






Centre for Eye Health

Clinical nuggets – visual pathway assessment

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Overall topics to be covered

- Review the visual pathways and the associated characteristics of visual field loss
- Application of key principles in clinical practice
 - Visual fields, optic nerve head, RNFL, Ganglion Cell Analysis
 - Clinical challenges
 - Optic atrophies
 - Post-chiasmal lesions
 - (may include retrograde degeneration at the ON/RNFL level)
- Five participant polls #1-5 during the lecture

Polls are **anonymous**, please participate

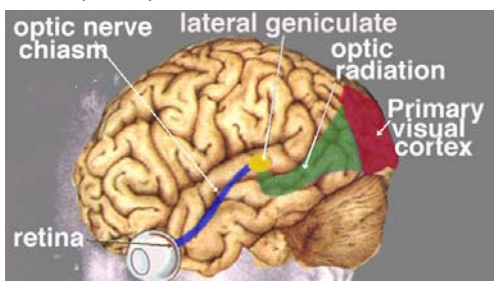
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Postretinal Pathways

- Visual pathway

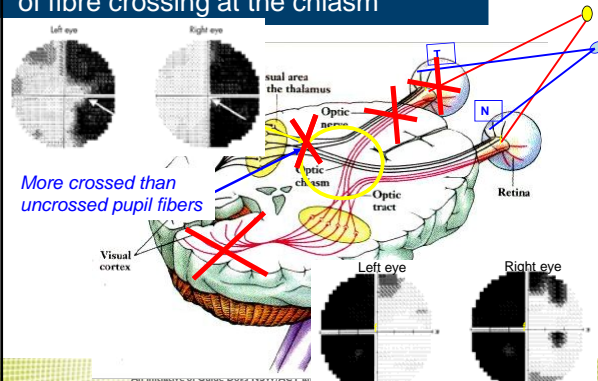


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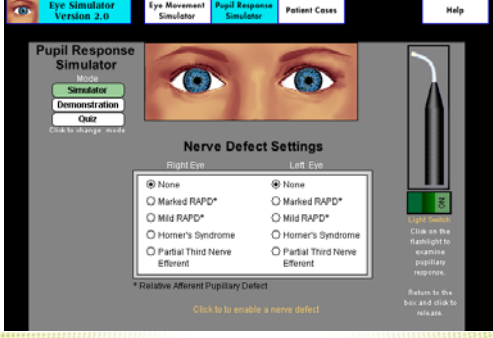
Postretinal Pathways - the significance of fibre crossing at the chiasm




<https://cim.ucdmc.ucdavis.edu/eyerelease/interface/topframe.htm>



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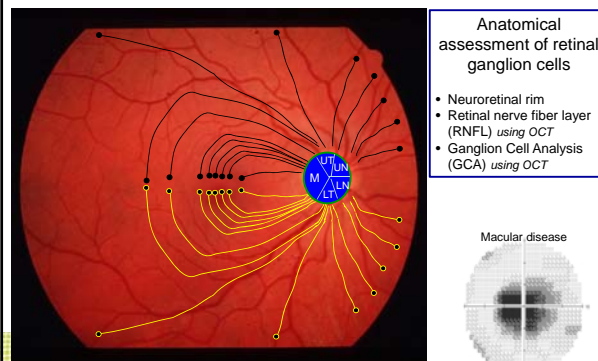


