SCOREBUILDERS

SPOTLIGHT *Series*

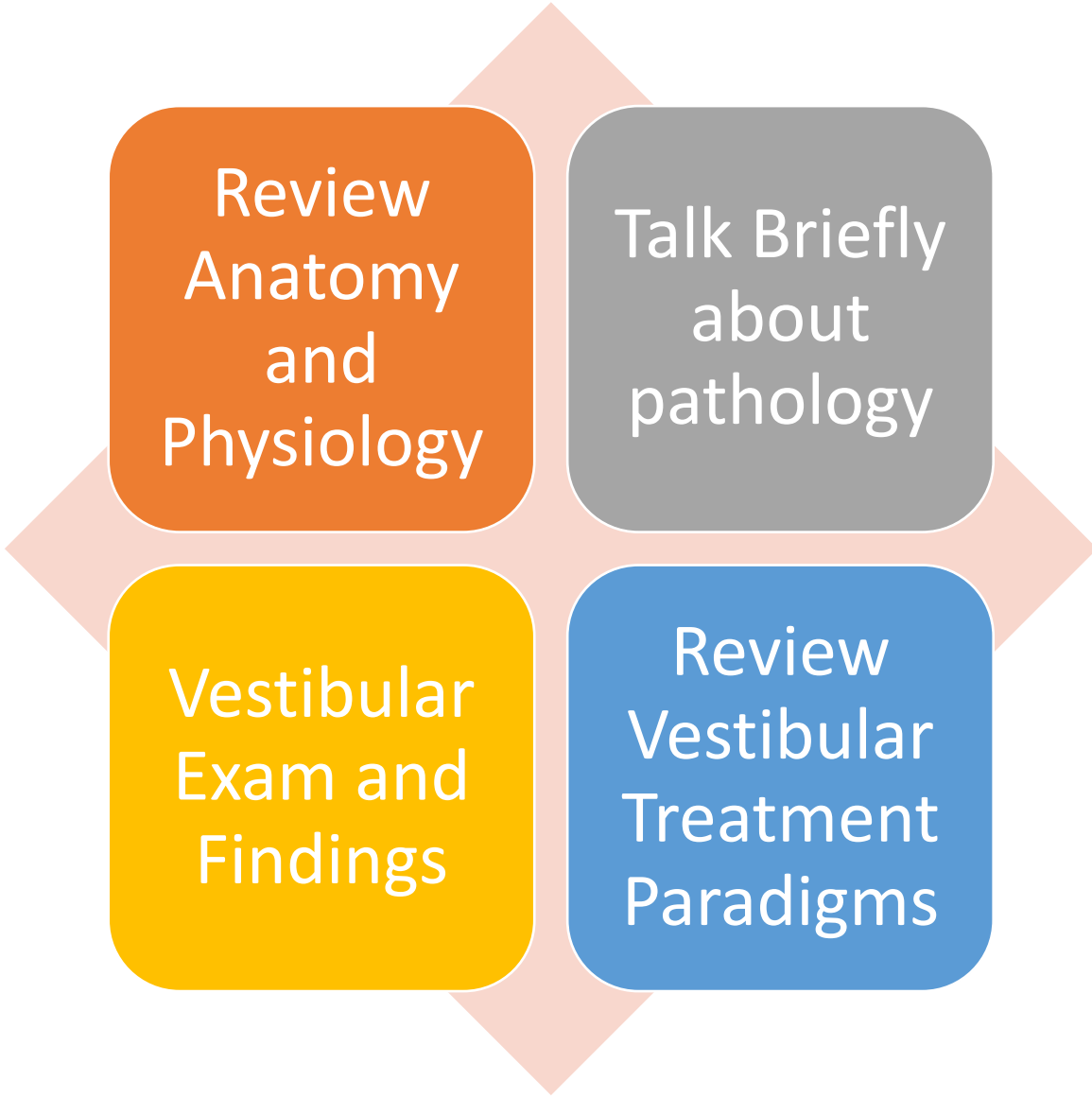
Vestibular System

Presented by Cory Hall DPT, ATC, NCS

About Me

- VCU DPT Graduate
- Began Career in Inpatient Rehab in Richmond VA
- Moved to Maine worked in Acquired Brain Injury Day Rehab
- Transitioned to Manage Multidisciplinary Neuro/Rehab Clinic
- Completed Emory Vestibular Course in 2017 and NCS in 2018
- Taught Vestibular to UNE for 4 years
- Teach Lab Component of UNE Adult Neuro Course
- First Year as a Scorebuilder’s Instructor

Objective


Review Anatomy and Physiology
Talk Briefly about pathology
Vestibular Exam and Findings
Review Vestibular Treatment Paradigms

