Vision Impairments that Affect Driving Performance
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Objectives

1. Participants will explain the epidemiological trend of the aging of America, and the potential impact on driving safety and community accessibility.
2. Participants will discuss functional vision deficits of 5 common age-related eye disease processes and “hidden” vision deficits associated with 3 non-vision disease processes.
3. Participants will compare and contrast standard optometric testing techniques for visual function and describe the relative impact on driving safety.
4. Participants will identify 3 compensatory strategies for functional vision deficits to maximize driving safety.
5. Participants will understand vision screening tool options to assess key visual performance areas that are necessary for driving safety.

Vision Impairment Expected Prevalence
(2006-2008 CDC Behavioral Risk Factor Surveillance System Data)
- U.S. population overall
  - 2014: estimated 318.9 million
  - 2050: expected to reach 438 million
- Prevalence of Vision Impairment (in millions)
  - Age-related Macular Degeneration expected to double 9.1 m to 17.8 m
  - Cataract expected to increase 24.4 m to 45.6 m
  - Diabetic Retinopathy expected to quadruple 2.5 m to 9.9 m
  - Glaucoma expected to increase nearly 90% 2.7 m to 5.5 m
  - Visually impaired expected to increase 2.9 m to 7.3 m
  - Blindness expected to increase 1.2 m to 3.0 m

Interesting findings regarding older drivers:
https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812273

- In 2014, more than 5,700 older adults were killed and more than 236,000 were treated in emergency departments for motor vehicle crash injuries: a daily average of 16 older adults killed and 648 injured in crashes.

- The population of people 65 and older increased by 26 % from 2005 to 2014, but driver fatalities in crashes involving older drivers declined by 10 %.

- In 2015, there were more than 40 million licensed older drivers, which is a 50 % increase from 1999.
Review of the Eye structure and function

Cranial Nerve II (Optic Nerve Pathway)

- Receives electrical and chemical impulses from photoreceptors in the retina—rods and cones
  - Signal
    → retina
    → optic nerve
    → optic chiasm
    → optic tract
  → lateral geniculate nucleus (thalamus)
  → optic radiation
  → visual cortex (occipital lobe)

http://scienceblogs.com/thoughtfulanimal/2010/06/30/ask-a-scienceblogger-sensation/
Function of Cranial Nerves


**Cranial Nerve III** (Oculomotor Nerve)
- Raises eyelids and controls pupils; ptosis, drooping eyelids
- Eye muscle function for smooth and binocular motor control
- **Superior Rectus**: rotates the eye upward and medially (adducts)
- **Inferior Rectus**: depresses and adducts the eye
- **Medial Rectus**: largest eye muscle; rotates the eye medially (adducts)
- **Inferior oblique**: rotates the eye externally, upward and outward

**Cranial Nerve IV** (Trochlear Nerve)
- Eye looks downward toward mouth
- Damage results in eye slightly elevated in primary gaze
- **Superior oblique**: internal rotation and depression

**Cranial Nerve VI** (Abducens Nerve)
- Damage results in eye turning inward (cross eyed, strabismus)
- Intermittent double vision in lateral gaze
- Esotropia (eye resting in inward position) causes distance vision issues: driving limitations
- **Lateral Rectus**: abducts the eye laterally for horizontal motion, away from midline

Measurement of Functional Vision (DMV visual considerations)

- **Acuity**
  - Measured as a fraction that expresses the ability to focus at near or far distance (20/20)
  - If you have 20/100 vision, it means that you need to be as close as 20 feet to see what a person with normal vision can see at 100 feet.
  - Testing: Distance: Snellen Eye Chart; Near: MN Read Card

- **Visual field**
  - Peripheral vision: any vision outside of central vision; temporal or nasal
  - Scotoma: a partial loss of vision or a blind spot in an otherwise normal visual field; geographic atrophy; ring scotoma
  - Visual field cut: hemianopia, quadrantanopia
  - Neglect: functional visual field deficit
  - Testing: Confrontation fields; OD/MD test: Goldmann or Humphrey Visual Field Test

- **Contrast sensitivity**
  - The ability to distinguish objects from the background with reduced functional visual acuity
  - A critical component of functional adequate vision
  - Primary factor for driving safety, (not required by DMV)
  - Testing: use charts: Continuous Text Low Contrast; Peli-Robeson Low Contrast

Age-Related Functional Vision Changes
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• Difficulty seeing when alternating through bright and shaded areas
• Problems seeing in low light or at night
• Changes in color perception
• Changes in peripheral vision
• Eye fatigue
• Difficulty adapting to glare from bright sunlight or glare from headlights
• Difficulty judging distances and speed; decreased depth perception
• Difficulty seeing objects up close when wearing distance lenses (car instrument panel)


Common visual disease processes that may affect Older Adult driving safety:*  
• Refractive Errors—incorrect prescription for glasses or contacts
• Cataracts—blurring, decreased detail, sensitivity to bright light and glare, decreased contrast sensitivity
• Glaucoma—”thief of sight”, decreased peripheral vision, decreased night vision
• Age Related Macular Degeneration—decreased central vision, detail; peripheral vision is better; younger onset may be Stargardt’s Disease
• Diabetic Retinopathy—mild to severe loss; affects ~ 30% of diabetic patients
• Retinitis Pigmentosa (RP)—peripheral vision is gradually lost; tunnel vision eventually declines to no vision.
• Corneal Opacities—eye injury, infection or certain eye diseases that lead to scarring or clouding of the cornea (chemical, radiation, contacts)
• Monocular vision: depth perception, peripheral vision limitations


