

Driving with Low Vision

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Driving is important and provides independence

- Our job is to help people who are able and legal to drive to continue to do so safely
- Many patients self-limit driving to grocery, church, etc, and don't drive on highways. This still provides a great deal of independence that is otherwise lost.

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Outline of the talk

- Why should I think that patients with low vision can drive?
- Central and Peripheral Vision
- Central vision
 - Visual acuity and scotomas
 - Medical conditions
- Peripheral vision
 - Visual fields
 - Medical conditions
- Modified Vision programs
- Examples

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Why should I think that people with low vision can drive?

- Low vision: When (using regular glasses) a person cannot do the visual tasks that are important in his/her daily life
- Low vision rehabilitation uses devices, adaptive strategies, to allow a person to do what is important to him/her effectively
- Even (self-) limited driving restores independence
- LOW VISION DOES NOT MEAN BLINDNESS

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What level of vision is needed for driving?

- Good question
- States differ widely in their requirements
 - 11 states have no visual field requirement (DE, NJ)
 - 4 states allow driving up to 20/200 visual acuity (CA, IA, MO, MS)
- What is effect of
 - General blurring?
 - Reduced central vision?
 - Blind spots in field of vision?
 - Visual field cuts?

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Central versus peripheral vision

- Central vision: Reading, recognizing faces, fine detail
 - Depends on macula working
- Peripheral vision: Mobility, orientation
 - Depends on whole retina working
- Disease may cause one or the other or both

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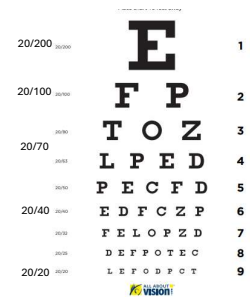
Measuring central vision: Visual acuity

20/X The driver sees at 20 feet
what is normally seen at X feet

20/20 Normal

20/40 Need twice as big

20/100 Need five times as big



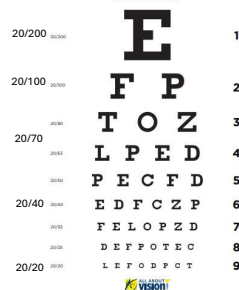
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Meeting MVA standards (assumes normal visual field)

- At branch: 20/40 for each eye
- By doctor: 20/70 for at least one eye (ok if blind in one eye)
 - Only restriction is need side view mirrors on both sides

Modified Vision Program:

- Worse than 20/70 but 20/100 or better for at least 1 eye



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Reading highway and street signs

Large highway sign: Letters about 18 inches

20/20: 900 feet
20/40: 450 feet
20/70: 260 feet
20/100: 180 feet



Street sign: Letters about 6 inches

20/20: 300 feet
20/40: 150 feet
20/70: 87 feet
20/100: 60 feet



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Do drivers have to read street signs?

- GPS
- Waze

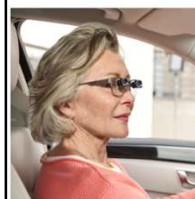


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Do drivers have to read street signs?

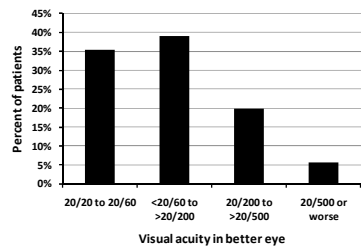
Bioptic telescopes (usually 3X to 4X)

- Must meet MVA standards with only regular glasses, not through bioptics
- Must learn how to spot with it, not drive with it



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Most patients seen in LV services have visual acuities much better than 20/200



35% with visual acuity 20/60 or better; 73% better than 20/200
Goldstein, et al. Arch Ophthalmol 130:1028-1037, 2012

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Medicare's definition of low vision (visual acuity, VA)

- Medicare's definition:
 - 20/70 or worse: Moderate visual loss
 - 20/200 or worse: Severe visual loss (legal blindness)
- But will also pay for low vision services for:
 - Blind spots in central field (central scotomas) even if VA is 20/20

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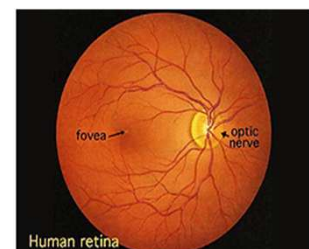
Central scotomas (blind spots)

- May affect very center: VA low
- May affect one side, or ring around center: VA may be relatively good

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Macula

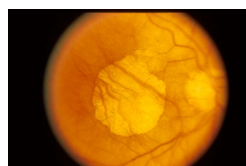
- The center portion of the retina
- Special structure to be able to make out fine detail
- Very center called the fovea



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Central scotomas

- Scotoma—blind spot in the field of vision
- Central scotoma—Fovea is blind
 - If look straight at something, can't see it
 - Must learn to look above or to the side, to put object of interest on seeing retina, and then compensate for scotoma to right or left, etc



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Central scotoma



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Other aspects of vision

- Night vision, vision in dim illumination
- Color vision
- Sensitivity to lights, glare

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Anatomy of Eye and Disorders of Eye

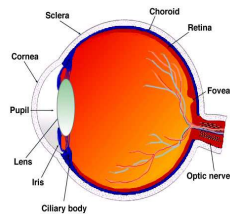
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Thank you to Shirin Hassan PhD for many of the pictures

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Vision

- Image must get
 - Transmitted through the eye
 - Focused by cornea and lens
 - Light sensed by retina and processed
 - Message sent to brain via the optic nerves and pathways
 - Processing in brain



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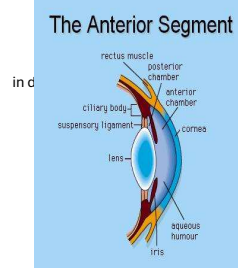
Protectors of the eye