Vestibulocochlear Organ

- Inner Ear

  Deep to Tympanic Membrane
- In wall of skull
- Cochlear Portion and Vestibular

  Portion
- Attaches to CN VIII

  Vestibulocochlear Nerve

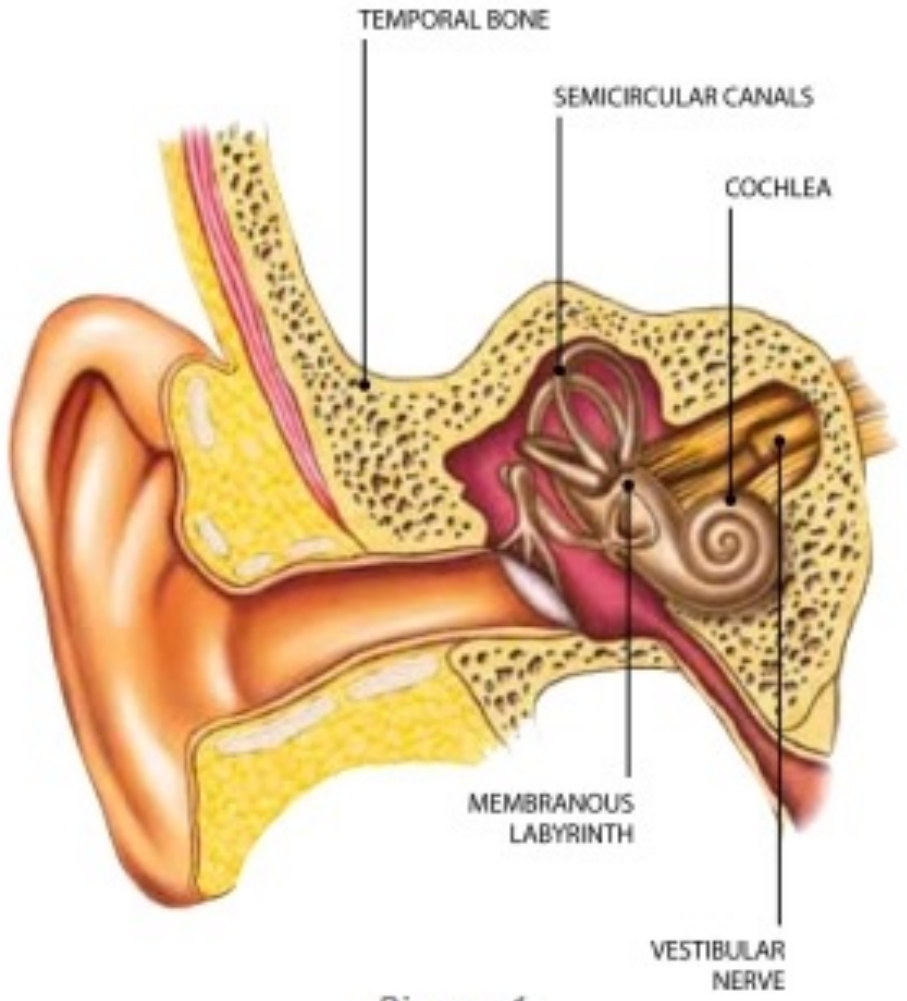


Diagram 1

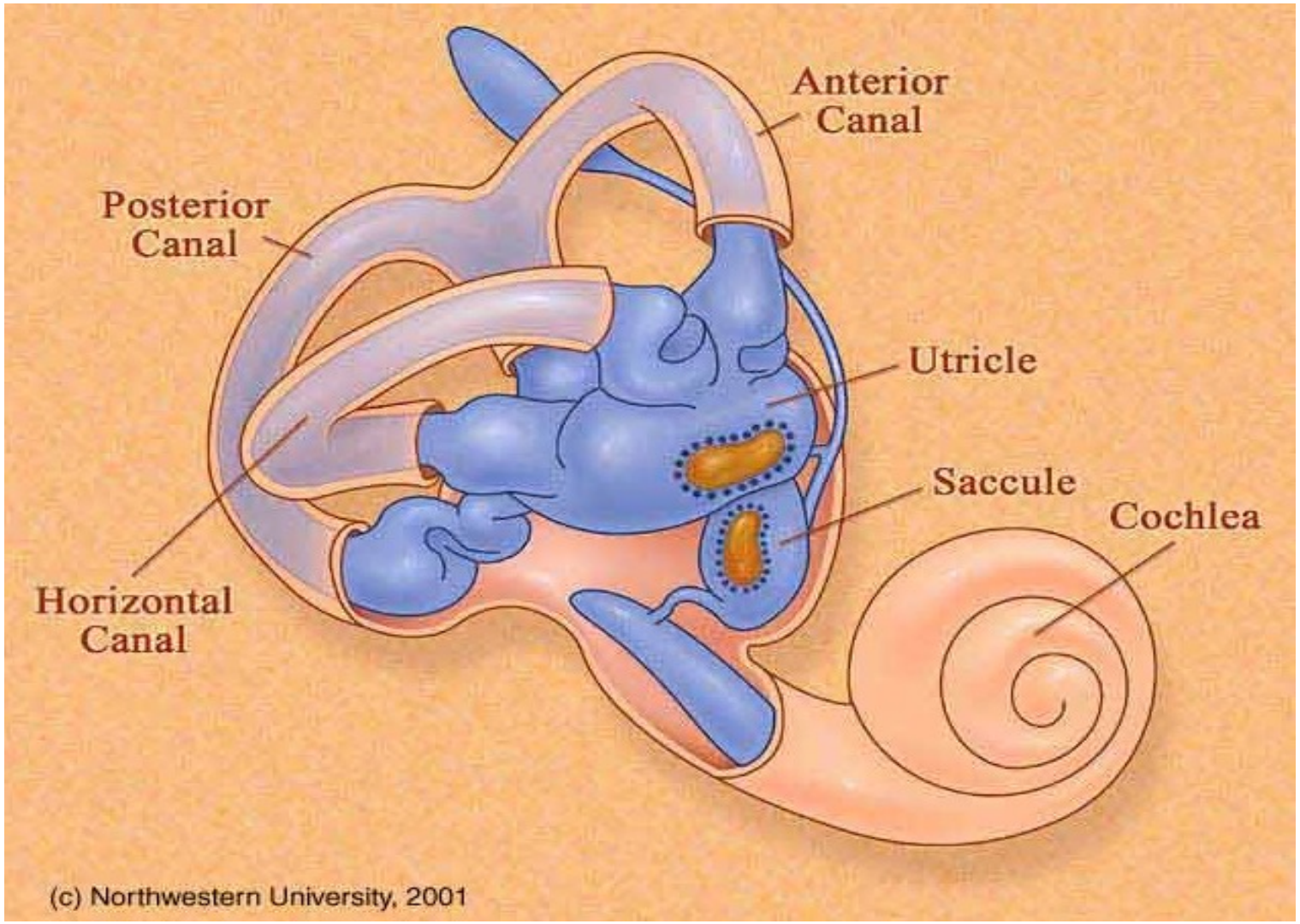
Vestibular Function

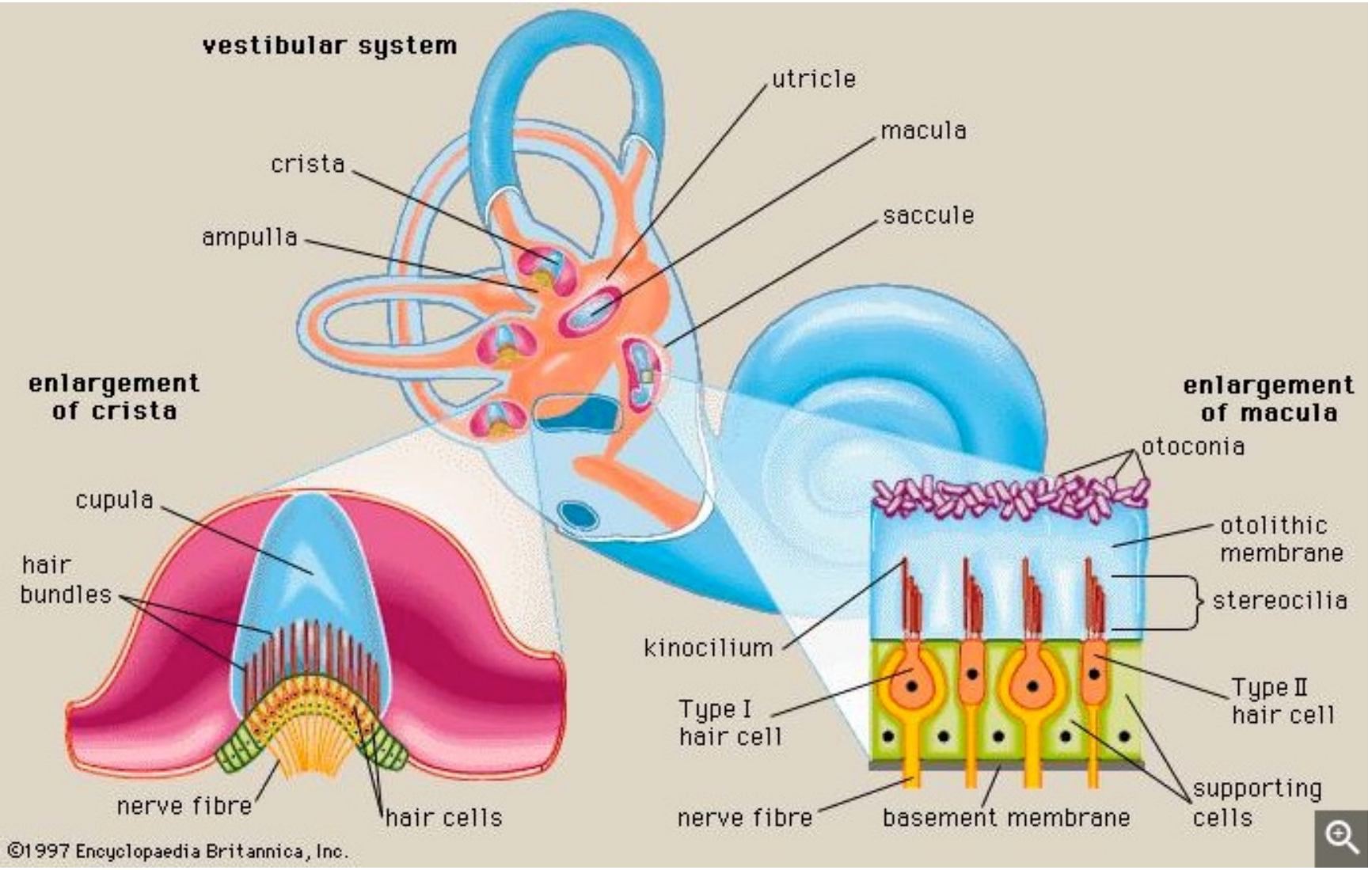
Motion Detection

Head and Eye Position

Spatial Orientation

Postural Control





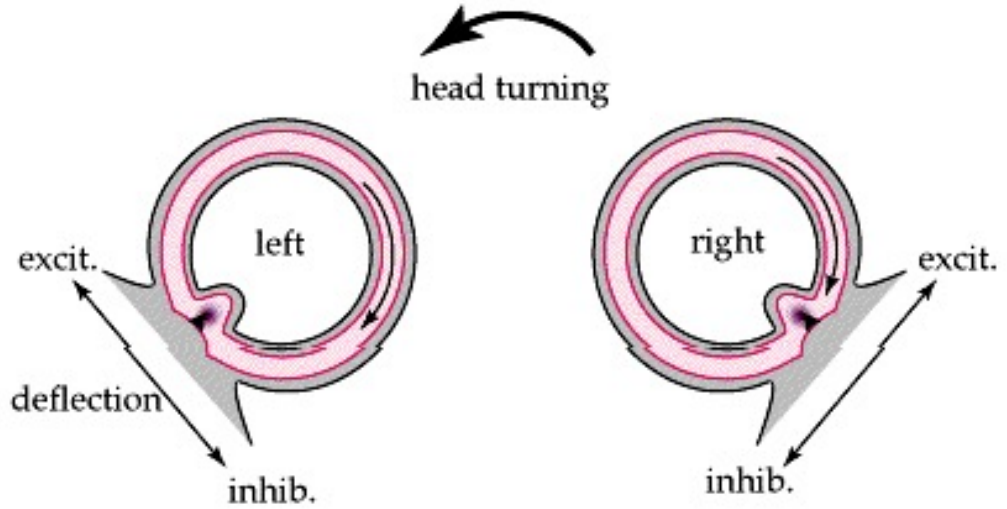
Anatomy

Semicircular Canals
- Anterior
- Posterior
- Horizontal

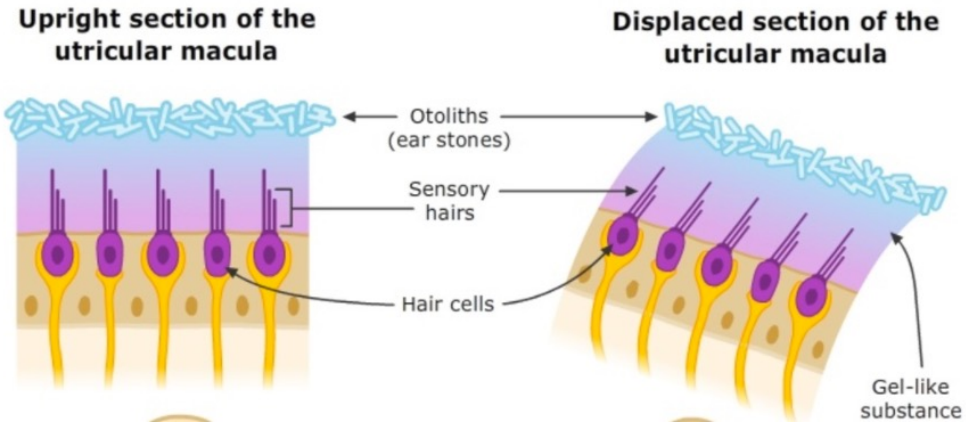
Otoliths
- Utricle – Horizontal
- Saccule – Vertical

Physiology of Vestibular System

- Angular Acceleration – Semi-Circular Canals
  - Based on Fluid movement in canal



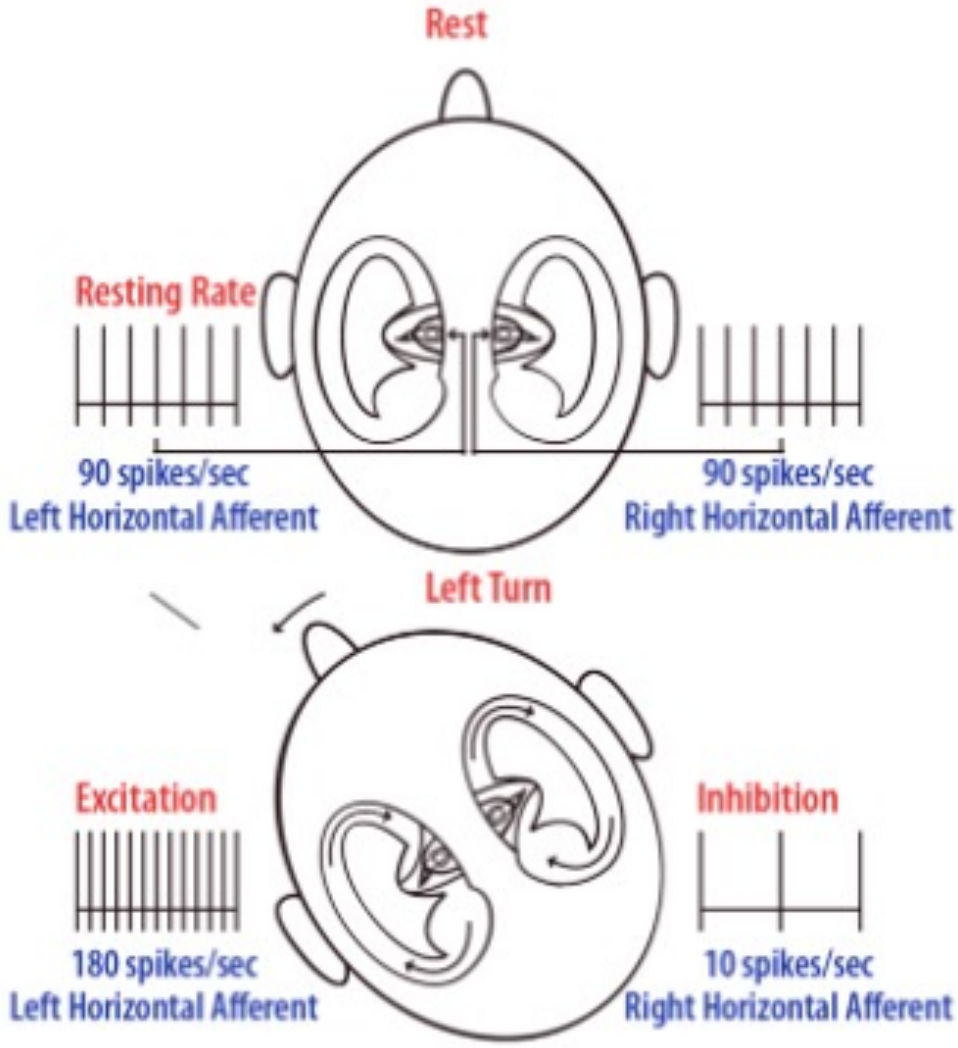
- Linear Acceleration (Lean/Tilt) – Otoliths
  - Based on gravity pulling otoconia



