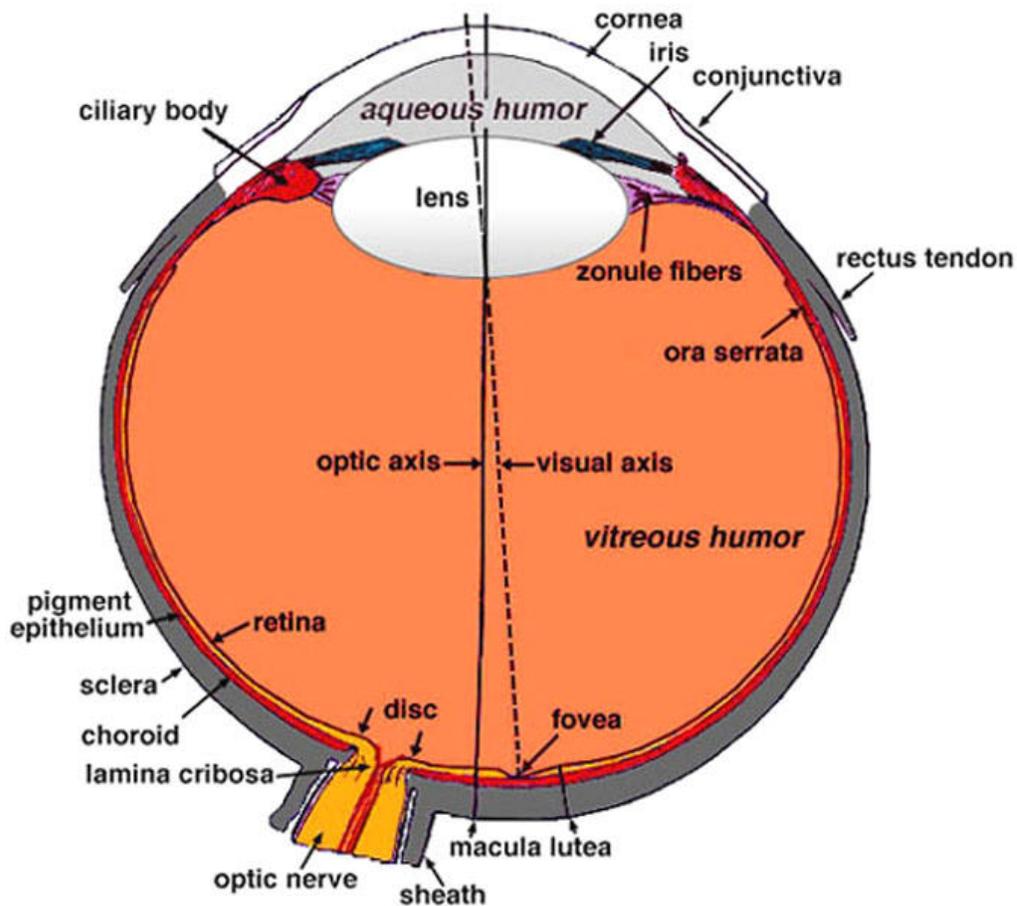


## The Eye as a Camera & Illumination



The aqueous humor has a composition like water. The lens has a yellowish tinge that gets more yellow as people get older.

### Optical power of the human eye

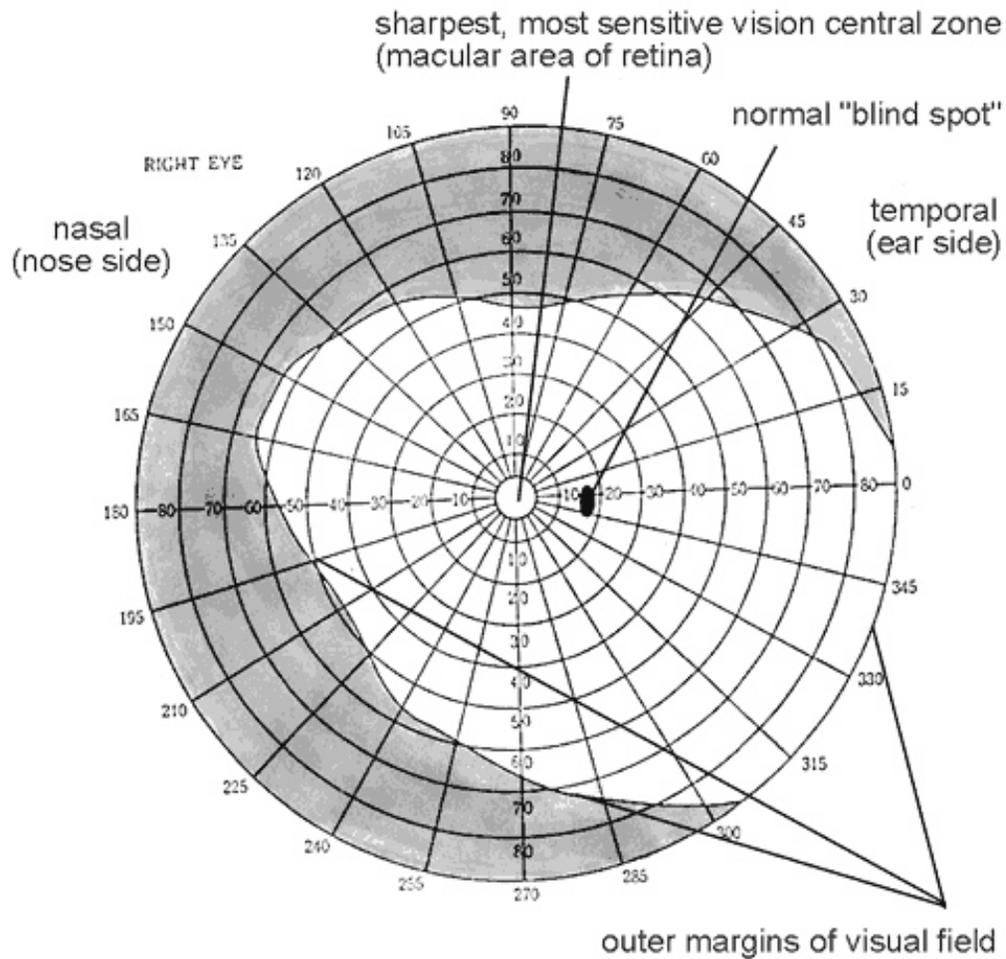
- Cornea: 43 diopters
- Lens (eye focused at infinity): 20 diopters
- Lens (eye focused at near): 28 diopters

$1/\text{focal length (in meters)} = \text{diopters}$

Question about Cataract surgery:

The lens of the eye is replaced by a Plexiglas like material.

