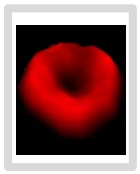

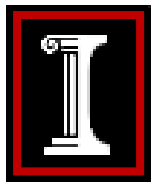

The Eye

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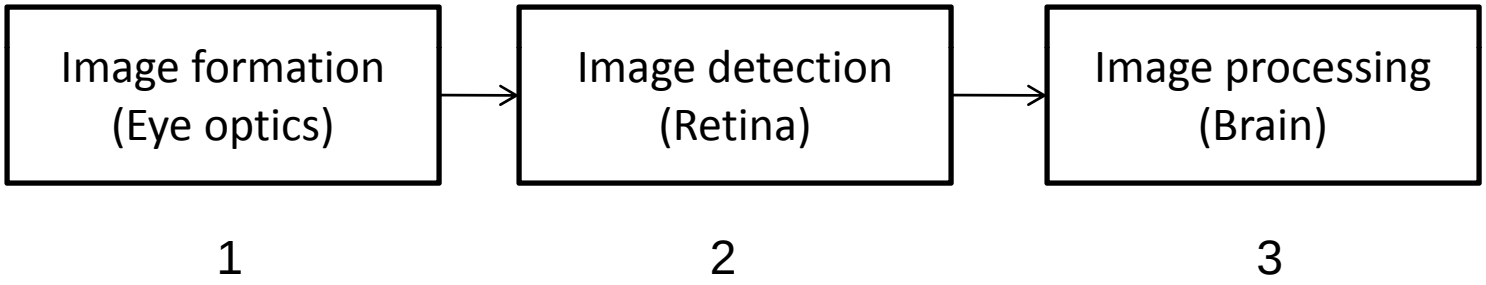
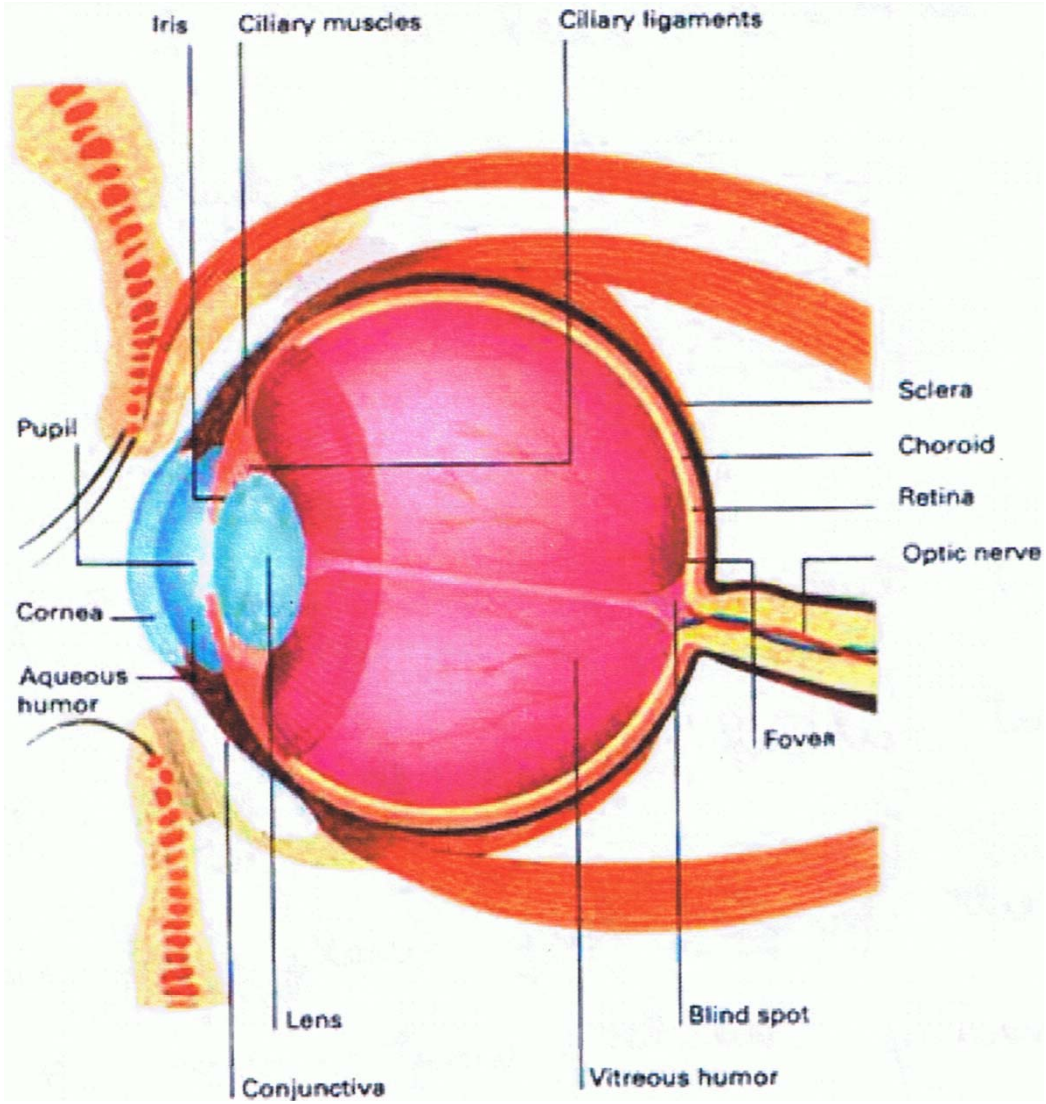
Introduction