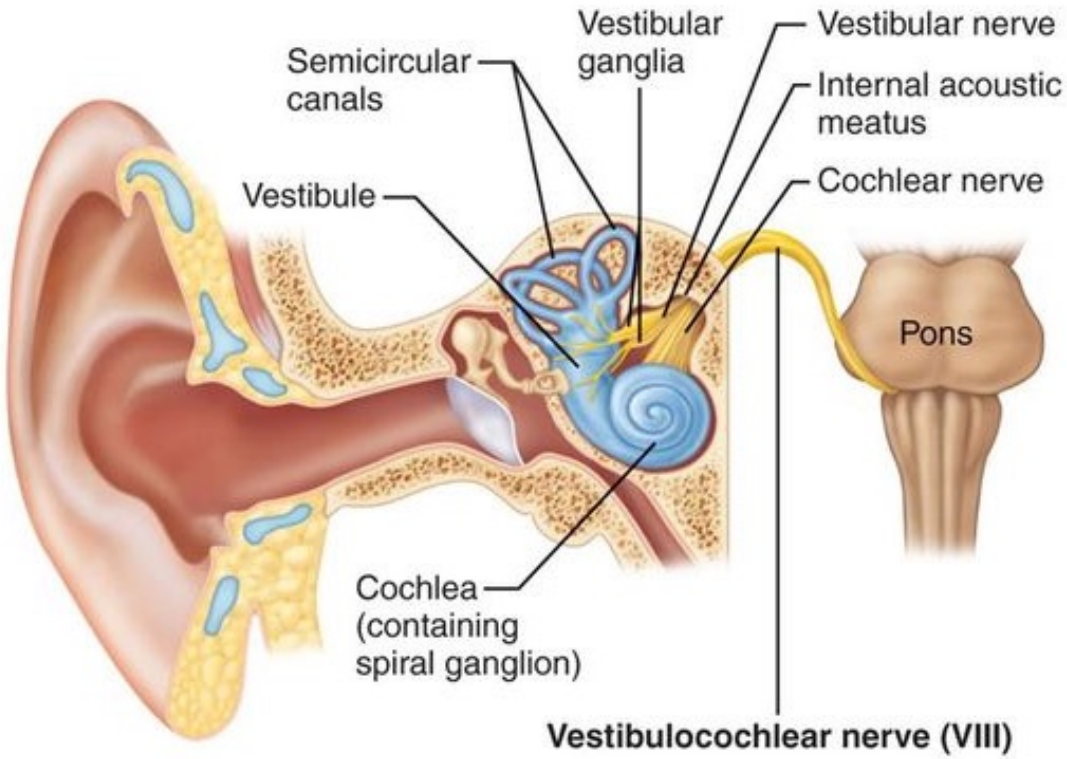
Excitation/Inhibition

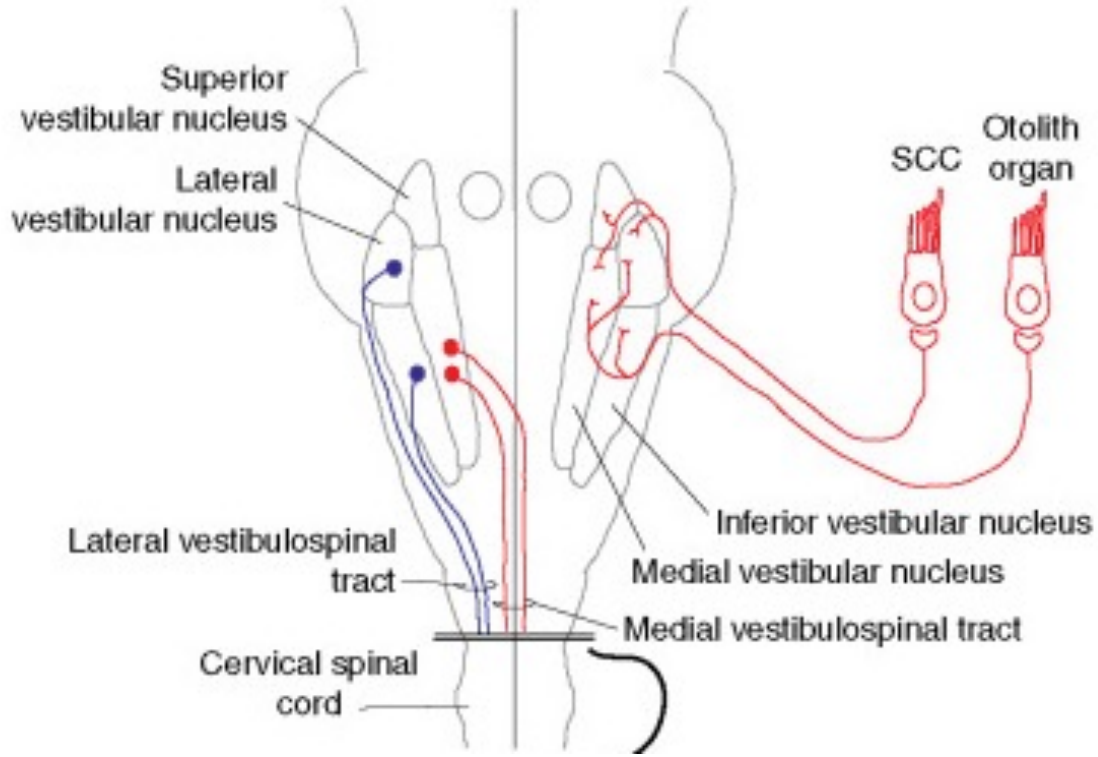
- Resting Tone of ~ 90 beats/sec

- Turn head left
  - Left Semi-circular canal Excites
    - 180 beats/sec
  - Right Semi-Circular Canal Inhibits
    - 10 beats/sec



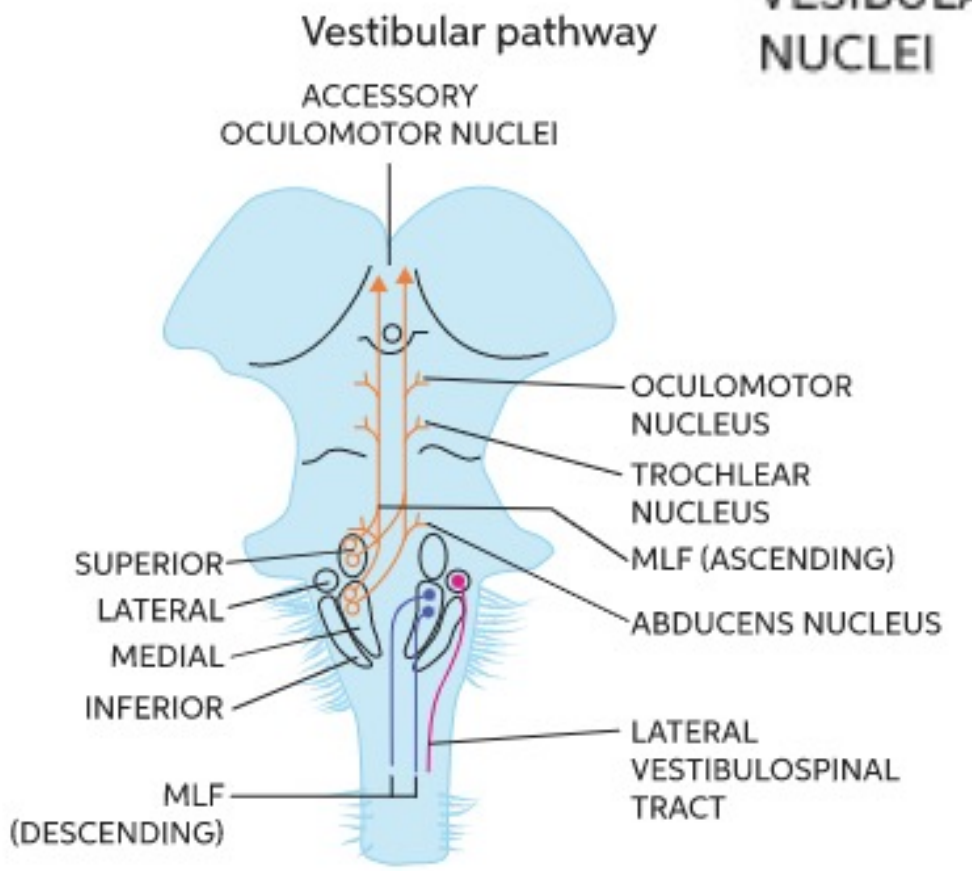
The Vestibulocochlear Nerves - VIII

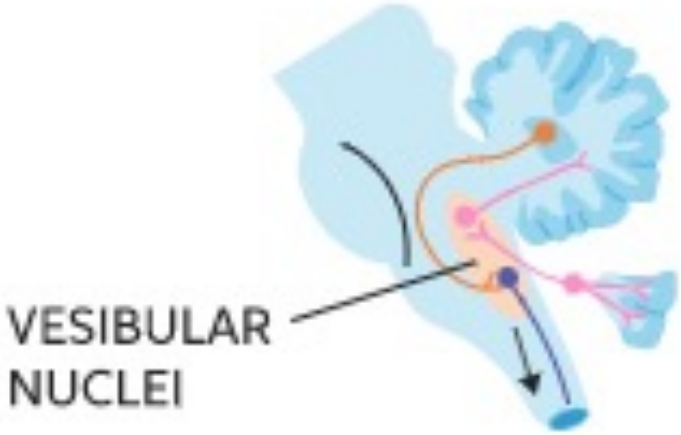




Superior Projections to Ocular Movement

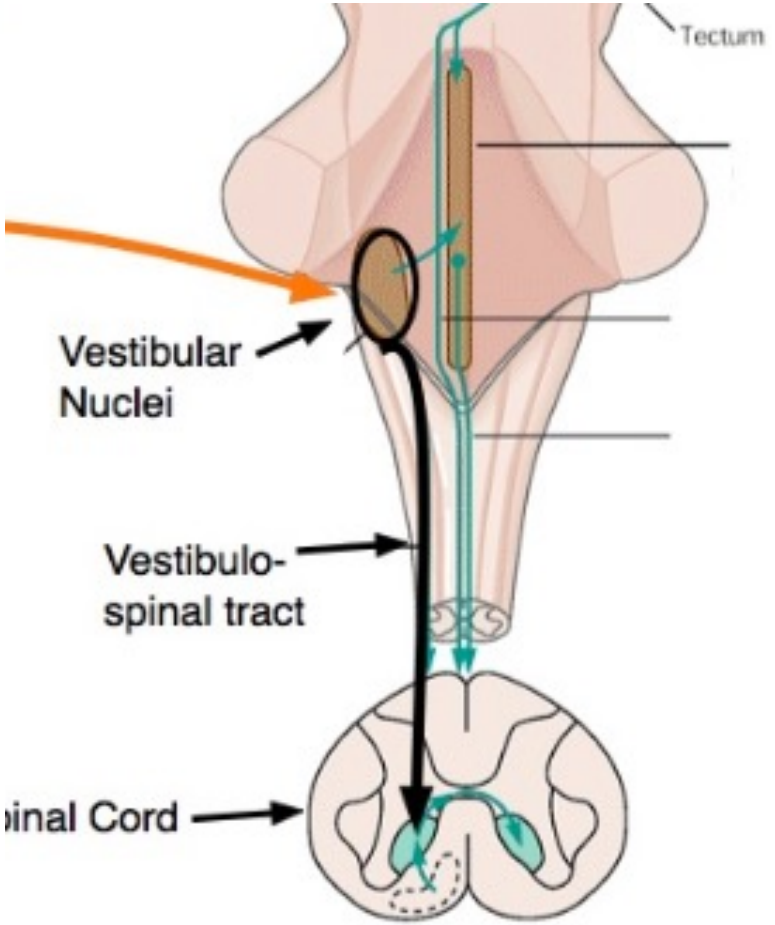
VOR





Inferior Projections to Postural Control Muscles

VSR



Vestibular Disorders

Dizziness? Is it even vestibular related?