Less common visual diseases that may affect teen drivers:
• Optic Atrophy: Degeneration or damage to the optic nerve
  – Chronic/stable or progressive
  – Due to brain trauma, inflammation, degenerative disorders, hemorrhage, tumor
  – Symptoms: decreased acuity and brightness, impaired color detection, decreased temporal vision
• Ocular Albinism: hereditary condition normally seen as decreased pigment in the eyes, skin, hair
  – Sensitive to bright light and glare
  – Associated sensory deprivation nystagmus or strabismus-- misalignment of eye: exotropia or esotropia

Eye Limitations in non-vision based disease processes:
• Parkinson’s Disease: Blepharospasms, decreased blink rate, blurry vision, double vision/diplopia
• Multiple Sclerosis: optic neuritis, blurry vision, fluctuating diplopia/double vision
• Myasthenia Gravis: eye fatigue, diplopia
Strategies to maximize functional vision for driving safety

Compensatory Strategies
- Best distance correction
- Expanded view and side mirrors
- Scanning and head positioning to redirect best visual field
- Electronic aids for vehicles
- Electronic apps for route finding
- Glare control for day and night: Sun-filters -vs- tinted sunglasses lenses
  - High definition, blue light blocker, non-polarized
  - Assists with glare control to maximize remaining vision
  - Protects eyes from UV light rays
  - Enhances contrast with the blue-light block
  - Improves color detection with color blindness
  - Reduces eye strain and minimizes headaches
- Brands: Cocoon non-polarized, Noir, Solar Shield, Enchroma (colorblind);
  - Maxi-Aids: Cocoons, Noir
  - Cocoons: Low Vision, Night Driving Twilight fit-overs
  - Eschenbach: Solar Shields, Haven Night Drivers
Clinical Visual Field Testing

Normal visual fields
- Vertical
  - Superior: 55-65 degrees
  - Inferior: 60-70 degrees
- Horizontal
  - Nasal: 50-60 degrees
  - Temporal: 90-110 degrees

Manual visual field testing
- Confrontation fields (some state DMV Medical Boards require degrees)
- California Central Visual Field Test: Mattingly Low Vision, Inc.

Optometric clinical tests: Perimetry
- Humphrey
  - Central vision testing
    - Common visual field test for central vision in glaucoma
    - Monocular test
    - Measures in degrees: 10-2, 24-2, 30-2
    - May be good predictor for driving safety for glaucoma, but not for full temporal and nasal vision
    - Dark area is impaired
  - Esterman Binocular VF
    - DMV accepted Humphrey
    - Binocular test
    - Measured in degrees: 80 degrees temporally
GOLDMANN VISUAL FIELD TEST WITH LEFT HOMONYMOUS HEMIANOPSIA

Visual field considerations
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- Should DMV require full visual field test to capture any field deficits?
- Should DMV consider vertical range measurement?
- Does visual field testing capture visual neglect?

**Bioptic Telescope Lens System Use**

- Considerations for use
- State specific requirements
  - Visual field
  - Visual acuity in carrier frame and through telescope
- Training requirements
  - Vary by state
  - Main parts: clinical, descriptive passenger driving, behind-the-wheel training
- Products: Ocutech, Inc.;
  https://ocutech.com/

![Ocutech VES Sport II](image1)

![Ocutech Explorer](image2)

![Ocutech SightScope](image3)
RESOURCES

- Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: a systematic review and meta-analysis http://www.thelancet.com/journals/langlo/article/PIIS2214-109X(17)30293-0/fulltext
- On-Road Driving Performance by Persons with Hemianopia and Quadrantanopia
- CDC Resources
  - Older Adult Drivers (https://www.cdc.gov/Motorvehiclesafety/Older_Adult_Drivers/index.html)
  - Podcast—Keeping Older Drivers Safe on The Road
- AAA Foundation for Traffic Safety
  - Senior Driver Web Site
  - AAA National: AAA Roadwise Review
    - A Tool to Help Seniors Drive Safely Longer
- Community Transportation Association of America
  - Senior Transportation
- The International Agency for the Prevention of Blindness (IAPB)
  - Vision 2020 https://www.iapb.org/vision-2020/
- National Highway Traffic Safety Administration
  - Active Aging Programs
  - https://icsw.nhtsa.gov/people/injury/olddrive/
  - Physicians Guide to Assessing and Counseling Older Drivers

Resources: Vision and Driving Agencies

- https://www.cdc.gov/motorvehiclesafety/older_adult_drivers/index.html
- https://www.cdc.gov/visionhealth/home/index.html
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- http://www.caregiverslibrary.org/caregivers-resources/grp-transportation/transportation-and-the-elderly-article.aspx
- https://biopticdrivingusa.com

Resources: Low Vision Agencies

- Vision Aware http://www.visionaware.org/
- Foundation Fighting Blindness http://www.blindness.org/
- National Association Listing http://www.lowvision.org/national_associations.htm
- E.A.R.S. for EYES (ADL/IADL CDs) http://www.earsforeyes.org
- American Optometric Association https://www.aoa.org

Low Vision Resources: Products

- http://www.cocoons.com Cocoons non-polarized blue light blocker sun-filters; under “Low Vision”; night driving glasses “Twilight”
- www.independentliving.com Independent Living Aids (ILA); NoIR non-polarized blue light blocker sun-filters
- http://freedomscientific.com/ Electronic visual aids
- www.maxiaids.com Aids for visual impairment
- https://ocutech.com/ Bioptic telescope lens systems approved for driving
- https://us.optelec.com/ Electronic visual aids
- https://www.enhancedvision.com/ Electronic visual aids