- Eyelids
- Lashes
- Lacrimal gland, and other glands producing tears
- Conjunctiva
- Sclera

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Image transmitted through eye

- Layers of eye must be transparent,
- yet strong enough to protect eye
 - Cornea has to be maintained unscarred
 - Iris and pupil
 - Lens



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Cornea

- Cells specialized to keep cornea relatively dehydrated and clear
- Most sensitive part of body
- Tough
- Sclera = white of eye, tough but opaque



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Corneal Disease

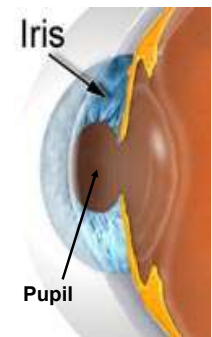
- Loss of clarity of cornea
- Distortion or scattering of light
- Deforming of cornea



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Iris and pupil

- The iris is pigmented and has muscles in it that control the size of the central opening
- The pupil is a hole in the center of the iris
- The size of the pupil helps to control the amount of light entering the eye
 - Dilates in dark
 - Constricts in light



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Disorders of the iris

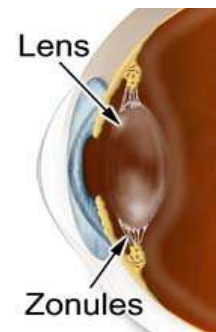
- Aniridia—iris does not develop, causing glare
- Can treat with contact lens that is partially opaque and has an artificial pupil



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The Lens

- Made up of fibers within a capsule
- Suspended by fine threads called zonules
- Tension on zonules and shape of lens controlled by muscles
- By around 40's, lens shape less flexible, need reading glasses
- Clear when young, yellows with age and may become clouded (cataract)



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Cataract—clouding of the lens

- Cataract is the leading cause of severe visual impairment and blindness in the world
- In developed parts of the world, cataracts are removed before they cause severe impairment of vision.



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Cataracts

- Cause blurring and scattering of light



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Treatment of cataracts

- The lens material is broken up and aspirated out of the lens capsule
- An artificial plastic lens implant (intraocular lens) is placed inside the lens capsule to replace the natural lens (pseudophakic)
- People may not have to wear glasses after cataract surgery, or may need for distance and/or near.



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Treatment of cataract



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Refractive errors:

All can be corrected with glasses

- A mismatch in the focusing power of the eye (cornea plus lens) relative to the size of the eye
- Myopia (nearsightedness)
 - The focusing power of the eye is too strong relative to the size of the eye (eye often longer)
- Hyperopia (farsightedness)
 - The focusing power of the eye is not strong enough
- Astigmatism
 - Light coming in from one direction may be bent more than light from another direction
- (Presbyopia: Need for reading glasses as get older)

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Contact lenses

- Go on the eye
- Good, undistorted, wide field of view

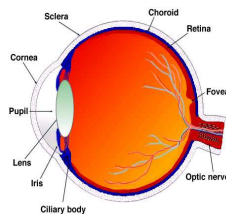
Refractive surgery (LASIK)

- Use laser or surgery to modify the shape of the cornea
- Can reduce need for wearing glasses, especially in nearsighted patients

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Sensing light

- Retina lines the inside of the eye
- Macula = The center portion of the retina

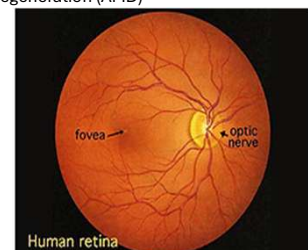


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Macula

- The center portion of the retina
- Special structure to be able to make out fine detail
- Very center called the fovea

- Advanced age-related macular degeneration (AMD) in about 10% of people over 75



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Albinism

- Normal pigment is absent
 - Sensitive to light
- Macula does not develop properly
 - Visual acuity is reduced
 - Nystagmus
 - No blind spots; no visual field defects

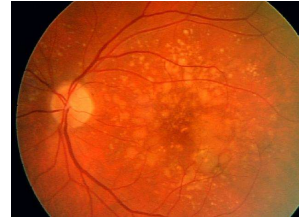


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Dry AMD (Nonexudative) includes a wide spectrum of disease

Early or intermediate dry AMD

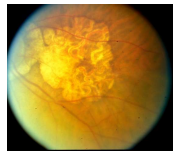
- ▶ Good visual acuity
- ▶ Drusen: yellow-white deposits under the retina
- ▶ Pigmentary alteration
- ▶ At risk for developing advanced dry or wet AMD, but most will NOT evolve into advanced disease



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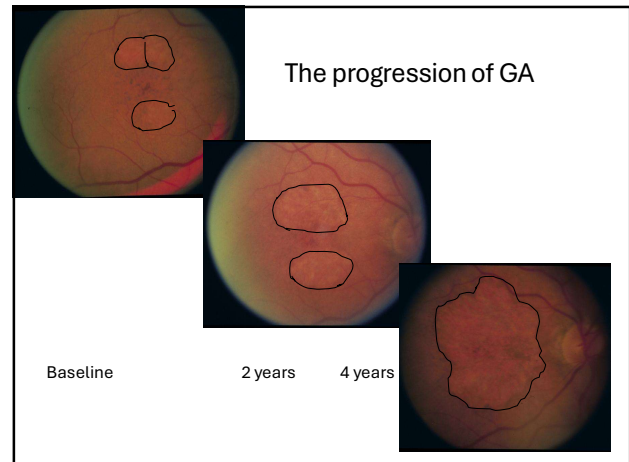
Advanced dry AMD Geographic Atrophy (GA)