- Cardiopulmonary
- Neurologic
  - Brain stem
  - Posterior Fossa
  - Oculomotor
  - Visual Perceptual

Differentiating Terms

- Vertigo – sensation of self motion when no self motion is occurring (rotational or linear)
- Dizziness – sensation of disturbed or impaired spatial orientation without a false sense of motion
- Unsteadiness – feeling of being unstable without a particular direction preference
- Lightheadedness – feeling of going faint, often described as floaty

Timing and Triggers

How long does the sensation last

- Seconds
- Minutes to an hour
- Hours
- Days/Constant

What Starts It

- Spontaneous?
- Positional
- Head movements
- Activities or environments

Cardiopulmonary

- Spontaneous and Episodic

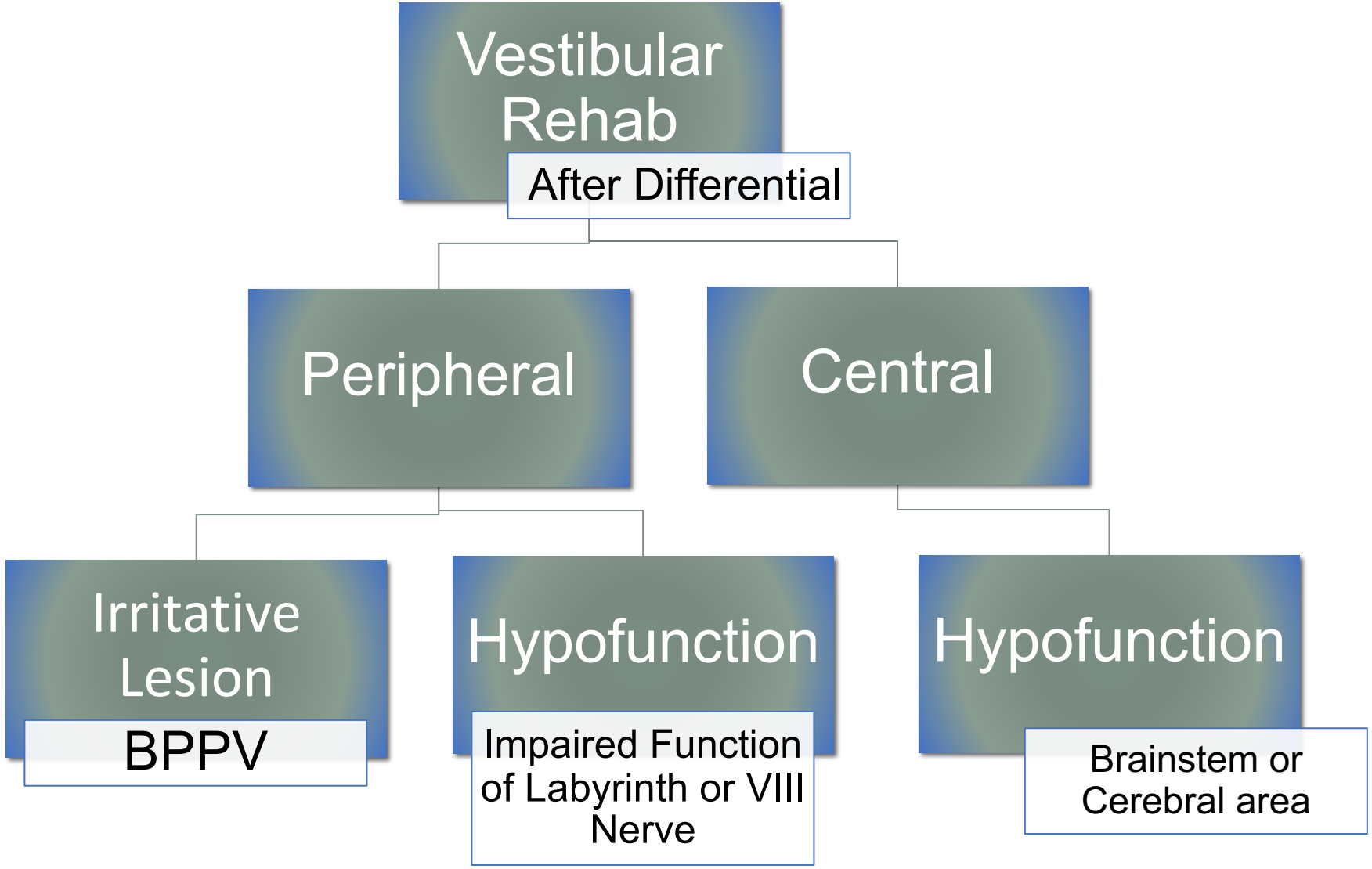
- Orthostatic hypotension
  - 20/10 drop w/ positional change
- Cardiac Arrhythmia or Syncopal Episodes
- Vascular insufficiency

Neuro Red Flags

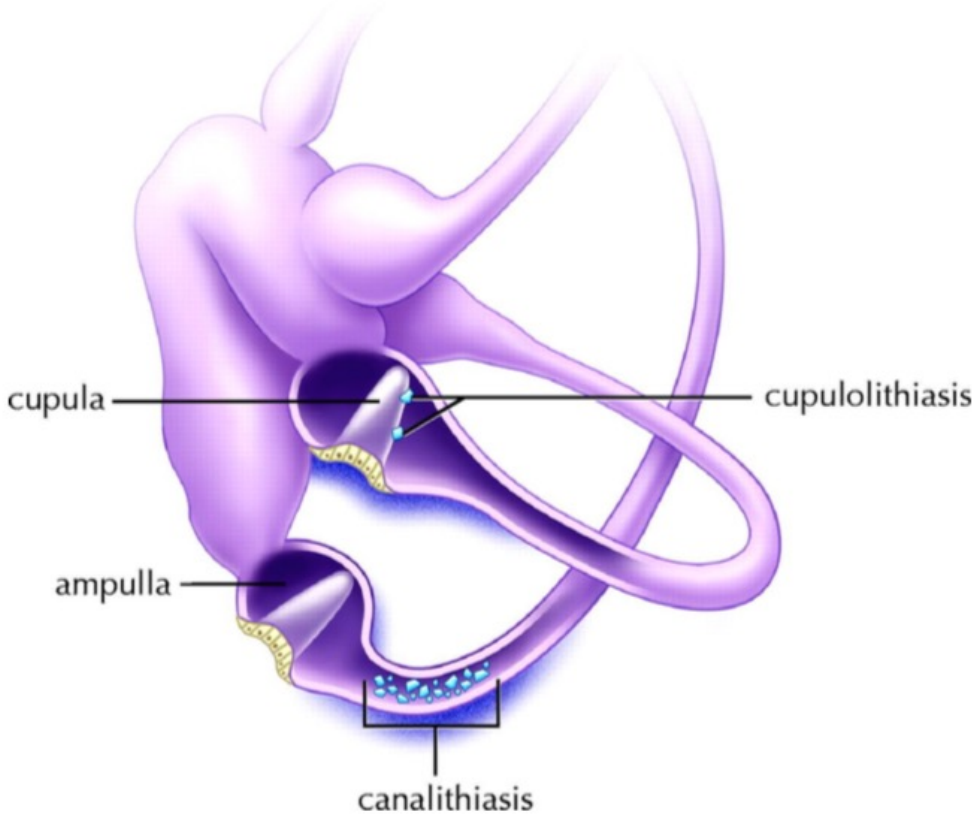
- Diplopia – double vision (or any oculomotor abnormalities)
- Dysphagia – trouble swallowing
- Dysarthria – trouble talking
- Dysmetria – discoordinated movements based on distance
- Visual Field cuts

- Pure vertical nystagmus
- Direction changing nystagmus

Same system different pathologies



BPPV What does that Mean?



Benign – mechanical issue/malfunction

Paroxysmal – sudden increase in symptoms but finite

Positional - happens when you change position of head

Vertigo – Sensation of spinning

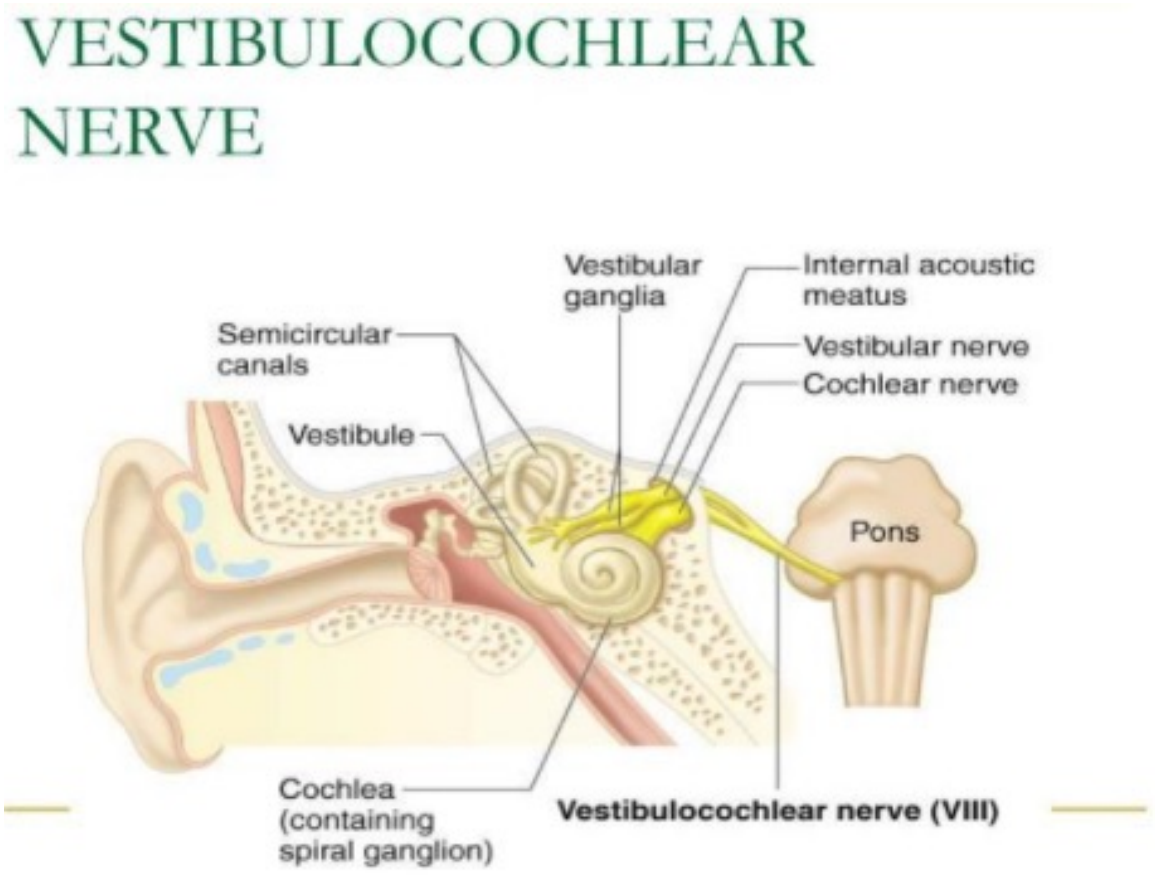
Symptoms

- Intense spinning (vertigo)
- Occurs when head is moved into certain positions
  - Lying down
  - Rolling over in bed
  - Bending over to pick something up
  - Looking above their head
- Typically of short duration < 1 min
- Reports of poor balance, sometime nausea

~60% female
Idiopathic most often
Older age

What causes Unilateral Hypofunction?

