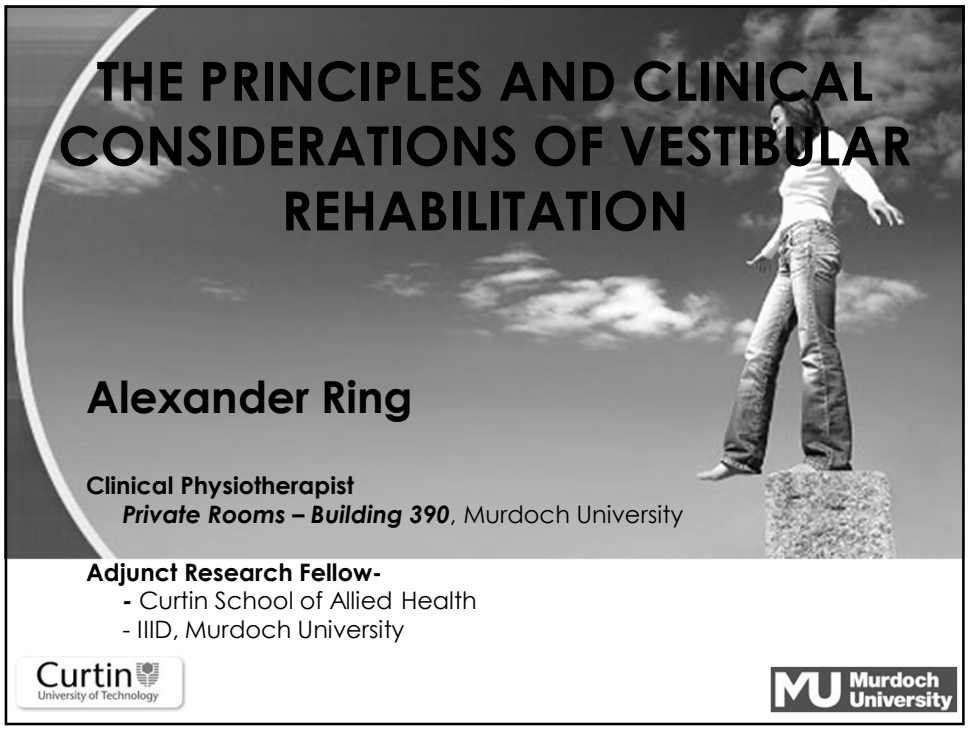

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TOPICS

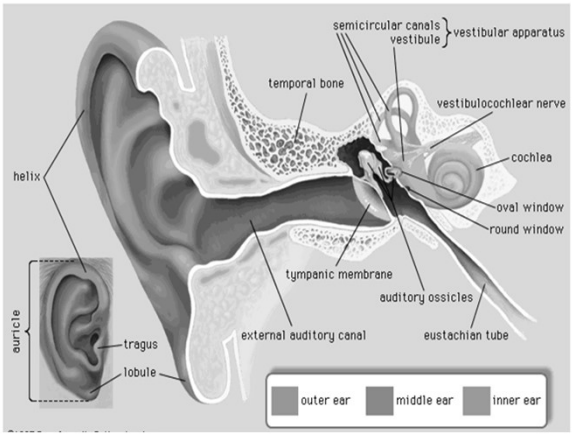
- Review Vestibular Occular Reflex – aka speedometer of the inner ear balance unit
- Driving the plasticity of the Vestibular system
- Mechanisms of recovery of this dysfunctional system
- Vestibular Balance Rehabilitation Therapy (VBRT) theories & goals
- Approach to VBRT Therapy

2

VESTIBULAR SYSTEM COMPONENTS

A functioning Vestibular System consists of:

- Peripheral Vestibular (sensory) Apparatus
- Central Processing Unit
- Motor Output



