the black, so the blue squares appear to be moving in a jerky fashion.

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perception constants

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size

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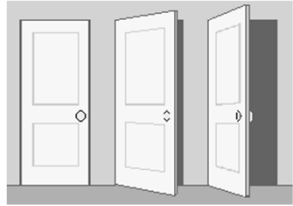
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shape

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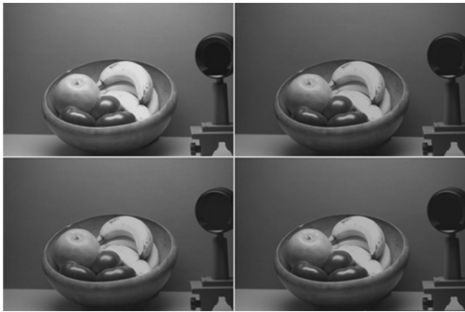
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brightness

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gestalt theory

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## Proximity

Things which are closer together will be seen as belonging together.



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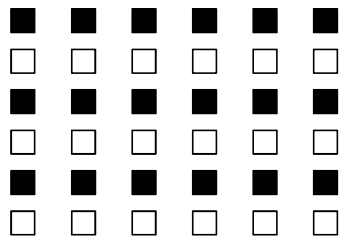
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## Similarity



The tendency to see groups from shared characteristics

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## Common Fate



Elements moving in the same direction are perceived as a group more than those which are a steady group because they show more coherence or unity

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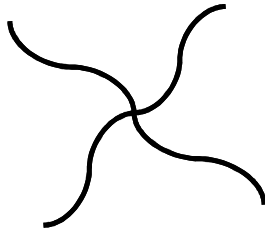
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## Good Continuation



The principle of continuity predicts the brains preference for continuous figures.

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IBM®

Closure

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## Light And Shadow



<http://psych.fullerton.edu/mbirnbaum/psych101/perception/>

What effect is light and shadow having on this scene?

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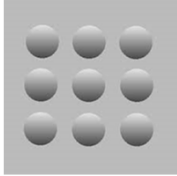
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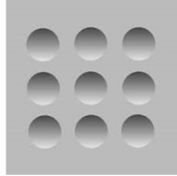
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## Light And Shadow



CONVEX



CONCAVE

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## Vision



We are incredible at remembering pictures. Hear a piece of information, and three days later you'll remember **10** percent of it. Add a picture and you'll remember **65** percent.

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HUMANS  
PROCESS IMAGES  
**60,000 x FASTER**  
THAN WORDS

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# illusion

when visual experience and visual stimuli collide

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## metamerism

*When matching colors look different due to a difference in illumination or surrounding.*

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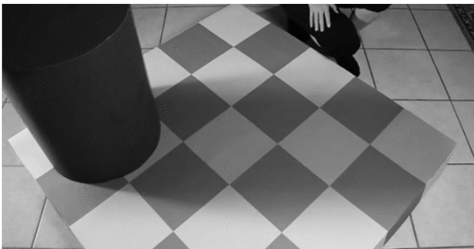
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## metamerism



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# cognitive illusions

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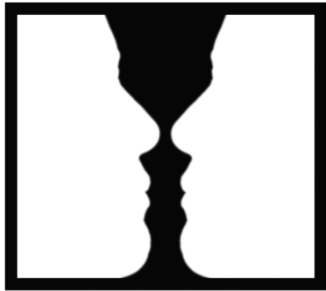
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ambiguous illusion