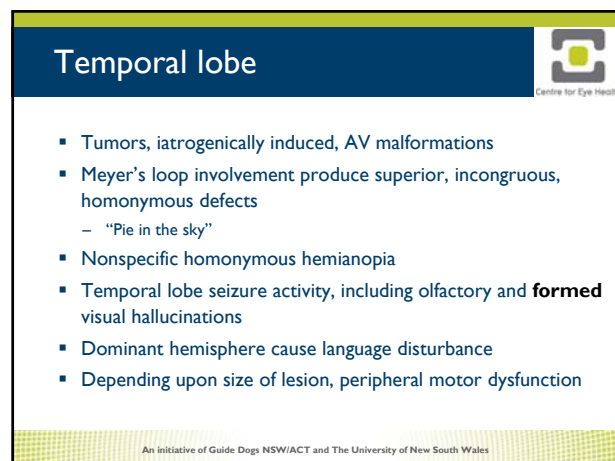
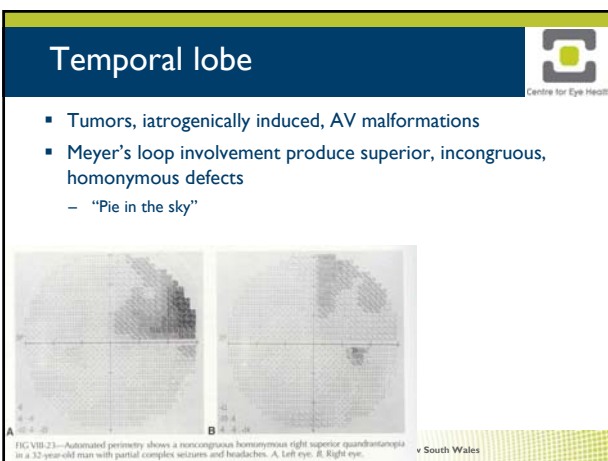
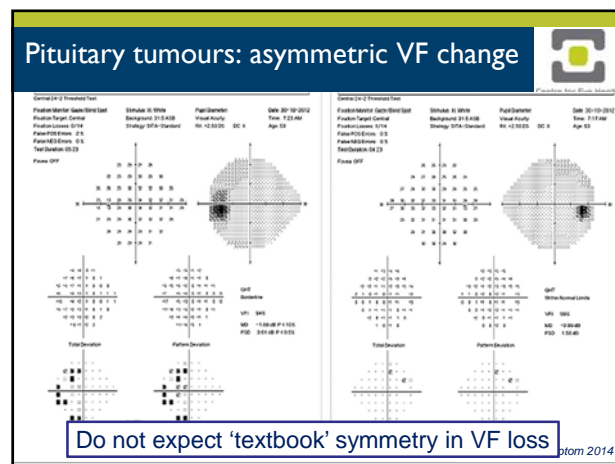
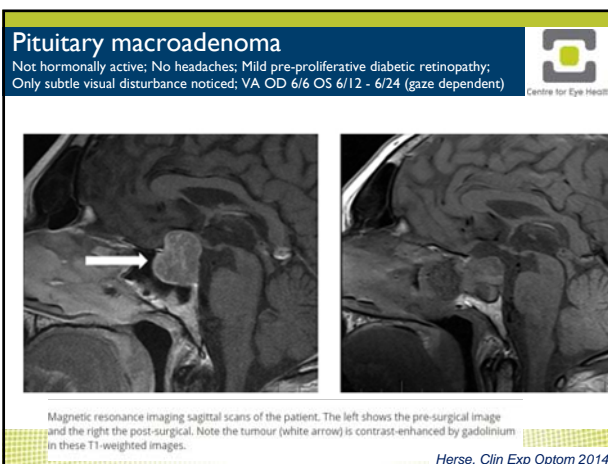
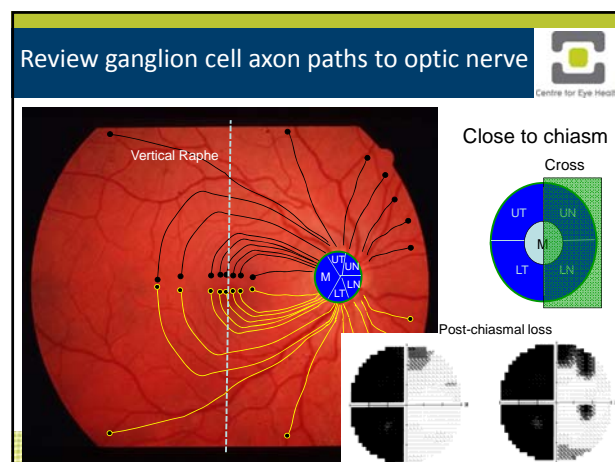
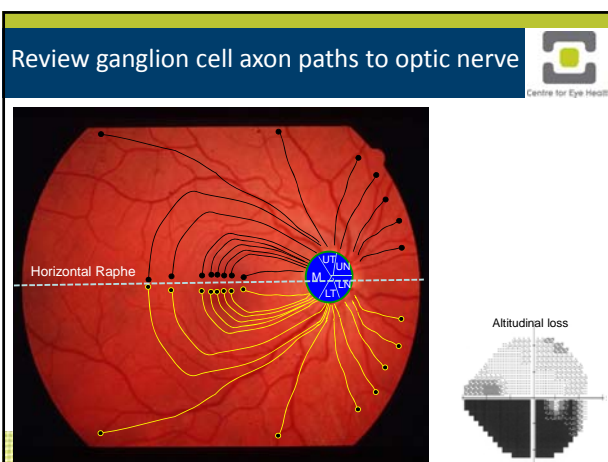
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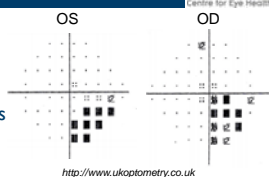
Review ganglion cell axon paths to optic nerve



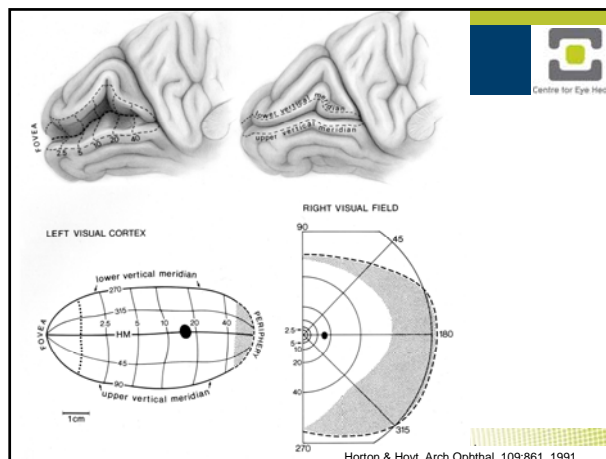


Parietal lobe

- Superior fibers involved first hence
 - "Pie on the floor"
- Usually vascular lesions
- Associated neuro-ophthalmic changes
 - Agnosias
 - Apraxia
 - Dominant hemisphere
 - Gerstmann syndrome: acalculia, agraphia, finger agnosia, and left-right confusion
 - OKN nystagmus inability to side of lesion (if damage near visual radiations)
 - Conjugate movements of the eyes to the side opposite the lesion on forced lid closure
 - Inattention (nondominant parietal lobe lesions)



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Scotoma



Quadrantanopia



Hemianopia



REM: VF would be **bilateral** except temporal crescent

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Lesions to selective brain regions cause specific functional defects

REM: VF loss with lesions here

Color

Facial recognition

Facial expression

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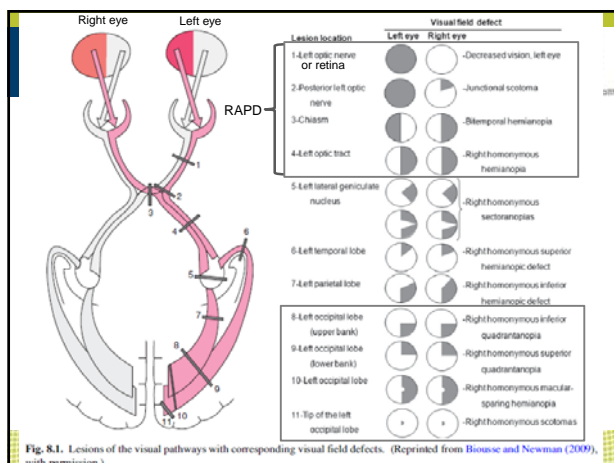


Fig. 8.1. Lesions of the visual pathways with corresponding visual field defects. (Reprinted from *Bosse and Newman (2009)*, with permission.)