- Vestibular Neuritis
- Labyrinthitis
- Internal Auditory Artery Stroke
- Concussion
- Perilymph Fistula
- Meniere's
- Vestibular Schwannoma
- Post Surgical



Classifying Conditions

<u>Hypofunction</u>

- Unilateral Vestibular Hypofunction (UVH)
  - Vestib Neuritis/labyrinthitis
  - Post surgical repair/vestibular schwannoma

- Central disorder
  - Tumor, CVA, MS, TBI

<u>Irritating Lesion</u>

- BPPV

Indications vs Contraindications

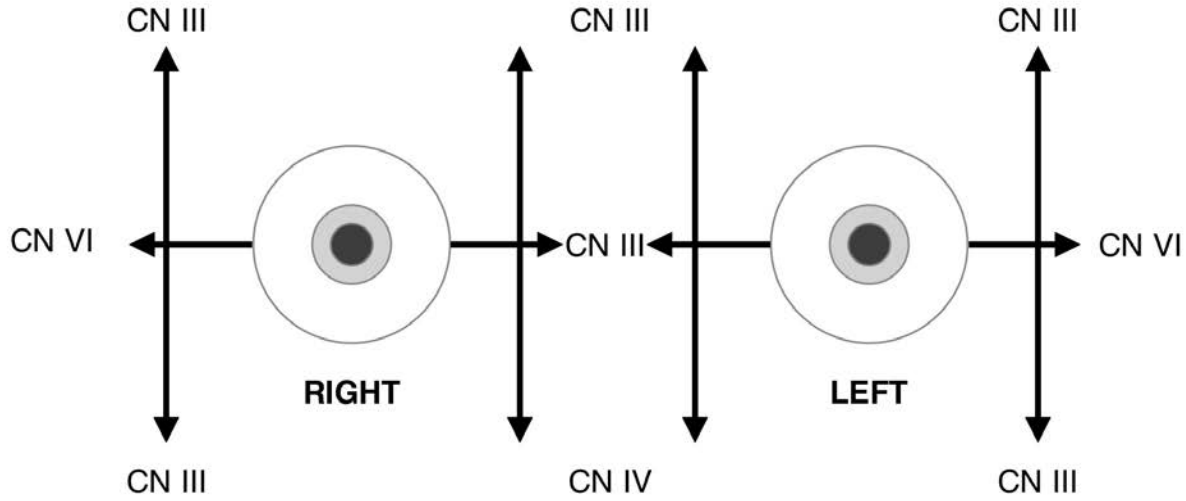
Indications

- Only appropriate to treat stable vestibular lesions
  - Otherwise it's just torture
  - However could be a progressive disorder that is currently stable
- Can consistently provoke symptoms
  - Change in body positions
  - Specific movement

- Contraindications
  - Progressive or inconsistent symptoms
  - Spontaneous symptoms

Vestibular Exam

Ocular Range of Motion



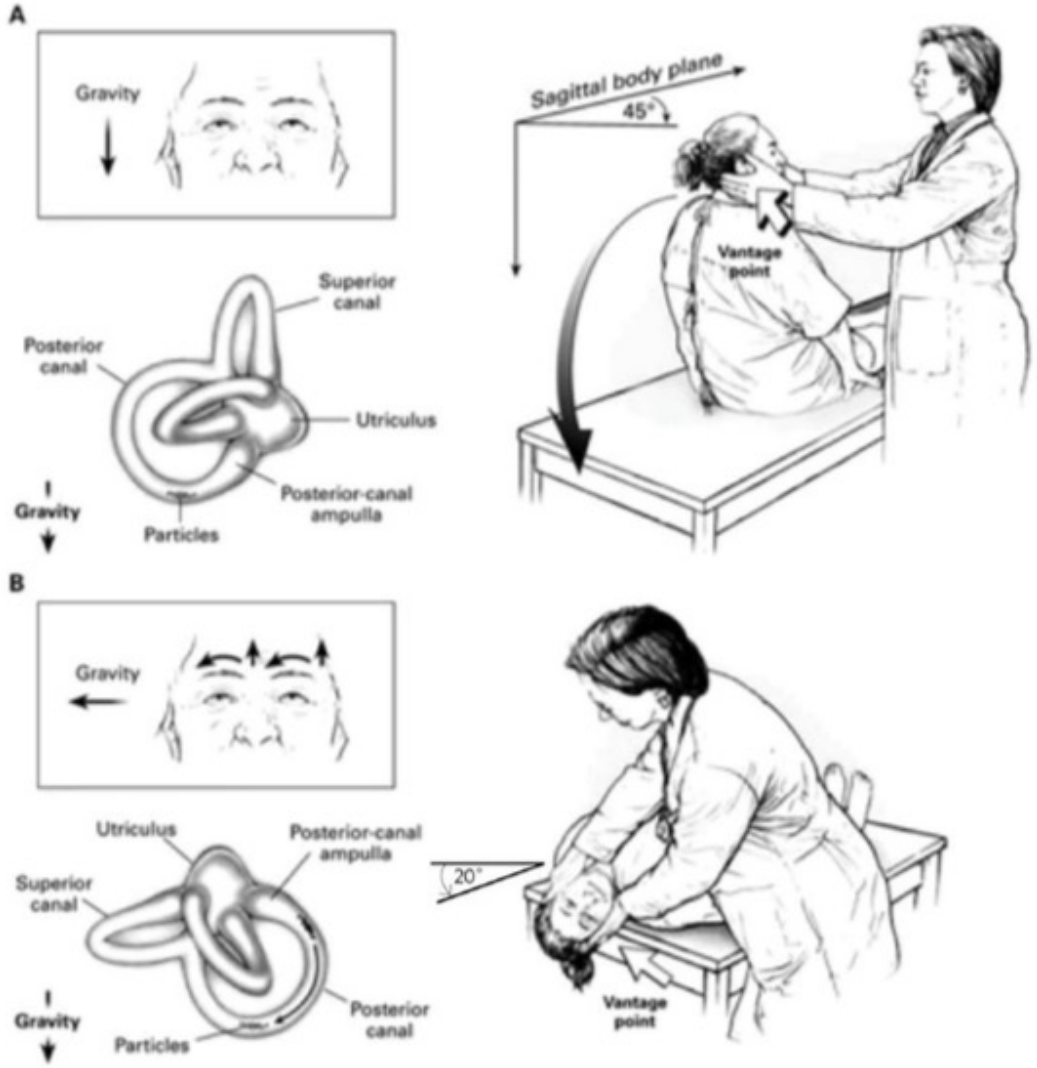
III	Oculomotor	EYE MOVEMENT: PUPIL SIZE + REACTIVITY EYELID MOVEMENT	Use penlight to assess patient for PERRLA
IV	Trochlear	EYE MOVEMENT: DOWN + LATERALLY	Hold penlight and ask patient to follow the movement of the penlight; move down and sideways
VI	Abducens	EYE MOVEMENT LATERALLY	Hold penlight + ask patient to follow movement; move side to side + diagonally

Types of Ocular Control

- Smooth Pursuit
- Saccades

Dix – Hallpike Test

- Turn Head 45° to Right in long sitting
- Lower Patient into supine with head turned 45° to right, extend neck 30° off end of table
- Observe for nystagmus, hold open the persons eyelid if necessary



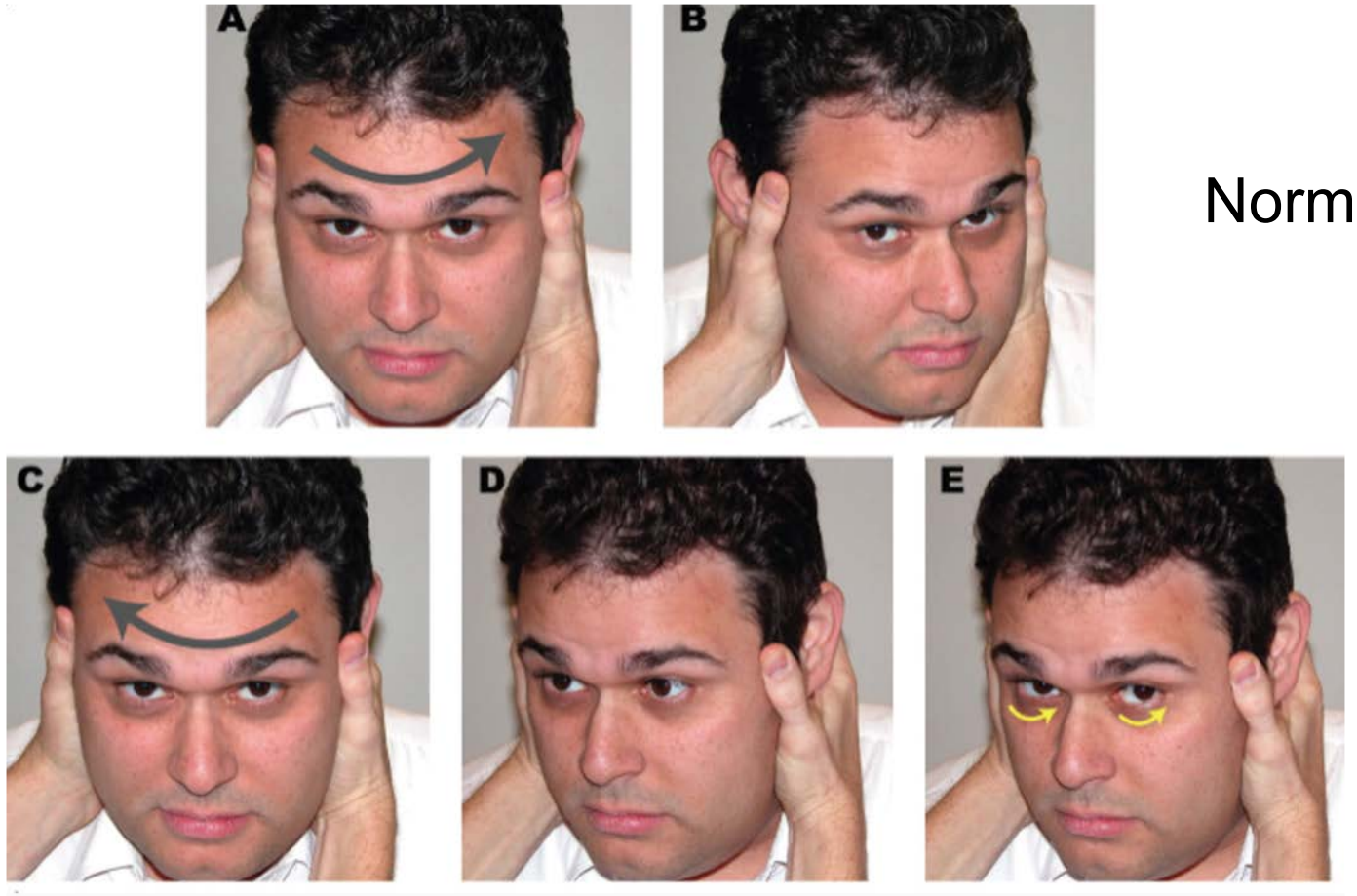
Bhattacharyya et al 2017

All images from here out are from this article

Positional Testing Requirements

- Must Clear Cervical spine prior to any BPPV eval
- AROM
  - Extension 30° Needed
  - Rotation 45° Needed to both sides
- Vertebral Artery Test
  - Full extension and rotation in sitting
  - Looking for lightheaded or confusion/neuro signs