- Causes gradual loss of central vision
- Many cases: Blind spots near and eventually involving the foveal center



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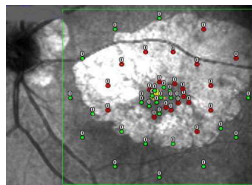
The progression of GA



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GA with good acuity

- The patient may still have great difficulty in reading and recognizing faces, because a full word or face does not 'fit' into the spared central seeing region. They must learn to compensate for blind spots

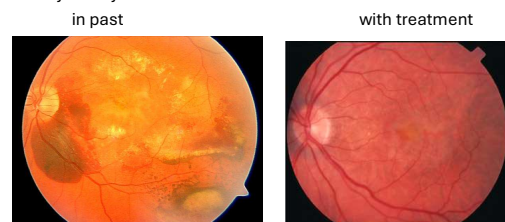


My grandfather has
a large garden with
fruit and vegetables

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Wet AMD

- Abnormal blood vessels grow under the macula.
- Bleed, leak, scar
- Since 2005, much better treatment, but requires injections into eye every 4-8 weeks



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Light, light, light for AMD

- Even in early stages, the patients have difficulty seeing in dimly lit surroundings.
- Good lighting is critically important to these patients
- Vision drops by 5 lines when put on moderate filter
- May be issue in tunnels, shaded areas

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Stargardt disease

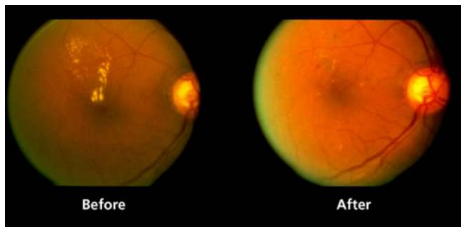
- Leading cause of macular degeneration in children and young adults
- Affects 1 in 10,000 people
- Similar to advanced dry AMD



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Diabetic retinopathy

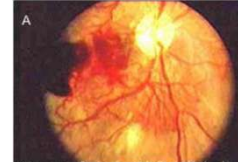
- Macular edema—swelling of the macular area, from abnormalities of existing blood vessels: Central visual loss
- Treat with intravitreal injection, laser in past, drops help some



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Diabetic retinopathy

- Proliferative retinopathy—new blood vessels grow, bleed into vitreous, cause retinal detachment: Central and peripheral loss
- Intravitreal injection, laser
- Retinal detachment surgery
- Can cause complete blindness



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Peripheral vision

- Mobility, orientation, driving
- Measured with visual fields (perimetry)

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There's a lot more to the retina than just the macula



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Measuring peripheral vision: Visual fields

VISUAL FIELDS ARE GENERALLY NOT TESTED IN A FORMAL WAY
UNLESS THERE IS A REASON TO

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Confrontation visual fields

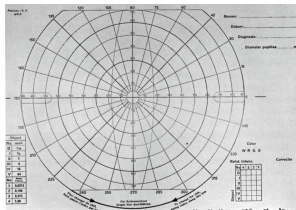
- Extremely valuable
- Most common way of assessing visual field, unless need to quantify field defect
- Face patient, cover one eye, count fingers in all quadrants



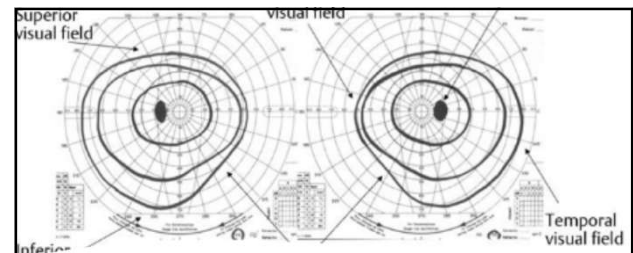
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Goldmann visual field (GVF) kinetic perimetry

- Using the same stimulus, map the whole visual field (isopter)
 - Within the isopter, look for scotomas
- Change stimulus size and map the field again.
- Goldmann III4 and V4 most relevant



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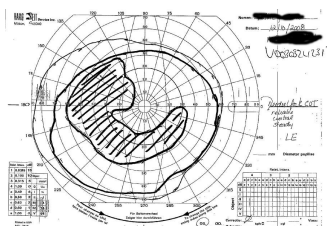


Goldmann visual field

- Maps whole field

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GVF with scotomas



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Goldmann visual fields: Advantages

- Mainly to assess peripheral fields
- Use for diseases with peripheral field loss, like retinitis pigmentosa
- Use to assess field for driving (III4 and V4)
- Use to assess for legal blindness (20 deg diameter field)
- Sometimes easier on patient than HVF
- Sometimes easier for child

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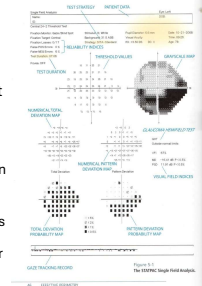
Disadvantages of GVF

- Done manually; different technicians may test differently
- Doesn't give precise value at given point
- Difficult to map out central scotomas
- Not available in many offices

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Humphrey visual field (HVF) testing

- Automated static perimetry: stimulus flashed in given locations, not moved. Measures threshold at each point
 - Designed especially for glaucoma testing
- HVF 24-2 Central 48 degrees III size stimulus**
- 54 locations tested, randomized order of presentation
 - Threshold using a staircase procedure
- Heavier testing of nasal field, where glaucoma affects first
 - Summary statistics to follow (worsening of) field over time