Key Points #1

Key questions to ask yourself

- Does the retinal and optic nerve look normal?
- Is there a RAPD?
- Is vision anomaly monocular or binocular?
- Are there other associated signs/symptoms?
- Is the vertical or horizontal midline in visual fields followed?
- Does the patient display anomalies consistent with higher visual areas?
- Are flashing lights achromatic or chromatic?

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Applying these principles in clinical practice

Clinical challenges

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Poll #1 - Patient #13: 77 yo male with a history of stroke (15 yrs ago). Visual field stable over a ~13 yr period (left partial quadrantanopia)

Blindspot

T axis

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Poll #1 - Patient #13: 77 yo male with a history of stroke (15 yrs ago). Visual field stable over a ~13 yr period (left partial quadrantanopia)

Poll #1: Which of the following is **most correct** relating to the superior quadratic visual field loss?

- The visual field loss is largely congruous
- The lesion is most likely on the left side of cerebral cortex
- The lesion is most likely at the chiasm
- A left RAPD will likely be present

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T axis

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Poll #1: Which of the following is **most correct** relating to the superior quadratic visual field loss?

- The visual field loss is largely congruous**
- The lesion is most likely on the left side of cerebral cortex (*expect right sided lesion*)
- The lesion is most likely at the chiasm (*not bi temporal*)
- A left RAPD will likely be present (*not a complete cut and thus congruous nature of quadrantanopia suggests post LGN*)

Blindspot

T axis

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Poll #1: A 77 yo male with a history of stroke (15 yrs ago). Visual field stable over a ~13 yr period (left partial quadrantanopia)

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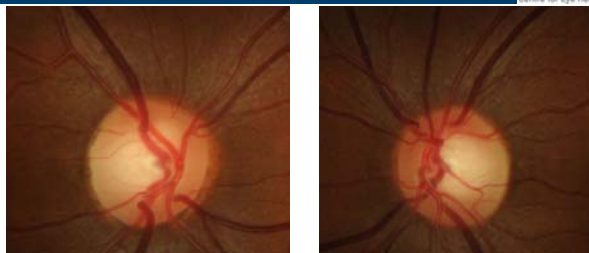
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Poll #2: 33 yo female; family history of glaucoma: IOPs 14mm Hg OU, AC quiet, normal CCT

Look carefully at the optic nerve heads

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Poll #2: 33 yo female; family history of glaucoma:
IOPs 14mm Hg OU, AC quiet, normal CCT
Look carefully at the optic nerve heads



Poll #2: Which of the following is **incorrect**?

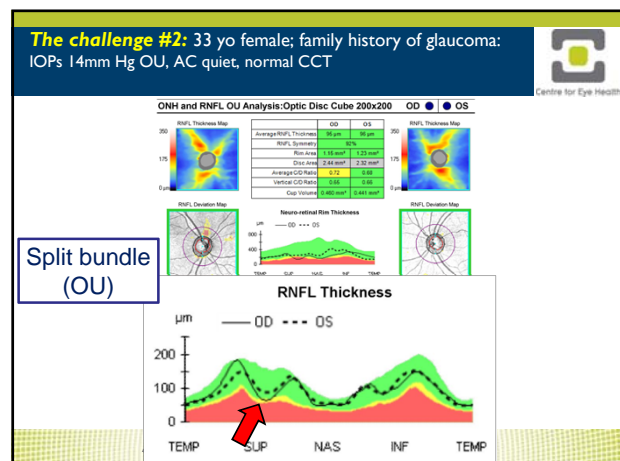
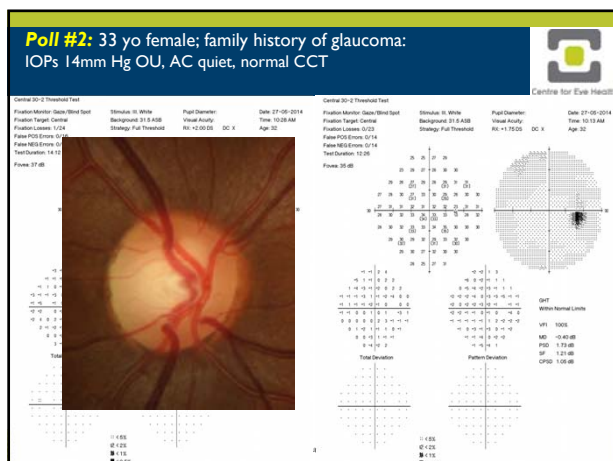
- The right optic nerve heads appear slightly larger compared to the left
- Artery:Vein ratio is within normal limits
- The notch is strongly suggestive of optic neuropathy
- The neuroretinal rim appears healthy in both optic nerve heads

Poll #2: 33 yo female; family history of glaucoma:
IOPs 14mm Hg OU, AC quiet, normal CCT
Look carefully at the optic nerve heads



Poll #2: Which of the following is **incorrect**?