- How do we see?
- There are 3 steps:



Introduction



1. Eye optics

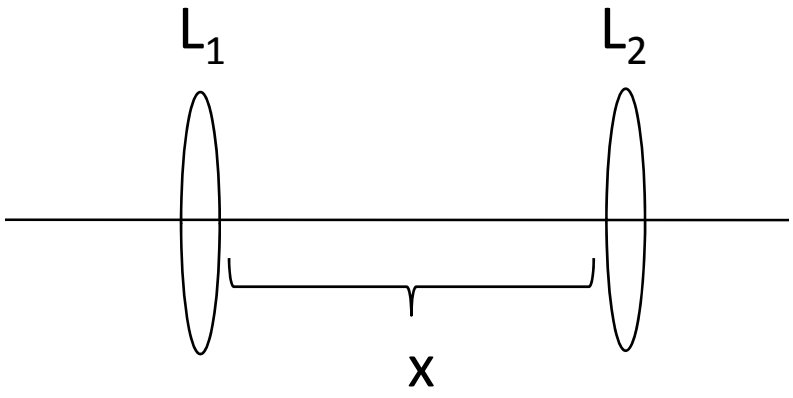
a) <u>The reduced eye</u>:

- The main optical components are: anterior cornea & lens
- Cornea: n = 1.37 (air: n = 1) → high power (convergence)

$$C = \frac{\Delta n}{f}$$

- cornea: C = 40m^{-1} =40d
- lens: C = 17 m^{-1} =40d

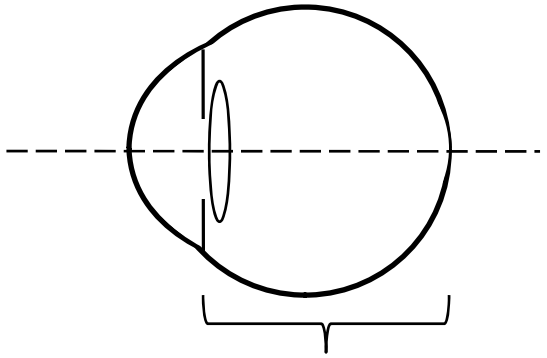
- Equivalent to:



1. Eye optics

$$C = \frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{x}{n f_1 f_2}$$ = equivalent power (1)

- Or even reduce it further to 1 lens
- One lens placed just behind the iris, i.e. 20 mm from retina, power = 50d



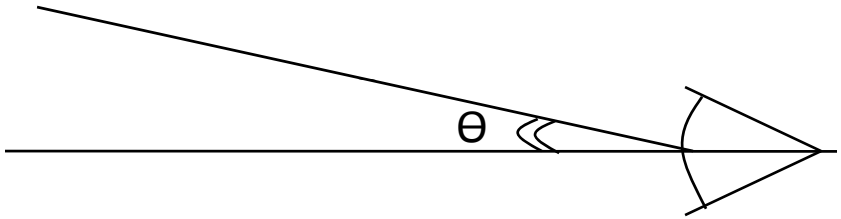
1. Eye optics

- Note $C = \frac{1}{20mm} = \frac{1}{0.2m} = 50d$ →retina at back focal plane
- $\frac{2}{3}C$ comes from cornea
- $\frac{1}{3}C$ comes from lens!