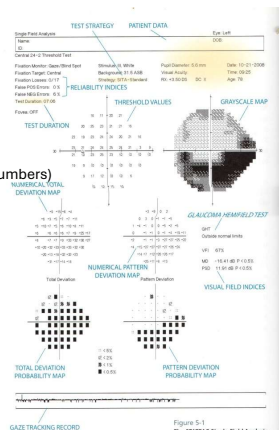
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Reliability Indices

Grayscale map
(may be deceptive; check numbers)

Threshold values

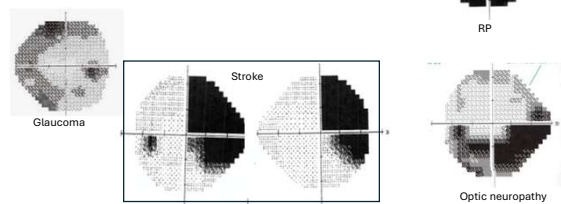
Mean deviation



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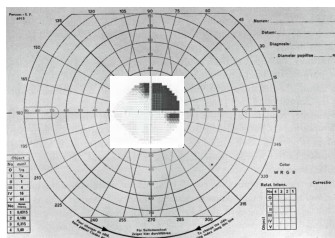
Humphrey visual fields

- Designed for glaucoma management
- Almost everyone does only 24-2 fields



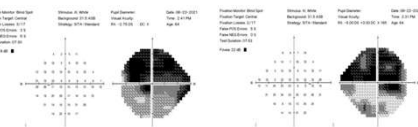
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BUT Humphrey 24-2 field is only a small part of the full field



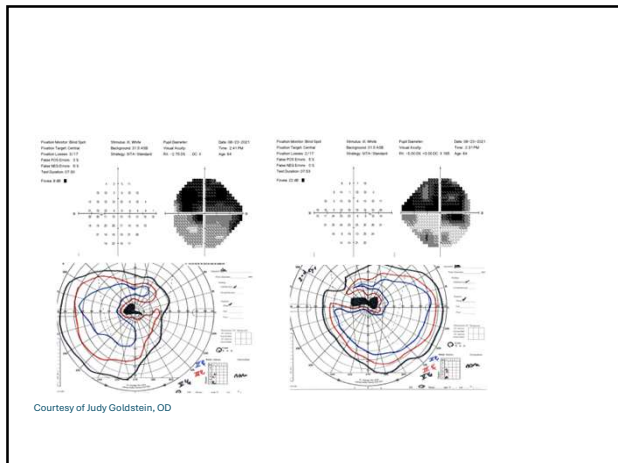
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HVF 24-2 does NOT tell the whole story



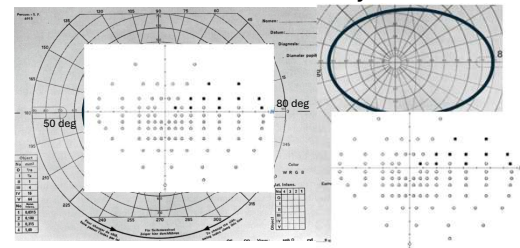
Courtesy of Judy Goldstein, OD

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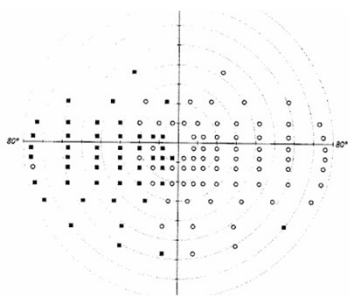
Humphrey monocular Esterman test:
 Goes out to 50 deg nasally, 80 deg temporally
 One brightness level: You see it or don't
 Does not measure actual sensitivity of each site



0 = seen
 ■ = not seen

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Mapping binocular peripheral field
 for driving
 Humphrey Esterman binocular visual field test

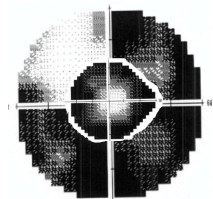
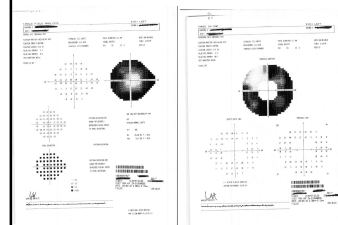


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Mapping peripheral fields with the Humphrey

24-2

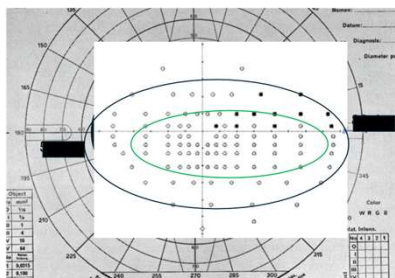
60-4



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MVA requirements for visual field
 (continuous)

- 140 degree diameter: Unrestricted
- 110 degree diameter or larger: Restricted (side mirrors)
- Must have 35 degrees on each side of midline



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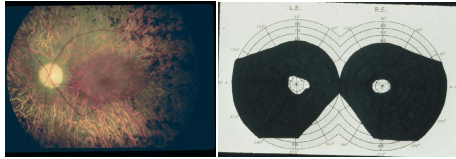
Visual Field Abnormalities

- Generalized constriction
- Visual field cut
- Scotoma within seeing boundary

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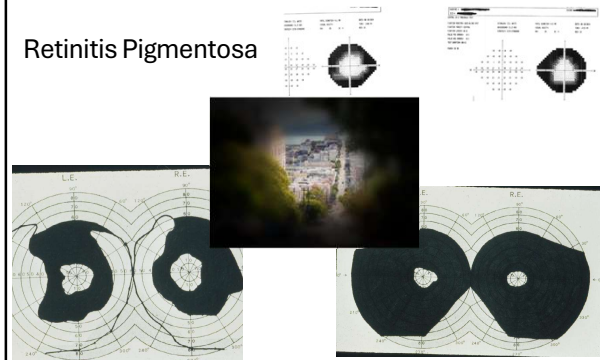
Retinitis pigmentosa