## Monocular visual field



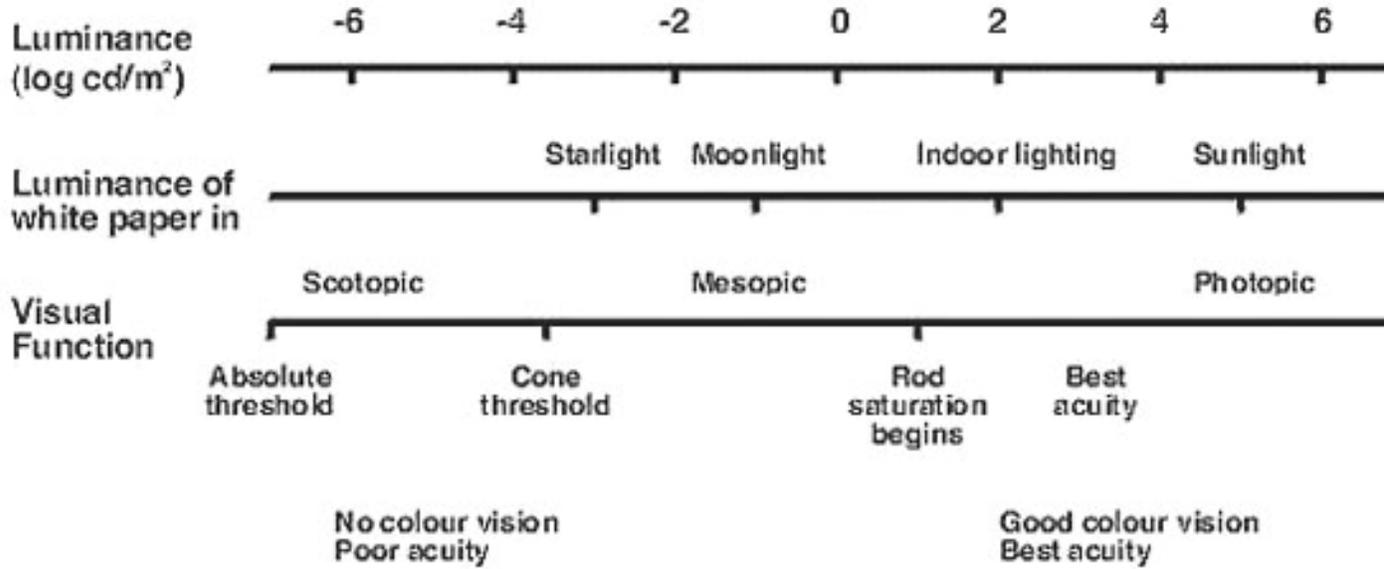
Q: Which eye is this a picture above of?

A: The right eye. The shape on the lower left is caused by the nose blocking parts of vision.

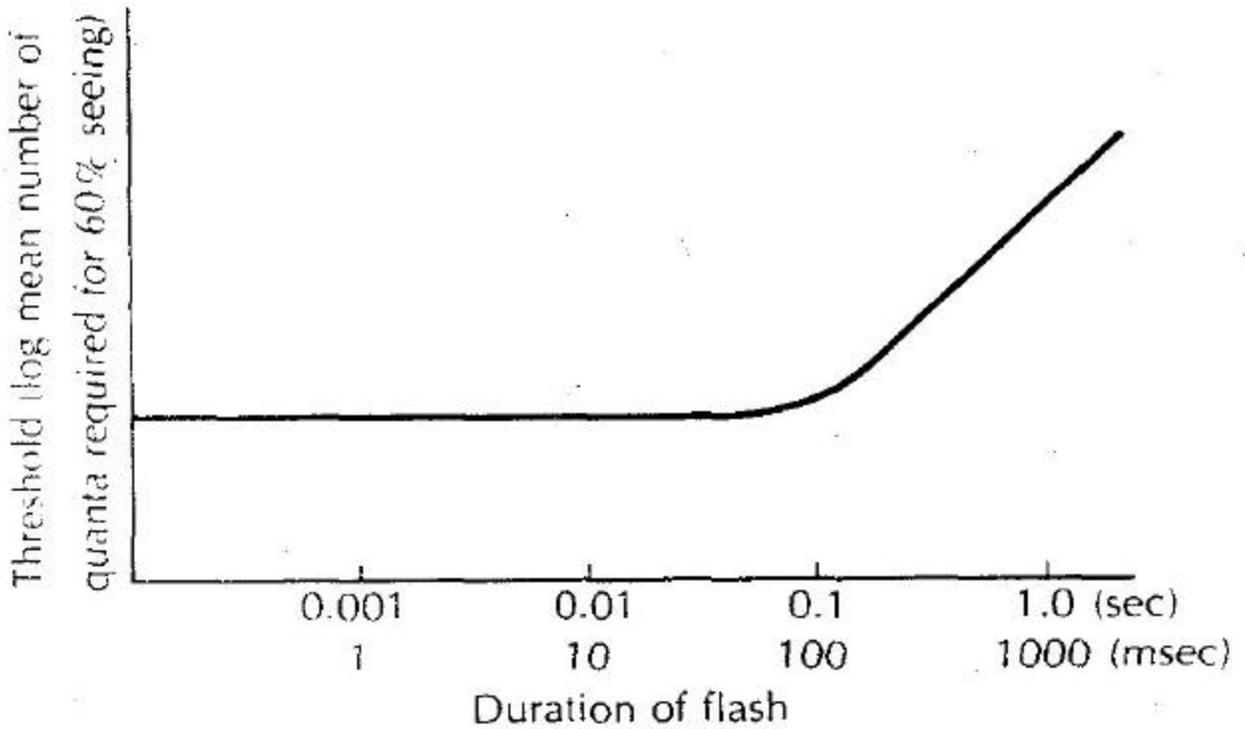
Q: What causes the normal "blind spot?"