- The lens changes its curvature, thus its power, but its role is to adapt → most of convergence comes from cornea

1. Eye optics

b) Visual acuity:



- The smallest angle for which the eye still solves the 2 objects (resolution angle)

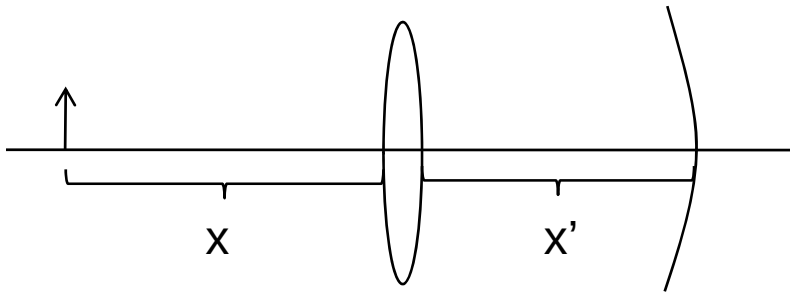
- $v = \frac{1}{\theta}$; $[\theta] =$ arc minute; 1 minute $= \frac{1}{60}\deg = \frac{1}{60}\frac{2\pi}{360} rad \simeq 0.3 mrad$
  - Visual acuity

1. Eye optics

c) The relaxed eye

- Relaxed = no accomodation
  - → Lens = the flatest, lowest power
  - → Looking far away
- Define net power, NP:

$$NP = C - \frac{1}{axis\ \ length} = \frac{1}{f} - \frac{1}{x'}$$



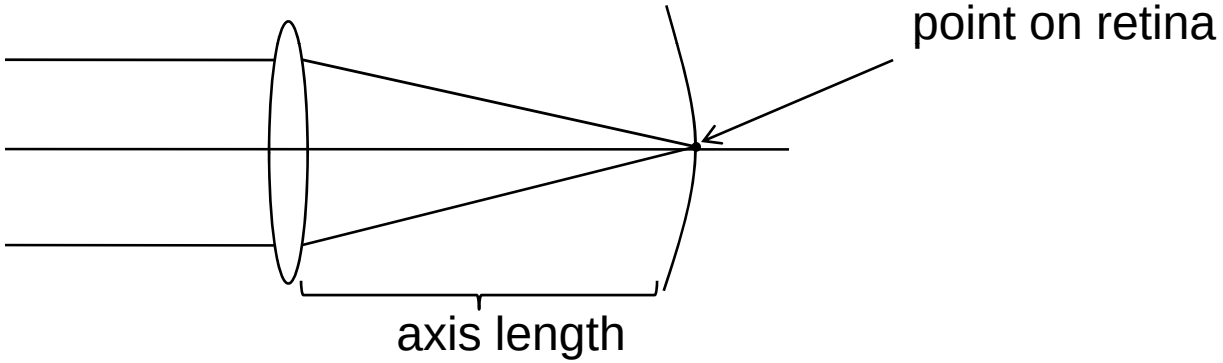
$$\boxed{NP = \frac{1}{x}}$$

1. Eye optics

- We have 3 distinct cases:
  - NP = 0 → Emmetropic eye
  - NP < 0 → Hyperopic
  - NP > 0 → Myopic

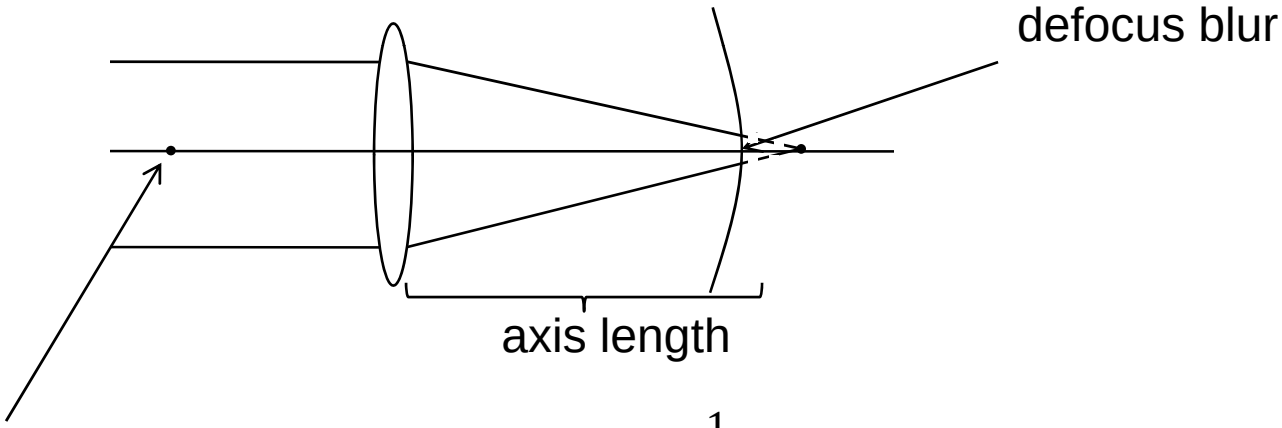
1. Eye optics

- Emmetropic eye: NP = 0



1. Eye optics

- Hyperopic: NP < 0 (confusing names)



