

## Vision Therapy With A Vestibular Twist



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## Introduction

- Overview of Vestibular Processing “BRIEF”
- Therapy Considerations
  - Vestibular Rehabilitation
  - Optometric Therapy
- Case Presentations

## Optometric Involvement in Vestibular Processing

- Applebaum, Hillier and Kavar – OT Course- From Eyesight to Insight
- Gillilan, et.al.-See Sick Syndrome (Pacific course)
- Suchoff, Ciuffreda, Kapoor-Visual and Vestibular Consequences of Acquired Brain Injury
- Yolton-Conflict and other causes of dizziness (PUCO course online)

## OTHERS

- Vision and Balance – The OD’s role in Managing Patients with dizziness and vestib. dysfunction. JBO 19(4) 2008 p.97-102.
- Vestibular Function, SI and Balance Anomalies: A Brief Literature Review. OVD 38(1)2007 13-7
- Ocular Fixation, Vestibular Dysfunction and Visual Motion Hypersensitivity. Optometry 80, 2009 p. 502-12.

## Simply the Size of a Fingernail

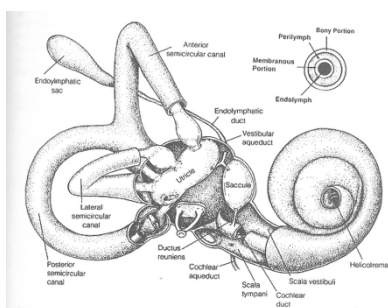


FIGURE 1-3. The membranous and bony labyrinths. The inset illustrates the perilymphatic and endolymphatic fluid compartments. Majority of the illustration by Mary Dorris from Fowler, 1992, with permission from Lippincott-Raven.<sup>2</sup>

## Skeffington Model of Vision “Four Circles”

- Centering
- Identification
- Speech Auditory
- Anti-Gravity



## What is Anti – Gravity ?

## What Mechanism Keeps the Infants Eyes Straight at Birth ?

Sensory...Motor...Combo ?

## Models of Strabismus and Binocularity

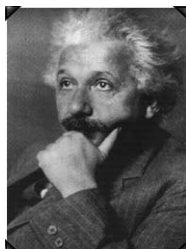
- Sensory Fusion – Worth
- Mechanical / Muscular – Scobee, Nordlow
- Accommodation – Donders, Rethy
- Neurological
  - Paresis – Snellen
  - Vergence – Parinaud, Adler
  - Version – Bielschowsky
  - Vestibular – Doden, Zeeman, Keiner



## Reflexogenic Theory Zeeman and Keiner

- Monocular duction reflex grafted upon the proprioceptive reflex pathway
- Binocular reflex grafted upon the vestibular pathway
- Convergence pathway grafted upon proprioceptive reflex pathway

“The world we create as a result of the level of thinking we have done this far, creates problems that cannot be solved at the same level in which we created them.



## Principles of Brain Processing and Visual Development

- Reciprocal Interweaving
- Bilateral Processing
- Automaticity
- Cumulative Burden / Capacity Limits

## Reciprocal Interweaving

- Motor
  - Roll, sit, crawl, creep, walk, etc.
- Visual Skills
  - EOM, Accommodation, Binocular
- Space World
  - Vestibular, Somatosensory, Auditory and Visual

## Reciprocal Interweaving

- Four Circles – Emergent is Vision
- OEP Analytical Findings
- VT Activities and ADL's
- Others
- Combinations of All ?

## Can Visual Localization improve with Proprioceptive Input ?

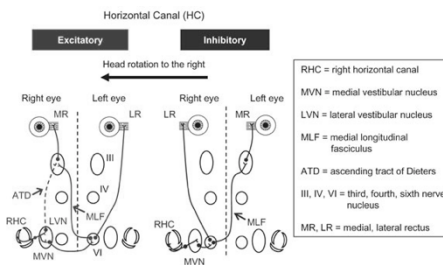
## Bilaterality

- Visual input
- Proprioceptive / Kinesthetic input
- Vestibular input
- Other
- Integration / Timing – Cerebellum ?