A: The blind spot on each eye is caused by the connection to the optic nerve; the optic nerve blocks the retina at that spot. Our brains automatically fill in the blind spot.

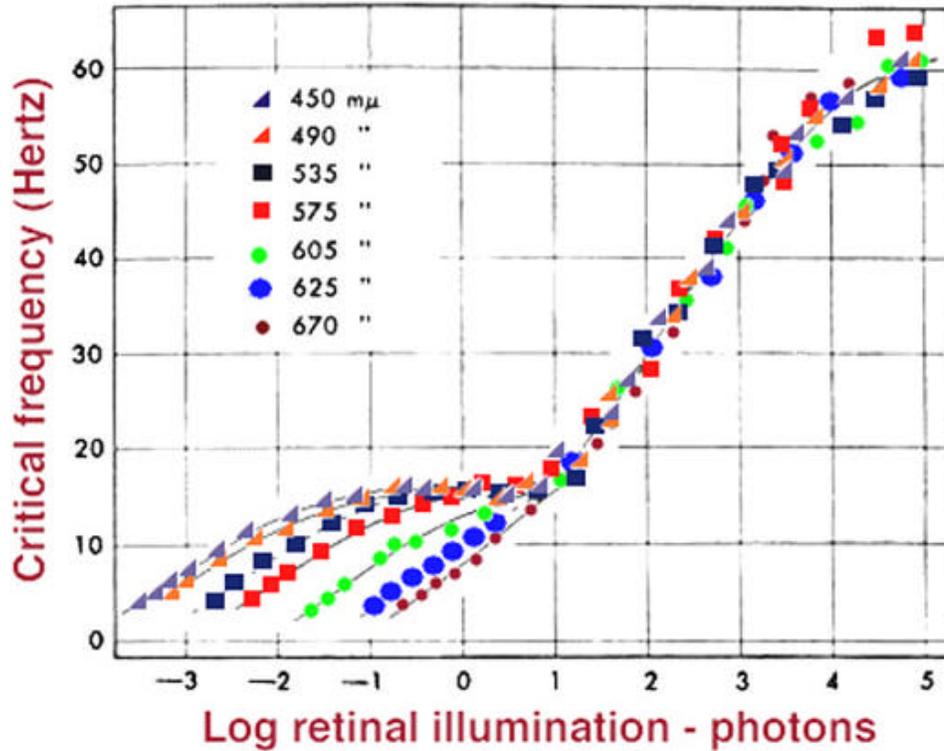
## Range of Vision



## Critical Duration



## Critical flicker frequency

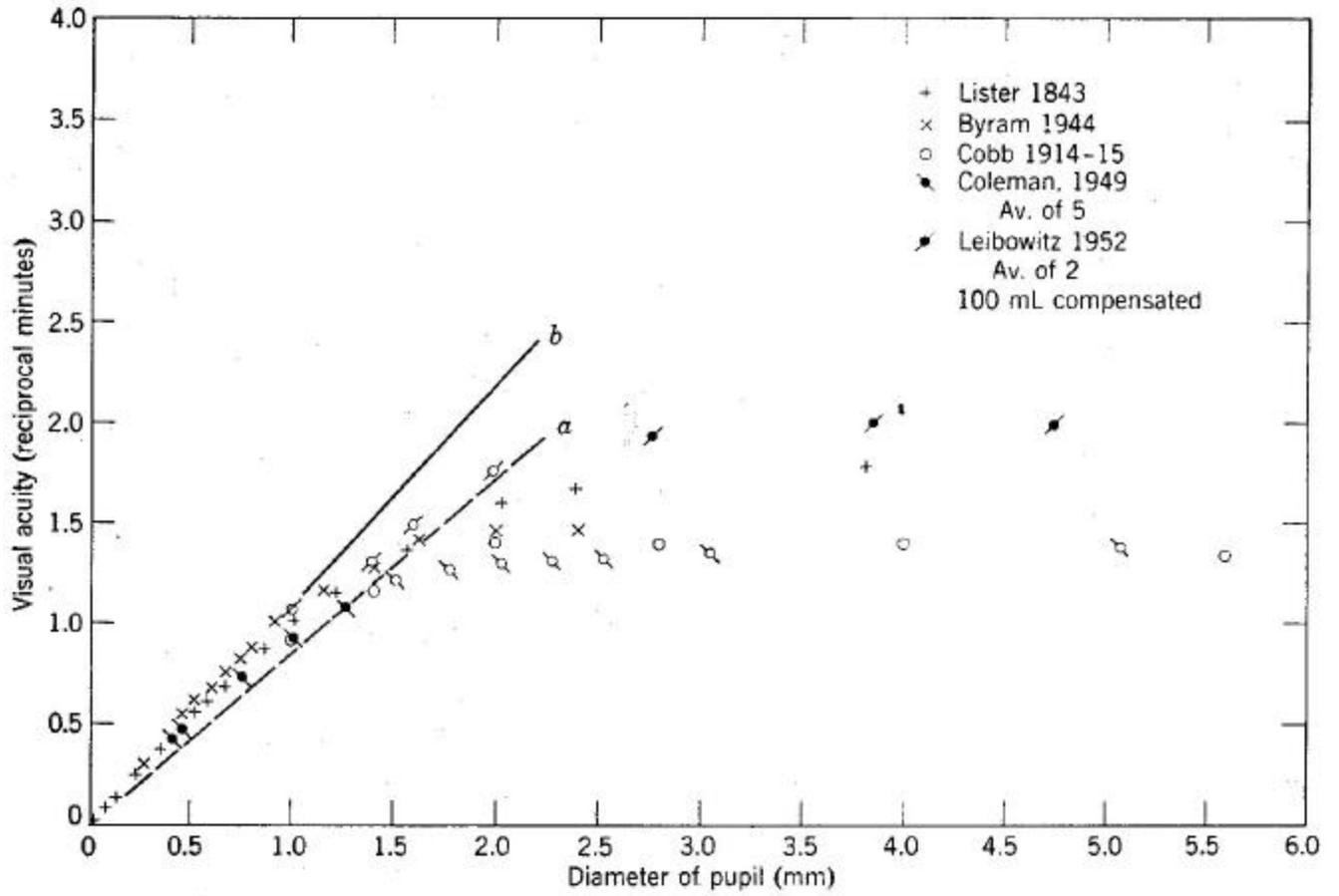


Our ability to distinguish “flicker” varies with illumination. People have finer temporal resolution as light increases.

Q: What gives nocturnal animals their night vision?