- The right optic nerve heads appear slightly larger compared to the left (**true**)
- Artery:Vein ratio is within normal limits (**true**)
- The notch is strongly suggestive of optic neuropathy**
- The neuroretinal rim appears healthy in both optic nerve heads (**true**)



Applying these principles in clinical practice

Optic atrophy

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Optic atrophy (OA)

- Optic atrophy
 - Morphologic description of the endpoint of any disease that causes RGC axon degeneration
 - Neuroretinal rim atrophy or pale appearance of ONH
- Categories
 - Primary OA
 - Secondary OA
 - Consecutive OA
 - Glaucoma
 - Retrograde degeneration OA

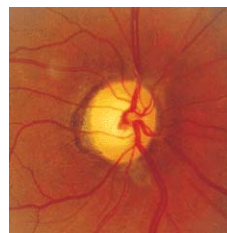
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I. Primary Optic atrophy (OA)

- Primary optic atrophy: *occurs without ONH swelling preceding the atrophy*
 - Compressive
 - Retro-bulbar neuritis (optic neuritis)
 - Hereditary optic neuropathy
 - Toxic & nutritional neuropathies
 - ONH drusen
 - Trauma

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Visual field loss secondary to optic neuritis



Savino & Danesh-Meyer 2001 (Neuro-ophthalmology) Wills Eye Hospital Atlas of Clinical Ophthalmology

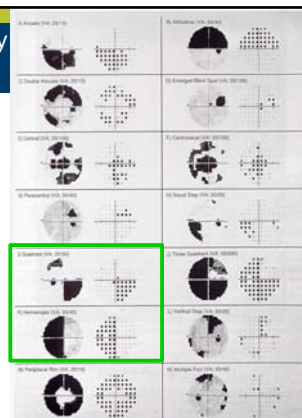


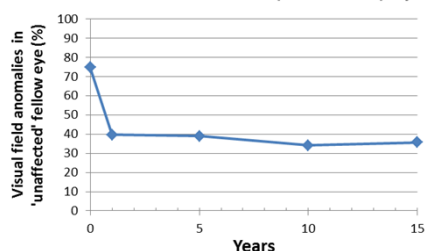
Figure 5-1. Composite of visual field abnormalities based on the Optic Neuritis Treatment Trial (ONTT). (Revised from Savino & Danesh-Meyer 2001, Wills Eye Hospital Atlas of Clinical Ophthalmology, 11:212, 1993 with permission.)

From: Visual Field Profile of Optic Neuritis: A Final Follow-up Report From the Optic Neuritis Treatment Trial From Baseline Through 15 Years

Arch Ophthalmol. 2010;128(3):330-337.

The JAMA Network

Visual field loss in fellow (unaffected) eye



Therefore, these findings appear to show that optic neuritis is not typically a unilateral disease.

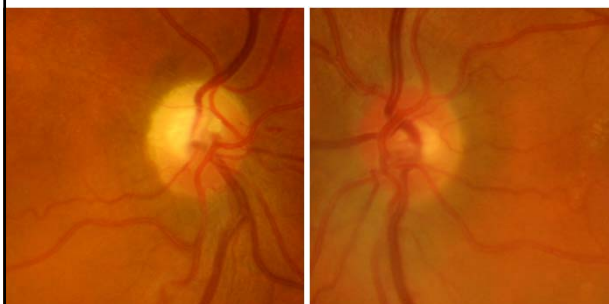
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2. Secondary Optic Atrophy (OA)

- Secondary optic atrophy: *occurs secondary to long-standing swelling of the ONH*
 - Chronic papilloedema
 - Anterior ischaemic optic neuropathy (AION)
 - Papillitis (*most common form of optic neuritis in children but also present in adults*)
 - No ONH fundus autofluorescence (*exclude ONH drusen*)
 - Critical to differentiate this from other causes of ONH crowding
 - See Chiang et al Clin Exp Optom 2015

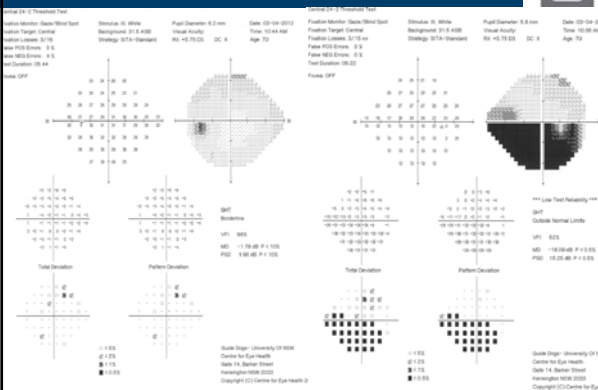
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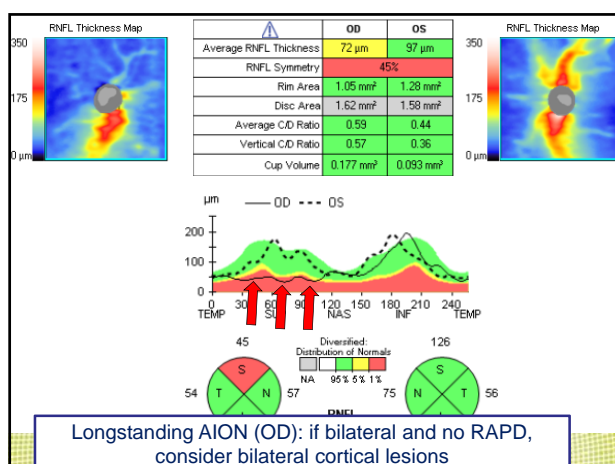
71 yo male with long-standing VF loss in OD (noticed after cardiac surgery 35 yrs ago). VA 6/12 OD, 6/75 OS. RAPD OD



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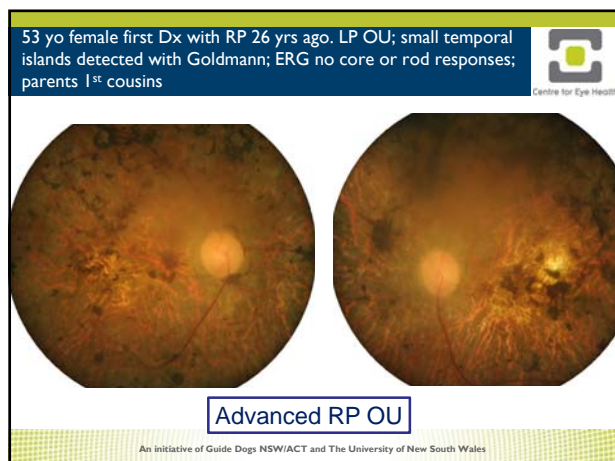
Classic VF loss in AION