reality is ambiguous

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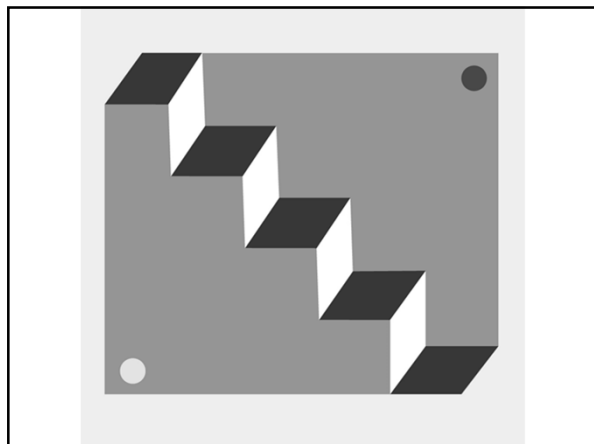
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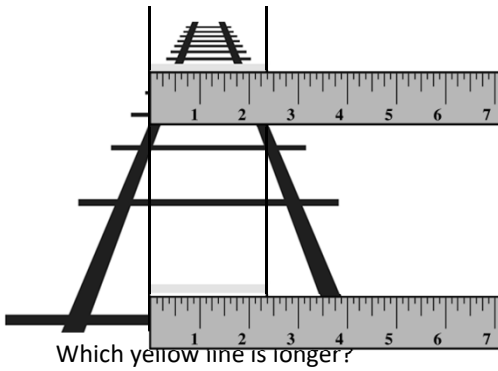
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### distortion illusion



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### paradox illusion

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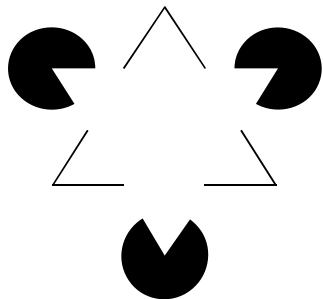
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### fiction illusion



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physiological  
illusions

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after Image

The diagram consists of a thick black rectangular border. Inside this border, on the left, is a light blue square containing a thick black cross. To the right of the blue square is a white square containing a tiny black plus sign (+).

Look at the + in the middle of the blue figure above for 15-30 seconds. Then look at the tiny + in the center of the **white square** on the right.

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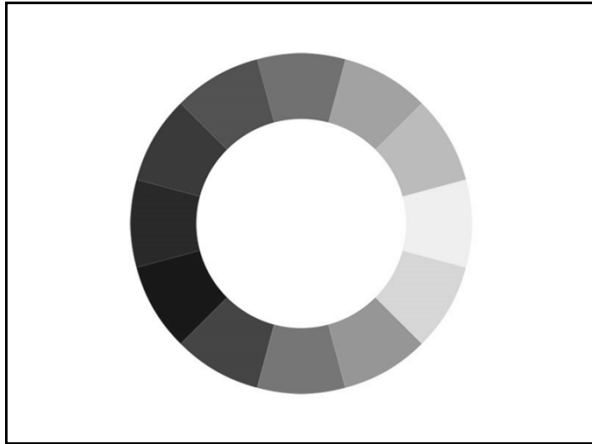
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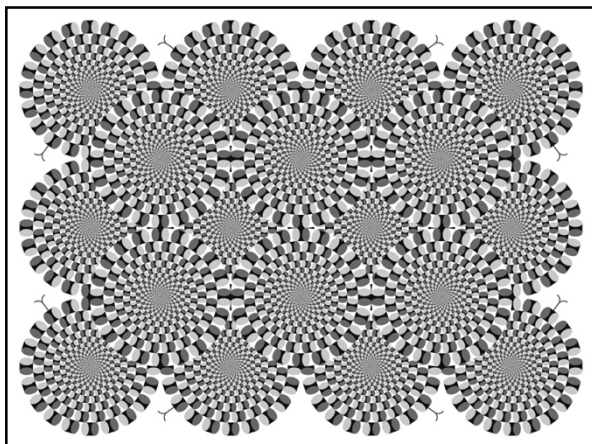
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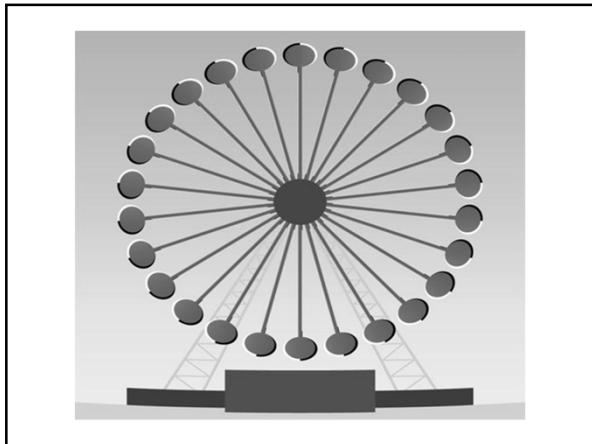
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the dark side of light