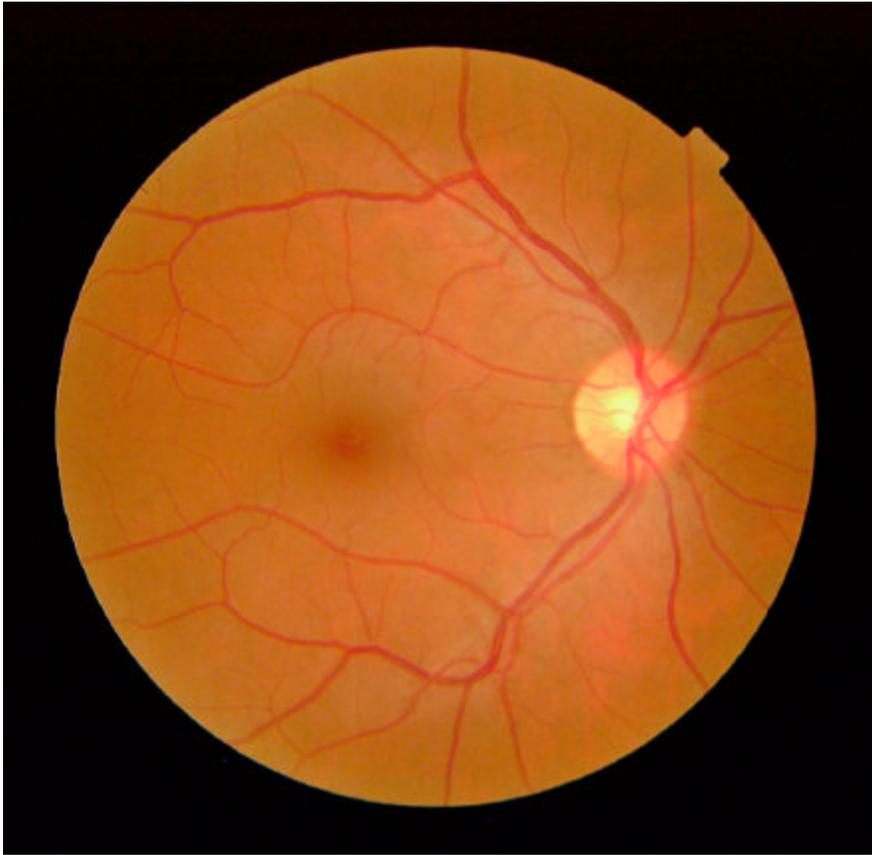
A: Nocturnal animals have “tapetum lucidum”, which is the term describing the process of allowing the light to pass through the eye twice. This gives the retina a “second chance” to grab the light, but causes a loss of sharpness of vision. Nocturnal animals also have more rods than other animals.

## Visual acuity versus pupil size



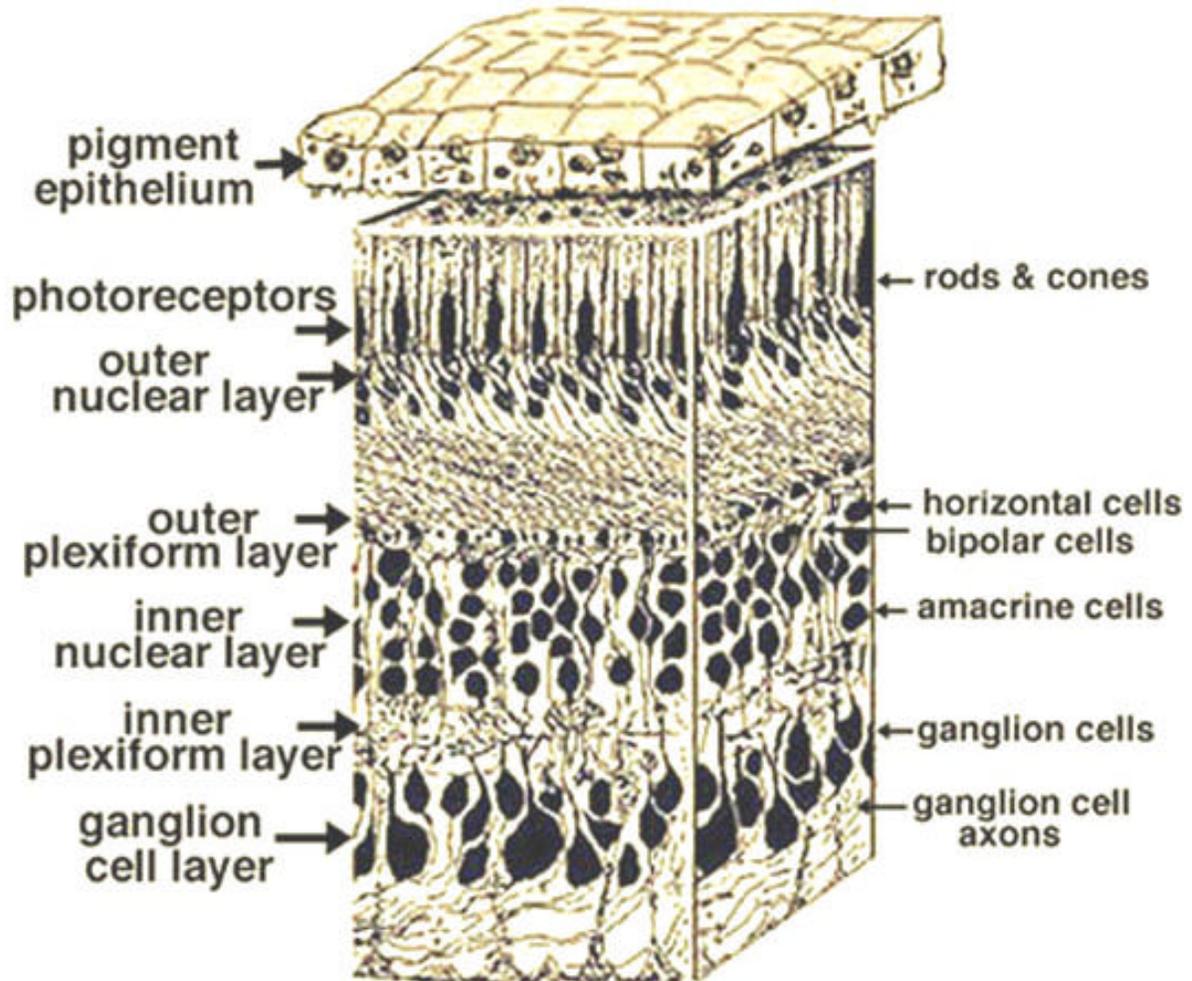
The pupil can get as wide as 10mm, with the aid of drugs, for medical purposes.