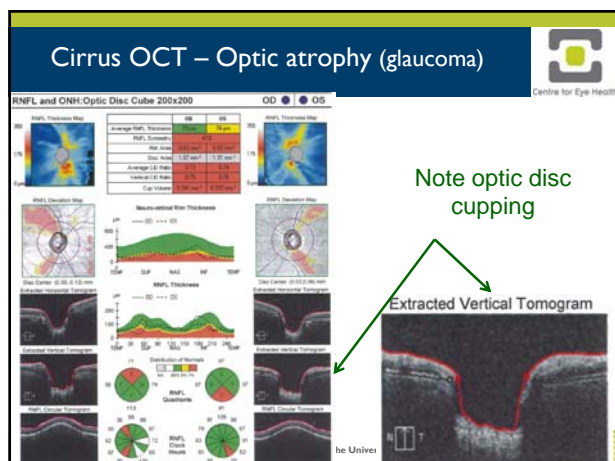
3. Consecutive Optic Atrophy (OA)

- Consecutive optic atrophy: occurs due to diseases of the inner retina or retinal blood supply
 - Retinitis pigmentosa (rod-cone) or cone-rod dystrophies
 - Vasculitis
 - Retinal necrosis/neuroretinitis
 - Excessive photocoagulation
 - Vascular (arterial or venous occlusive disease)



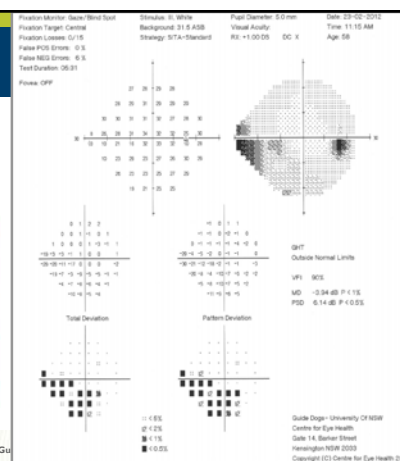
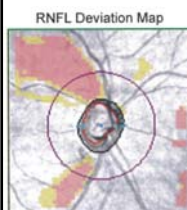
Glaucoma

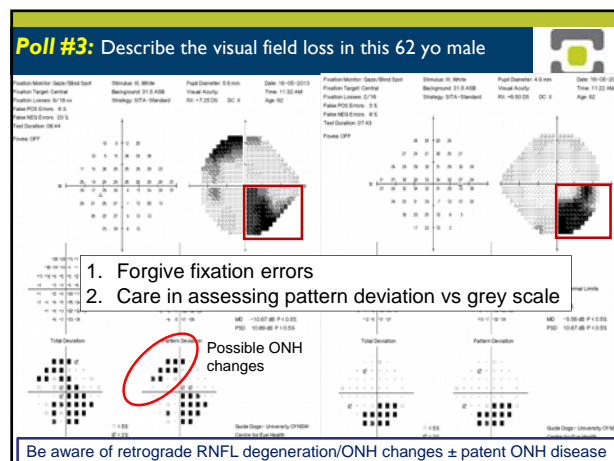
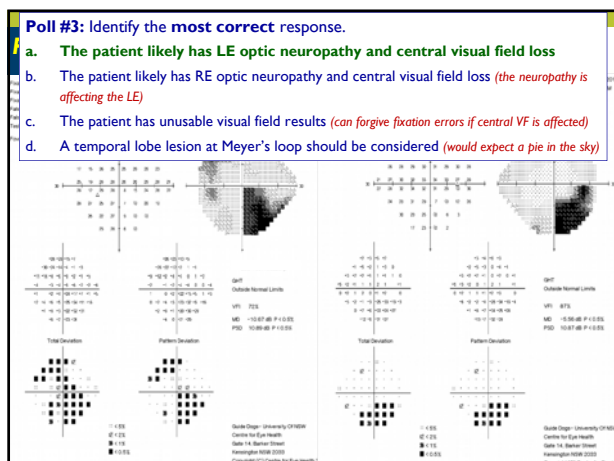
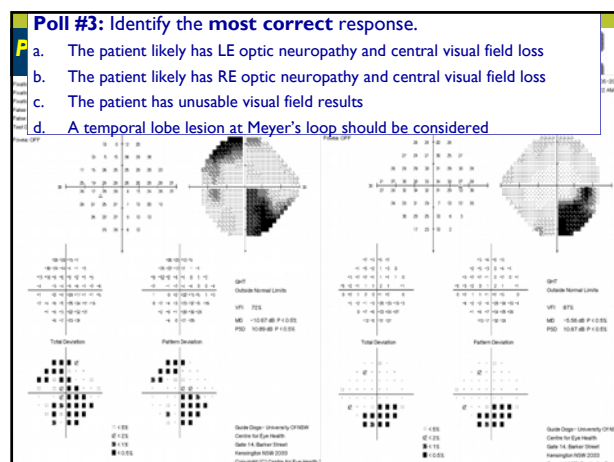
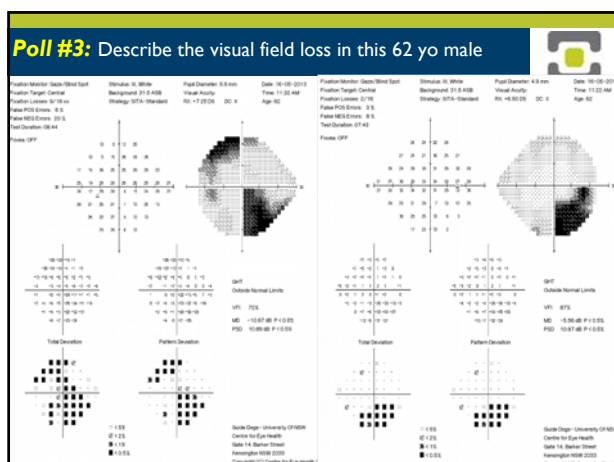
- Most common optic nerve disease?
- An optic neuropathy
 - chronic destruction of ganglion cells
 - characteristic atrophy (cupping)
- Functional loss
 - Typical "distinctive" visual field defects involving the nerve fiber bundles