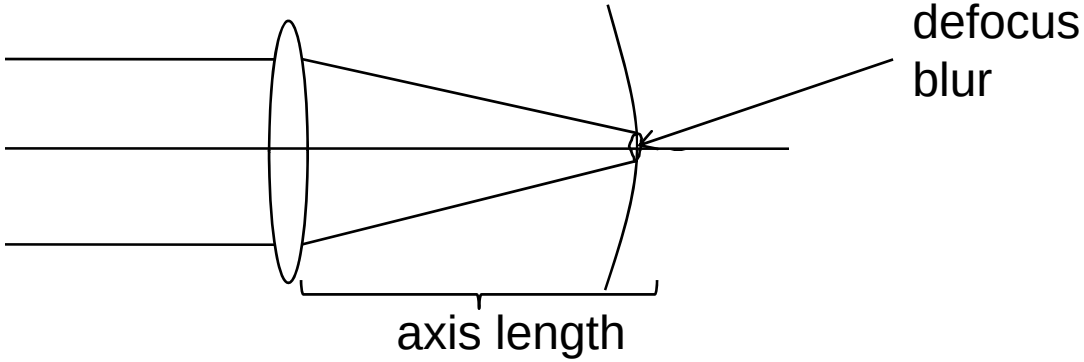
as if the object is closer ($NP = \frac{1}{x} < 0$)

decrease the object distance for good image

- Correction ➔ positive lens

1. Eye optics

- Myopic: NP > 0



- correction? $\frac{1}{x} > 0$!!!
- Clinical language: “state of refraction”
- Refers to the power neede for correction:

  Eg. “-2s myopic” → needs -2s to make NP = 0

1. Eye optics

d) Importance of pupil size:

- Pupil is larger in the dark
- Large pupil → larger aberrations

  that sinΘ ≠Θ → accomodation

e) Accomodation:

- Contraction/relaxation of ciliary muscle →

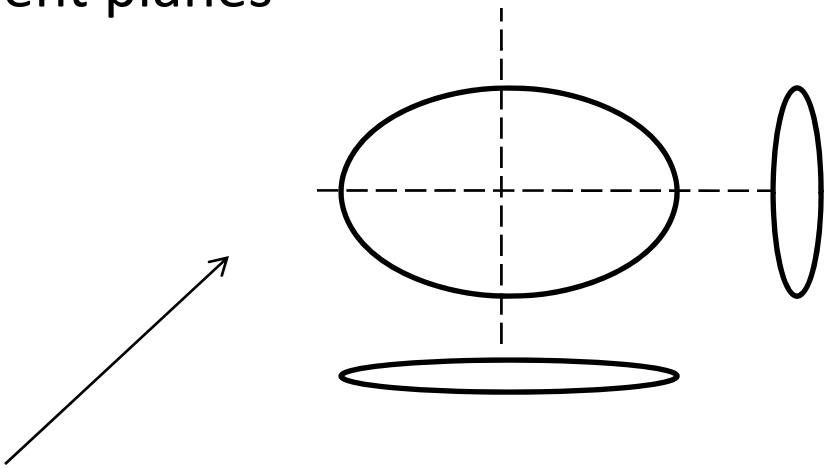
→Lens changes curvature → see closer object

- "presbiopia" = lens looses flexibility
- Range of accomodation: NP_{max}- NP_{min}

1. Eye optics

f) Astigmatism:

- The lens can be assymetric, i.e. Different curvatures in different planes



Most common orientation (eyelids apply pressure?)

1. Eye optics

g) Corrections:

- Glasses, contact lens
- More extreme method: intraocular lenses & cornea
- Hyperopia → positive lenses (hyper)

  → Self accomodation for most cases
- Myopia → negative lenses (O.5s is already a problem)
- Presbyopia → different lenses for different distances (eg. Reading & driving) → bifocal
- Astigmatism → astigmatic lenses (difficult with contact lenses)