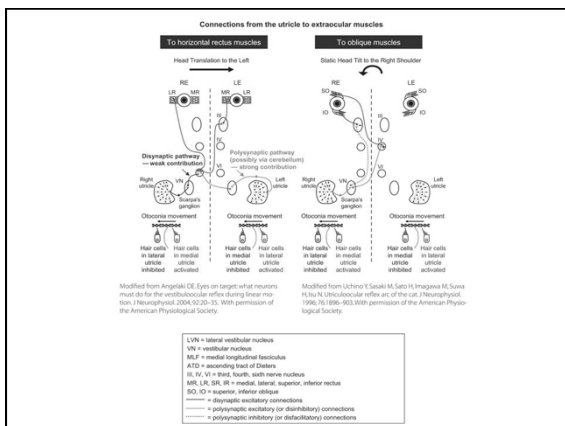
## Bilateral Motor Input

- Trampoline
- Balance Board, Walking Rail
- Pull up bar
- Pepper Shoulder Thrust
- Blowing, Sucking
- Wii Applications

## Bilateral Vestibular Input



Redrawn from Ito M, Nishimaru N, Yamamoto M. Pathways for the vestibulo-ocular reflex excitation arising from semicircular canals of rabbits. *Exp Brain Res*. 1976;24:257-71. With permission of Springer Science and Business Media and the authors.



**What is the first sensory system that is fully developed at birth?**

**Automaticity**

**Cumulative Burden and/or Capacity Limit of Information Processing**

**Principles of Brain Processing and Visual Development**

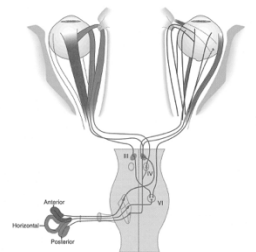
- Reciprocal Interweaving
- Bilateral Processing
- Automaticity – Balance ?
- Cumulative Burden / Capacity Limits

**Vestibular Processing and Development**

## FUN FACTS

- First fully myelinated system (at birth !)
- Position of SC canals aligned with planes of EOM and each directly connected neurologically
- Gain of VOR at birth is 1.0, adult is 0.6
- Developmental changes in postural control
- Developmental changes in smooth gaze

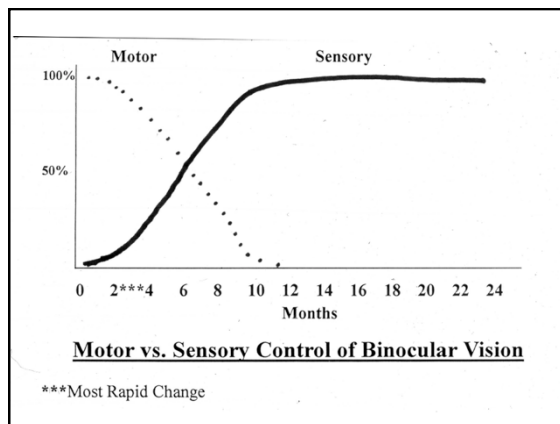
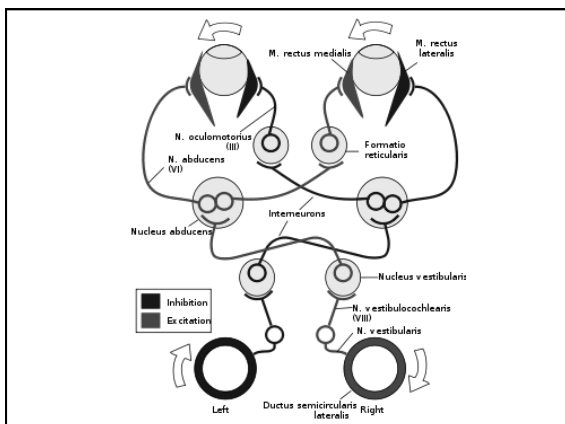
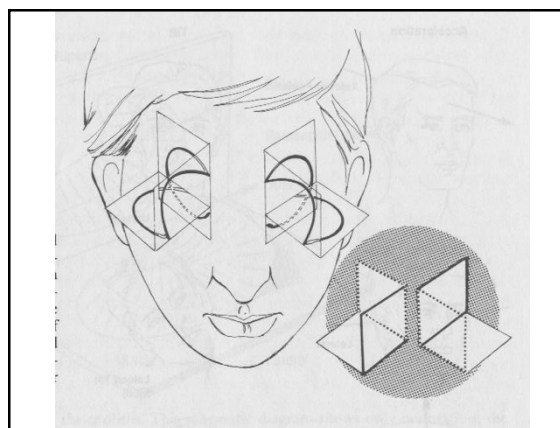
## SC Canals input to EOM