Glaucoma: VF loss

OCT results





Key points #2

- May get optic atrophy without ONH swelling
 - Compressive lesions, retrobulbar inflammation, retrograde degeneration, trauma, toxicity, nutritional
- Long-term ONH swelling leads to axonal loss (secondary OA)
- Many retinal conditions lead to secondary neuronal loss and glial remodelling (consecutive OA)
- Hereditary optic atrophy Dx of exclusion
- Optic neuritis is predominantly a binocular disease
- Be aware of key characteristics of VF loss
 - Arcuate; observance of vertical of horizontal midline

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Applying these principles in clinical practice

Post-chiasmal lesions
(retrograde degeneration of ON/RNFL)

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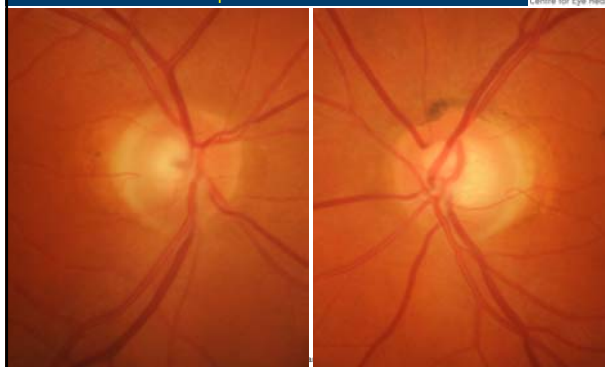
5. Post-chiasmal lesions

(may include retrograde degeneration ON/RNFL)

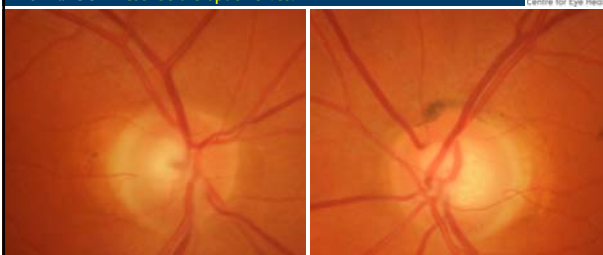
- Retinal nerve fiber layer loss and associated ONH changed due to RGC loss due to post-LGN lesions (temporal/parietal/cortical)
- Retrograde (trans-synaptic) degeneration: relatively new concept**
 - The visualisation of retrograde trans-synaptic degeneration secondary to **stroke** depends upon:
 - Time post insult
 - Brain location
 - Size of insult & size of GCA imaging *Jindahra et al 2012; Park et al 2013*
 - Retrograde degeneration secondary to **Multiple Sclerosis (MS)** lesions post-LGN *Klistorner et al 2014; Huang-Link et al 2014*

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Poll #4: 69 yo male; birth defect causing paralysis on right side; had a TIA 8 yrs ago (? Stroke). IOPs 16mm Hg OU, AC quiet, normal CCT **Describe the optic nerves?**



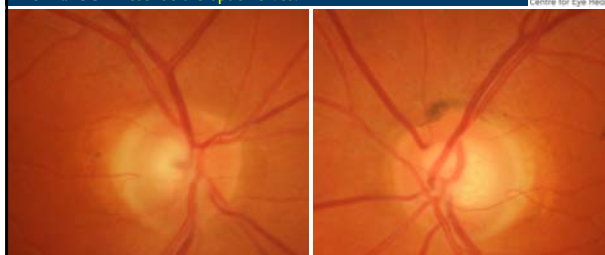
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Poll #4: Which of the following is **incorrect**?

- The optic nerve heads appear slightly asymmetric in overall appearance
- Moderate beta zone atrophy exists OU
- The LE has an abnormal neuroretinal rim infero-temporal and superiorly
- The neuroretinal rim appears healthy in both optic nerve heads

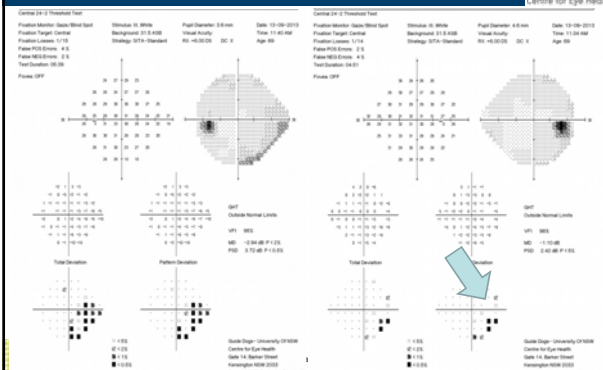
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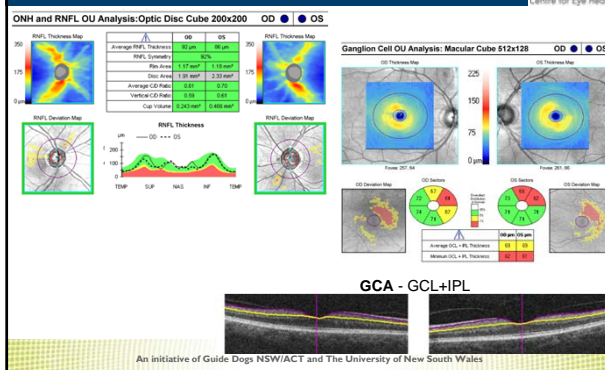
Poll #4: Which of the following is **incorrect**?