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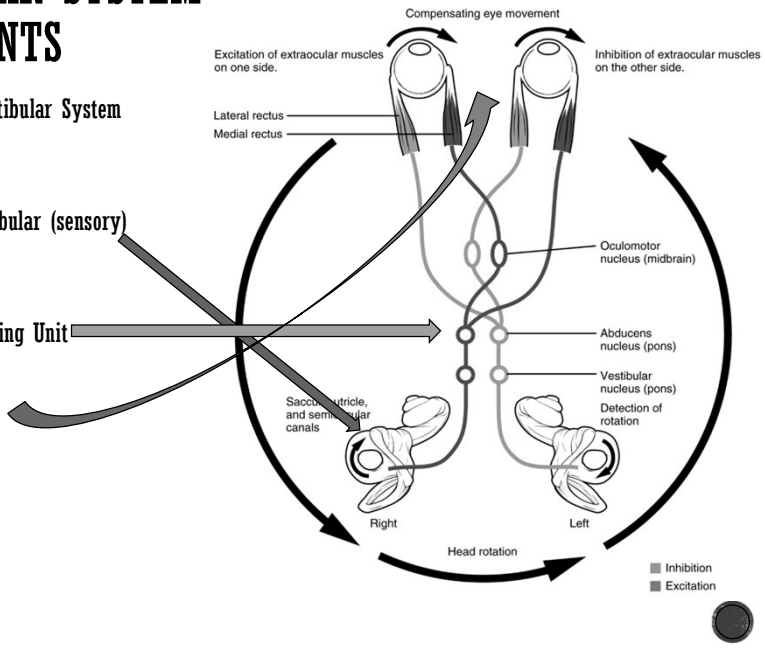

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VESTIBULAR OCULAR REFLEX (VOR)

- Activation of the vestibular system results in compensatory eye movements to maintain gaze stability *(ideally equal & opposite to head movt)*
- *i.e. image remains stable on retina during head movement.*

- When we make a head movement, our eye muscles are triggered instantly to create an eye movement opposite to that of our head movement at the exact same speed to readjust the visual world, which, in turn, stabilizes our retinal image by keeping the eye still in space and focused on an object, despite the head motion

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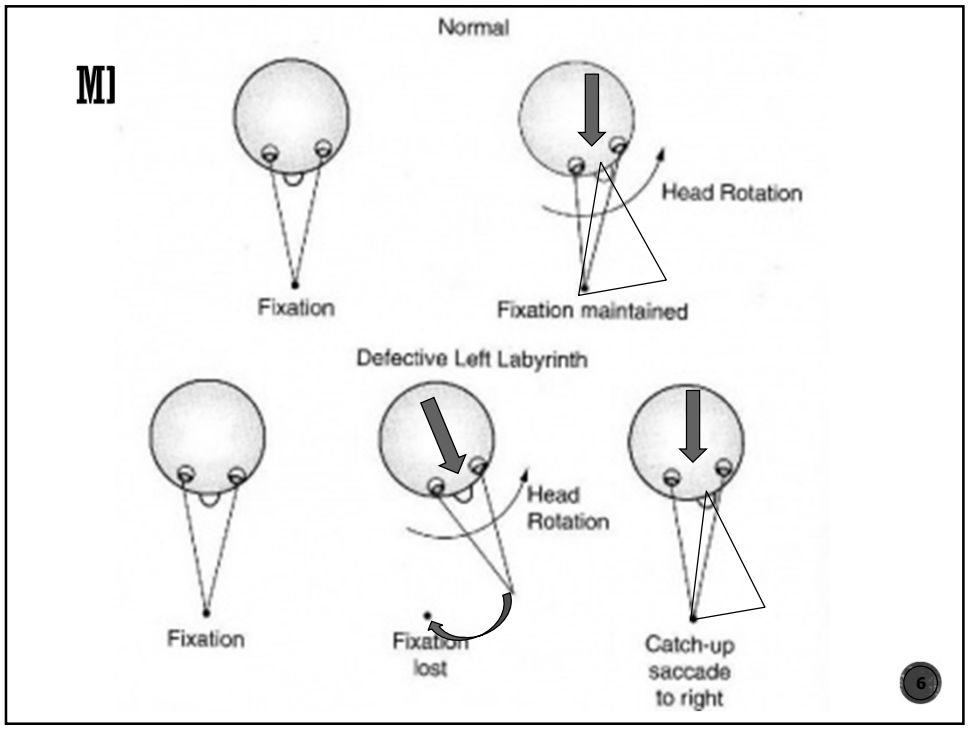

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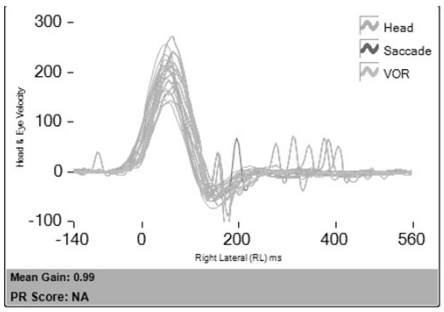
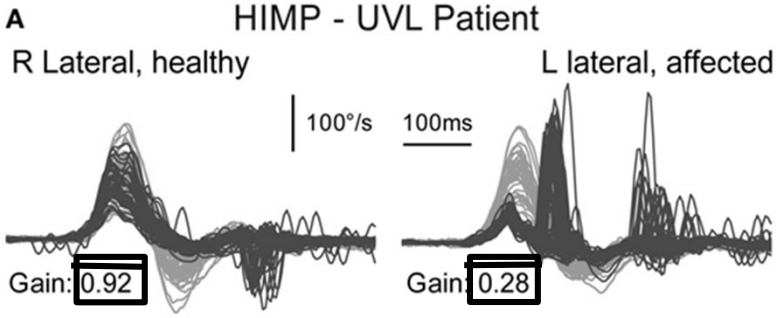
MEASURING GAIN





