Aging-Related Vision Impairment and Its Relevance to Cognition

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NIA/AGS U13 Sensory Impairment & Cognition Decline Workshop  October 2, 2017
Acknowledgments

• National Institute on Aging
  • R01AG004212
  • P30AG022838
• National Eye Institute
  • R01EY018966
  • R21EY027817
  • P30EY003039
• Research to Prevent Blindness
• EyeSight Foundation of Alabama
Anatomy of the Eye

- Anterior chamber (aq. Humor)
- Ciliary body (muscle)
- Vitreous body/humor
- Optic disc
- Conjonctiva
- Iris & Pupil
- Suspensory ligaments
- Extraocular muscle
- Retina
- Sclera
- Trabecular meshwork
- Schlemm's canal
- Optical axis
- Optic nerve
- Fovea centralis
- Visual axis
- Lens
- Cornea
- Lens
- Posterior chamber & Pupil
- Zonule fibers
Layered Organization of Retina: Schematic

- photoreceptor layer
- outer nuclear layer
- outer plexiform layer
- inner nuclear layer
- ganglion cell layer
- inner plexiform layer
- nerve fiber layer
- inner limiting membrane
- choroid
- pigment epithelium
- sclera

Light flow from inner toward outer layers. Light passes through multiple layers before reaching photoreceptors.

Plexiform layer = synapses
Nuclear layer = cell bodies
Spectral Domain Optical Coherence Tomography (SDOCT)

- Light flow from inner toward outer layers
- Light passes through multiple layers before reaching photoreceptors

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- ILM: Inner limiting membrane
- IPL: Inner plexiform layer
- INL: Inner nuclear layer
- OPL: Outer plexiform layer
- ONL: Outer nuclear layer
- ELM: External limiting membrane
- IS/OS: Junction of inner and outer photoreceptor segments
- OPR: Outer segment PR/RPE complex
- NFL: Nerve fiber layer
- GCL: Ganglion cell layer
- RPE: Retinal pigment epithelium
  + Bruch’s Membrane

Plexiform layer = synapses
Nuclear layer = cell bodies
- Visual field defects with Lesions along Geniculo-cortical pathway
Integrative Visual Pathways

Common Aging-Related Vision Problems

- Spatial contrast sensitivity impairment
- Scotopic dysfunction
- Slowed visual processing speed

Spatial contrast sensitivity loss

Owsley et al. *Arch Ophthalmol* 2001; 119; 881-887
Slowed dark adaptation

Slowed visual processing speed

- Time needed to make a correct judgment about a visual target or event.
- One of the most robust behavioral phenomena of human aging
- Deficits in many cognitive domains are associated with slowed visual processing speed
- Population-based studies indicate 1 out of 3-4 older adults have severe processing speed slowing.
- Slowed visual processing speed associated with many daily life difficulties.

Vision-Cognition Relationships

• “Bottom-up” influences
  • Near visual acuity impairment associated with worse cognitive function several years later (Reyes-Ortiz et al. JAGS 2005; 53: 681-686)
  • Improving near vision by correcting refractive error reduces depressive symptoms in nursing home residents (Owsley et al. Arch Ophthalmol 2007; 125: 1471-1477)

• “Top-down” influences
  • Semantically salient visual targets are located and fixated more rapidly than cognitively irrelevant targets (Henderson et al. Psychon Bull Rev 2009: 16: 850-856).
  • A “preferred retinal locus” (when foveal fixation is not possible) is more likely to be located in a retinal area where sustained attentional performance is at its best (Barraza-Bernal et al. Vision Res 2017; 140: 1-12.)

• “Common cause” hypotheses (Olderbak et al. Frontiers in Psychology 2015; 6: 1189)
Plasticity

• When the macula has an absolute scotoma due to end-stage AMD, is the visual cortical area devoted to the fovea recruited for other purposes?

• “Brain training” for older adults: most of these exercises rely on visual stimulation—can aging-related cognitive declines be mitigated or postponed by these practice with these visual exercises?
Thank you
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Kinetic sculpture
“Complex Vision”
Artist: Yaacov Agam