## Normal Fundus



Fundus is the back of the eye.

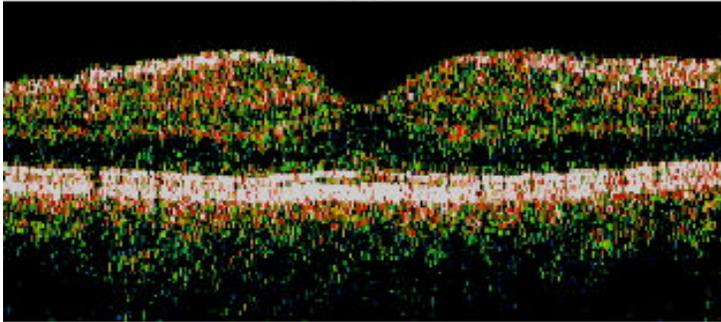
## The Human Retina



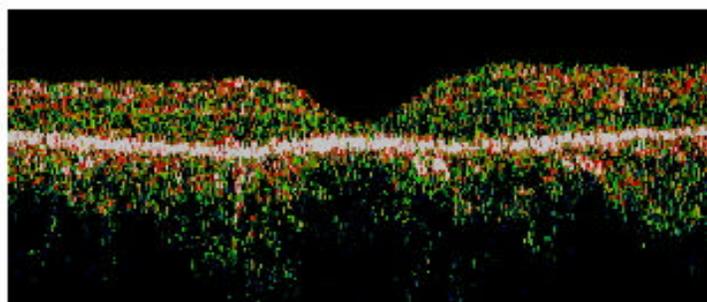
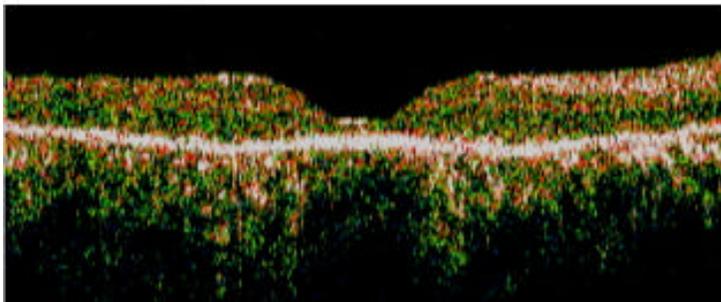
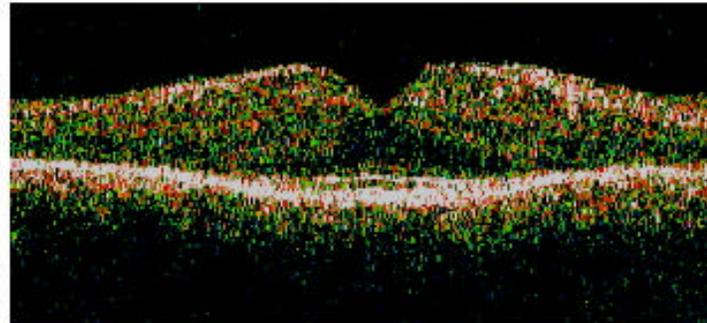
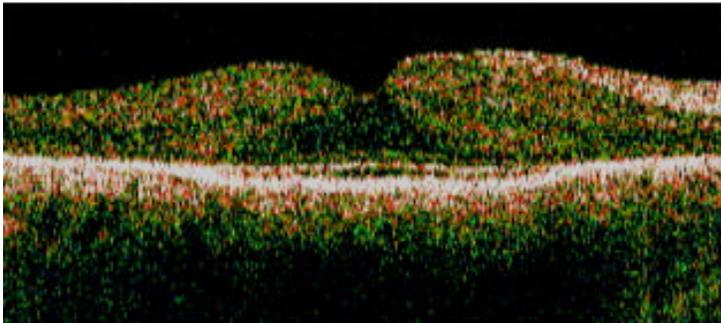
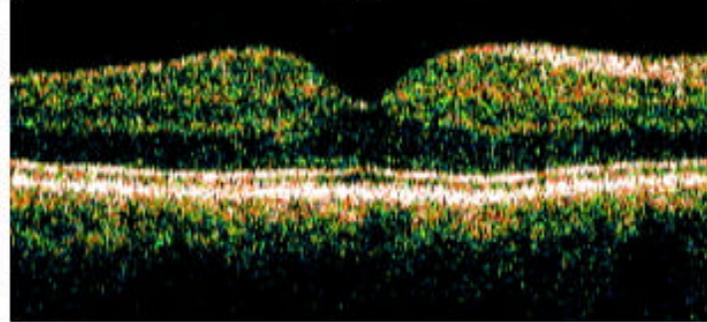
The light passes up from the bottom of the image and through many layers to reach the rods/cones. The intermediate layers are transparent and do not cause any deterioration of light quality.