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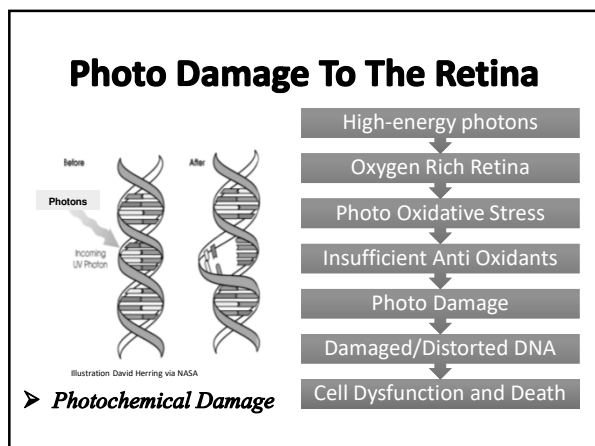
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**ROS**

- cell signaling

In such times of stress they proliferate out of control and cause considerable damage.

**Oxidative Stress**

- high energy light
- heat exposure

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## Photosensitizers

**“Photosensitizers increase our susceptibility for damage from solar radiation.”**

*Joan E. Roberts, PhD,  
Professor of Chemistry*

A femtosecond is one millionth of a nanosecond or  $10^{-15}$  of a second

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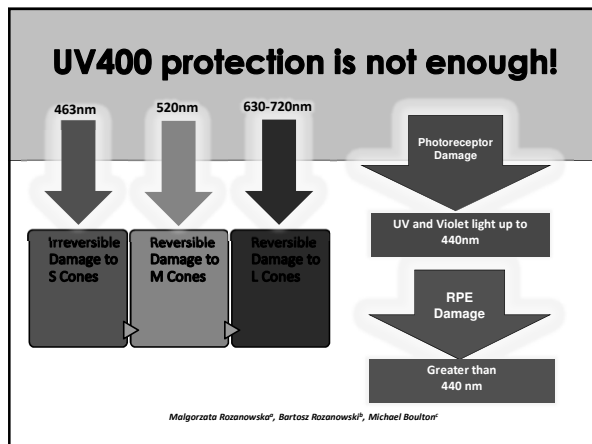
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## Focus on Prevention

Sun Damage starts young and is insidious. The damage is cumulative and irreparable.

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## Age:

Up to 70% more UV transmits to a child's retina

Source: Sidney Lerman, M.D. Clinical Light Damage to the Eye

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## Age:

81% of children aged 12 to 15 in a large Australian study showed evidence of solar related eye damage.

*Source: Minas Coroneo, M.D. American Journal of Ophthalmology*



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- Cumulative damage
- Antioxidant loss

## AGE



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- Genetics
- Light Eye Color (AMD)
- Dark Eye Color (Cataracts)
- Gender



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**We cannot control age,  
genetics or gender.  
So what can we control?**

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**diet**



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**WARNING!!! Smoking is a  
Major Cause of Blindness**

**Smokers** ...three times  
more likely to develop AMD  
than non-smokers.

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**move**

- ✓ blood flow
- ✓ efficient transfer of nutrients to cells
- ✓ disposal of waste products from our cell

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**Exposure to UV and Blue Light**

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Give patients a chance to educate themselves and to share what they have learned with family and friends.

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Thank You!

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