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VESTIBULAR BALANCE REHABILITATION THERAPY (VBRT)

- An exercise-based treatment approach for individuals with "vestibular system disorders" to assist with the neuroplasticity of **vestibular compensation**
  - Symptom and impairment driven
  - Used in Vestibular and non-vestibular causes

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VBRT IS DRIVEN BY NEUROPLASTICITY

- **Neuroplasticity** **(in the vestibular system)**
  - The ability of the vestibular system to make long term neuronal changes to the input that cause error signals in the brain.

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MECHANISMS OF RECOVERY OF THE VESTIBULAR SYSTEM

- Cellular recovery/ spontaneous recovery
- Adaptation
- Substitution

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THE **WHAT** AND **HOW** OF VESTIBULAR COMPENSATION

Sudden permanent lesion of vestibular function

Static Compensation

- Occurs when tonic symmetry is established between the vestibular nuclei
- Does not require input from the contralateral vestibular nucleus
- Involves the intrinsic property of the neurons
- Neurochemical influences
- Synaptic changes
- Occurs in the absence of visual stimulus

Dynamic Compensation

- Requires head motion
- Requires retinal slip
- Requires exposure to light
- Physio assesses symmetric VOR gains during low velocity head rotations

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VESTIBULAR REHABILITATION –DRIVEN BY COMPENSATION.

- Compensation can be affected by improving the **Gain**
- ***Gain*:** Ratio of the eye movement to the head movement = 1.0
- Retinal image motion must be less than 2° per sec. So for a head velocity of 100° per sec, the gain of the VOR must be 98% accurate, as any greater would cause the vision to be obscured. ***["Retinal slip"]***

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COMPENSATORY MECHANISMS.

- Adaptation
  - changing the gain phase, or direction of the vestibular response
  - Gain: is the ratio of eye movement to head movement amplitude
- Substitution
  - Other sensory mechanism inputs (eg: COR's)
  - Alternative motor responses (eg: saccades)
  - Strategies based on prediction or anticipation

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VBRT: TREATMENT THEORY & GOALS

1. Adaptation
2. Habituation
3. Substitution

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1. ADAPTATION

Definition:

- long term change in the firing rate of the central Vestibular neurons - increase the gain in the remaining vestibular system

Goals:

- to see clearly during head movements
- Stimulus to induce adaptation - retinal slip
- improving postural stability
- decrease symptoms

Indications:

- patients with Unilateral or bilateral vestibular hypofunction, central lesions affecting Vestibular Nucleus

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2. HABITUATION

Definition

Long-term reduction of a response to a noxious stimulus, brought about by repeated exposure to the provocative stimulus

Goals

- Significant reduction in dizziness >50% - 90%
- Minimise risk for falls
- Normal VA during head movement
- Independence in ADLs
- Return to all activities

Indications:

- patients with non-vestibular dizziness, Chronic Vestibulopathies, UV hypofunction.

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2. Habituation: Treatment progression

Ideas for Progression:-

- by increasing speed and range of movements.
- Symptoms should return to baseline before continuing, Wait an additional 30 s prior to proceeding to next repetition
- When a movement can be performed for 2 days without symptoms, remove exercise from list
- Symptom duration/intensity should diminish within 2 - 3 weeks
- • Re-assess after 3 weeks

Eg:

- Cawthorne–Cooksey
- Brandt- Daroff

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3. SUBSTITUTION

Definition:

- Recruitment of an alternate strategy to perform 'task'
- Task – function that was done by now damaged systems

Goals:

- Minimize symptoms with head motion; normal use of sensory inputs for balance; reduce falls and fall risk; return to most normal activities

Indications:

self-reported disequilibrium with head motion/walking,

instability with head motion /while walking,

high risk for falls while walking,

history of falls, patients with UVL, BVL, Central

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3. SUBSTITUTION: MECHANISMS THAT SUBSTITUTE FOR VESTIBULAR LOSS

Strategies for gaze stability

- Modify saccadic eye movements
- Visual tracking (pursuit)
- Decrease head movements
- Cervico-Occular Reflex (COR)
- Central pre-programming
- Substitution visual / somatosensory cues