- The optic nerve heads appear slightly asymmetric in overall appearance (*Left ONH shows superior and inferotemporal anomalies*)
- Moderate beta zone atrophy exists OU (*true – has both alpha & beta OU*)
- The LE has an abnormal neuroretinal rim infero-temporal and superiorly (*true*)
- The neuroretinal rim appears healthy in both optic nerve heads**

Poll #4: 69 yo male; birth defect causing paralysis on right side; had a TIA 8 yrs ago (? Stroke). IOPs 16mm Hg OU, AC quiet, normal CCT



Poll #4: 69 yo male; birth defect causing paralysis on right side; had a TIA 8 yrs ago (? Stroke). IOPs 16mm Hg OU, AC quiet, normal CCT



Poll #5: 57 yo male; IOPs 25mm Hg OU, AC quiet, 470um CCT; gonio open angles no secondary glaucoma. Slightly smaller than average ONH size

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Poll #5: Which of the following is **incorrect**?

- a. If corrected for CCT, the IOP would be higher
- b. The left rim appears irregular and pale
- c. The right optic nerve head has subtle thinning of neuroretinal rim superiorly/superiotemporally
- d. The left optic nerve head is slightly smaller than the right

Poll #5: 57 yo male; IOPs 25mm Hg OU, AC quiet, 470um CCT; gonio open angles no secondary glaucoma. Slightly smaller than average ONH size

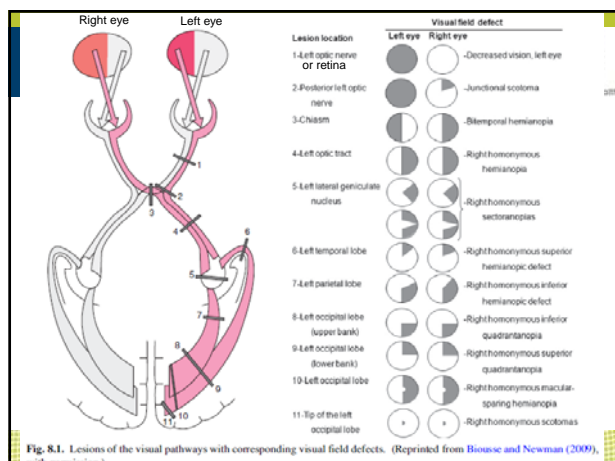
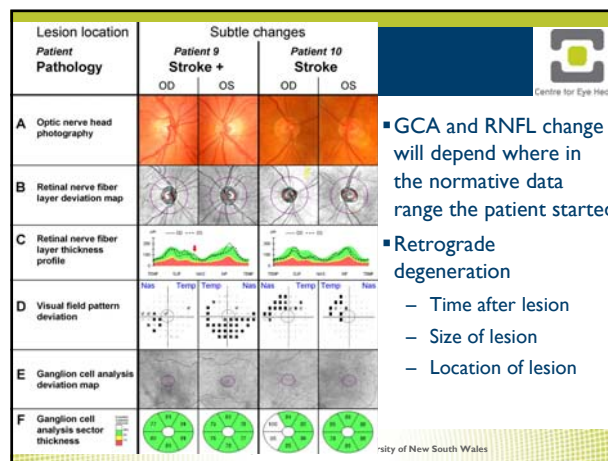
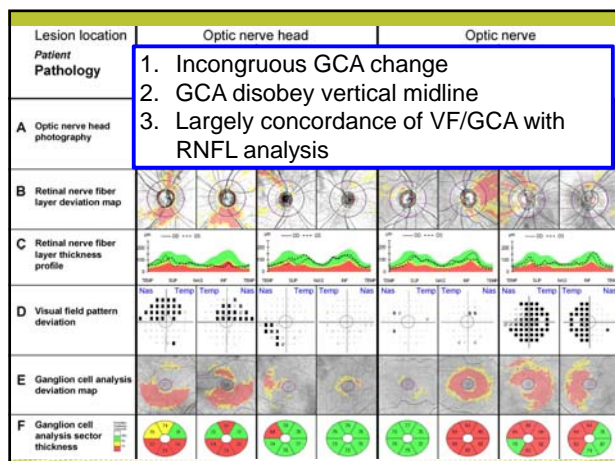
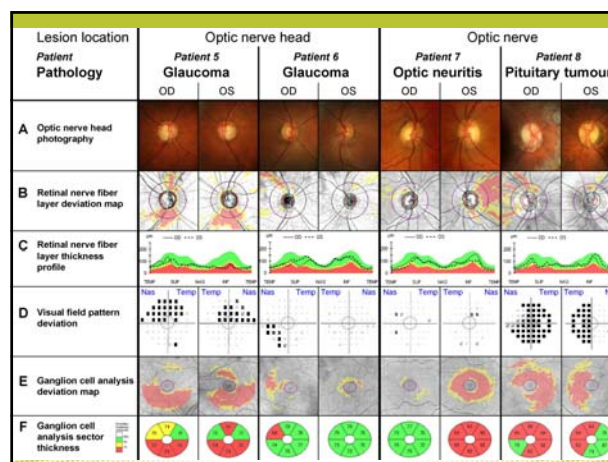
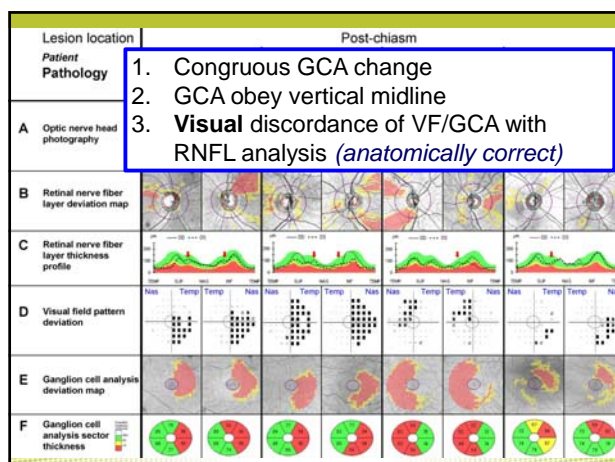
Poll #5: Which of the following is **incorrect**?