*In vivo* microscopy

OD

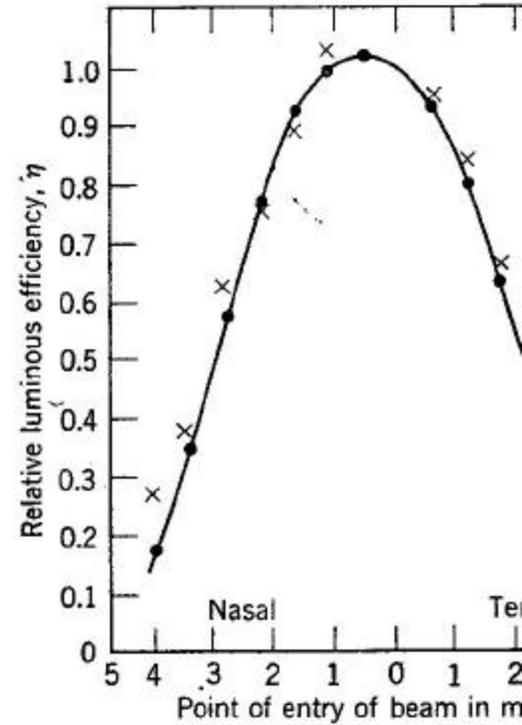
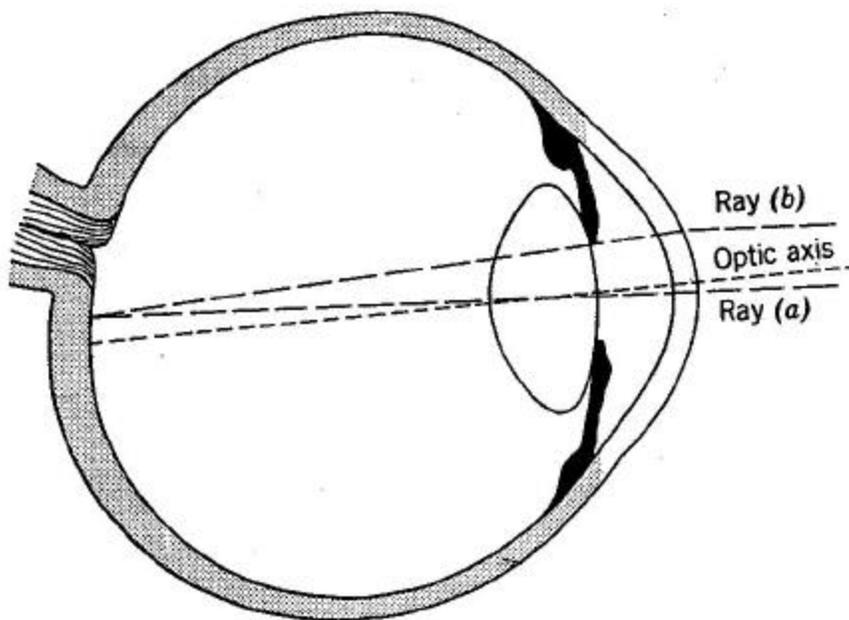


OS



Black areas are photoreceptors.

