NORMAL AGING VISION: Is Change Inevitable

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AGING DEMOGRAPHICS
WE KNOW THIS ALREADY

- Most older people have “excellent” vision.
- Some eye problems associated with age are annoying but do not cause visual loss.
NORMAL AGING VISION

• What exactly is “normal” in people over the age of 65?

• **Definition**: Having no immediately apparent structural or pathological defect that could account for reduced function (???)

• Conditions that occur in most older people (loss of accommodation, miosis) are considered normal
NEAR POINT CHANGES

"FOR THE LAST TIME, I DO NOT NEED GLASSES! NOW BE QUIET AND TURN THE PAGE."

FIGURE 2.20 The near point—the closest distance at which an object can be seen without blur—increases with age.

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VISUAL DIFFICULTIES

- < 50% of people under the age of 40 wear refractive correction
- Approximately 90% of people in their 40s or beyond need lens correction

**Presbyopia**

- Similar to farsightedness (hyperopia).
- Usually occurs around age 40.
- Caused by loss of elasticity in lens of eye.
- Close objects are out of focus, distance vision is clearer.
**VISUAL FUNCTION & AGE**

- Up to age 70, loss in static corrected acuity can be explained by miosis & lens changes.

- As age increases, the # of people who achieve normal corrected acuity decreases.

- VERY IMPORTANT: These people show no signs of ocular disease.

  Weymouth (1960)
CORNEA

- Corneal sensitivity decreases with age
- Touch threshold almost doubles between the ages of 10 and 80, especially after 40
- Consider entropion & ectropion

- Advantages and disadvantages regarding contact lenses
- Corneal curvature changes with age
- Astigmatism increases throughout life

Millodot (1977)
CORNEA

• As corneal sensitivity decreases, corneal fragility increases.

• Considerably less pressure is required to damage corneal epithelium in people over 60 than in younger individuals.

Increases risk for contact-lens wearers.

Millodot & Owens (1984)
CORNEA

• Linear increase in corneal curvature in the horizontal meridian with age

• Vertical meridian also steepens with age but with a much shallower slope

• Between the ages of 60 & 70, average cornea is reported to be spherical

• After 70, against-the-rule astigmatism becomes common

Hayashi et al. (1995)
ANTERIOR CHAMBER

- Depth of anterior chamber decreases with age
- At age 15-20, average depth = 3.6 mm
- At age 70, average depth = 3.0 mm
- This decrease in chamber depth could cause interference with aqueous flow

Weale (1962)
PUPILLARY MIOSIS & LIGHT

- Diameter of pupil in dark minus diameter of pupil in bright light becomes less & less with age

- Consequence: reduction in retinal illuminance

Birren et al. (1960)
• Lens grows throughout life

• Axial thickness ↑ by about 28% between the ages of 20 & 70

• Nuclear thickness remains constant while cortical thickness ↑

Dubbelman et al. (2001)
LENS

• Yellow pigment of the lens absorbs short wavelengths more than long ones

• Older people have decreased sensitivity in violet/blue end of the spectrum

• White objects may appear yellow & distinction between blues & greens is decreased
• Older people need significantly more light to achieve the same level of retinal illuminance

• Visual performance of an older individual will be especially impaired at twilight

• Driving should be given much more thought (testing conditions vs. reality)
VITREOUS

- Vitreous is subject to liquefaction & syneresis with age
- This increases speed & amplitude of the movements of vitreous floaters

Floaters may become distracting
In the absence of pathology, changes in the retina & further upstream are not directly observable.

Inferences must be made on the basis of visual function.

There’s the rub! Which function(s)?
ON THE ONE HAND

- No consistent change has been found in cone density with age
- Number of foveal cones remains stable
- Thus, loss of acuity in the absence of disease is not caused by a loss of photoreceptors

Curcio et al. (1993)
ON THE OTHER HAND

- There is a significant loss of rod density - as much as 30% in central retina
- Remaining rods increase in size, maintaining stable rod coverage
- Losses in scotopic function with age are either optical or post-receptoral

Curcio et al. (1993)
Approximately 20-30% thinning of retinal nerve fiber layer in healthy older people

Concomitant loss of pattern evoked potential in the same area

Functional impact is currently unknown
• Older people cannot reach levels of dark adaptation that younger people can.

Jackson et al. (1999)
Older people are more sensitive to glare & take longer to recover.

Fig. 4.15  Recovery times (mean ± SD) from macular dazzling as a function of age for a far and b near vision. After Gomez-Ulla et al. (1986).
VISUAL FUNCTION & AGE

- Inability to achieve at least 20/25 acuity cannot be explained for about 10% of people between the ages of 75 & 85

- Visual acuity has long been understood (at least by the rehabilitation community) to be an inadequate measure of visual function
HIGH - LOW CONTRAST ACUITY

Median acuities (N=900)

- **High contrast high luminance**
- **Low contrast high luminance**
- **Low contrast low luminance**
- **Low contrast surround glare**
CONTRAST SENSITIVITY

- High-frequency cut-off can be mimicked by artificial pupils & neutral density filters
- This means that the lens and pupil changes are responsible for upper frequency loss.
VERNIER ACUITY

- Observer is asked to align objects, not recognize them (hyperacuity task)
- Segments of a line, points of light, etc. are aligned vertically or horizontally
- This ability remains intact throughout life
VERNIER ACUITY

Vernier Alignment Thresholds vs Age Groups

Vernier Alignment Threshold in arcsec (Log scale)

Age Groups

Gap Size 8 min
Gap Size 16 min
Gap Size 32 min
Gap Size 64 min
Gap Size 91 min
STILES-CRAWFORD EFFECT

- Tests the directional sensitivity of the retinal receptors
- Relies on proper alignment of the retinal receptors
- Light entering different points of the pupil is differently absorbed by receptors
STILES-CRAWFORD EFFECT
STILES-CRAWFORD EFFECT

A

Left, normal eye.

B

Right, amblyopic eye.

log relative sensitivity

beam position at pupil plane (mm)

log relative sensitivity

beam position at pupil plane (mm)
COLOUR PERCEPTION

• There has always been a debate concerning colour vision changes in older people

• Question:
  – To what degree are changes in colour perception due to optical media (especially the lens) & to what extent are they due to retinal changes?

• Are the short-wavelength (blue) cones playing a big role?
OPTICAL CORRECTION

The diagram illustrates the R-B luminance contrast balance across different age groups. The x-axis represents age groups, ranging from under 30 to 80s. The y-axis shows the R-B luminance contrast balance, indicating how well the eyes can distinguish between red and blue light. The bars represent the contrast balance for each age group, with error bars indicating the variability within each group. The chart also includes a separate section labeled 'pseudophakes' for individuals with pseudoephakes (presbyopia correction).
SYMMETRY PERCEPTION

• Detection of symmetry is an important visual ability

• Consider how many objects in our environment are approximately symmetrical (faces, butterflies etc)
Our data show a decline in symmetry perception in people over 65 … but it’s an organized change.
Every man desires to live long, but no man would be old.

Jonathan Swift

'Thoughts on Various Subjects'