- May have nightblindness from birth, or nightblindness may develop over time
- Begin losing peripheral vision at variable age (16-50)
- Gradual reduction in peripheral vision, leading to 'tunnel vision', and can ultimately lead to total blindness



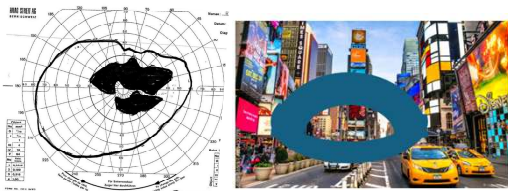
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Retinitis Pigmentosa



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Retinitis pigmentosa



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Send message to brain

- Optic nerve
 - Glaucoma
 - Optic neuropathy
 - Optic neuritis, multiple sclerosis
- Pathways within brain
 - Stroke
 - Tumor

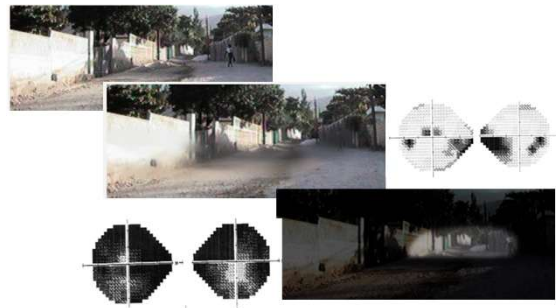
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Glaucoma

- Pressure of the eye is too high
- Causes damage to the optic nerve fibers
- Leads to peripheral visual loss, later may affect center
- Reduces contrast
- Asymptomatic at beginning
- Treated with drops, laser, surgery

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Glaucoma



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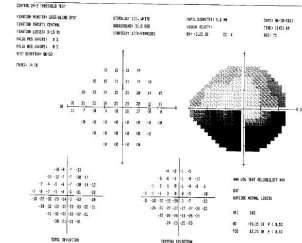
Optic neuritis

- Disease of early adulthood, more commonly women
- Sudden decrease in vision in one eye
- Often recovers over time
- In some people, it is the first sign of multiple sclerosis

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Optic nerve disease:

- Before fibers from two eyes group together in chiasm
 - One eye only
 - Central loss in optic neuritis
 - Altitudinal visual field cut in ischemic optic neuropathy (common)

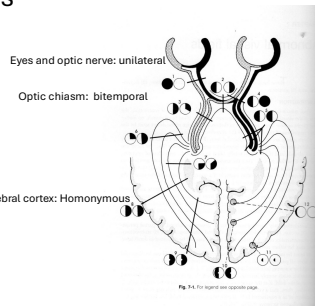


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Nerve pathways

Some fibers cross over, so that the right side of the brain sees the field to the left, and vice versa

Nerve fibers continue through various parts of the brain, ending in the occipital lobe (back of the brain)



Homonymous = same side
Hemianopia = half of field is nonseeing

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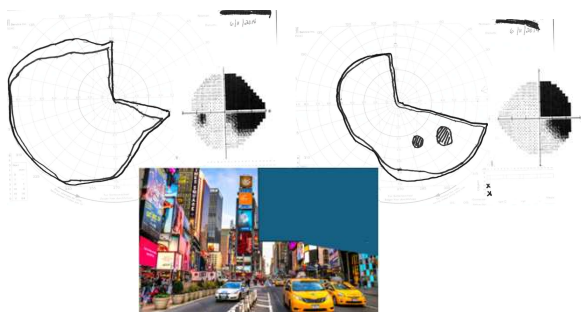
Higher visual pathways

- Fibers from both eyes combine
- Right side of brain serves left visual field and vice versa
- Get visual field defect in both eyes (homonymous), more similar as go further back in brain
- Homonymous hemianopia when occipital pole involved (stroke)

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Stroke

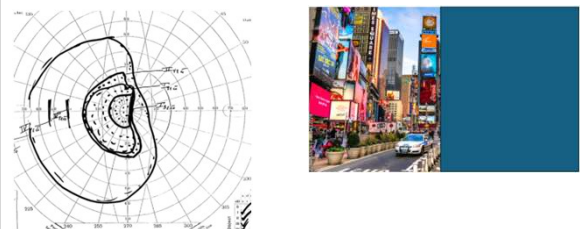
Right homonymous quadrantanopia
Incomplete homonymous hemianopia



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Stroke

Right homonymous hemianopia

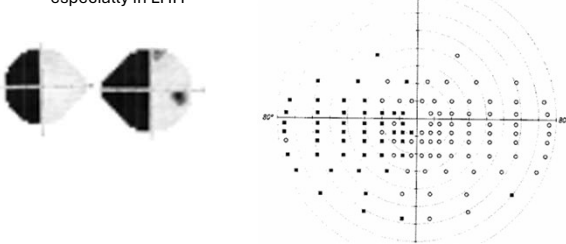


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Stroke

Left homonymous hemianopia (LHH)

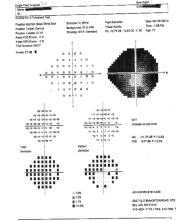
- Must compensate for loss of vision to one side
- May be accompanied by 'neglect', not being aware of lost vision, especially in LHH



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Defining legal blindness by visual field* get gvf

Diameter (width) of field is less than 20 degrees in both eyes



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Glare sensitivity

- Bright sun, time of day
- Recovery when go into tunnel, or shaded area
- Headlight glare at night
- Albinism
- Cataract
- Corneal disease
- Cone dystrophy