Movement of the eye	Canal stimulated	Net response to stimulation	End response to stimulation	Muscles activated	Movement of the eye
Face into earth	Anterior	Superior	Rightward tilt	Left lateral rectus/medial oblique	Up
Face turns right w/ tilt	Horizontal	Medial	Ch II, VI	Right lateral rectus/contralateral medial oblique	Horizontal
Face tilt up	Posterior	Medial	Ch II, IV	Right lateral rectus/oblique	Down

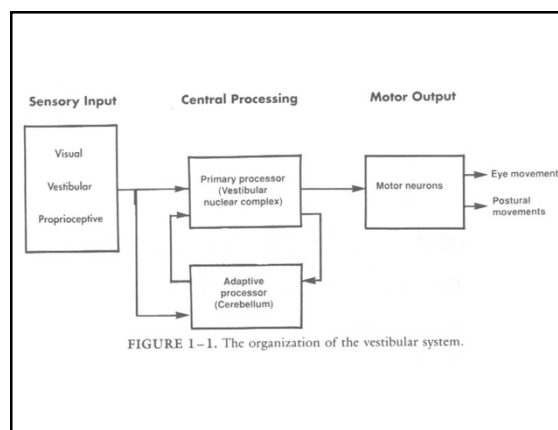
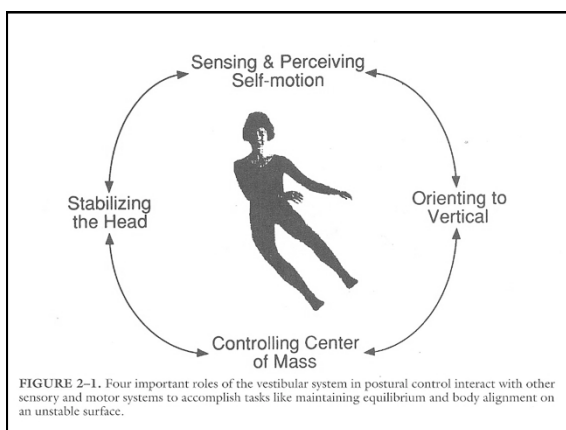
## SC Canal Paths to EOM's

FACE	CANAL	EOM	EYES
Down	Anterior	ipsi SR contra IO	Up
R or L	Horizontal	ipsi MR contra IO	Horizontal
Up	Posterior	ipsi SO contra IR	Down



**What effects do lenses  
and prisms  
have upon vestibular  
processing ?  
( ie - VOR )**

## **Vestibular Processing General Functions**

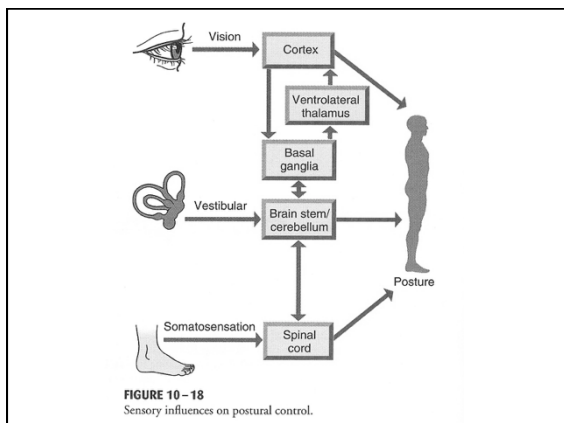


### **Specific Vestibular Functions**

- Extensor tone
- Cocontraction
- Equilibrium responses
- Gravitational security
- \*Bilateral coordination
- \*Eye movements
- \*Stability for visual information processing