- a. If corrected for CCT, the IOP would be higher (CCT is well below normal thickness and true IOP will be higher)
- b. The left rim appears irregular and pale
- c. The right optic nerve head has subtle thinning of neuroretinal rim superiorly/superiotemporally (true)
- d. The left optic nerve head is slightly smaller than the right (true)

Poll #5: 57 yo male; IOPs 25mm Hg OU, AC quiet, 470um CCT; gonio open angles no secondary glaucoma

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Lesion location	Post-chiasm							
	Patient 1 Meningitis		Patient 2 Aneurysm		Patient 3 Head trauma		Patient 4 "Mini"-stroke	
Patient Pathology	OD	OS	OD	OS	OD	OS	OD	OS
A Optic nerve head photography								
B Retinal nerve fiber layer deviation map								
C Retinal nerve fiber layer thickness profile								
D Visual field pattern deviation								
E Ganglion cell analysis deviation map								
F Ganglion cell analysis sector thickness								



Key Points #3

- Carefully assess pupils (RAPD)
- Assess the symmetry in visual field defect and ensure suitable testing is undertaken (central vs peripheral)
- Interpret imaging results (RNFL and GCA) in conjunction with visual fields
- Consider retrograde degeneration (trans-synaptic degeneration)
- In diagnosing glaucoma - *has there been progression?*

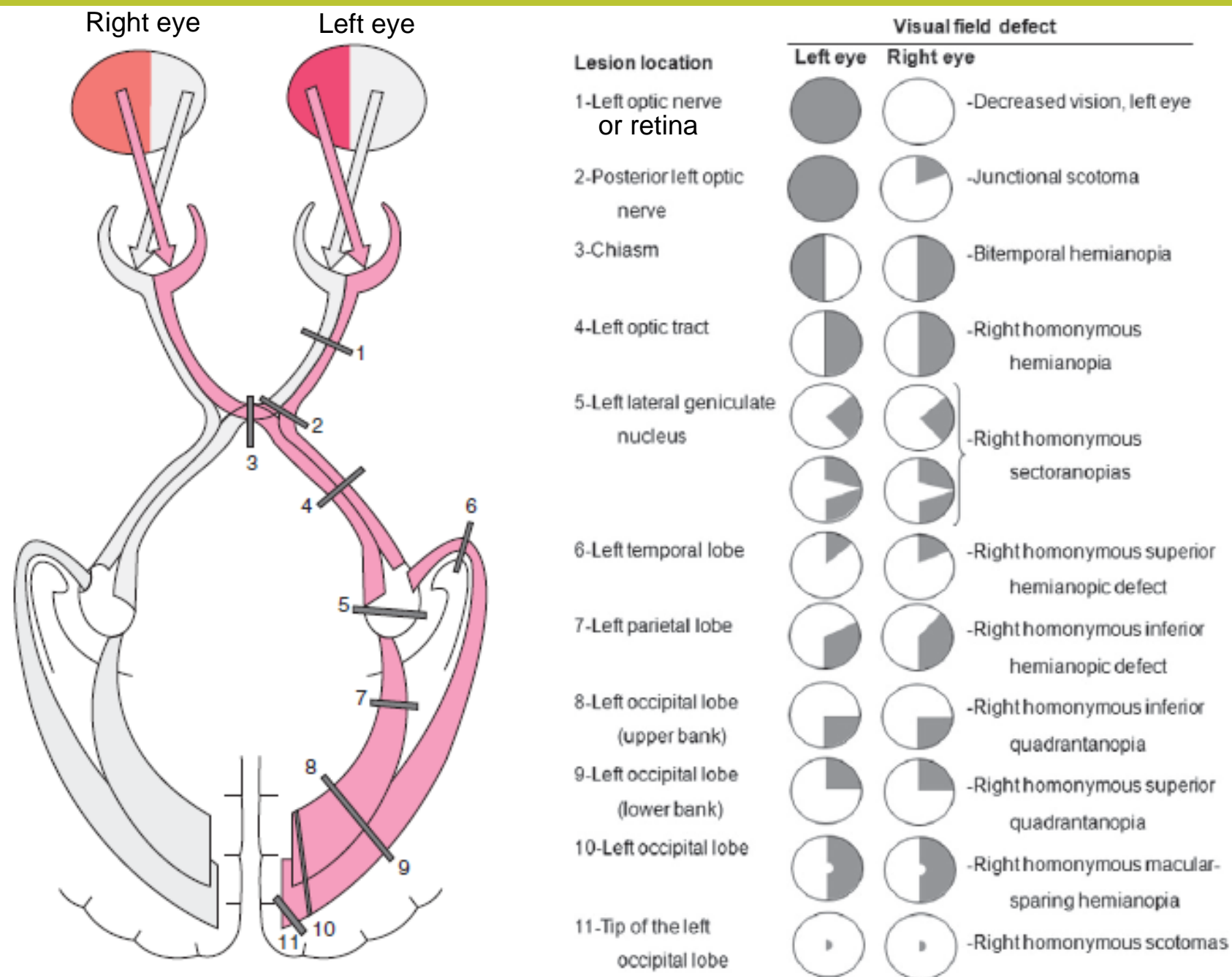
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Thank you for your attention
End of lecture





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Fig. 8.1. Lesions of the visual pathways with corresponding visual field defects. (Reprinted from [Biousse and Newman \(2009\)](#), with permission.)