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Night Vision Difficulty

- Mild age-related decline
- Macular degeneration
- Retinitis pigmentosa

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Color vision difficulty

- Generally other cues, so not that critical
 - Position in traffic light
 - Shape of signs
- Red-green color difficulty present in 9% of men, mostly mild
- Optic nerve disease
- Cone dystrophy

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Visual hallucinations: Charles Bonnet

- 20-30% of patients with AMD, glaucoma
- Critical to tell every patient about it



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The Modified Vision Programs

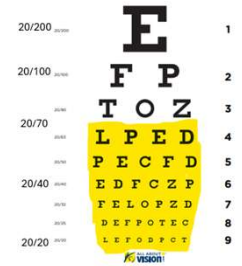
- Visual Acuity
 - Written into law (COMAR)
- Visual Field
 - At discretion of Medical Advisory Board

91

Measuring central vision: Visual acuity

20/X The driver sees at 20 feet
what is normally seen at X feet

20/20 Normal
20/40 Need twice as big
20/70 Need 3.5 times as big
20/100 Need five times as big



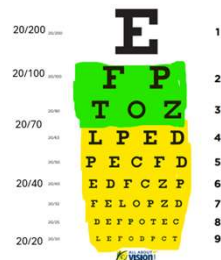
92

Modified Visual Acuity

20/X The driver sees at 20 feet
what is normally seen at X feet

20/20 Normal
20/40 Need twice as big
20/70 Need 3.5 times as big
20/100 Need five times as big

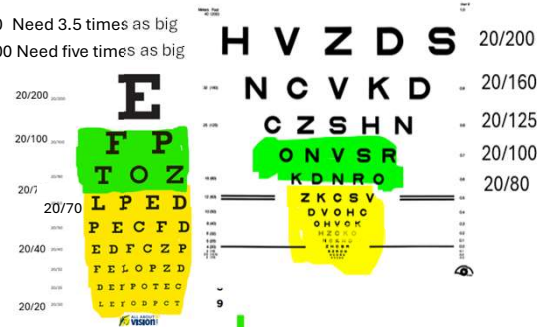
Yellow: Normal MVA standards
Green: Modified Vision



93

Modified Visual Acuity ETDRS with more divisions than Snellen

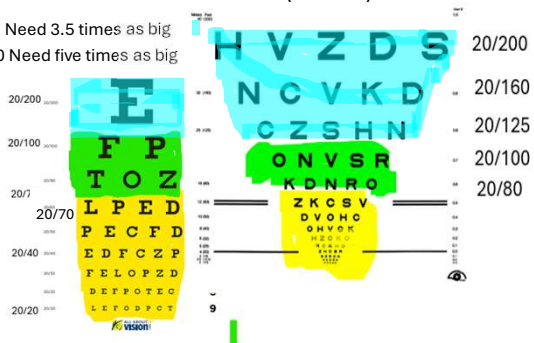
20/70 Need 3.5 times as big
20/100 Need five times as big



94

Legal Blindness (blue): 20/200 or worse (Snellen) Or: No letters on 20/100 line (ETDRS)

20/70 Need 3.5 times as big
20/100 Need five times as big



95



Normal vision

Vision through

96

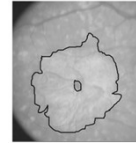
Why should someone with 20/100 be able to drive?

- Seeing signs is not that important
- Can't recognize people but can see them
- Will see cars, etc
- Learn to compensate
- They self-limit their driving
- Restores independence

97

Why should someone with 20/100 NOT be able to drive?

- May not be able to compensate
- Things too blurred for them
- Need good cognitive skills
- May have large blind spot surrounding center



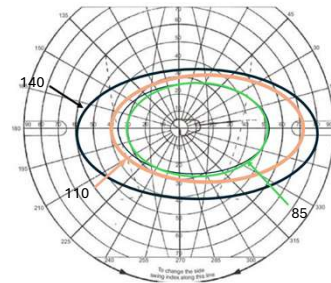
98

Modified visual field

- Narrowed visual field (70-105 according to JS)
- Scotomas within field
- Cut to left or right

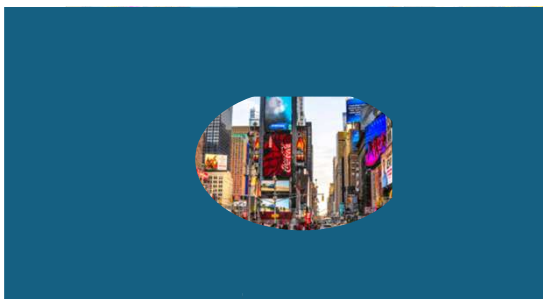
99

Narrowed (constricted) visual field



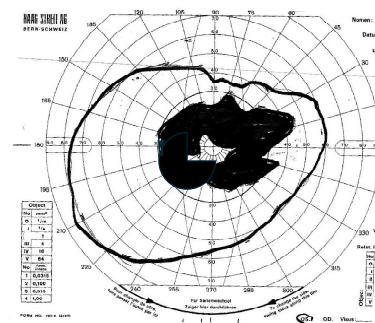
100

Constricted visual field



101

Scotomas within isopter



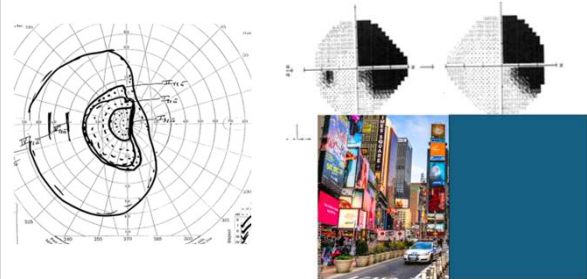
102

Scotoma within isopter



103

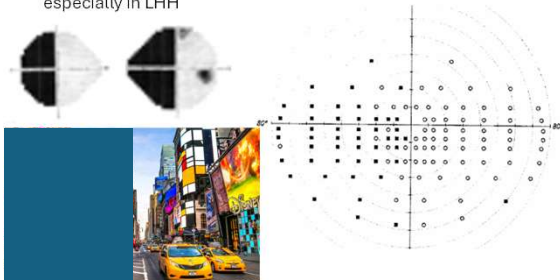
Visual field cut Right homonymous hemianopia