## **BALANCE**

- Visual
- Vestibular
- Somatosensory
- Integration



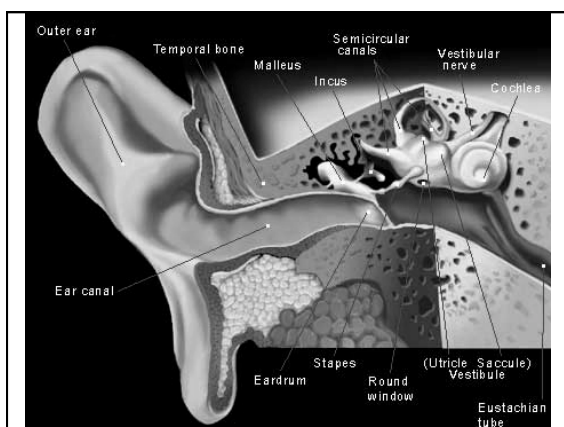
## Vestibular Considerations in OT

“In sensory integrative therapy, vestibular stimulation is used to either quiet, stimulate or organize a child’s activity level.” -Jean Ayres

**What do you use in your therapy room to quiet, stimulate or organize your patient’s activity level ?**

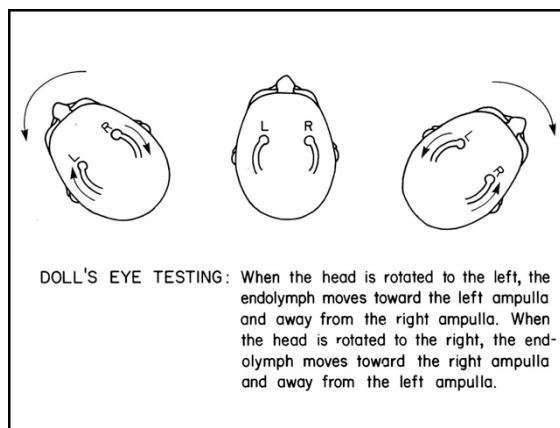
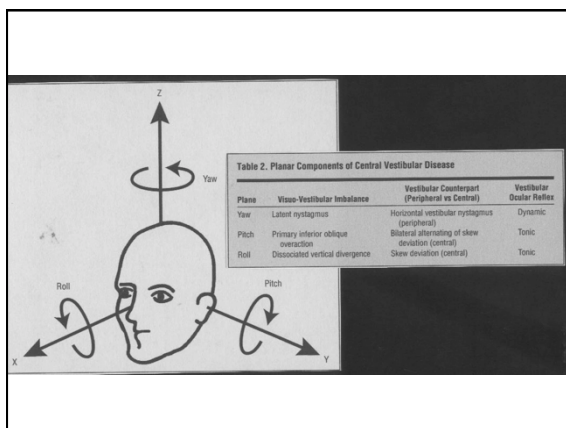
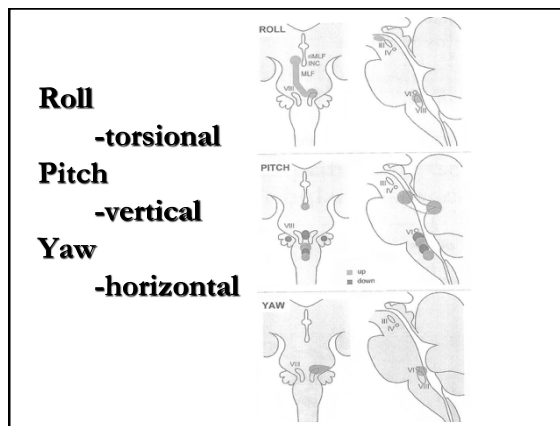
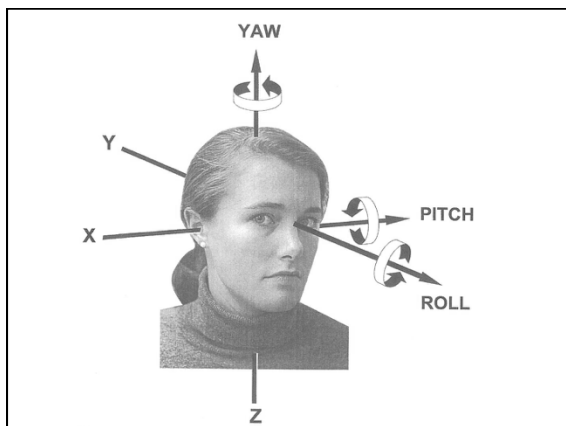
## Peripheral Vestibular System