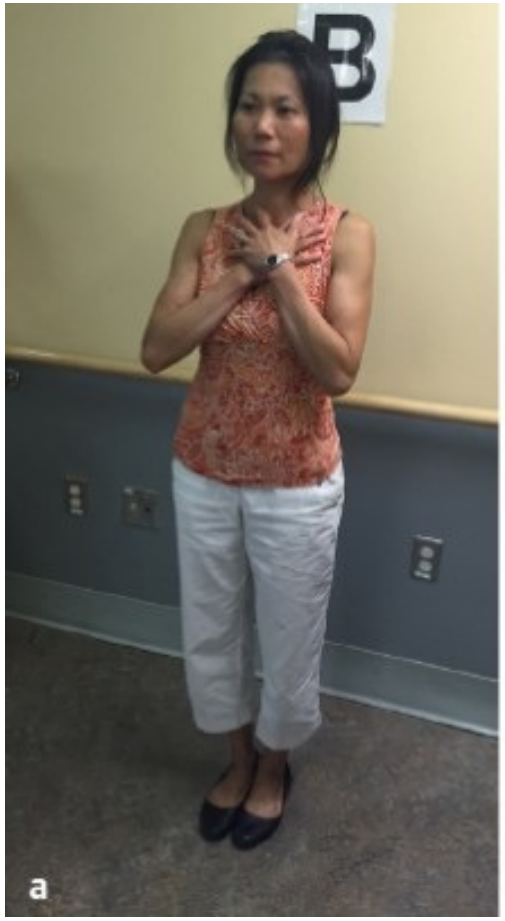
Head Thrust – Hypofunction Test

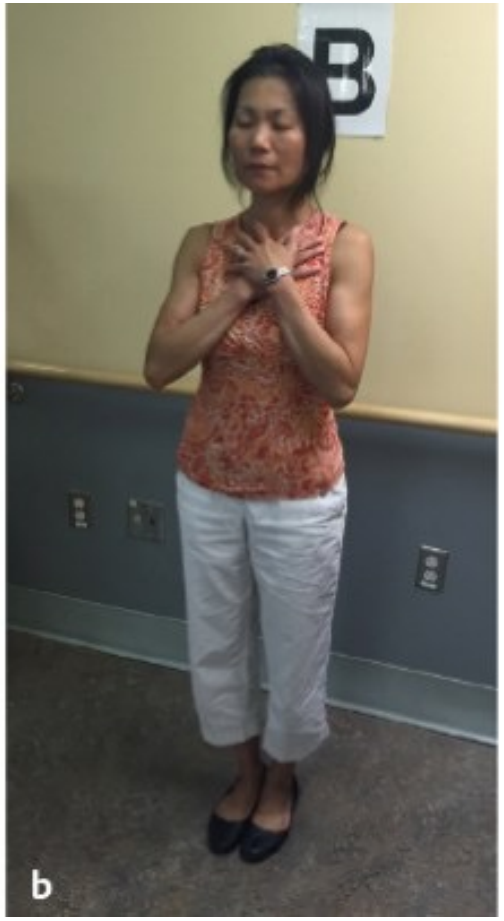


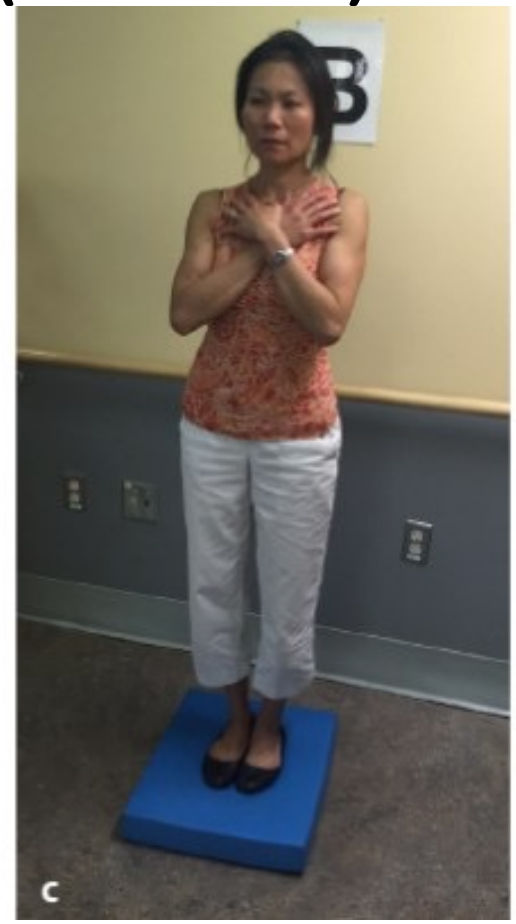
Normal VOR

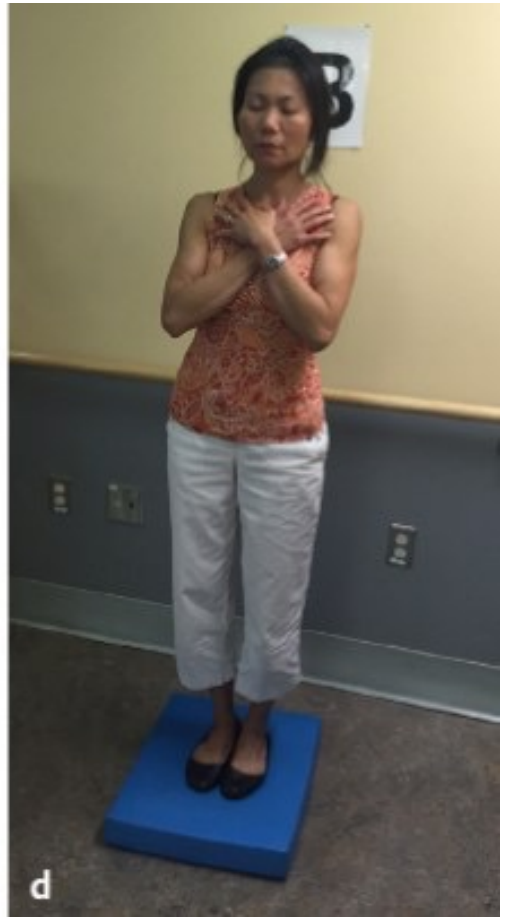
Abnormal VOR - Retinal Slip

Modified Clinical Test of Sensory Integration and Balance (mCTSIB)









4 Conditions – Max time of 30 seconds on each
Reported as total time 110/120
Direction of sway and/fall is also helpful

- 1) Eyes Open on Firm Surface
  - Vision
  - Proprioception
  - Vestibular

- 2) Eyes Closed on Firm Surface
  - ~~Vision~~
  - Proprioception
  - Vestibular

- 3) Eyes Open on Foam Surface
  - Vision
  - ~~Proprioception~~
  - Vestibular

- 4) Eyes Closed on Foam Surface
  - ~~Vision~~
  - ~~Proprioception~~
  - Vestibular

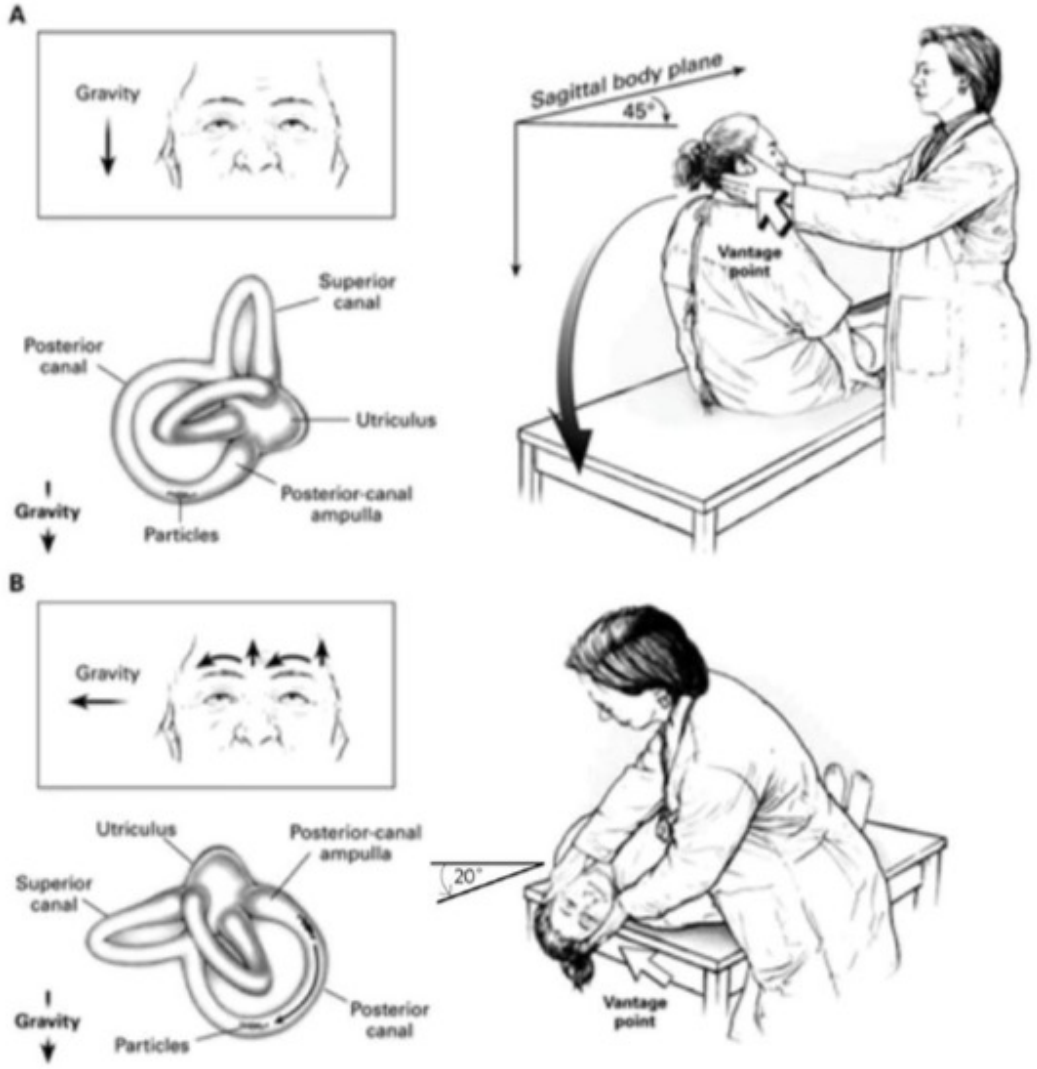
- Vestibular Impairment will do well on all conditions except 4 with consistent sway
- Visually dependent will do poorly on conditions 2 and 4
- Poor proprioception would do poorly on conditions 3 and 4
- Central motor weakness or ataxia would do poorly on all conditions

BPPV

- Triggered Dizziness with Positional changes lasting seconds to minutes
- Positive Hallpike Testing - Nystagmus

Dix – Hallpike Test

- Turn Head 45° to Right in long sitting
- Lower Patient into supine with head turned 45° to right, extend neck 30° off end of table
- Observe for nystagmus, hold open the persons eyelid if necessary



Bhattacharyya et al 2017

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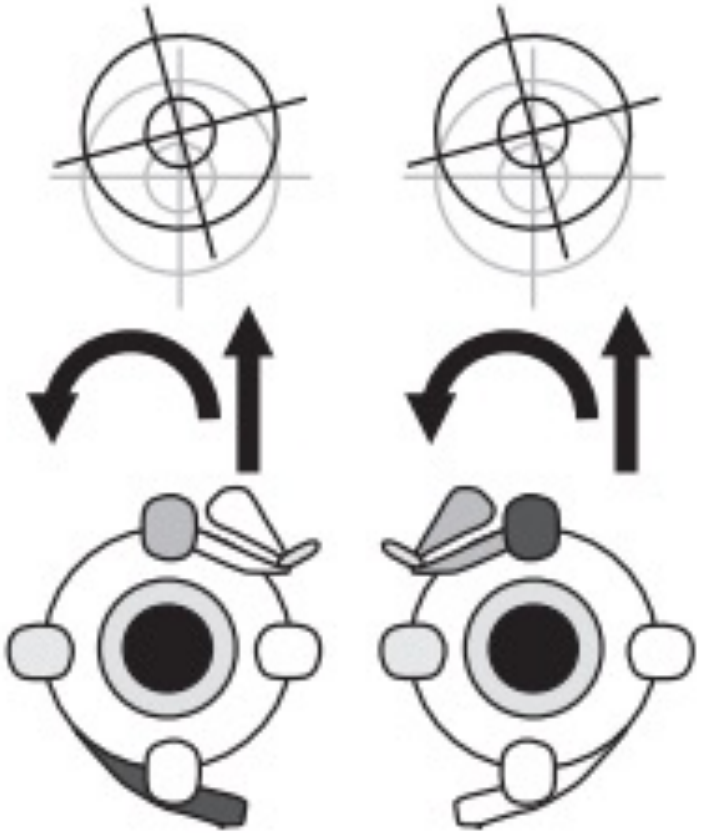
Findings for Right Posterior Canal