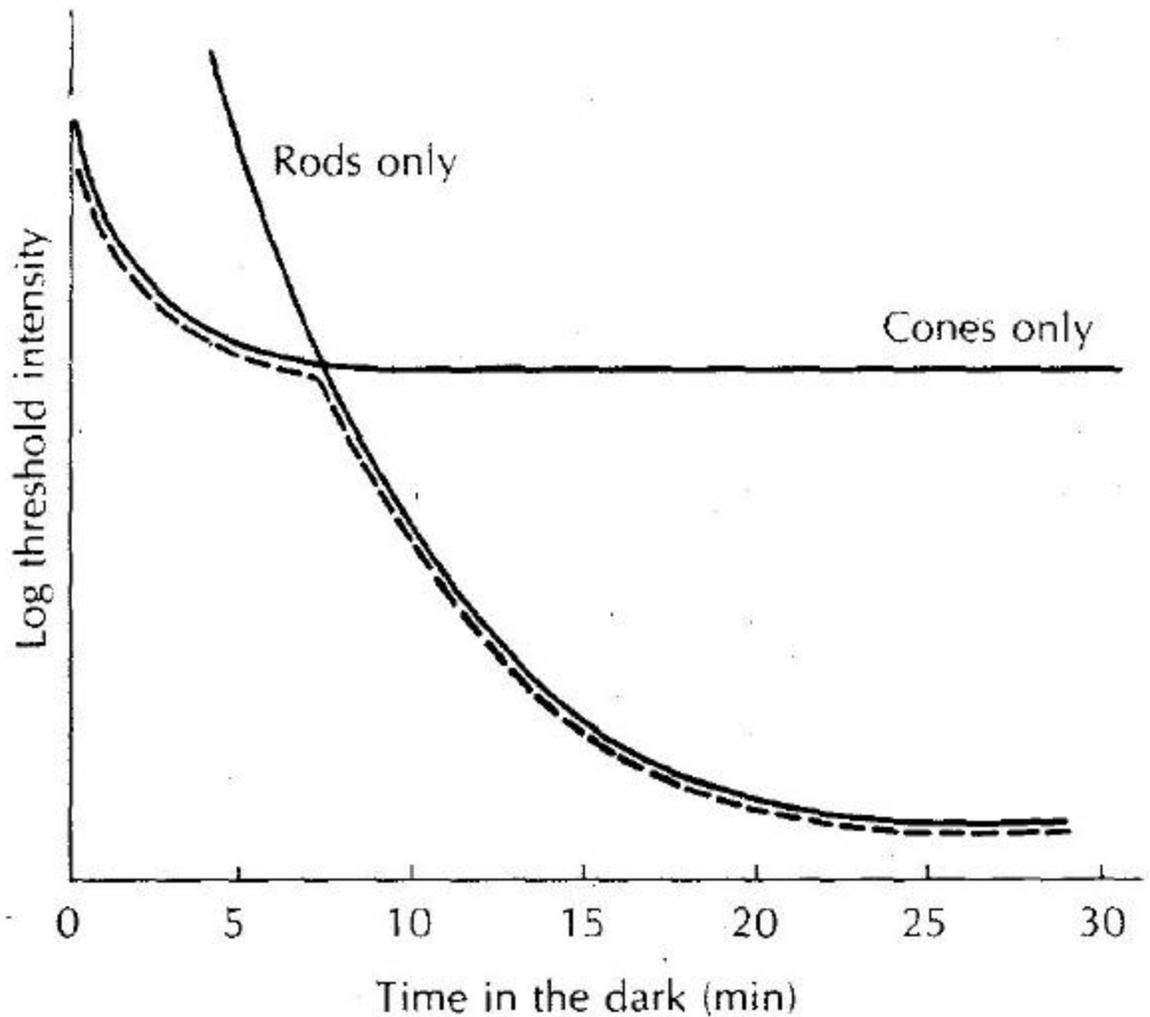
## Directional sensitivity



Cones capture daytime light, sharpness of light, and have directional sensitivity. The cones are more sensitive in the center of the eye, which cuts down on glare and improves contrast naturally.

Rods capture dim light and without color sensitivity. Rods also cannot capture light that is directly in front of them, (example: a star will disappear if looked directly at).

## Dark Adaptation



Rods have a 7 minute half life to adapt to light change  
Cones are much faster.

People who are red/green color blind are missing a pigment, not a cone.

Blues and greens are brightest at night time. Yellows are brightest during the day.

## Illumination

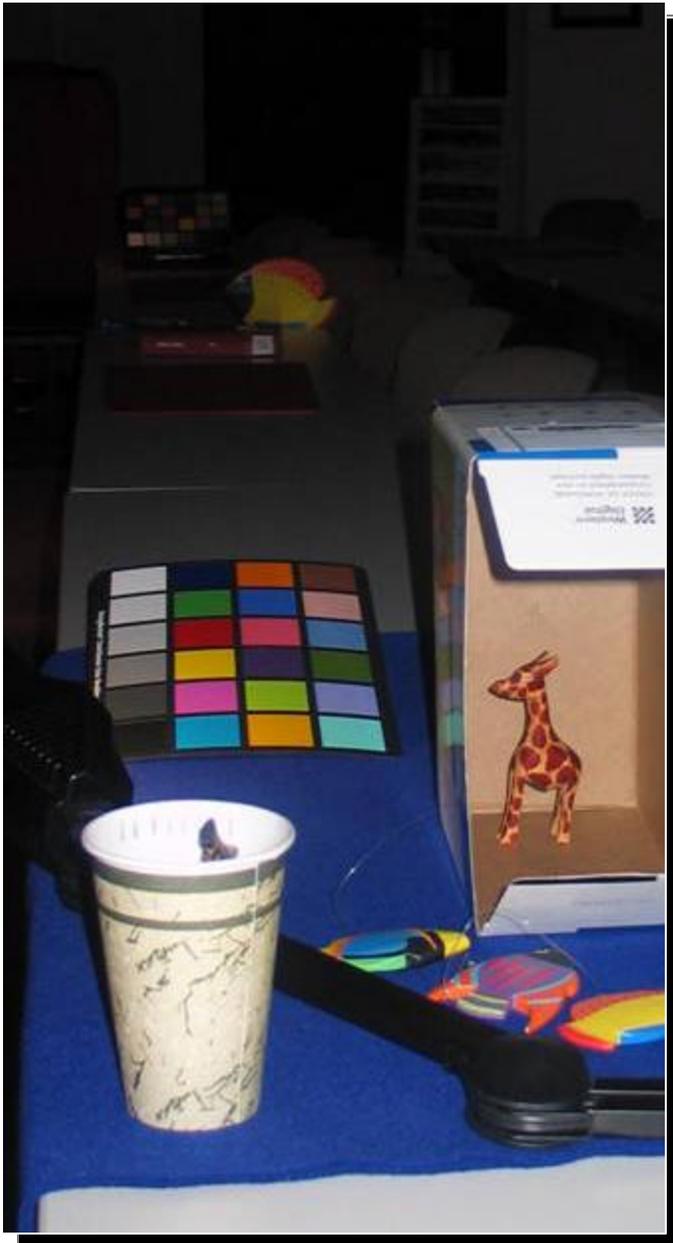
Possible class on Thursday 10 November 2005.

Midterm will be low on math, big on concepts. Relationships between things: aperture & focus, depth of field. Be prepared to draw a diagram.

Not much computation goes into flashes.

Red eye is caused by flash light bouncing off of retina and being captured in a picture. Red eye reduction is essentially an early flash that causes pupils to dilate, thereby reducing amount of light let into the pupil, thus lowering the amount of red light let out of the eye.