104

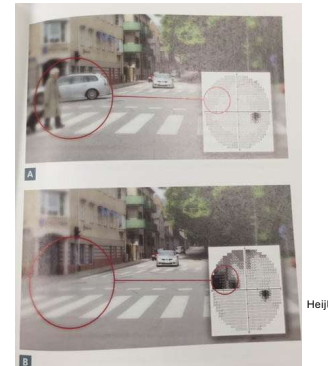
Stroke Left homonymous hemianopia (LHH)

- Must compensate for loss of vision to one side
- May be accompanied by 'neglect', not being aware of lost vision, especially in LHH



105

'Filling in' the blind spot



106

Why should someone with an 85 degree field or a field cut be able to drive?

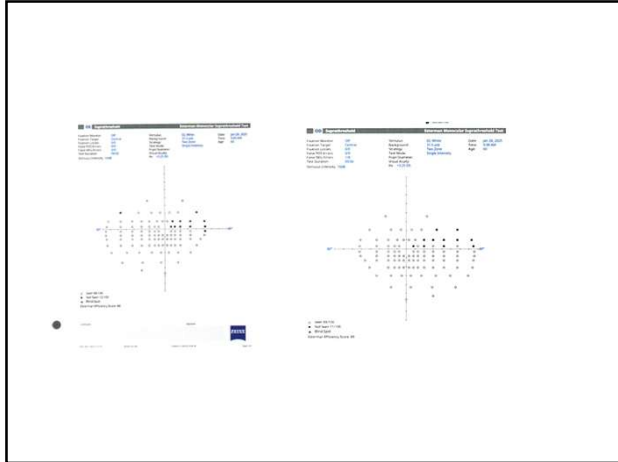
- Experience shows that people with unreported strokes drive successfully
- Learn to compensate
- Adaptive equipment
- They self-limit their driving
- Restores independence

107

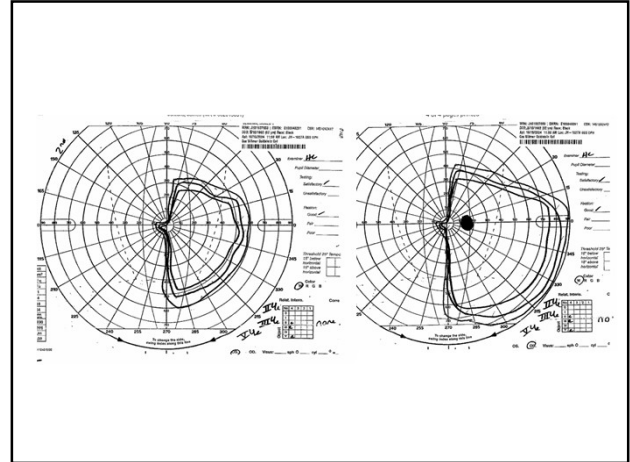
Why should someone with an 85 degree field or a field cut NOT be able to drive?

- May miss people, cars
- Turns difficult
- May not be able to compensate
- Often unaware that they are missing things

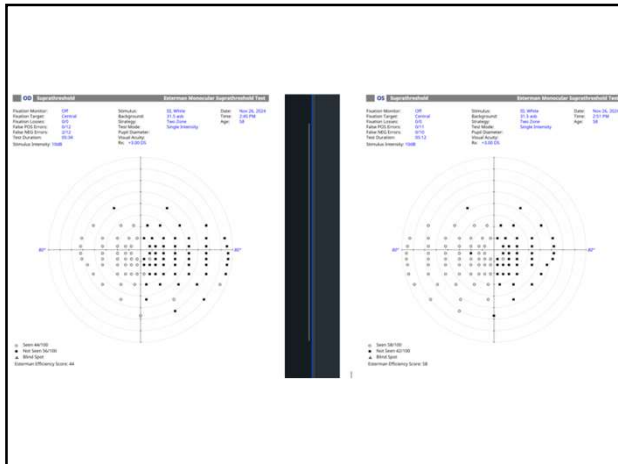
108



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116



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Please do not write outside of the lines in this chart			Exam Date: 10/10/2022
	Right Eye	Left Eye	Each Eye
Acuity without lenses	20/20	20/20	20/20
Acuity with present lenses	20/20	20/20	20/20
Field of Vision (in degrees)	120	120	120

Driver's License Requirements

To qualify for an unrestricted driver's license, the State of Maryland requires, shown to name:

- Minimum vision
- Visual acuity (ability to read 20/40) in each eye
- Continuous field of vision of at least 140 degrees
- Horizontal binocular field of vision of at least 140 degrees

Be subject to periodic testing:

- Visual acuity of at least 20/70 in one or both eyes
- Continuous field of vision of at least 110 degrees, with at least 35 degrees lateral to the midline of each side

Persons with visual acuity of less than 20/70, but no worse than 20/100, require special handling by the Motor Vehicle Administration.