- If you turn head to right you are testing right posterior canal
- Direction
    - Upbeating (towards persons forehead) and Right rotational

Positive Posterior Canal will be upbeating and towards side of lesion



Eggers et al 2019

Post Canal Canalithiasis Treatment

Canalith Repositioning Maneuver RULES

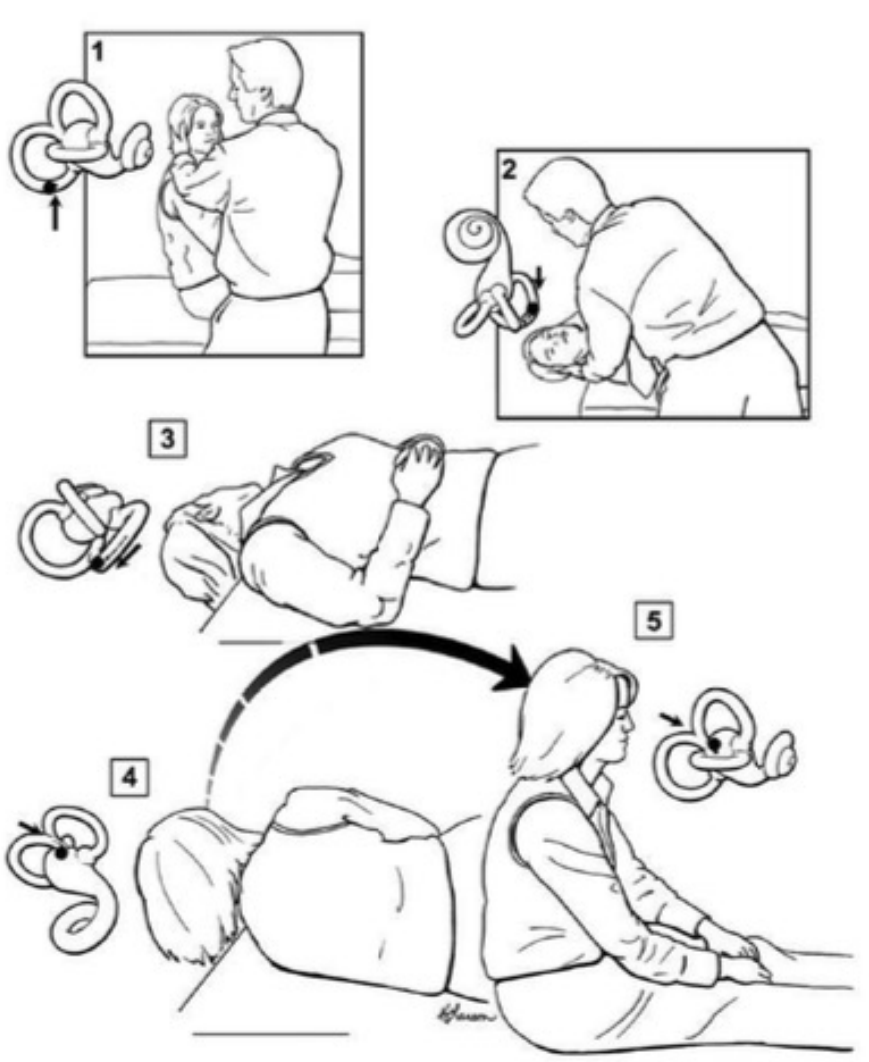


Figure 3. Depiction of the canalith repositioning maneuver (Epley maneuver) for right ear posterior semicircular canal benign paroxysmal positional vertigo. Adapted and reproduced with permission from Fife et al.[62] © 2008 Barrow Neurological Institute, Phoenix, Arizona. Refer to **Table 10** for description.

1) Turn Head 45° towards AFFECTED EAR in long sitting

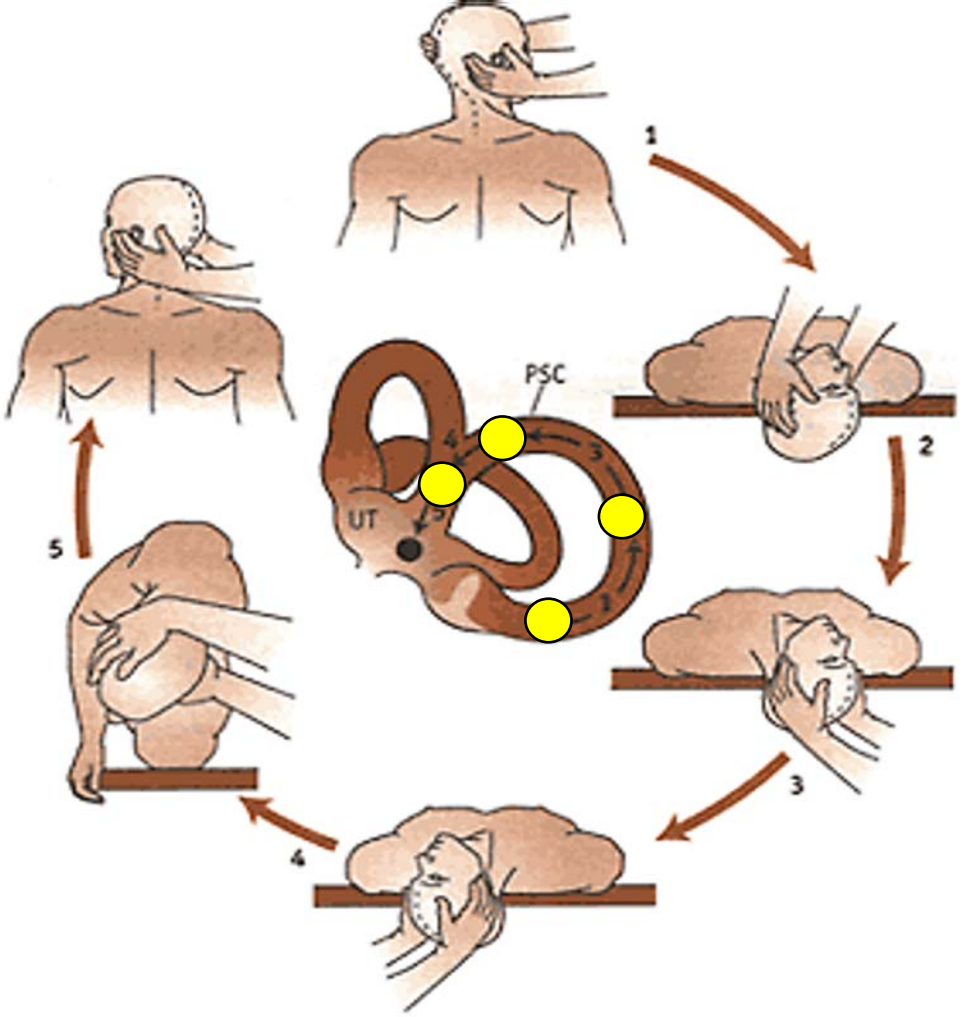
2) Pt is laid back supine with head still turned and neck extended 20-30° off end of table and maintain for 1 min

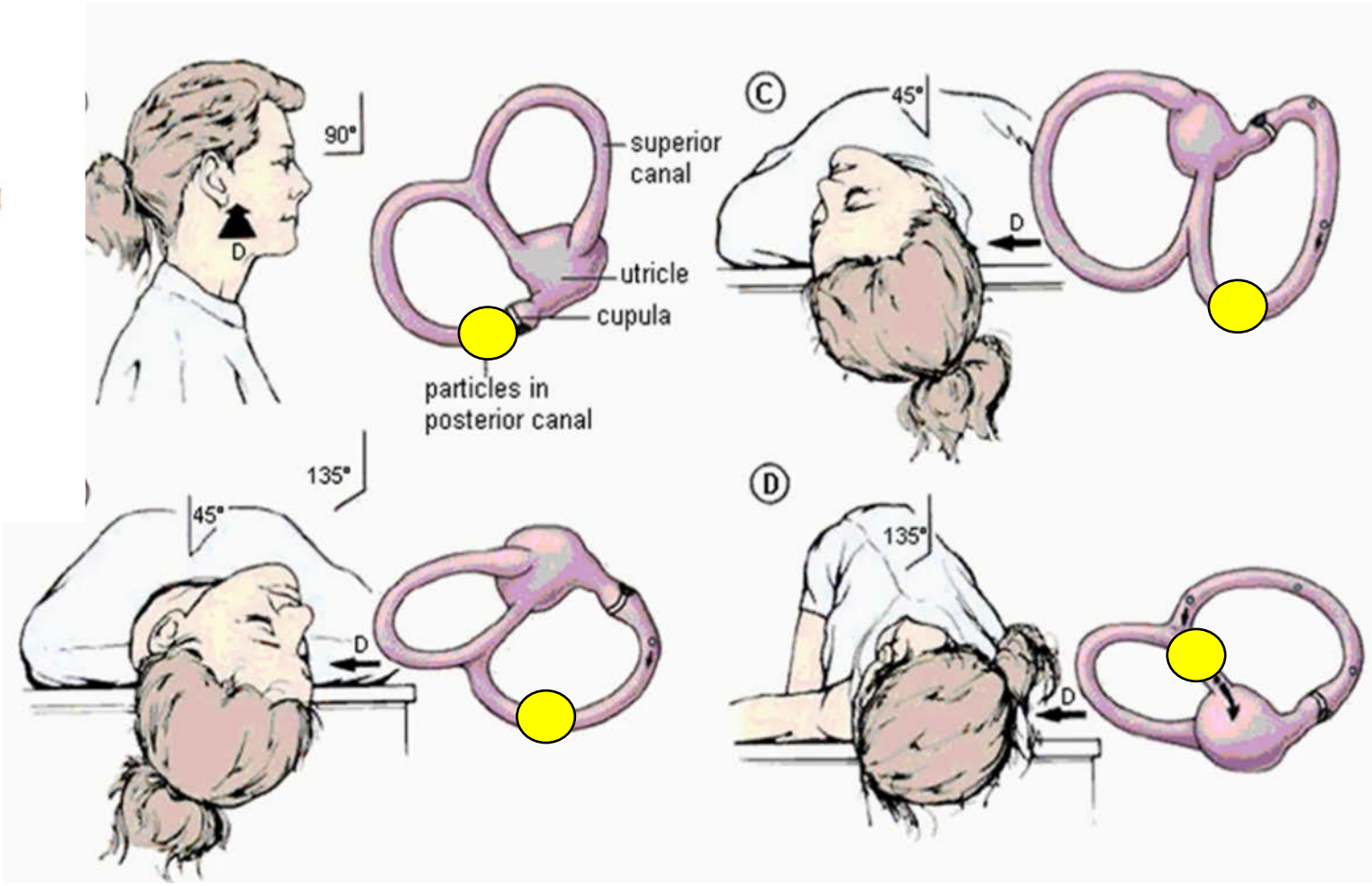
3) Turn Neck 90° towards UNAFFECTED EAR (end position is 45° rotated opposite way)

4) Roll patient onto side of UNAFFECTED shoulder, in effect turning head 90° further. Head will end up face down to floor

5) Tuck chin and bring patient up to sitting

Repositioning





Right Canalith Repositioning Maneuver – treatment right posterior canalithiasis

1. Turn Head 45° to the right in long sitting
2. Pt is rapidly laid back supine with head turned right and neck extended 20-30° below horizontal and maintain for 1 min
3. Turn Neck 90° left (end position is 45° facing left) wait up to 1 min
4. Roll patient onto left side, in effect turning head 90° further. Head will end up 45° face down to floor wait up to 1 min
5. Tuck chin and bring patient up to sitting