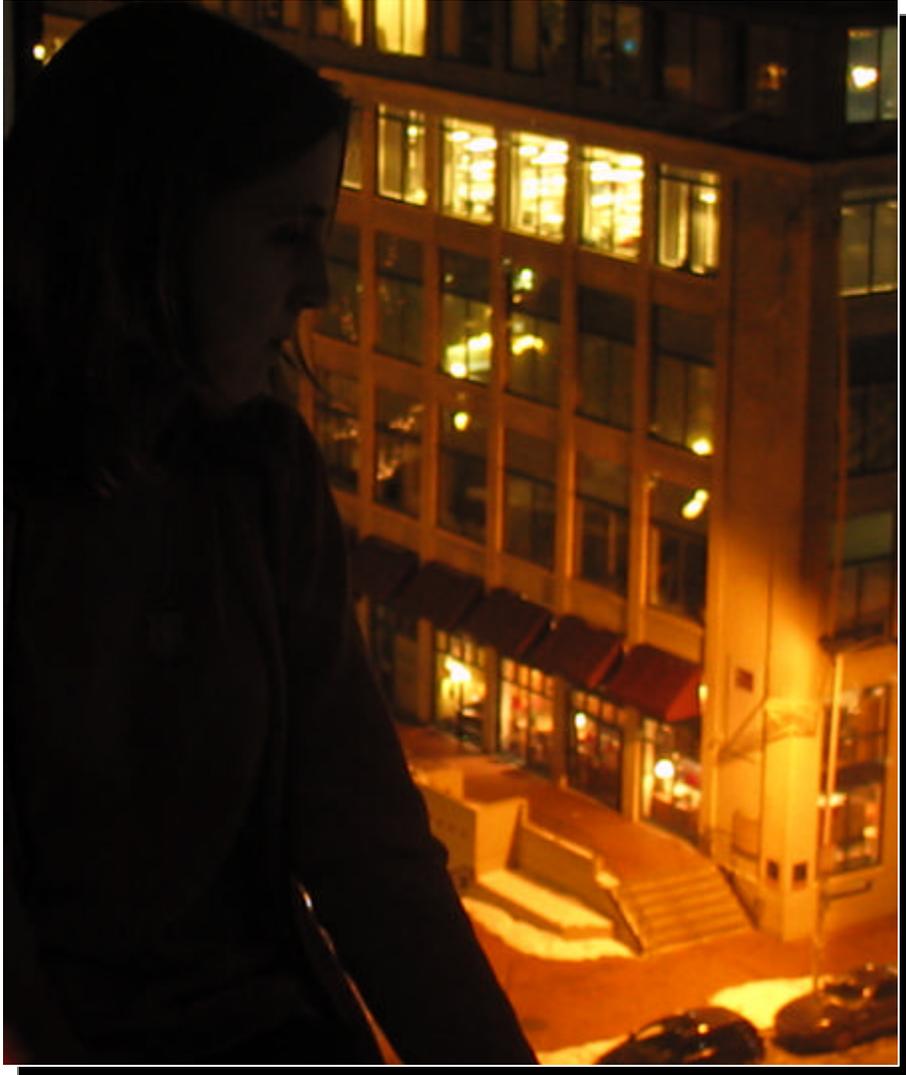
Retro reflections is when light is sent back in the direction of origin. Mirror reflection is when light is reflected over an angle.



The above image was taken with a flash. Flash brightness falls off at a square of the distance it travels. In the above image the box is well lit, but further down the table the image is still under exposed.



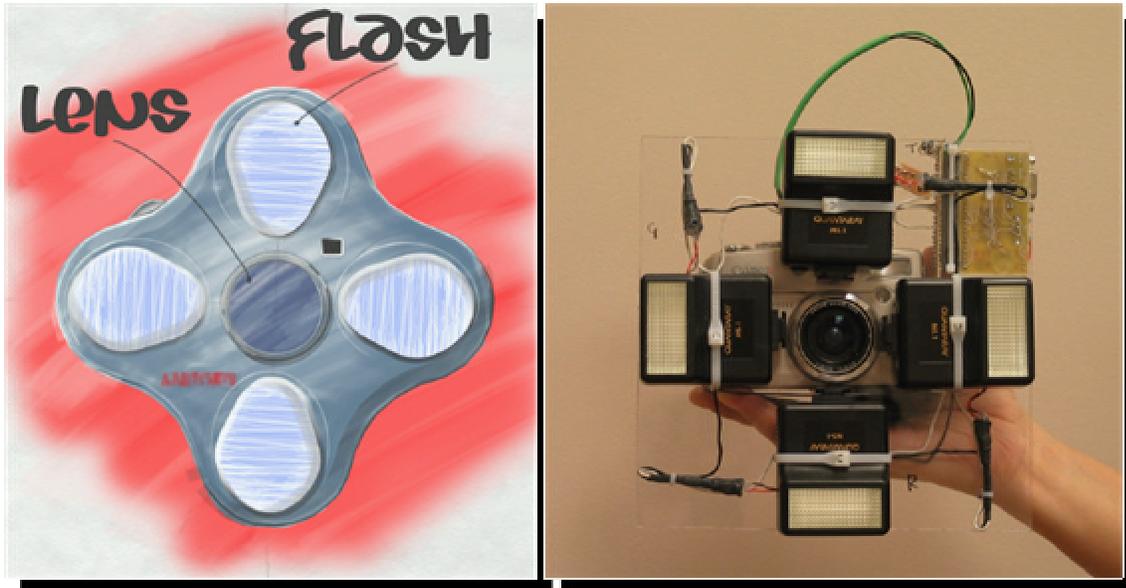
Taken with Flash



Taken with ambient light

The first image uses a flash which reflects the subject's image on the glass. The camera also sets itself for a low exposure time when using a flash; consequently, the building behind the glass is hardly visible in the first image.

## Non Photo Realistic Rendering (NPR)



By taking 4 pictures of the same object, each picture with the flash coming from a different direction, a single image can be made that details the real edges of an image. Additional computations can be done on that image and the original to produce a “cartoon” like image.





**Our Method**



**Canny Intensity  
Edge Detection**

The Canny intensity edge detection method gives too much information and makes it difficult to find the relevant information.