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VBRT : TREATMENT USED

1. Gaze Stabilization
2. Postural Control
3. Motion Provoked Dizziness

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TREATMENT: 1. GAZE STABILIZATION

1. *Indications*: poor dynamic visual acuity, dizziness or oscillopsia with head motion, restricted activities (e.g., driving, sports)
2. *Basis*: concepts of VOR adaptation and substitution
   1. Head movement while maintaining focus on a target
      • Error signal (retinal slip) drives change
      • Improved VOR gain or use of compensatory eye movements
3. *Goals*:
   1. see clearly with head movements for age
   2. minimize symptoms with head motion
   3. return to ADL

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Gaze Stabilization Exercises

X1 Exercises

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Gaze Stabilization Exercise: progression guide

1. **Duration**
2. **Speed**
3. Position
4. Distance
5. Background complexity
6. Target size and contrast
7. Frequency

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Gaze Stabilization Exercise: X1 sample

X1 Exercises

i. Repetition
   i. (3-5X/day, total of 12-20 minutes/day)
ii. Active head movement
   i. Yaw and Pitch
   ii. Small Amplitude
iii. Patient education important!
   i. Neck soreness
   ii. Increased dizziness initially (might)
iv. Goal oriented and specific

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Gaze Stabilization Exercise: X2 sample

- **X2 VIEWING**
  - May need to reduce other parameters
  - Speed
  - Position
  - Time
  - Background complexity

  Requires motor coordination & practice
  Not all patients will reach this level
  - Older
  - BVH

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Gaze shift & Remembered target

Based on concept of substitution

May facilitate compensatory eye movements

Gaze shift between two targets:

- Eyes and head facing 1st target
- Eyes shift to 2nd target while head remains still
- Head turns to face 2nd target

Remembered target

- Focus on target
- Close eye and imagine you are looking at the target
- Now turn head and attempt to keep eyes on target
- Open eyes after head turn to check for accuracy

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TREATMENT: 2. POSTURAL CONTROL

1. *Indications*: self-report of disequilibrium with head motion/walking, instability with head motion or while walking, high risk for falls while walking, history of falls, restricted activity (e.g., sports, work-related)

2. *Basis*: principles of substitution
   balance and gait exercises

3. *Goals*:
   Minimize symptoms with head motion
   normal use of sensory inputs for balance
   reduce falls and fall risk
   return to most normal activities

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TREATMENT: 2. POSTURAL CONTROL PRINCIPLES OF PLANNING A EXERCISE REGIMEN

(Safety First)

1. Static then Dynamic
   1. Challenging but successful
   2. Observe posture
   3. Consider integrity of other systems Vision, Somatosensory, Vestibular, Musculoskeletal
   4. Consider goals and prior level of function Athlete/ Sports/ Participation Goals

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TREATMENT: 3. MOTION PROVOKED DIZZINESS

1. *Indications*: dizziness or vertigo with position changes; dizziness with busy visual backgrounds

2. *Basis*: concept of habituation

3. *Goals*:
   1. Minimize symptoms with position change

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TREATMENT: 3. MOTION PROVOKED DIZZINESS –PLANNING RX

Evaluate:

1. Positions, movements or activities causing symptoms (noxious)

   1. Motion Sensitivity Test – symptom intensity and duration for 16 position changes
      1. Visually provoked symptoms
   2. Visual Vertigo Analog Scale – symptom intensity for 9 different visual environments

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TREATMENT: 3. MOTION PROVOKED DIZZINESS

- Choose moderately stimulating motions (conditions) (NOT severe)
- Number of repetitions: 3 – 5 for a given motion
- Number of motions: < 4 movements
- Consider volume of additional exercises of home program and other exercises that might cause symptoms
- Frequency: 2-3x/day
- Intensity: exercises should be performed with enough intensity (speed/ROM) to bring on mild- moderate amount of dizziness (5/10 or less)
- Over time increase intensity of movements to bring on same degree of dizziness

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Further Reading:

Clinical Practice Guideline -2016

Hall, C., Herdman, S., Whitney, S., Cass, S., Clendaniel, R., Fife, T., … Woodhouse, S. (2016). Vestibular Rehabilitation for Peripheral Vestibular Hypofunction: An Evidence-Based Clinical Practice Guideline. Journal of Neurologic Physical Therapy, 40(2), 124–155.

Update: An Updated Clinical Practice Guideline From the Academy of Neurologic Physical Therapy of the American Physical Therapy Association. Journal of Neurologic Physical Therapy 46(2):p 118-177, April 2022.

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