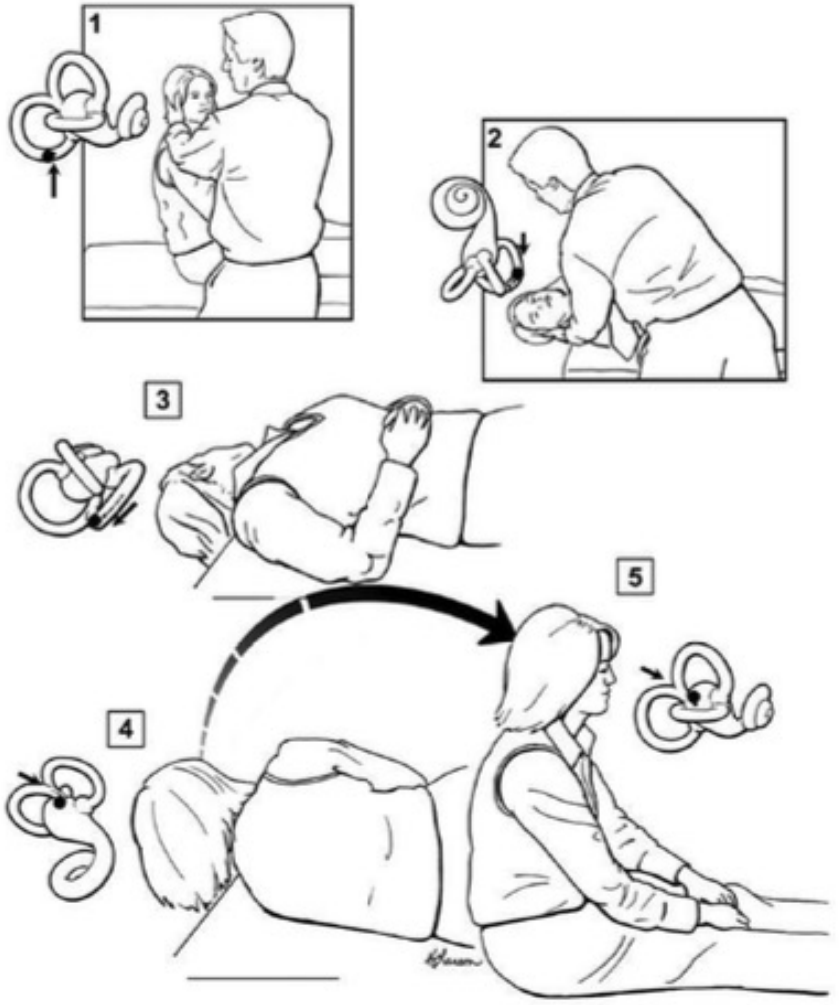


Figure 3. Depiction of the canalith repositioning maneuver (Epley maneuver) for right ear posterior semicircular canal benign paroxysmal positional vertigo. Adapted and reproduced with permission from Fife et al.[62] © 2008 Barrow Neurological Institute, Phoenix, Arizona. Refer to **Table 10** for description.

Left Canalith Repositioning Maneuver – treatment left posterior canalithiasis

1. Turn Head 45° to the left in long sitting
2. Pt is rapidly laid back supine with head turned left and neck extended 20-30° below horizontal and maintain for 1 min
3. Turn Neck 90° right (end position is 45° facing right) wait up to 1 min
4. Roll patient onto right side, in effect turning head 90° further. Head will end up 45° face down to floor wait up to 1 min
5. Tuck chin and bring patient up to sitting

How effective are these treatments?

- Posterior Canal - Level A
  - CRM 80-91% effective
    - Increases if you perform 2-3 times

General Course of Treatment

1st Treatment

- History/Subjective
- Diagnose canal and type
- Talk through and perform Canal Repositioning Maneuver
- Re-evaluate for improvement, retreat if needed (2-3 max)
- If time allows assess balance

2nd visit 3-7 days after eval

- Reassess, retreat if required
- Teach self treatment
- Evaluate balance
  - Start general balance treatment if indicated

Unilateral Hypofunction

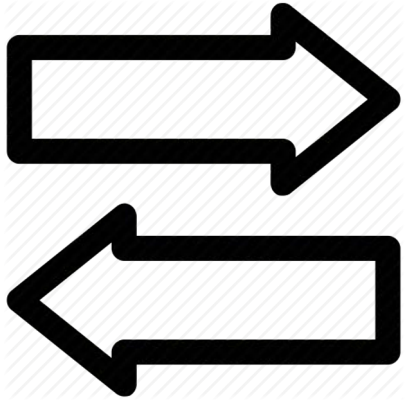
- Triggered dizziness for seconds (happens repeatedly) with head motion
- Positive testing for Head thrust to side of lesion
- Fall towards side of lesion on mCTSIB

Impairment based Plan of Care

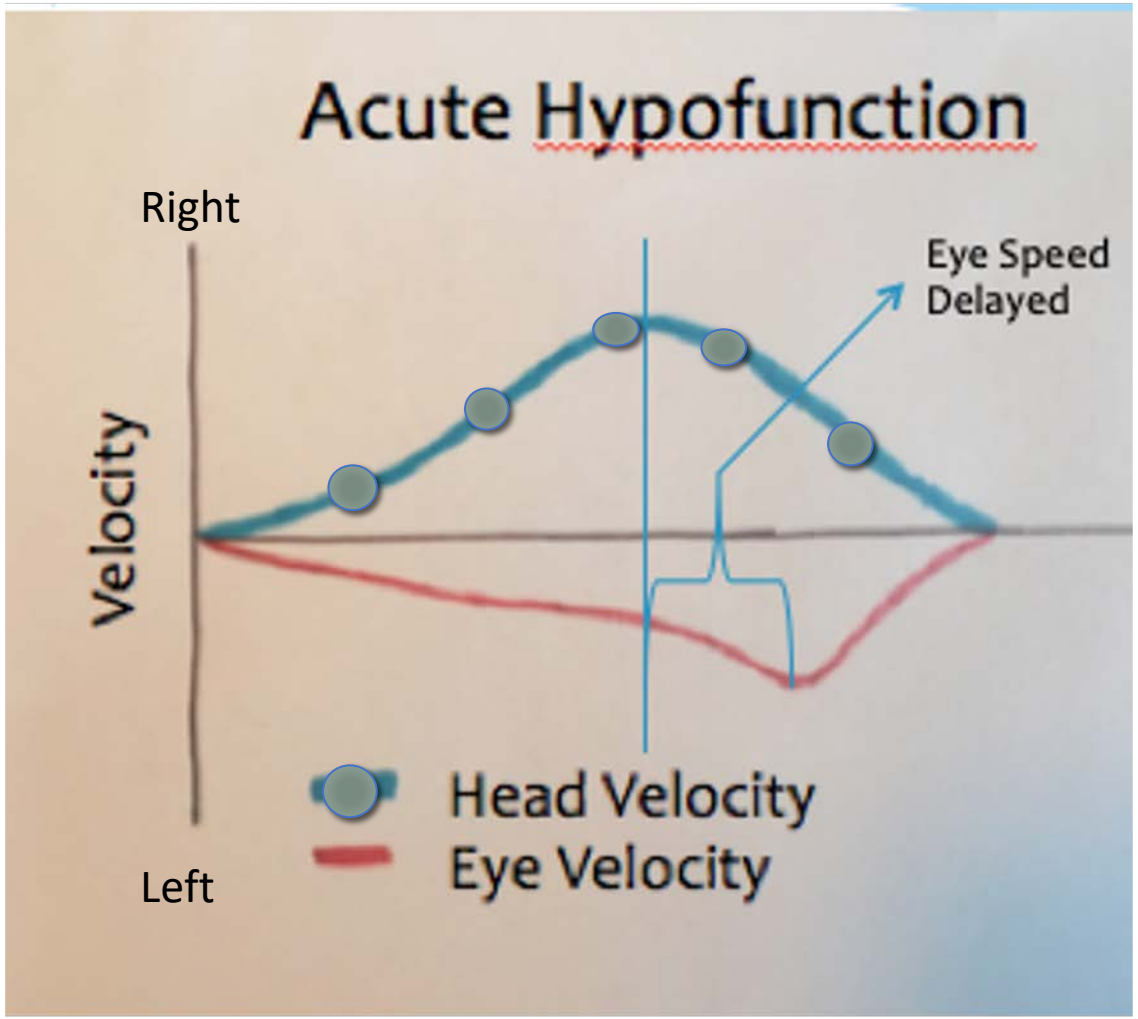
1. Gaze Instability
   - Symptoms during head movements
   - Decreased visual acuity during head movements
2. Imbalance/ Postural Instability
   - Static/Dynamic
3. Motion sensitivity
   - Positioning and positional vertigo
4. Functional Activities

Vestibular Rehab Theories

- Adaptation
  - Improve existing normal strategies
    - VOR and VSR
- Substitution
  - Use alternative strategy to replace vestibular input
- Habituation
  - Get conditioned to dizziness to increase function



Adaptation – VOR Impairment



- Head moves – Eyes don't match
- Corrective Saccade to reduce the retinal slip
- This mismatch is what makes people feel dizzy

- Creates error signal that drives improvement
  - **MAIN THEORY FOR VESTIBULAR REHAB**

UVH – Impairments

- Gaze instability! – ADAPTAION to VOR
- Postural balance – adapt VSR/Substitute with sensory reweighting
- Motion sensitivity –Habituate to position and Position Changes
- Self vs Environment Motion – common problem chronically if pt decompensates – Adaptation and habituation
- Functional mobility – gradual return to ADLs

UVH – General Rehab Principles

- Highly structured targeted program
- Encourage movement to minimize compensation
  - General movement routine (walking)
  - Keep eyes open
  - Normalize head movements
- Emphasis on home exercise
- Need to stop vestibular suppressants

UVH CPG 2016

UVH - Timeline

- Uncomplicated acute -1x/wk for 2-3 weeks
- Chronic 1x/wk for 4-6 weeks
- With comorbidities may need considerably more

- Need to maintain higher level of function or do exercises consistently to maintain gains
  - May decompensate with illness/stress

Summary

Overview of Clinical Picture

BPPV

- History of periodic vertigo (true spinning sensation) with positional changes
- Upbeat Rotational Nystagmus towards involved side in Dix Hallpike testing
- Head Thrust Negative
- Balance minimally impaired

Unilateral Hypofunction

- History of disorientation or oscillopsia with head turns that only lasts for seconds but constantly repeating
- Hallpike Testing Negative
- Head trust Positive toward involved side
- mCTSIB would show vestibular impairment and sway would be consistently to one side

Vestibular Disorders

	Hypofunction	Irritative Lesion
Problem Origin	Sensory Neural	Mechanical – otoconia in Semicircular canals
Effect	↓ Nerve Impulse	↑ Nerve Impulse Inappropriately
Location	Peripheral Vestibular Nerve/ Organ (Vestib Neuritis)	Peripheral – Semicircular Canal (BPPV)
Course	Stable or Progressive	Stable (consistent)
Mechanism of Change	Plasticity – utilized to recalibrate the brain Sensory reweighting to get normal postural response	Clear debris from semicircular canal

Prognosis

Unilateral Hypofunction

- Return to almost normal function depending on comorbidities
- Oscillopsia/disequilibrium should greatly resolve
- Encourage normal utilization of movement patterns to prevent decompensation

Timeline

- weeks to months

BPPV

- Resolve symptoms, teach self management and return to prior level of function

Timeline

- Should resolve in Min to days

SPOTLIGHT *Series*

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