- Auditory Processing
- Otolith organs-linear acceleration
  - Utricle -horizontal
  - Saccule - vertical
- Semicircular canals-angular acceleration
  - Anterior
  - Posterior
  - Horizontal

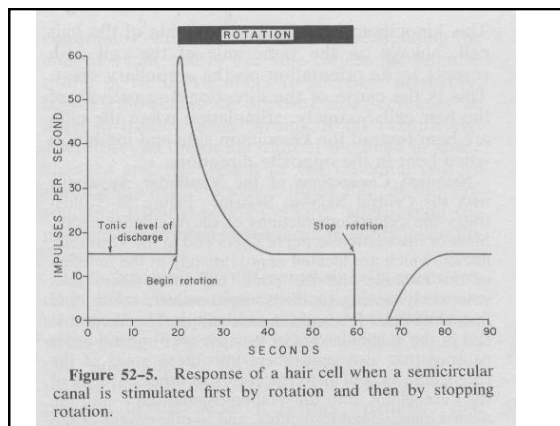
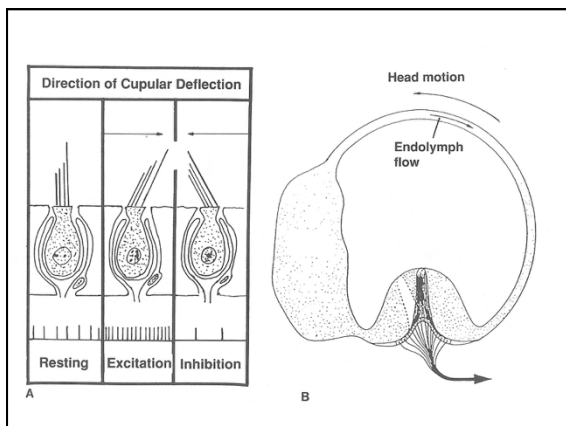


## Semicircular Canal Stimulation

- Shaking head up and down
- Shaking head horizontally
- Rotational
- Temperature – COWS mnemonic
- Excitatory and Inhibitory
- Neural integrator

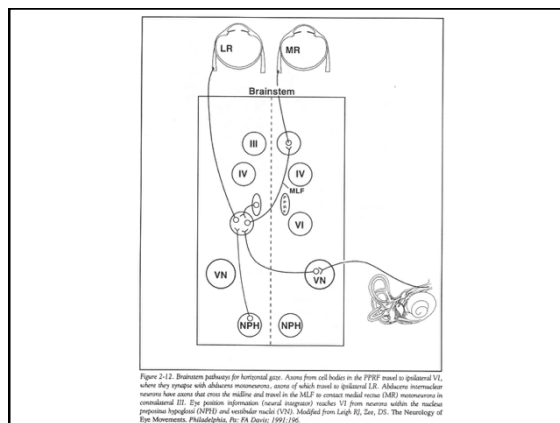
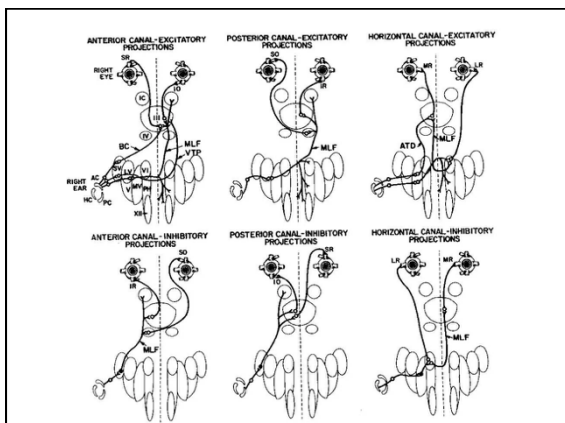


**DOLL'S EYE TESTING:** When the head is rotated to the left, the endolymph moves toward the left ampulla and away from the right ampulla. When the head is rotated to the right, the endolymph moves toward the right ampulla and away from the left ampulla.