For Commercial Drivers Only

Does this patient have 20/40 vision or better in EACH eye? ☐ Yes ☒ No

Can this patient distinguish between red, green and amber colors? ☒ Yes ☐ No

1. Are corrective lenses (standard spectacles) needed to meet vision requirements for driving? ☒ Yes ☐ No

If corrected lenses are needed, has this patient acquired this vision? ☒ Yes ☐ No

2. Does this patient meet the continuous field of vision requirements specified by the MVA? ☒ Yes ☐ No

3. Did the visual examination reveal any optical or medical reason that could preclude granting a license? ☒ Yes ☐ No

If yes, please submit a Maryland MVA-DC-200 form.

Will treatment improve the patient's vision for driving? ☐ Yes ☒ No

If yes, diagnosis/treatment:

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Section 2 - To Be Completed by a Licensed Ophthalmologist (Optometrist or O.D.)

Visual field testing is required for applicant testing & license renewal. This program is designed for license consideration by the applicant's licensed Ophthalmologist or Optometrist. The Ophthalmologist or Optometrist is responsible for the accuracy of the data entered on this form and for the accuracy of the data entered on the applicant's license.

1. Date of Vision Examination: 6/10/2024

2. Briefly describe the cause and nature of the applicant's vision condition: Glaucoma, optic atrophy

3. Is this condition a result of an underlying general medical condition? (e.g., Diabetes, Head Trauma, CVA) ☒ Yes ☐ No

If yes, list the general medical condition: Diabetes

If this patient's vision condition is a result of an underlying general medical condition, the physician treating the general condition must provide a "Physician's Report Form" for review by MDOT MVA's Medical Advisory Board.

4. Is this vision condition stable? ☒ Yes ☐ No

If this condition is unstable, should applicant be considered every: 12 months ☐ Yes ☒ No

5. Visual acuity (ability to read) (right eye): 20/20 ☐ Yes ☒ No

Right eye: 20/20 Left eye: 20/20 Both eyes: 20/20

6. Horizontal binocular field of vision (degrees): 140 ☐ Yes ☒ No

Right eye: 140 Left eye: 140 Both eyes: 140

7. Field of horizontal vision with correction (degrees): To Right: 140 To Left: 140 Total: 280

8. Field of horizontal vision with correction (degrees): To Right: 140 To Left: 140 Total: 280

9. Field of horizontal vision with correction (degrees): To Right: 140 To Left: 140 Total: 280

10. Does this applicant's vision condition affect driving? ☒ Yes ☐ No

If yes, please explain: Glaucoma, optic atrophy

11. Field of vision (field) is at least 110 to 140 degrees, with at least 35 lateral to the midline of each side. Does this patient meet these minimum requirements? ☒ Yes ☐ No

12. In addition to the "Daylight Driving Only" and "Outside Mirrors Each Side" restrictions required by this program, what restrictions do you recommend on this applicant's driver's license? (e.g., type of highway, maximum speed limits, maximum driving distance, specific destinations, etc.)

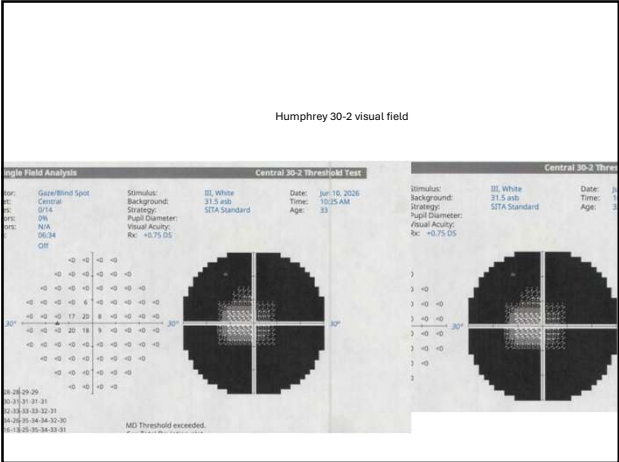
no restriction 1, 20 on Blue Ridge

13. Do you recommend the above stated applicant be granted driver's license consideration? ☒ Yes ☐ No

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I evaluated [redacted] today. Visual acuity was 20/80 for the right eye, 20/100 for the left eye, and 20/70 for both eyes together. As a member of the MVA Medical Advisory Board I know that the 20/70 for both eyes together qualifies her for the regular MVA system, so she should be able to go ahead, get her permit, etc.

120



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The Modified Vision form

Customer ID: _____
Page: 2 of 4

by mail to MVA, Driver Wellness and Safety Division, Room 124, 6601 Ritchie Highway, NE, Glen Burnie, MD 21061.

1. Date of Examination: _____

2. Briefly describe cause and nature of the applicant's vision condition: _____

3. Is visual deficit the result of an underlying condition? (i.e. Diabetes, TBI, CVA) ☐ Yes* ☐ No

If yes, please specify: _____

4. Is this vision condition stable? ☐ Yes ☐ No

*Please inform the driver that it is their responsibility to have their primary care provider complete a "Physician's Report Form" for review by MVA's Medical Advisory Board.

MVA Modified Vision Program notification:
*Visual acuity less than 20/70, but no worse than 20/100
*Continuous field of vision of at least 110 degrees with at least 15 degrees lateral to the midline of each side
(See page 6, Instructions to Medical Provider, for more information regarding this program)

5. Visual Acuity and Field of Vision

	Right Eye	Left Eye	Both Eyes
Acuity without corrective lenses	20/____	20/____	20/____
Acuity with corrective lenses	20/____	20/____	20/____
Field of Vision	____ degrees	____ degrees	____ degrees

6. Does the driver's vertical field of vision contraindicate safe driving? ☐ Yes ☐ No

7. Did your vision examination include any other vision tests? ☐ Yes ☐ No

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