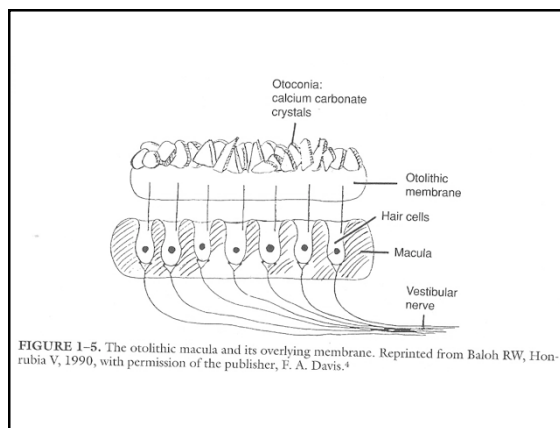
**Figure 52-5.** Response of a hair cell when a semicircular canal is stimulated first by rotation and then by stopping rotation.





## Otoliths

- Linear acceleration and gravity detection
- Saccule-vertical linear movement
- Utricle-horizontal linear movement
- Stimulate in plane of regard (walk, jump)
- Can you stimulate otoliths without semi-circular canal involvement ?



## Otoliths register linear acceleration and static tilt

## Central Vestibular System

- Vestibular nuclei
  - 4 major, >7 minor
- Cerebellum
  - Modulator
- Neural Integrator
  - Horizontal EOM is NPH, the Nucleus Prepositus Hypoglossi

## **Vestibular Reflexes**

- \*Vestibular-Ocular Reflex
- Vestibulospinal Reflex
- Vestibulocollic Reflex

## **Cervical Reflexes**

- \*Cervico-Ocular Reflex
- Cervicospinal Reflex
- Cervicocollic Reflex
- Visual-Vestibular-Cervical Triad

## **Other Brain Systems Implicated in Vestibular Processing**

- Reticular Activating System
- Limbic System
- Basal Ganglia
- Cerebellum
- Others

**Vestibular processing is intricate  
in most everything we do,  
this is quite similar to vision.**

## **Vestibular Testing**

- \*Subjective Complaints, Observations
- \*Doll's Eye
- \*Dynamic VA – 2Hz, criteria 3 lines or >
- \*Head Thrust – fixates far, shifts head laterally, refixation ?
- Head Shaking Nystagmus – down 30deg, 20X R/L, jerk nystagmus ? Closed eyes ?
- SC Post Rotary Nystagmus Test

## **Vestibular Dysfunction**

**Developmental  
vs.  
Later Onset**

## **Vestibular Dysfunction**

- Hyporegistration
- Hyperregistration

## **Factors leading to poor vestibular development and control**

- Ear infection / Effusion
- Developmental Disabilities
- Drug / Alcohol
- Medication toxicity
- \*Lack of Movement

## **Neuro-Otological Perspective**

- Dizziness, Vertigo
- Inner concussion syndrome
- Benign paroxysmal positional vertigo – BPPV
- Perilymph fistula
- Secondary hydrops
- Vestibular neuritis / labyrinthitis
- Ototoxicity
- Autoimmune mediated vestibulopathy
- Meniere's Disease

## **Treatment Options**

- Deny Existence
- Medical Treatment
- Optometric Considerations
  - Optical Considerations
  - Compensatory Strategies
  - Optometric Therapy

## **Medical Treatment**

- Otitis media and effusion\*
- Spontaneous recovery
- Vestibular adaptation
- Substitution
- Habituation
- Medication and Surgery

## **Optometric Treatment**

- Optical
- Compensatory Strategies
- Vision Therapy

## **Optical Considerations**

- Part vs. full time
- Single vs. multiple pairs
  - Complexity of Rx, Progressive lenses
- Size of frame
- Base curves
- Pupillary distance
- Effects of low plus, low base in

## **Compensatory Strategies**

- Head vs. eye movement
- Blinking
- Somatosensory feedback
- Reduce environment

## **Optometric Therapy**

- Basic Visual Skills
- Motor Skills
- Visual Information Processing
- Syntonics
- Reflex Therapy
- \*Visual-Vestibular Therapy
- Others

## **Basis of Vestibular Activities**

- Multidisciplinary approach
- Vestibular, Somatosensory, Visual and Auditory processing
- Automaticity, Cumulative Burden
- Feedback from patient
- Observations of patient

## **Vestibular-Cervical Activities**

- Tone and stability of neck
- Inhibition of head movement
- Dynamic head movement

## **Vestibular Activity Protocols**